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Technical English for Engineering

A Course For Master Students

«For Internal Use Only»

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PREFACE

"***Technical English for Engineering***" course has been prepared for those students who are preparing their master degree and who are learning English as a foreign language to relate their reading in English to topics relevant to their future careers. The course concentrates on the core everyday technical language used across four subjects, namely: process engineering, materials science, environmental science and science and technology of medicine.

The aim of this course is to develop in students an ability to handle the kind of written technical English that they will be concerned with as an integral part of their specialist subjects of interest. In addition, it presents and practices spoken English and practical everyday communication in the field of engineering. This course is not intended to be a basic English course, and should be used in conjunction with any good general English course. It also does not intend to teach grammar, but rather a good basic English grammar level is a prerequisite to use it. In preparing this course, the focus was made on improving students' vocabulary and communicating skills in their fields by selecting basic specialized topics in each specialty. It is, therefore, understood that the course requires the basics of specialized technical knowledge on the part of either the students or the teacher.

The course is organized into four chapters; each of them involves five units in the field of interest. All units are intended to develop in students the confidence and ability in extracting information from technical manuals and textbooks in a wide range of technical areas end to equip learners with the linguistic skills and specialist vocabulary necessary to understand daily situations in a work environment.

Each unit begins with a reading comprehension section that includes a reading text to study interactively with the students during the lecture that focuses on relevant vocabulary that is presented and practiced in professional contexts. This is then followed by a word study (vocabulary) exercise to ensure a deep understanding of the basic vocabulary of the topic discussed in the unit that is then followed by questions on the text. The unit also encompasses sets of comprehension checks in the form of statements so that to force the students to read more attentively for meaning and to treat his reading not simply as a language exercise relevant only to the English class, but as a technique for acquiring information which will be useful in a wider field of study. The contextual reference section draws the learner's attention to the way pronouns and demonstratives are used to refer to something already mentioned and so serve to relate one statement to another. The rephrasing section teaches the learners how different expressions may refer to the same thing; it also offers a good way to learn synonyms. After these sections, the students transit to practice and application activities that link core vocabulary with related terms and phrases through grammar and vocabulary section. At the end a guided writing section is included in some units. The objective of this section is to offer to the students a way of integrating all what he has learned in a single piece of writing.

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Chapter 1

ENGLISH FOR PROCESS ENGINEERING

Unit 1 Corrosion

(1) Corrosion is the name given to the process by which metals deteriorate in the presence of moisture. We consider metals to be long lasting and stable materials, but they are not really so, and will be quickly levelled by corrosion unless properly protected. Pure metals seldom occur in nature, and corrosion is the electrochemical process by which nature reduces them to their stable oxide or other compound form in which we find ores.

(2) As you know, electric current flows in two ways. Primarily, it flows within a metal when the electrons of that metal move in response to an electrical pressure or voltage. Metal atoms characteristically exchange their electrons readily and these move freely without affecting the atoms themselves. Therefore, in this type of electric current flow the basic structure of the metal is undamaged.

(3) There is, however, another form of electric current flow in which the structure of the metal is so radically altered that we say corrosion has taken place. This occurs when an electric current leaves its metal path or circuit and flows into a liquid. The medium by which an electric current flows in a liquid is by the actual movement, rather than just electrons, and this is primarily accomplished by the movement of metal atoms. Corrosion occurs as these atoms break away from the metal surface and flow into the liquid in response to the electrical pressure. The amount and duration of the corrosion is proportional to the amount and duration of electric current flow.

(4) For example, if you bury a piece of iron in the ground where it is in contact with soil moisture (a current carrying liquid) and permit one ampere of current to flow out of the iron for one year, you will find that approximately twenty pounds of the iron will be lost through corrosion. If you bury a piece of lead, such as an electric cable, the same one ampere of current flow will destroy about 75 pounds per year. This electric current which causes corrosion is a direct current that flows quite readily and does so primarily from natural causes.

(5) Figure 1 illustrates this corrosion process, which is known as electrolysis. Note the necessary components of the corrosion cell. There must be a complete electric circuit composed of an external metal conductor and an internal electrolyte, and there must be a source of electrical potential to cause a current to flow. If either of these components is missing, corrosion will not occur and it is on this that we base corrosion prevention.

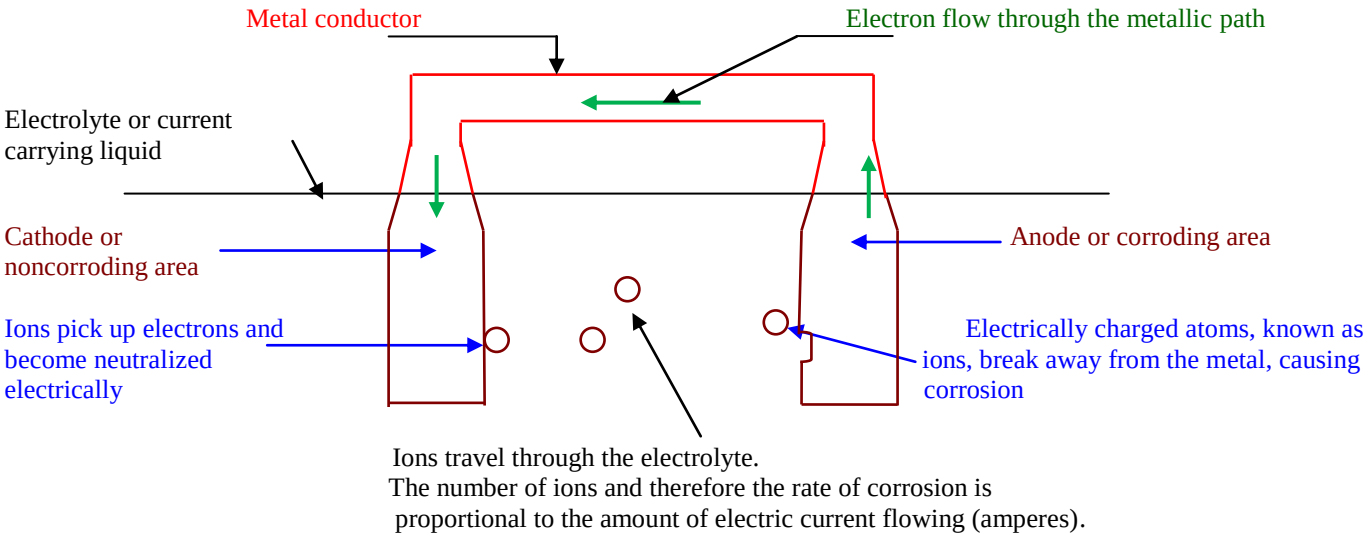


Figure 1: The Basic Corrosion Cell.

(6) Anode and cathode are merely arbitrary designations for areas on the metal surface that have an electrical potential difference (voltage) between them so that a current can flow in the direction indicated. They may be microscopically close together on the same surface area, or miles apart on different parts of a pipeline system which is electrically interconnected. Any number of corrosion cells may operate on the same piece of metal, each with its own anode and cathode.

(7) Any metal will suffice to support this corrosion cell, and practically any aqueous liquid, whether acid or basic. Being electrical in nature, it operates according to Ohm's law; that is, the amount of current flowing and hence corrosion decreases as the resistance of the circuit increases, and it increases as the potential difference between the anode and cathode increases. You can thus expect the amount of corrosion to be proportional to how good an electrolyte you have and to how much resistance you have in the external metal circuit. Of course, if you break the circuit at any point, you will not have corrosion.

(8) There are chemical reactions which take place in the electrolyte as a part of this corrosion cell. These are usually complete and are not shown here because they are not necessary to this basic illustration. However, thy affect the force and duration of corrosion activity by affecting the electrical balance. The metal ions themselves seldom reach the cathode, as they enter into this chemical reaction in the electrolyte. The formation of rust (usually ferric or ferrous oxide) when iron corrodes is due to such a chemical reaction.

(9) The potential difference between the anode and cathode can come from several sources. Almost any chemical or physical difference between the anode and cathode areas will cause a natural potential difference, whether the difference is in the electrolyte or the metal. Such common differences which cause potentials sufficient to support substantial corrosion are different metals (copper and iron coupled will have a potential difference of approximately 0.6, for example), impurities in the metal, different metal surface conditions, different concentrations of chemicals within the electrolyte (especially oxygen concentration), and temperature differentials. Any direct electric current, such as stray currents from improperly grounded D.C. motors or generators, will support corrosion; and so, usually, will alternating current. Because of the large voltages and amperages usually involved, stray currents can cause unbelievably extensive and rapid corrosion.

(10) It is important to remember that this corrosion process is universal for all metals. Cast iron, steel, copper, lead, concrete, reinforcing steel, stainless steels, exotic metals all will corrode given a favourable environment. For the common metals, such as cast iron and structural steel, most environments are corrosive, and it is always necessary to consider protection against corrosion when using them. Fortunately, such protection is readily available and at low cost.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(n.)**, a metal in the form in which it is found in nature.
2. _____ : **(adv.)**, in a complete or basic manner; thoroughly; fundamentally.
3. _____ : **(n.)**, a route along which something moves or travels.
4. _____ : **(adj.)**, made different in some particular way, as in size, style, or the like; modify.
5. _____ : **(v.)**, disintegrate or wear away.
6. _____ : **(adv.)**, promptly; quickly; easily.
7. _____ : **(v.)**, to escape.
8. _____ : **(v.)**, to put in the ground and cover with earth.

9. _____ : **(adj.)**, by chance, without plan.
10. _____ : **(v.)**, to be enough or adequate.
11. _____ : **(v.)**, to interrupt.
12. _____ : **(adj.)**, connected to one another.
13. _____ : **(adj.)**, deviated from the direct course; left the proper place.
14. _____ : **(adj.)**, two things combined or connected.
15. _____ : **(adj.)**, connected to the earth or some other conducting body, especially electrical circuits or equipment.

II - Main Ideas

In order to read effectively, it is essential to constantly keep in mind the main points the author is making. As you read the passage determine the main idea or point of each paragraph.

1. The main idea of paragraph **(1)** is:
   - **a.** metals are not really long lasting and stable.
   - **b.** a definition of corrosion.
   - **c.** pure metals seldom occur in nature.
2. The main idea of paragraph **(2)** is:
   - **a.** electric current flows in two ways.
   - **b.** a definition of one type of current flow.
   - **c.** the basic structure of the metal is undamaged by current flow.
3. The main idea of paragraph **(3)** is:
   - **a.** there is another type of current flow.
   - **b.** the current flows in a liquid by actual movement of the atoms.
   - **c.** a definition of the second type of current flow.
4. The main idea of paragraph **(4)** is:
   - **a.** the electric current which causes corrosion is direct current.
   - **b.** to give an example of corrosion.
   - **c.** soil moisture is a current carrying liquid.
5. The main idea of paragraph **(5)** is:
   - **a.** to describe the diagram.
   - **b.** to describe the corrosion cell.
   - **c.** to define electrolysis.
6. The main idea of paragraph **(6)** is:
   - **a.** anode and cathode have potential difference between them.
   - **b.** anode and cathode are arbitrary designations.
   - **c.** a description of the anode and cathode.
7. The main idea of paragraph **(7)** is:
   - **a.** a description of the metal surface.
   - **b.** a description of Ohm’s law.
   - **c.** an application of Ohm’s law to corrosion.
8. The main idea of paragraph **(8)** is:
   - **a.** a description of rust.
   - **b.** the chemical reactions in the electrolyte are complex.
   - **c.** a description of the composition and operation.
9. The main idea of paragraph **(9)** is:
   - **a.** stray currents can cause extensive corrosion.
   - **b.** different metals cause a potential difference.
   - **c.** the sources of potential differences.

10. The main idea of paragraph **(10)** is:

- **a.** all metals corrode.
- **b.** most environments are corrosive.
- **c.** protection against corrosion is available and cheap.

III - Understanding the Passage

3.1 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

- **a.** _____ There are more than two types of current flow.
- **b.** _____ Incomplete corrosion cell can produce corrosion.
- **c.** _____ The anode and cathode of a corrosion cell may exist on the same piece of metal.
- **d.** _____ All refined metals corrode.
- **e.** _____ As the potential difference increases, the rate of corrosion increases.
- **f.** _____ A complete corrosion cell must have external source of current such as stray currents from motors.

3.2 Implicit Information

Indicate by true or false those statements which can be inferred from the information in the passage. A statement may be true but not supported by information in the passage.

- **a.** _____ Most metals are used in a refined form.
- **b.** _____ Electron exchange within a metal does not cause corrosion.
- **c.** _____ An acid solution is a better electrolyte than a basic solution.
- **d.** _____ Corrosion prevention is a process of destroying the corrosion cell.
- **e.** _____ It is easy to predict how much corrosion will take place if the metal and the voltage are known.
- **f.** _____ A potential difference will cause a current to flow, assuming a current carrying medium is present.
- **g.** _____ Any time metal is used as a construction material, corrosion must be considered.

3.3 Contextual Reference

In order to avoid repeating a word an author uses pronouns and phrases to replace the original word. An understanding of these reference techniques is essential to effective reading. Answer the following questions about the referents in this paragraph.

(1) There are chemical reactions which take place in the electrolyte as a part of this corrosion cell. **(2)** **These** are usually complex and are not shown here because they are not necessary to **this basic illustration**. **(3)** However, **they** affect the force and duration of corrosion activity by affecting the electrical balance. **(4)** The metal ions themselves seldom reach the cathode, as **they** enter into this chemical reaction in the electrolyte. **(5)** The formation of rust (usually ferric or ferrous oxide) when iron corrodes is due to **such a chemical reaction**.

- **a.** In sentence **(2)** what are "these"? _____
- **b.** In sentence **(2)** what is "this basic illustration"? _____
- **c.** In sentence **(3)** what is "they"? _____
- **d.** In sentence **(4)** what is "they"? _____
- **e.** In sentence **(5)** what is "such a chemical reaction"? _____

3.4 Special Technical Vocabulary

Without looking back to the text, use a word or phrase from the box below to complete the second sentence in each group. The meaning of the completed sentence should be essentially the same as the first one.

proportional to - suffice - whether or - characteristically - in response

a. Electrical pressure or voltage causes the electrons of a particular metal to move.
The electrons move _____ an electrical pressure or voltage.

b. Metal atoms exchange their electrons readily. This is a well-known characteristic of metal atoms.
Metal atoms _____ exchange their electrons readily.

c. As the amount and duration of the electric current flow increases, the amount and duration of the corrosion increases.

The amount and duration of the corrosion is _____ the amount and duration of the electric current flow.

d. Any metal is able to support this corrosion cell.
Any metal will _____ to support this corrosion cell.

e. Almost any chemical or physical difference between the anode and cathode areas will cause a natural potential difference. It makes no difference if the potential difference is in the electrolyte or the metal.

Almost any chemical or physical difference between the anode and cathode areas will cause a natural potential difference _____ the difference is in the electrolyte _____ the metal.

3.5 Cohesion

Without looking back to the original text, complete the following paragraph with the connectors from the box below.

since - of course - hence - whether - and - thus - that is

Any metal will suffice to support this corrosion cell, _____ practically any aqueous liquid, _____ acid or basic. _____ it is electrical in nature, it operates according to Ohm's law _____ , the amount of current flowing and _____ corrosion decreases as the resistance of the circuit increases, and it increases as the potential difference between the anode and the cathode increases. You can _____ expect the amount of corrosion to be proportional to how good an electrolyte you have and to how much resistance you have in the external metal circuit. _____ if you break the circuit at any point, you will not have corrosion.

B) Grammar: Infinitive Patterns (Part-1)

In technical English there are six pattens employing infinitives which are very common. The use of these patterns enables us to combine sentences or to change the emphasis in a sentence by changing the word order. An understanding of these patterns will help you to understand some of the long, complicated sentences which appear in technical prose. They will also help you to write concise clear sentences.

Patterns # 1 **NP + to be + inf. + X**

NP = noun phrase **inf. =** infinitive **X**= any additional sentence elements

Examples:

1. The objective of the course is to learn English.
2. The purpose of dehydration is to remove H_2O from the gas.

❖ The following **nouns** are often found in the NP of this pattern:

function - objective - approach - purpose - procedure - effect
method - problem - way - technique - result

Exercise:
Rewrite the following sentences using the above pattern and identify the parts of the sentence. Remember that each of the new sentences will use one of the words from the above list.

Examples:

1. Stopping the current flow is the result of protecting either the anode or the cathode.
2. The effect of protecting either the anode or cathode is to stop the current flow.

❖ Note in sentence 2 how "the effect" is emphasized by occurring at the beginning of the sentence.

a. The electrolyte provides a path for the ions. This is its function in the corrosion cell.

_____

b. An increase in the rate of corrosion may be the result of any direct electric current such as stray current from improperly grounded D.C. motors.

_____

c. Using dissimilar metals causes a potential difference.

_____

d. The stopping of the flow of current is the function of any method of corrosion prevention.

_____

e. Using plastic removes on element of the corrosion cell. This is its function.

_____

Patterns # 2 **NP + to be + adj. + inf. + X**

NP = noun phrase **inf. =** infinitive **X**= any additional sentence elements

Examples:

1. It is easy to learn English.
2. Coating is essential to protect certain pipe systems.

❖ Note that the noun phrase is often **"it"** but not always.

❖ The following **adjectives** are often found in this pattern:

important - necessary - likely - difficult – sufficient - impossible
easy - adequate - possible - essential

Exercise:
Rewrite the following sentences using the above pattern and identify the parts of the sentence. Remember that each of the new sentences will use one of the words from the above list.

Examples:

1. We must remember that passive films are corrosion resistant only in certain environments.
2. It is important to remember that passive films are corrosion resistant only in certain environments.

a. Breaking the corrosion cell is essential in every case.

b. An increase in the rate of corrosion is the likely result of more oxygen in the electrolyte.

c. The universality of corrosion must be remembered. This is essential.

d. D.C. motors must be grounded. This is necessary.

e. Controlling corrosion in a moist climate is difficult.

Patterns # 3 **NP + V. + NP + inf. + X**

NP = noun phrase **V.** = verb **inf. =** infinitive **X**= any additional sentence elements

Examples:

1. I cannot permit you to go now.
2. The electrolyte allows the electrons to travel from the anode to the cathode.

❖ The following **verbs** are often used in this pattern:

to allow - to enable - to cause - to permit - to provide - to expect

Exercise:
Rewrite the following sentences using the above pattern and identify the parts of the sentence. Remember that each of the new sentences will use one of the words from the above list.

Examples:

1. The rate of corrosion will increase if the amount of electric current increases.
2. An increase in the amount of electric current flow will cause the rate of corrosion to increase.

a. The electrons are stable to leave the anode. The electrolyte allows this to happen.

b. Corrosion of the anode is caused by the flow of electrons away from it.

c. An increase in the rate of corrosion is caused by a greater potential difference.

d. We are able to stop corrosion by breaking the corrosion cell.

e. The metal can remain undamaged if the flow of electrons takes place within the metal.

A Review Exercise:
Identify the parts of the sentences below then indicate the pattern (1,2 or3) of each one.

Example:

NP to be inf. X
A basic approach to understanding crystals is to understand the relationship between a crystal and its component parts. ⟶ Pattern 1

a. One method for studying crystals is to organize all that is known about the atoms, ions, or molecules that are present in the crystal.

b. Then it is possible to determine how the properties of these components would affect the properties of the crystal.

c. Another method requires us to first examine the crystal and to then imagine the atoms, ions or molecules.

d. Both methods permit us to understand the basic structure of the crystal.

e. In the laboratory, however, the most common method is likely to be a combination of the two.

C) Process Description

1. **Read the extract and discuss it with your teacher**.

The dry form of the Leclanché cell, which has an e.f.m. of 1.5 V, is the primary cell most commonly used today. The positive pole consists of carbon rod surrounded by a mixture of carbon powder and manganese dioxide. This mixture acts as the depolariser, i.e. a mixture of substances that prevent polarisation and the consequential reduction in potential difference (p.d.). At the top of the carbon rod is a brass cap, which acts as the positive terminal. The carbon rod and the mixture of carbon powder and

manganese dioxide which are contained in a porous gauze bag, are placed in a zinc container, and the space between the bag and the container is filled with the electrolyte, which consists of paste of ammonium chloride and zinc chloride. The zinc container acts as the negative pole. The top of the cell is closed with a sealing compound.

2. Now complete the letters with the names of the parts and answer the following question.

a. The Leclanché cell _____ (measurement).

b. The positive pole _____ (structure).

c. The mixture of carbon powder and manganese dioxide _____ (location).

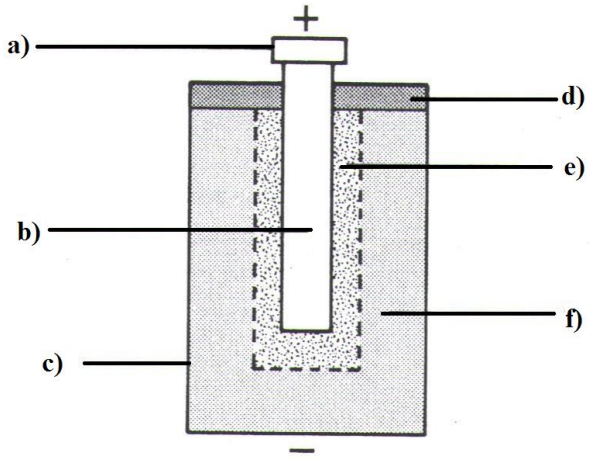
d. The mixture of carbon powder and manganese dioxide _____ (function).

e. The brass cap _____ (location).

f. The brass cap _____ (function).

g. The depolariser and the carbon rod _____ (location).

h. The zinc container _____ (function).



Unit 2 Corrosion Prevention

(1) Corrosion may be prevented or mitigated readily. All methods have one basic feature in common, that is, they act to stop or divert the flow of electric current which causes corrosion.

(2) This corrosion can be stopped in many ways. A very common one is to put a non-conductive coating on the metal, such as, plastic, coal tar or paint. This serves to break the electric circuit necessary to the corrosion process. The trouble with this method is that good coatings are expensive and there is no coating which is 100% effective in practice. Corrosion current will escape wherever breaks occur in the coating, even microscopic ones, and accelerated pitting often occurs because of the concentration of current flow at these breaks. However, when properly applied and maintained, coatings can be very effective.

(3) Another type of coating serves to provide a passive chemical film at the metal surface. By passive we mean that the film is chemically stable in the given electrolyte and will not permit an electric current to flow through it. Examples are cement coatings on iron which provide a highly alkaline environment in which iron is usually passive, and anodizing of aluminum which provides an aluminum oxide film which is passive in normal atmosphere. Stainless steel and many other metals automatically provide their own passive film to protect them selves against corrosion in many environments.

(4) In the case of stainless steel a tough, thin, invisible oxide film forms from the initial corrosion action when the steel is first introduced to moisture. This chemical film is normally impervious to further corrosion, and will repair itself when scratched or otherwise damage. However, the introduction of an unfavourable environment, such as adding chloride ions (free chlorine) to the moisture in contact with the surface of the stainless steel, will break down this film and corrosion will ensue. This is true of all passive films; they are corrosion resistant only in certain environments. None is universal.

(5) Chemical treatment of the water or other electrolyte in contact with a metal surface is often a very practical method of protecting boilers, steam lines, chemical process equipment and paper mill machinery against corrosion. There are a great many treatment methods and their action is often complex. In general, they operate either to remove free oxygen or other corrosion inducing chemicals from the electrolyte, or to create a passive film at the metal surface. Chemical treatment is not usually practical in unconfined water such as with soil moisture or marines structures.

(6) The important fact to remember with chemical treatment is that no method is universally effective, and if improperly applied many methods can be harmful. Each is designed to provide a certain definite chemical reaction in a certain definite environment and, for example, just because one method works well in the boiler of one plant does not mean it will work in another plant's boiler. The only way to secure effective chemical treatment is to test water and other factors and to design a treatment for a specific environment. This can usually be accomplished at relatively low cost, and invariably this scientific approach is far less expensive than the costly trial and error method often used.

(7) Of course, a basic method of corrosion prevention is to substitute a different material, one that won't corrode in the given environment. Plastics, stainless steels and non-ferrous metals are commonly utilized for just this reason. Plating and claddings also serve this purpose. However, the original metal was usually desired because it was inexpensive, easy to obtain, and possesses desirable qualities. Therefore, it often pays to consider corrosion protection rather than substitution. A frequent example is with the common grades of structural steel, where a supposed lack of corrosion resistance is usually the only reason why other materials are substituted.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**, to make less sever, intense, painful, etc.
2. _____ : **(adj.)**, of, pertaining to, or characteristic of the whole; all.
3. _____ : **(n.)**, production of hollows or indentations in a surface.
4. _____ : **(n.)**, a layer of anything that covers a surface.
5. _____ : **(adj.)**, not permitting penetration or passage; impenetrable.
6. _____ : **(adv.)**, static, constant.
7. _____ : **(n.)**, an external layer of metal plates.
8. _____ : **(n.)**, metal bonded to an inner core of another metal.

II - Main Ideas

In order to read effectively, it is essential to constantly keep in mind the main points the author is making. As you read the passage determine the main idea or point of each paragraph.

1. The function of paragraph **(1)** is:
   - **a.** to introduce the topic (corrosion prevention).
   - **b.** to state the similarity among all types of corrosion prevention.
   - **c.** to point out the ease with which corrosion can be prevented.

2. The main idea of paragraph **(2)** is:
   - **a.** no coating is 100% effective.
   - **b.** coating is one type of corrosion prevention.
   - **c.** coatings can be effective.

3. The main idea of paragraph **(3)** is:
   - **a.** cement coatings is an example of passive protection .
   - **b.** some metals automatically provide their own passive film.
   - **c.** a passive chemical film is one type of corrosion protection.

4. The main idea of paragraph **(4)** is:
   - **a.** to describe how the film protecting stainless steel repairs itself.
   - **b.** to describe the characteristics of the passive film protecting stainless steel.
   - **c.** to explain why no passive films are universal.

5. The main idea of paragraph **(5)** is:
   - **a.** in certain cases metal can be protected by treating the electrolyte.
   - **b.** chemical treatment is not practical in unconfined water.
   - **c.** there are many methods of treating electrolyte.

6. The main idea of paragraph **(6)** is:
   - **a.** chemical treatment can be harmful if improperly applied.
   - **b.** chemical treatment is very specific for certain situations.
   - **c.** testing is a more scientific approach than trial and error method.

7. The main idea of paragraph **(7)** is:
   - **a.** a certain metal may have desirable qualities which outweigh the fact that it corrodes easily.
   - **b.** substitution of a noncorroding material is the best type of corrosion prevention.
   - **c.** corrosion prevention is preferable to substitution.

III - Understanding the Passage

3.1 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ Corrosion prevention is nearly impossible to provide.

b. _____ All corrosion prevention methods are based on essentially the same theory.

c. _____ Coating is common, expensive and 100% effective.

d. _____ The effectiveness of a passive film depends upon the environment.

e. _____ A particular chemical treatment of an electrolyte is widely applicable.

f. _____ Substitution of materials is not always practical because no material can replace metal in every situation.

3.2 Implicit Information

Indicate by true or false those statements which can be inferred from the information in the passage. A statement may be true but not supported by information in the passage.

a. _____ All corrosion methods operate according to the same principle.

b. _____ Coating can actually increase the rate of corrosion.

c. _____ The type of metal will determine the type of coating to apply.

d. _____ One advantage of passive films is that they won't need to be maintained.

e. _____ Pipes are not made of stainless steel in many cases because it is too expensive.

f. _____ The inside of a pipe is more likely to be protected by treatment of the electrolyte than the outside.

g. _____ Plastics have disadvantages which make them unsuitable for replacement of metal pipes in every case.

3.3 Contextual Reference

In order to avoid repeating a word an author uses pronouns and phrases to replace the original word. An understanding of these reference techniques is essential to effective reading. Answer the following questions about the referents in this paragraph.

(1) This corrosion can be stopped in many ways. **(2)** A very common one is to put a non-conductive coating on the metal, such as, plastic, coal tar or paint. **(3)** **This** serves to break the electric circuit necessary to the corrosion process. **(4)** The trouble with **this method** is that good coatings are expensive and there is no coating which is 100% effective in practice. **(5)** Corrosion current will escape wherever breaks occur in the coating, even microscopic **ones**, and accelerated pitting often occurs because of the concentration of current flow at **these breaks**. **(6)** However, when properly applied and maintained, coatings can be very effective.

a. In sentence **(3)** what are "this"? _____

b. In sentence **(4)** what is "this method"? _____

c. In sentence **(5)** what is "ones"? _____

d. In sentence **(5)** what is "these breaks"? _____

3.4 Special Technical Vocabulary

Complete the second sentence in each pair by adding a word from the list.

supposed - invariably - to ensue - to secure - impervious
given - automatically - to pay - to serve

a. Further corrosion is unable to penetrate this chemical film
This chemical film is _____ to further corrosion.

b. This can usually be accomplished at relatively low cost, and this scientific approach is always far less expensive than the costly trial and error methods often used.
This can usually be accomplished at relatively low cost, and _____ this scientific approach is always far less expensive than the costly trial and error methods often used.

c. There is another type of coating whose purpose is to provide a passive chemical film at the metal surface.
Another type of coating _____ to provide a passive chemical film at the metal surface.

d. However the introduction of an unfavourable environment, such as adding chloride ions (free chlorine) to the moisture in contact with the surface of the stainless steel, will break down this film and as a result there will be corrosion .

However, the introduction of an unfavourable environment, such as adding chloride ions (free chlorine) to the moisture in contact with the surface of the stainless steel, will break down this film and corrosion will _____ .

e. Therefore there are often many advantages if corrosion protection is considered rather than substitution.
Therefore, it often _____ to consider corrosion protection rather than substitution.

3.5 Cohesion

Without looking back to the text, re-order the following sentences into a logical paragraph. Complete the sentences with connectors from the list.

as a result of - however - for example – such as

_____**a.** Corrosion current will escape wherever breaks occur in the coating, even microscopic ones, and accelerated pitting often occurs _____ the concentration of current flow at these breaks.

_____**b.** You can stop a corrosion current in many ways.

_____**c.** The trouble with this method is that good coatings are expensive, and there is no coating which is 100% effective in practice.

_____**d.** _____, when properly applied and maintained, coating can be very effective.

_____**e.** This serves to break the electric circuit necessary to the corrosion process.

_____**f.** _____ a non-conductive coating, _____ plastic, coal tar or paint, can be put on the metal.

B) Grammar : Infinitive Patterns (Part-2)

Patterns # 4 **NP + V. + inf. + X**

NP = noun phrase **V.** = verb **inf. =** infinitive **X**= any additional sentence elements

Examples:

1. This English course is designed to prepare students for their technical course.
2. The protection serves to break the current.

- Note that the verb in this pattern may be active or passive.
  - The following **verbs** are often used in this pattern:

to act	**to operate**	**to begin**	**to tend**	**to suffice**
to serve	**to design**	**to continue**	**to intend**	**to require**
to fail	**to manage**	**to attempt**	**to use**	**to appear**

Exercise:
Rewrite the following sentences using the above pattern and identify the parts of the sentence. Remember that each of the new sentences will use one of the words from the above list.

Example:

1. The reversion of pure metals to their stable oxides begins as soon as they are exposed to moisture.
2. Pure metals begin to revert to their stable oxides as soon as they are exposed to moisture.

a. The flow of current continues as long as complete electric circuit exists.

_____

b. Any corrosion method breaks the current flow. It is designed for this purpose.

_____

c. Chemical treatment is used in boiler lines. It alters the electrolyte.

_____

d. Coating metal often isn't able to provide adequate corrosion protection.

_____

e. There is a tendency for the rate of corrosion to increase in direct proportion to the duration and strength of the current.

_____

Patterns # 5 **(in order) + inf. + NP + V. + X**

NP = noun phrase **V.** = verb **inf. =** infinitive **X**= any additional sentence elements

Examples:

1. To help him solve the problem, a formula was provided.
2. A formula was provided to help him solve the problem.
3. In order to prevent corrosion, the circuit must be broken at some point.
4. The circuit must be broken at some point in order to prevent corrosion.

- Note that this pattern is used to explain the reason for an action. The verb may be passive or active. "Must" often appears in this pattern, but other modals also appear.

- This pattern often employs "there"

1. In order to prevent corrosion, the circuit must be broken at some point.
2. In order to prevent corrosion, there must be a break in the circuit at some point.

- The following verbs are often used in this pattern.

to avoid - to stop - to allow - to increase - to start - to help - to decrease - to protect
to have - to provide - to limit - to solve - to prevent - to supply

Exercise:
Rewrite the following sentences using the above pattern and identify the parts of the sentence. Remember that each of the new sentences will use one of the words from the above list.

Example:

1. An electrolyte must be present. The electrons must have a path to travel from the anode to the cathode.
2. An electrolyte must be present to provide a path for electrons to travel from the anode to the cathode.

a. Coatings and claddings are used. They protect the surface of the metal.

_____

b. Electric motors must be grounded. This limits the amount of stray current.

_____

c. In the basic corrosion cell a source of potential must be present. The source of potential allows current to flow.

_____

Patterns # 6 **NP + inf.**

NP = noun phrase **inf.** = infinitive

Examples:

1. The man to ask about your schedule is the head of the department.
2. Water is the most important component to remove in order to prevent the formation of hydrates in the gas.

❖ Note : the infinitive phrase in this pattern functions as an adjective and may follow any noun phrase in the sentence.

Exercise:

Combine the following pairs of sentences using an infinitive phrase. If there is only one sentence, simplify it by using an infinitive phrase.

a. The operating temperature which must be used is determined by the desired characteristics of the final product.

_____

b. Breaks in the coating material are a problem. This problem must be avoided.

_____

c. The steps are essentially the same. These are the steps which must be followed.

_____

d. The important fact concerning chemical treatment is that no method is universally effective. This fact should be remembered.

_____

e. Scientists hope to develop a plastic. This plastic will replace metal in automobile engines.

_____

Process Description

1. Read the following short description about plating, and discuss this technique and the new vocabulary with your teacher. The figure below is an illustration of this technique which helps in understanding it.

Non-ferrous metals can be used to protect steel from corrosion by **plating** it- that is, covering it with a thin layer of metal. An example is **galvanizing** (zinc plating).

Steel can be **hot-dip galvanized**, by placing it in **molten** (liquid) zinc. It can also be **electro-galvanized**, which is a type of **electroplating**. With this technique, the steel component is placed in a liquid (often an acid) -called the electrolyte- and connected to the **negative terminal** (-) of an electrical supply, to become the **cathode** (the negative side). A piece of zinc is also placed in the electrolyte, and is connected to the **positive terminal** (+) of the supply. This then becomes the **anode** (the positive side). An electric current then flows between the pieces of metal, through the electrolyte. This causes reaction, which deposits zinc on the cathode, plating the component.

A related process, called **anodizing**, is used to protect aluminium. The component to be **anodized** is connected to the positive terminal (to become the anode) and placed in an electrolyte, with a cathode. As electricity flows, **aluminium oxide** is deposited on the anode. As this is harder than aluminium metal, it provides protection.

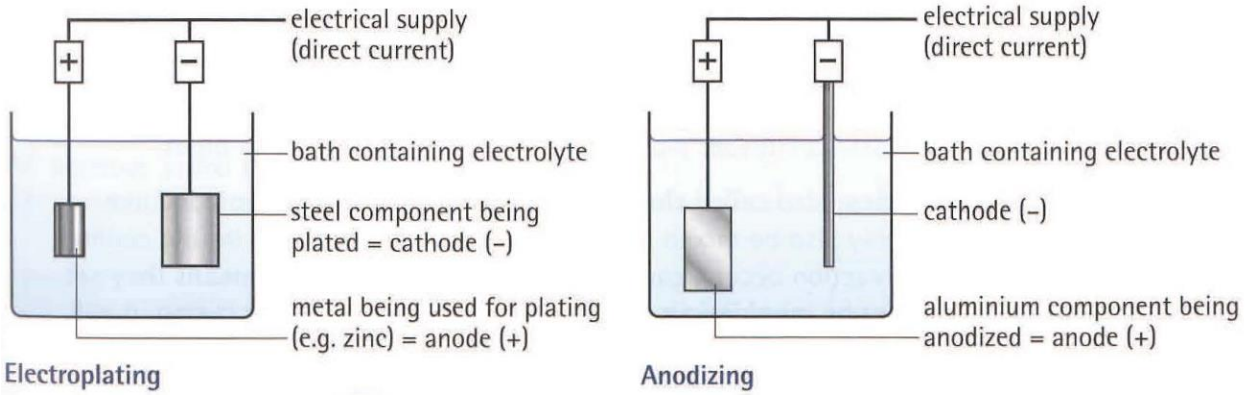
2. Now complete the checklist for electroplating using the words in the box. Look at the text above to help yourself.

anode - electrolyte - galvanizing - plated - cathode
electroplating - negative - positive

- Check that there is sufficient **(1)** _____ in the bath to completely cover the component, in order to ensure that the component will subsequently be **(2)** _____ over its entire surface area.

- Ensure that the component is connected to the **(3)** _____ terminal of the electrical supply. During the **(4)** _____ process, the component should function as the **(5)** _____.

- Ensure that the metal being used for plating - e.g. zinc for **(6)** _____ -is connected to the **(7)** _____ terminal of the electrical supply. During the process, it should function as the **(8)** _____.



Unit 3 Crude Oil and Hydrocarbons

(1) Oil and gas were formed from the remains of organic matter, particularly zooplankton and algae (microscopic animals and aquatic plants) in seas and lakes millions of years ago. The organic material decayed to produce a sludge consisting mainly of carbon and hydrogen molecules which we call hydrocarbons, with small proportions of other elements such as sulphur. It was covered by mud and heavy sandy sediment which caused heat and pressure to build up and convert it to oil and, after exposure to higher temperatures, to gas. The sandy sediment bonded together to form porous sandstone. The oil and gas travelled up through the space or pores in the sandstone, until reaching an impermeable layer. By drilling through this impermeable rock, the oil and gas can be recovered at the surface.

(2) The hydrocarbons in crude oil are a complex mixture of different sizes and shapes of molecules depending on where the oil and gas are found. The chemistry of hydrocarbons and their complexity allows them to be used to make a wide variety of products.

(3) Atoms combine to produce compounds by forming bonds with other atoms to produce molecules. Carbon forms four bonds and hydrogen forms a single bond. Bonding together, they form hydrocarbons. The simplest hydrocarbon is the gas methane, known by its chemical symbol CH_4. Heavier molecules are formed as the carbon atoms form longer chains. The chains are formed by each carbon atom inside a chain using two of its bonds to join with other carbon atoms on each side and the other two bonds to join with two hydrogen atoms. The carbon atoms at each end of the chain only require one bond to hold on to the chain so they each attach to an extra hydrogen atom. Fuel gases are mainly propane (C_3H_8) and butane (C_4H_{10}). By more complicated bonding, hydrocarbons form rings and branches. The simplest ring formation is benzene (C_6H_6). The content of benzene as an additive to petrol is restricted to 1% because it is carcinogenic. Hydrocarbons with more than four carbons atoms are liquids and as the size and molecular weight increases, compounds become practically solid, as bitumen. The compounds in crude oil are not used directly but are separated in a refinery by distillation and either broken or joined together to make fuels, plastics, paints and fertilizers.

(4) Crude oil is classified according to its density whether heavy or light, and its sulphur content. Oil with a low sulphur content is described as "sweet". The sweet crude oil from the North Sea and West Texas are more valuable than Middle East crude because the low weight and sulphure content means they are easier to transport and refine. Sulphur is a useful by-product of refining and is used in steelmaking, papermaking, fertilizers, and dyes.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____: **(v.)**, to decompose, to rot.
2. _____: **(n.)**, any of various more or less mudlike deposits or mixtures.
3. _____: **(n.)**, ratio, comparative relation between things as to size, quantity etc.
4. _____: **(adv.)**, chiefly, principally, for the most part, in the main, to the greatest extent.
5. _____: **(v.)**, to keep within limits, as of space, action, choice, intensity, or quantity.
6. _____: **(adv.)**, in effect, virtually, almost, nearly.
7. _____: **(n.)**, the volatilization or evaporation and subsequent condensation of a liquid.
8. _____: **(adj.)**, having considerable use, service, price or importance.

II - Main Ideas:

As you read the passage determine the main idea or point of each paragraph.

1. The main idea of paragraph **(1)** is:
   - **a.** to introduce the topic of the text.
   - **b.** to describe how oil was formed.
   - **c.** to point out that oil can be reached by drilling.
2. The main idea of paragraph **(2)** is:
   - **a.** to state that oil is made up of complex molecules.
   - **b.** to indicate that crude oil is a blend of molecules.
   - **c.** to discuss the chemistry of crude oil.
3. The main idea of paragraph **(3)** is:
   - **a.** to describe the chemistry and physical state of hydrocarbons.
   - **b.** to reveal how hydrocarbons are found.
   - **c.** to specify that hydrocarbons must be separated before use .
4. The main idea of paragraph **(4)** is:
   - **a.** to mention the types of crude oil.
   - **b.** crude oil that contains sulphur is less valuable than one that is sulphur-free.
   - **c.** to indicate that sulphur is a valuable by-product of refining.

III - Understanding the Passage

3.1 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

- **a.** _____ Living organisms are the main source of crude oil.
- **b.** _____ Crude oil is very often recovered by drilling.
- **c.** _____ Methane is the smallest and the lightest hydrocarbon.
- **d.** _____ Hydrocarbons are compounds formed by the union of carbon and hydrogen atoms.
- **e.** _____ There are likely three types of hydrocarbons structures.

3.2 Implicit Information

Indicate those statements which can be inferred from the information in the passage. A statement may be true but not supported by information in the passage.

- **a.** _____ Millions of years ago, oil fields were lakes or seas.
- **b.** _____ Crude oil is not located in the porous sandstone under pressure.
- **c.** _____ The commercial value of the crude oil depends from where it was recovered.
- **d.** _____ under normal conditions pentane which is a hydrocarbon containing five carbon atoms is gaseous, while benzene is liquid.
- **e.** _____ Crude oil is highly valuable only if it is refined.

3.3 Contextual Reference

Answer the following questions about the referents in this paragraph.

(1) Petroleum is a thick natural compound commonly called “crude oil”. **(2)** It is usually found beneath the surface of the earth. **(3)** **It** is flammable, therefore it can be burned. **(4)** It is a mixture of hydrocarbons. **(5)** **These** are compounds of hydrogen and carbon. **(6)** Hydrocarbons molecules vary in size. **(7)** **Their size** depends on the number of hydrogen and carbon atoms which they contain. **(8)** Each hydrocarbon is named for the number of atoms in its molecule. **(9)** **They** are named using conventional

chemical standards. **(10)** **These** come from Latin language. **(11)** For example, the prefix "meth" in the name methane indicates that the hydrocarbon molecule contains one carbon atom. **(12)** The prefix "eth" means that the hydrocarbon molecule contains two carbon atoms. **(13)** It follows that the molecular weight of ethane is not the same as **that** of methane. **(14)** Since petroleum is a mixture of different hydrocarbons with different molecular weights, it must be refined, cleaned, and separated into its component parts.

a. In sentence **(3)**, it refers to: _____

b. In sentence **(5)**, these refers to: _____

c. In sentence **(7)**, their size refers to: _____

d. In sentence **(9)**, they refers to: _____

e. In sentence **(10)**, these (of methane) refers to: _____

f. In sentence **(13)**, that refers to: _____

3.4 Cohesion

Place the following expressions in the sentences indicated between brackets in the text **in 3.3**. Replace and reorder the words in the sentences where necessary.

a. may be defined as **(1)**.

_____

b. since **(3)**

_____

c. consequently **(13)**

_____

d. therefore **(14)**

_____

3.5 Rephrasing

Rewrite the following sentences replacing the underlined words with expressions from the text in **3.3** which have the same meaning.

1. Petroleum is a thick natural compound **usually** called "crude oil".

_____

2. It is **inflammable**.

_____

3. It is usually found **below the earth's surface**.

_____

4. **Molecules of hydrocarbons** vary in size.

_____

5. The prefix 'eth' **indicates** that the hydrocarbon molecule contains two carbon atoms.

_____

B) Vocabulary and Grammar Activities

Activity 1 General Vocabulary

Complete the sentences with one of the following words. Add a / an or make the word plural if necessary.

barrel - energy - equipment - experience - reservoir - layer

a. Oil is found in _____ under the ground.
b. People working on a drilling rig have to move _____ that is very heavy.
c. _____ of oil is 159 litres.
d. Oil and gas are very important sources of _____ .
e. Tom is a geologist with twenty years' _____.
f. Over thousands of years, dead plants and animals were covered in _____ of mud and sand.

Activity 2 Grammar: Articles

Complete the sentences with a, an or the if necessary. Leave the gap empty if nothing is required.

Oil has formed on **(1)** _____ Earth in the past and is still forming today. Most oil comes from **(2)** _____ microscopic plants and animals. Oil from **(3)** _____ North sea is found in **(4)** _____ rocks that were made about 150 million years ago. At that time, the seas and wet areas of land were rich in **(5)** _____ microscopic organisms. When **(6)** _____ organism dies, it sinks to the bottom of **(7)** _____ sea. It forms **(8)** _____ layer of organic material. This gets covered in **(9)** _____ layers of sand and mud. **(10)** _____ air can't reach **(11)** _____ organic matter.

Activity 3 Writing Definitions

Use the expressions in column B and C in the following table to write appropriate definitions for the items in column A. Use your dictionary if necessary.

A	B	C
produced gas		is composed mainly of octane, nonane, and decane
crude oil	**gas**	is a combination of decane and heavier hydrocarbons
commercial natural gas		contains methane, ethane, butane, propane, and little pentane
gasoline	**liquid**	contains pentane and heavier hydrocarbons
diesel fuel		is a mixture of the heaviest hydrocarbons
motor oil	**solid**	is composed of methane with some ethane and butane
asphalt		consists of hexane, heptane, octane, nonane, and decane

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

C) Guided Writing

Stage # 1 Sentence building

Join each of the groups of words below into one sentence using the additional material at the beginning of each group. Omit the underlined words, number your sentences and begin each one with a capital letter.

1. **although / both / often**
   Petroleum is a liquid commonly called "crude oil".
   Natural gas and crude oil are called petroleum.
2. **which**
   Methane is a hydrocarbon.
   Methane has one carbon atom.
3. **since / it**
   Petroleum is a mixture of different hydrocarbons.
   Petroleum must be refined before it can be used.
4. **they / many / called**
   Natural gas and crude oil are mixtures of numerous compounds.
   These compounds are called hydrocarbons.
5. **if they / they**
   When methane and decane are ignited, methane and decane will burn.
6. **these / varying**
   Hydrocarbons are compounds of hydrogen and carbon.
   Hydrocarbons vary in molecular size.
7. **with**
   Decane is a hydrocarbon.
   Decane has 10 carbon atoms

Stage # 2 Paragraph building

Rewrite the seven sentences in a logical order to make a paragraph. Before you write the paragraph, do the following change: join sentence 4 and sentence 5 with **but**.

When you have written your paragraph, reread it and make sure that the sentences are presented in a logical order. Give the paragraph a suitable title.

Stage # 3 Paragraph reconstruction

Read through the paragraph again. Make sure that you know all the words, using a dictionary if necessary. Without referring to your previous work, rewrite the paragraph. Here are some notes to help you.

petroleum - liquid - crude oil - natural gas - crude oil - petroleum - mixtures - compounds - hydrocarbons

compounds - hydrogen - carbon - molecular size

methane - hydrocarbon - one carbon atom

decane - hydrocarbon - 10 carbon atoms

ignited - burn

petroleum - mixture - hydrocarbons - refined - used

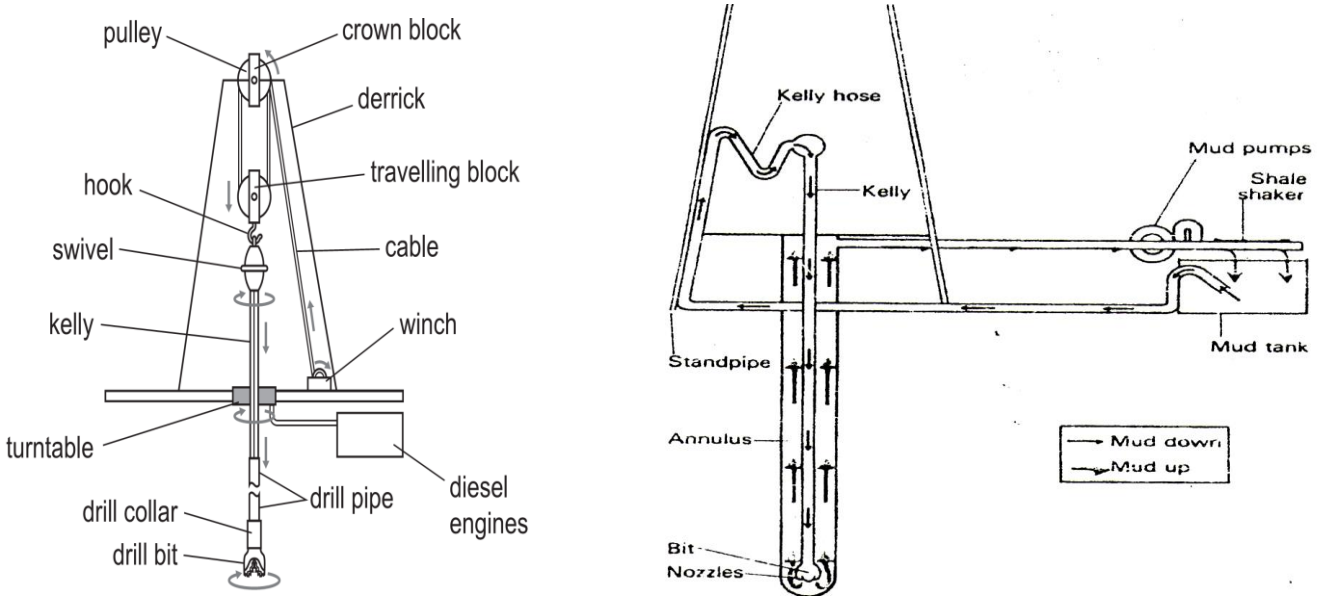
Unit 4 The Rig

(1) Oil is contained in rocks under the ground and in rocks under the sea. To find it, oilmen have to drill boreholes. The equipment for drilling these holes is the drilling rig. Most rigs work on the rotary system. A bit rotates at the end of a pipe. As the bit rotates, it cuts and crushes the rock at the bottom of the hole. The cuttings are carried to the surface by a special fluid. This fluid is called "mud". Mud is a mixture of clay, water and chemicals.

(2) Look at the diagram of the rotary rig. Notice the string. This is made up of "joints" or "singles". Each joint or single is a hollow section of pipe, 30 ft. long. The string is made up of a number of these singles, all joined together. The bit is connected to the bottom of the string. At the top of the string there is a special pipe called the "kelly". The kelly is not round, but hexagonal. It fits into a hexagonal hole in the rotary table. The rotary table turns the kelly, the kelly turns the string, and the string turns the rotary bit.

(3) Mud is not only used for carrying the cuttings up to the surface. It is also used for keeping the bit cool. The mud is pumped down through the string. It comes back up again through the annulus. The mud engineer or "mud man" is in charge of the mud. For example, he tells the floormen how to mix the mud at the mud tanks.

(4) It is often necessary to pull the string out of the hole. There are different reasons for this. Perhaps, for example, the drill bit is dull. If the bit is dull, it must be changed. To do this, the driller and the floormen must trip the pipe. They must pull the string out **(a)**, change the bit **(b)**, and then run the string back into the hole **(c)**. Tripping the pipe is also called "making a round trip." Round trips are expensive. Oilmen make them only if they must.



1. Oil Rig **2. Mud System**

Diagram 1

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(n.)**, the equipment used in drilling an oil well.
2. _____ : **(n.)**, a hole drilled in the earth, as for the purpose of extracting a core releasing gas, oil, water, etc.
3. _____ : **(adj.)**, turning or capable of turning around on an axis, as a wheel.
4. _____ : **(n.)**, breaks up into small pieces, using great power.
5. _____ : **(n.)**, the pieces of rock drilled by the bit.
6. _____ : **(n.)**, anything that flows. Liquids, gases and melted substances are all fluids.
7. _____ : **(n.)**, a natural earthy material that is plastic when wet, consisting essentially of hydrated silicates of aluminium used for making bricks, pottery, etc.
8. _____ : **(adj.)**, having a space or cavity inside; not solid; empty.
9. _____ : **(n.)**, workers on a rig, also called "roughnecks".
10. _____ : **(adj.)**, not sharp; worn out; gone. If the bit is gone, it must be changed.
11. _____ : **(adj.)**, a man in charge of mud; a mud man.

II - Understanding the Passage

2.1 Questions on the text

Answer the following questions. The information can be either in the reading passage and diagrams or in vocabulary section.

a. What is the driller's job?

b. How long is a single? How long is a joint?

c. As the bit rotates, what two things does it do?

d. In the petroleum industry, what is mud?

e. What is the string made of?

f. What is the name of the space between the drill and the borehole?

g. Who mixes the mud? Where is the mud mixed?

h. Oilmen make round trips only if they must. Why?

i. What is bentonite? What does it consist of?

2.2 True/False Questions

Study the diagram 1 of the lifting and rotary rig systems. Right **T (true)** or **F (false)** next to each statement.

a. _____ The crown block is in the centre of the derrick.

b. _____ The traveling block is below the crown block.

c. _____ The swivel is between the kelly and the turntable.

d. _____ The cable moves diagonally downwards from the winch.

e. _____ The hook on the travelling block does not rotate.

f. _____ The turntable moves vertically downwards.

2.3 Extra Vocabulary

Choose from these words and expressions to complete the paragraph below:

cuttings - fluid - shale shaker - rotary - mud tanks - annulus - crushes

The **(1)** _____ bit cuts and **(2)** _____ the rock at the bottom of the hole. Drilling **(3)** _____ carries the **(4)** _____ from the bottom of the hole, up the **(5)** _____ to the surface. The cuttings are separated from the mud at the **(6)** _____ and the clean returns to the **(7)** _____.

B) Drilling Technical Vocabulary

Activity 1 History of Oil Drilling

Complete this article about the history of oil drilling. Use the correct form (present or past, active or passive) of the verbs in brackets.

Long ago, wells **(1)** _____ **(dig)** in the ground using percussion drilling. A heavy wooden cutting tool **(2)** _____ **(suspend)** by a rope from a pulley on a wooden tripod. The tool **(3)** _____ **(pull up)** by hand or steam engine, and then it **(4)** _____ **(drop)** into the hole. The rock **(5)** _____ **(break)** by the weight of the tool. The maximum depth was only about 70 metres.

Nowadays, much deeper oil wells of 700 m **(6)** _____ **(dig)** using a method called rotary drilling. A sharp drill bit **(7)** _____ **(suspend)** by a drill string from a pulley on a steel derrick. The drill bit **(8)** _____ **(rotate)** in the hole by a powerful engine. The rock **(9)** _____ **(break)** by the rotation of the drill bit.

Now there is also a new method of drilling which **(10)** _____ **(cut)** the rock using lasers. No cutting tool or drill bit **(11)** _____ **(use)**. Instead, the rock **(12)** _____ **(split)** by beams of high-energy light. A fiber-optic cable **(13)** _____ **(carry)** the light from the lasers on the surface down the hole to a set of lenses. The lenses then **(14)** _____ **(focus)** the light to a sharp point on the rock face, which **(15)** _____ **(cut)** almost 100 times faster than by a drill bit. As a result, the cost of drilling **(16)** _____ **(reduce)**, and drilling jobs **(17)** _____ **(complete)** much more quickly.

Activity 2 Rig Components

Look back to the diagram 1, then match the sentence halves 1-7 with a-g, and 8-14 with h-n. Pay particular attention to the words in bold.

1	☐	**The derrick is**	a	**on the drilling platform.**
2	☐	The **derrick** stands	b	the **cable**, and moves up or down.
3	☐	The **crown block** is fixed	c	or **releases** the **cable**.
4	☐	The **winch** pulls in	d	of the **travelling block**.
5	☐	The **travelling block** is attached to	e	to the top of the **derrick**, and rotates.
6	☐	A **hook** is fixed to the bottom	f	the tower (the top part) of the **oil rig**.
7	☐	The **hook** below the travelling block	g	is attached to a **swivel**.
8	☐	The top part of the swivel can't rotate,	h	through a **turntable**.
9	☐	The lower part of the **swivel** is attached	i	and makes it rotate.
10	☐	The **kelly** fits into and goes	j	bottom of the **drill pipe** above the drill bit.
11	☐	The **kelly** is attached below	k	but the **bottom part** can .
12	☐	A **diesel engine** drives the **turntable**	l	the bottom of the **drill pipe**.
13	☐	**The drill bit** is attached to	m	to a 4-sided or 6-sided **kelly**.
14	☐	**A drill collar** is fitted over the	n	the turntable to the **drill pipe**.

Activity 3 Process Description

a. Read this description of the rotary system of an oil rig and match parts with functions in the table below.

The lifting and rotary systems of an oil rig.

Lifting system. When the winch rotates, it pulls the cable. The two blocks have lots of pulleys. The cable passes round the pulleys in the two blocks. The crown block does not move up or down. It is fixed to the top of the derrick. The travelling block moves vertically. When the winch turns, it raises the travelling block up towards the crown block.

Rotary system. The swivel hangs from a hook on the travelling block. The kelly (a long square pipe) is fixed to the swivel at one end. The lower end of the kelly is attached to the drill pipe. It goes through the turntable. The square shape of the kelly slides exactly into the square hole of the turntable. When the engines are on, the turntable rotates. The turntable turns the kelly and the kelly turns the drill pipe. When the drill pipe rotates, the drill bit rotates and cuts the rock.

		Part		Function
1	☐	The winch	a	turns the Kelly.
2	☐	The kelly	b	raises and lowers the rotary equipment.
3	☐	The turntable	c	supports the swivel and the kelly.
4	☐	The engines	d	pulls the cable
5	☐	The hook	e	turns the drill pipe
6	☐	The cable	f	drive the turntable

b. Now complete this description of the drilling process, using nouns from the word list.

drill pipe - derrick - turn table - oil rig - crown block - kelly - hook
drill collar - winch - swivel - travelling block - drilling platform

The **(1)**_____ is the tower of the **(2)**_____ , and stands on the **(3)** _____. At the top of the derrick is the **(4)**_____. This rotates when the **(5)** _____pulls or releases the cable. Below the crown block is the **(6)** _____, which moves up and down and raises or lowers the **(7)**_____with the drilling equipment. The hook is at the bottom of the travelling block and is attached to a **(8)** _____ the top part of which can't rotate, while the bottom part can. The lower part of the swivel is attached to a **(9)**_____, which fits into and goes through a **(10)**_____ . Below this, the kelly is attached to the **(11)** _____. At the bottom of the oil well, a heavy **(12)** _____ fits over the drill pipe just above the drill bit and helps to weigh it down. When the diesel engines are running, the turntable, the kelly and the drill pipe rotate, making the drill bit tum and cut into the rock.

c. Put these instructions in the correct order. Write a number 1 - 10 next to each one.

Note: **trip in** the drill string = **lower** the drill string into the well

trip out the drill string = **raise** the string out of the well

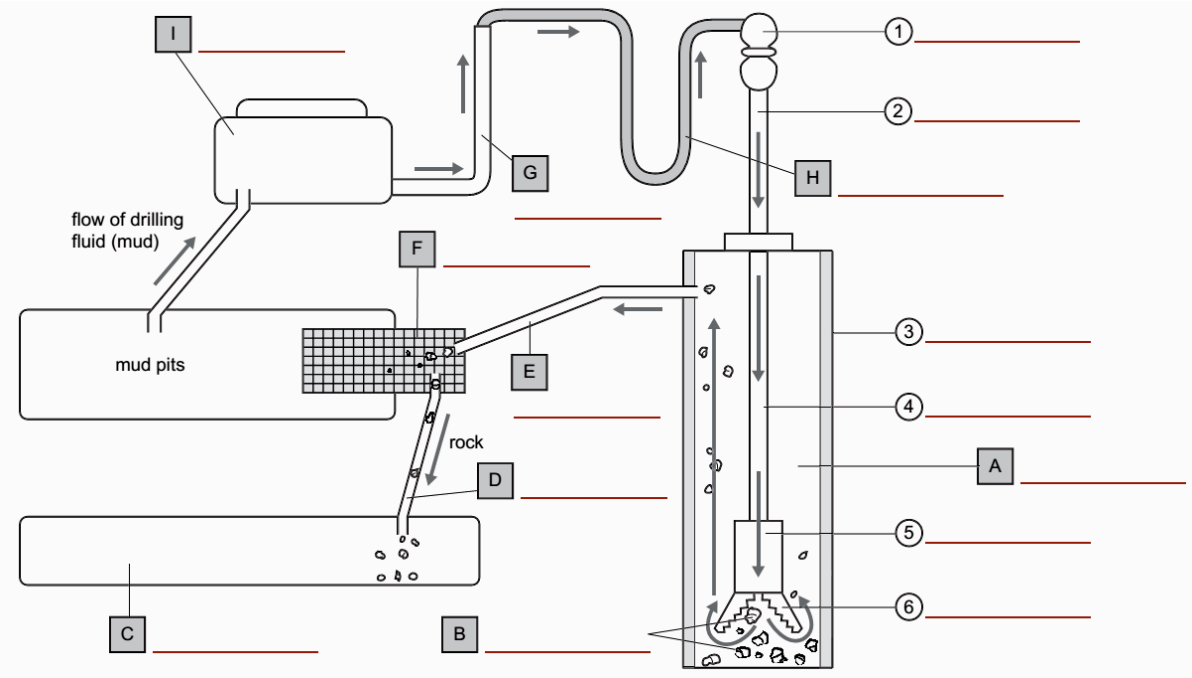
Instructions: How to drill for oil

_____ Trip the drill string into the well hole.	_____ Attach another drill pipe to the string.
_____ Slide the kelly into the turntable.	_____ Install the casing in the well hole.
_____ Put the collar on the drill bit.	1 Attach the drill pipe to the drill bit.
_____ Trip the drill string out of the well hole.	_____ Drill the hole
_____ Fix the kelly to the drill pipe.	_____ Switch on the power.

Activity 4 The Circulation System in an Oil Rig

a. Label items 1 - 6 on the diagram with words from the box.

Kelly - swivel - drill string - drill collar - drill bit - casing



b. Read this text and label items A - I on the diagram. Use some of the words in italics in the text.

The circulation system

The circulation system cleans out the well. It pumps a special liquid (called ***drilling fluid*** or ***drilling mud***) down the drill string into the well hole. This liquid picks up pieces of rock (***rock cuttings***) and carries them up the well hole and out of the well.

This is how the system works. The ***mud pump*** sucks the drilling fluid from large open tanks (called ***mud pits***) and pumps it through the ***stand pipe*** and ***the rotary hose***. The fluid then enters the kelly through a hole in the swivel. The fluid then moves through the kelly and the drill string to the drill bit. Then the mud flows out of the drill bit and around the bottom of the well. It collects the rock cuttings and carries them up through the ***annulus*** (the space between the drill string and the casing). At the top of the annulus, the mud and cuttings leave the well through the ***mud return line*** (or pipe).

Now the mud flows into the ***shaker***. This moves quickly from side to side. The fluid flows through the small holes in the shaker, but the large rock cuttings stay on the shaker. The fluid then flows back into the mud pits, and the large cuttings slide down the ***shale slide*** into the ***reserve pit***.

c. Complete these statements. Underline the correct words.

1. The mud enters the swivel through an _____ **(inlet / outlet)** in the swivel.
2. The mud leaves the drill bit through an _____ **(inlet / outlet)** in the bit.
3. The rotary hose connects the _____ **(pump / drill bit)** to the rotary equipment.
4. The mud flows _____ **(into / out of)** the well through the drill string.

d. Put these stages in the circulation system in the correct order. Number each one.

Stages in the circulation system

_____ It then flows down through the drill string.

_____ From the rotary hose it enters the swivel and the kelly.

_____ The pumps suck the drilling mud out of the mud pits.

_____ It then leaves the drill bit and flows around the annulus.

_____ The fluid picks up pieces of rock and sand.

_____ The fluid then goes into the mud pits again, and the cuttings enter the reserve pit.

_____ The shaker takes the cuttings out of the fluid.

_____ At the top of the well, the fluid flows through the mud return line into the shaker.

_____ Then the mud rises up the well hole between the drill pipe and the casing.

_____ They then pump the fluid through a hose to the rotary equipment.

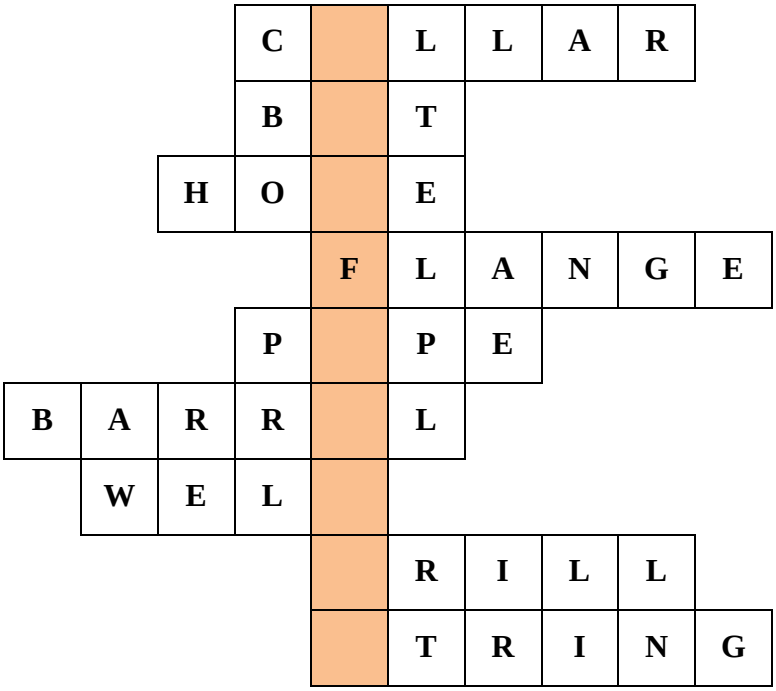
e. Complete these statements. Choose the correct verb and use the correct verb form.

1. The pumps _____ **(push/pull)** drilling mud out of the mud pits and _____ **(push/pull)** it through the rotary hose.
2. The rotary hose _____ **(carry/flow)** the drilling mud into the swivel.

3. The mud _____ **(pass/leave)** into the drill string through a hole in the swivel and then _____ **(flow/contain)** through the kelly.
4. The drilling mud _____ **(enter/leave)** the well hole through the mud return line.
5. In the shaker, the mud _____ **(rise/sink)** through the holes, but the rock cuttings _____ **(stay/flow)** on the shaker.

Activity 5 Puzzle

Complete the puzzle. What do the missing letters spell?



Unit 5 The Oil Refining Process: Fractional Distillation

1) Crude oil (also called petroleum) is a mixture of different hydrocarbons. Many useful products can be made from these hydrocarbons. But first the useful ones must be extracted from the crude oil and separated from one another.

How is this done?

(2) The different hydrocarbon components of crude oil are called fractions. The fractions are separated from one another using a process called fractional distillation. This process is based on the principle that different substances boil at different temperatures. For example, crude oil contains kerosene and naphtha, which are useful fractions (naphtha is made into petrol for cars, and kerosene is made into jet fuel). When you evaporate the mixture of kerosene and naphtha, and then cool it, the kerosene condenses at a higher temperature than the naphtha. As the mixture cools, the kerosene condenses first, and the naphtha condenses later.

(3) This is how fractional distillation works. The main equipment is a tall cylinder called a fractionator (or fractional distillation column). Inside this column there are many trays, or horizontal plates, all located at different heights. Each tray collects a different fraction when it cools to its own boiling point and condenses.

(4) The crude oil is heated to at least 350°C, which makes most of the oil evaporate. The fluid then enters the column. As the vapour moves up through the fractionator, each fraction cools and condenses at a different temperature. As each fraction condenses, the liquid is collected in the trays. Substances with higher boiling points condense on the lower trays in the column. Substances with lower boiling points condense on the higher trays. The trays have valves, which allow the vapour to bubble through the liquid in the tray. This helps the vapour to cool and condense more quickly. The liquid from each tray then flows out of the column.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**, to obtain from a substance by chemical or mechanical action, as by pressure distillation, or evaporation.
2. _____ : **(n.)**, a part or element of a larger whole, especially a part of a machine or vehicle.
3. _____ : **(adj.)**, Relating to or denoting the separation of a mixture into small or tiny amounts.
4. _____ : **(n.)**, the action of purifying a liquid by a process of heating and cooling.
5. _____ : **(v.)**, bring or gather together.
6. _____ : **(n.)**, a thin sphere of liquid enclosing air or another gas.
7. _____ : **(adv.)**, at a fast speed; rapidly; promptly.

II - Main Ideas.

As you read the passage determine the main idea of each paragraph.

1. The main idea of paragraph **(1)** is: _____
2. The main idea of paragraph **(2)** is: _____
3. The main idea of paragraph **(3)** is: _____
4. The main idea of paragraph **(4)** is: _____

III - Understanding the Passage

3.1 Questions on the Text

Answer these questions on the reading text.

a. Why do different substances need to be extracted from crude oil?

_____

b. What fact of science does fractional distillation use?

_____

c. Which component of the column collects the condensed liquid from each fraction?

_____

d. What is the function of the valves on each tray?

_____

3.2 True/False Questions

Study this diagram of the oil distillation process Right **T (true)** or **F (false)** next to each statement.

a. _____ Crude oil is heated and pumped into the column.

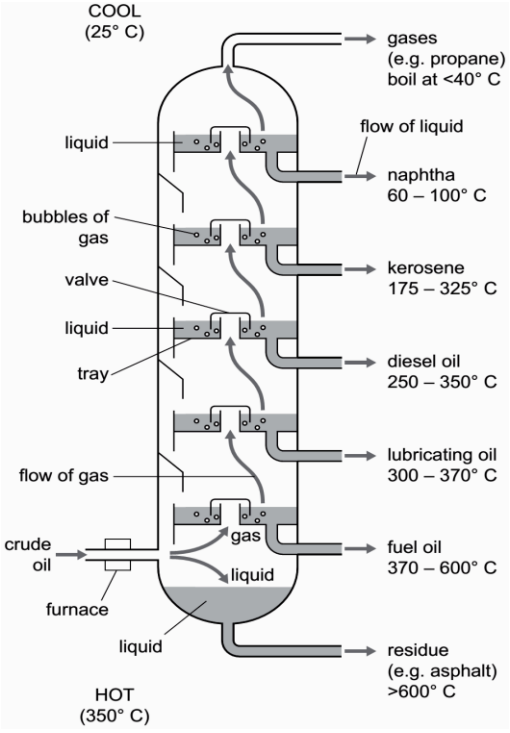
b. _____ When this happens, all the crude oil evaporates and the vapour/gas rises through the column.

c. _____ As the vapour goes up the column, the temperature decreases.

d. _____ All the vapour from the crude oil flows to the top of the column and leaves it through a pipe.

e. _____ When the temperature falls to between 175°C and 325°C, some of the vapour condenses into liquid kerosene.

f. _____ This substance condenses at a higher temperature than naphtha.



Fractional Distillation Tower

3.3 Understanding Distillation Process

Put these stages in the distillation process into the correct order. Write a number **1-8** next to each stage.

A ☐ As the vapour rises through the trays in the column, the temperature falls.

B ☐ The condensed liquid of the fraction is collected in a tray.

C ☐ When a fraction in the vapour cools to its own boiling point, it condenses.

D ☐ This is how the distillation process in the fractionator works.

E ☐ Most of the fractions in the crude oil evaporate.

F ☐ The condensed liquid flows out of the fractionator through a pipe from the tray.

G ☐ High-pressure steam is used to heat the crude oil to a high temperature.

H ☐ The crude oil vapour enters the fractionator and rises up the column.

B) Refining Process Vocabulary

Activity 1 Connectives

Complete these sentences using each word from the box once only.

for - as - that - to - by - which - when - from

a. Jet fuel is made from kerosene, _____ condenses between 175°C and 325°C.

b. _____ naphtha vapour is cooled to between 60°C and 100°C, it condenses.

c. Diesel oil is produced _____ cooling crude oil vapour to between 250°C and 300°C.

d. _____ crude oil vapour rises through the fractionator, it cools.

e. Lubricating oil is used _____ reducing friction between moving parts.

f. The boiling point of industrial fuel oil ranges _____ 370°C to 600°C.

g. A fractionator is a tall column _____ is filled with trays or plates at several levels.

h. The trays in the column are designed _____ allow contact between vapour and liquid.

Activity 2 Passive/Active Voice

Rewrite these sentences using the passive form of the verbs.

a. You have to refine crude oil so that you can use it for petrol or jet fuel.

Crude oil _____ so that it _____ fuel.

b. In the past, people burnt crude oil in lamps, but now they extract kerosene from it.

In the past, crude _____ ,but now kerosene _____ it.

c. When you boil crude oil, you convert most of the fractions into vapour.

When crude oil _____ , most of _____ vapour.

d. The trays collect the condensed fluid and then a pipe carries it out of the fractionator.

The condensed _____ trays, and then it _____ pipe.

Activity 3 Oil Refinery

Fill in the blanks using the words in the box to complete the text.

pipeline - bitumen - boiled - heaviest - boiling points - taken out - diesel oil distillation tower - stored - lightest - piped out - fractions - crude oil - oil

An oil refinery turns **(1)**_____into petroleum gas, petrol/gasoline, kerosene, **(2)**_____ , fuel oil, asphalte/**(3)**_____; and many other products. Here's how it works. First, the crude oil is pumped into the furnace, where it is **(4)** _____. Next, the boiling **(5)** _____ enters the bottom of the **(6)** _____ . Boiling separates the crude oil into **(7)** _____ . Fraction means part. The fractions of crude oil are products with different **(8)** _____: petroleum gas, petrol, and so on. The **(9)**_____product, petroleum gas, rises to the top. The **(10)**_____product, like asphalt, sink to the bottom. After the products are separated, they are **(11)** _____ of the tower. The different products are **(12)**_____ in tanks in the refinery. Finally, they are **(13)** _____ of the refinery by tanker lorry, rail tanker, boat, or **(14)**_____ .

Activity 4 Extra Vocabulary

Complete the sentences by using the words from the list in the box.

bring - is connected - is refined - is returned - is stored - take - travels

a. This is the jetty. Tankers _____ crude oil to the refinery. The unload the crude oil here.

b. The crude oil_____along these pipe lines into the tanks at the tank farm.

c. The crude oil_____in these tanks until it is refined. Some of them are 80 metres high.

d. This is the main refinery. This is where the oil _____ in the distillation towers.

e. These pipes take the products out of the refinery. Some of the pipes _____kerosene to the airport.

f. The refinery uses river water for cooling the machinery. The used water _____ here, to the salt marsh. It is often cleaner when it is returned.

g. The refinery_____to the main road here. All of the workers come and go this way.

Activity 5 The Oil Refining Process: Cracking, Reforming, Alteration, Treating and Blending

a. Read this text and label the flow chart.

The molecules in petroleum mainly consist of two elements: carbon (C) and hydrogen (H). This is why they are called hydrocarbons. Hydrocarbons may be gaseous, liquid, or solid at room temperature and atmospheric pressure. Solids have a higher number of carbon atoms and a higher boiling point. Gases have a lower number of carbon atoms and a lower boiling point. After fractional distillation, petroleum fractions can be changed in three main ways:

1 A large hydrocarbon can be broken down into smaller ones. This is called cracking.
2 Smaller hydrocarbons can be combined to make a larger one. This is called reforming.
3 One hydrocarbon can be changed into another one. This is called alteration.

1 Cracking

Cracking breaks down larger, heavier hydrocarbons into smaller, lighter hydrocarbons. For example, heavy gas oil can be broken down into lighter products such as petrol and diesel. The process takes place in a **cracking unit**. The hydrocarbons are heated under pressure to high temperatures until they break apart. This is called thermal cracking. Sometimes a catalyst (such as bauxite) or hydrogen is used to speed up the cracking process.

2 Reforming

Reforming combines smaller, lighter hydrocarbons to make larger, heavier ones. The process takes place in a **reformer**. It uses heat, pressure, and a catalyst (usually containing platinum) to convert naphtha into high octane petrol and petrochemicals.

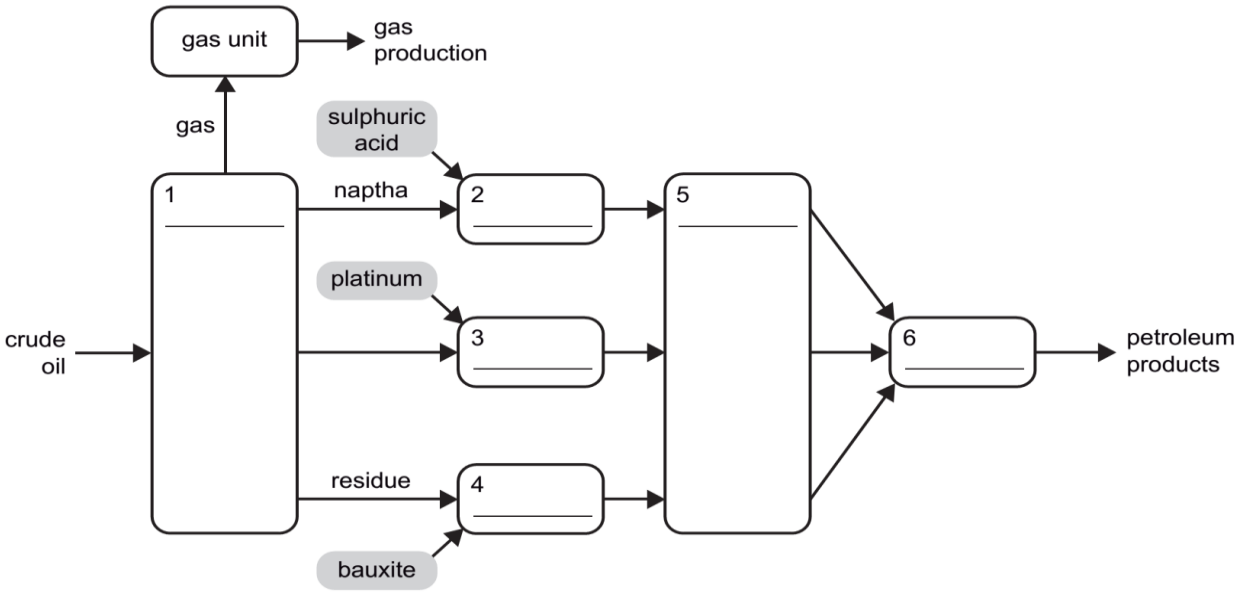
3 Alteration

Alteration rearranges or changes the hydrocarbons in one fraction to produce a different fraction. The most common method is called **alkylation**, which takes place in an **alkylation unit**. In this process, lighter hydrocarbons are converted into high-octane petrol using a catalyst such as sulphuric acid. After the above processes, the fractions are **treated** in the **treatment unit** where they are passed through chemical filters to remove impurities such as sulphur, water, or salts.

Finally, different fractions can be **blended**, or mixed together, in the **blender** to create products such as petrol, lubricating oils, kerosene, jet fuel, diesel oil, heating oil, and petrochemicals for making plastics and other polymers.

a. Label the flow chart using the words from the box below.

treating - reforming - cracking - alkylation - blending – fractional distillation



b. Match the items in this table.

Example: 1 + 11 + 15 + 20:
1fractional distillation ⟶ **11**distillation column ⟶ **15** separate fractions from crude oil ⟶ **20** cool fractions at different temperatures

Process	Location	Purpose	Method
1 fractional distillation **2** cracking **3** reforming **4** alkylation **5** treating **6** blending	**7** reformer **8** blender **9** alkylation unit **10** treatment unit **11** distillation column **12** cracking unit	**13** remove sulphur **14** break down heavy hydrocarbons **15** separate fractions from crude oil **16** create products such as petrol **17** change hydrocarbons **18** combine hydrocarbons	**19** heat under high pressure **20** cool fractions at different temperatures **21** heat under pressure; use platinum as catalyst **22** use sulphuric acid as catalyst **23** mix fractions together **24** pass through chemical filters

Activity 6 Sentence Completion

Complete the sentences. In each sentence, insert one word from list A and one word from list B. Use each word once only.

A: advantage - benefit - disadvantage - drawback - recommend - suggest
B: be - of - should - that - which - would

a. An important _____ of petroleum is _____ it can be refined into many different products.

b. One _____ of petroleum is that it contains carbon, _____ is emitted as a greenhouse gas.

c. Another major _____ _____ petroleum is that it is a finite resource which will run out one day.

d. One _____ of the treatment process is that some dangerous chemicals can _____ extracted from the petroleum fraction.

e. I _____ _____ that the heavy gas oil should be cracked into a lighter hydrocarbon

f. I _____ that the light hydrocarbon _____ be reformed into a slightly heavier product.

Activity 7 Nouns and Adjectives

Properties of petroleum products

Lubricating Oil

Oils are in a viscous (or thick) liquid state at normal room temperature or slightly warmer. They are immiscible (that is, they cannot be mixed) with water. However, they are miscible (that is, they can be mixed) with other oils.

Viscosity: One of the most important properties of lubricating oil is its viscosity. The viscosity of a liquid is its thickness, stickiness or resistance to flow. The oil must be viscous enough to maintain a lubricating layer on the moving parts of an engine, but fluid (or free-flowing) enough to flow around the engine parts to keep them well coated under all conditions. The viscosity index indicates how much the oil's viscosity changes as temperature changes. A higher viscosity index indicates that the viscosity changes less when the temperature changes. A lower index shows that the viscosity changes more when the temperature changes.

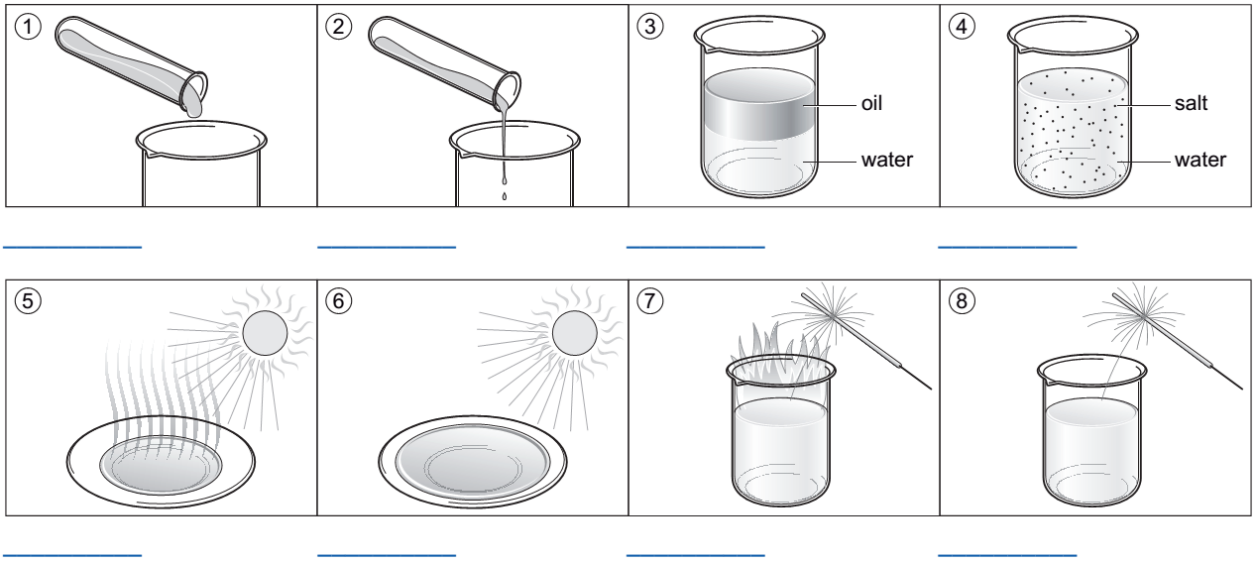
Pour point: This is the lowest temperature at which the oil can be poured out of a container or pumped around an engine. If the temperature falls below the pour point, the oil is too viscous to flow. A low pour point is useful because we want engines to start up easily in cold temperatures.

***Flash point*:** This is the lowest temperature at which the oil gives off vapours which are flammable (that is, able to ignite or catch fire easily). It is dangerous for the oil in a motor to ignite and burn, so a high flash point is desirable.

Jet Fuels

There are two types of jet fuel used in aviation: avtag (aviation turbine gasoline) and avtur (aviation turbine kerosene). These fuels must have three important properties. First, they must be free from impurities. Secondly, they must have a low viscosity index (that is, they must be able to flow at low temperatures). Thirdly, they must be stable (that is, not volatile) at high temperatures. Volatile liquids evaporate more quickly when heated, whereas stable liquids do not evaporate quickly.

a. Read the text and label the liquids with words describing their properties



b. Complete this table by using property adjectives from the text above

Property		Opposite	
Adjective	**Noun**	**Adjective**	**Noun**
1 _____	viscosity	**5** _____	fluidity
2 _____	miscibility	**6** _____	immiscibility
3 _____	flammability	**7** _____	non-flammability
4 _____	volatility	**8** _____	stability

Chapter 2

ENGLISH FOR MATERIALS SCIENCE

POLYMERS AND COMPOSITES

Unit 1 Engineering Materials: Polymers

(1) **(1)** Engineers have to know the best and most economical materials to use. **(2)** Engineers must also understand the properties of these materials and how they can be worked. **(3)** There are two kinds of materials used in engineering: metals and non-metals. **(4)** We can divide metals into ferrous and nonferrous metals. **(5)** The former contain iron and the latter do not contain iron. **(6)** Cast iron and steel, which are alloys, or mixtures of iron and carbon, are the two most important ferrous metals. **(7)** Steel contains a smaller portion of carbon than cast iron contains. **(8)** Certain elements can improve the properties of steel and are therefore added to it. **(9)** For example, chromium may be included to resist corrosion and tungsten to increase hardness. **(10)** Aluminium, copper, and the alloys, bronze and brass, are common non-ferrous metals.

(2) **(11)** Plastics and ceramics are non-metals, however, plastics may be machined like metals. **(12)** Plastics are classified into, two types: thermoplastics and thermosets. **(13)** Thermoplastics can be shaped and reshaped by heat and pressure but thermosets cannot be reshaped because they undergo chemical changes as they harden. **(14)** Ceramics are often employed by engineers when materials, which can withstand high temperature, are needed.

Natural and synthetic polymers

(3) **(15)** With names such as polytetrafluoroethylene and polyethyleneteraphthalate, it's not surprising that polymers are usually called by their more common name, plastic. **(16)** But what, exactly, is a polymer or a plastic? Polymers are compounds made up of several elements that are chemically bound. **(17)** Most compounds consist of large numbers of tiny molecules, which each contain just a few atoms. **(18)** For example, a water molecule (H_2O) contains two hydrogen atoms and one oxygen atom. **(19)** But the molecules of polymers contain huge numbers of atoms, joined together in long chains.
(20) Rubber, thanks to its many uses from rubber bands to car tires, is one of the best-known polymers. **(21)** It comes from latex, a natural liquid which comes from rubber trees. **(22)** Rubber is therefore a natural polymer. **(23)** However, most of the polymers used in industry are not natural, but synthetic. **(24)** The term 'plastic' is generally used to refer to synthetic polymers, in other words, those that are manmade.

Thermoplastics and thermosetting plastics

(4) **(25)** Synthetic polymers can be divided into two main categories:
(26) **Thermoplastics** can be melted by heat, and formed in shaped containers called molds. **(27)** After the liquid plastic has cooled, it sets to form a solid material. **(28)** A thermoplastic is a type of plastic that can be heated and molded numerous times. **(29)** Examples of thermoplastics that are common in engineering include:

- **ABS (acrylonitrile butadiene styrene):** stiff and light, used in vehicle bodywork.
- **PC (polycarbonate):** used to make strong, transparent panels and vehicle lights.
- **PVC (polyvinylchloride):** a cheaper plastic used for window frames and pipes.

(30) Thermosetting plastics, also called thermosets, can be heated and molded like thermoplastics. **(31)** They may also be mixed from cold ingredients. **(32)** However, during cooling or mixing, a chemical reaction occurs, causing thermosets to cure. **(33)** This means they set permanently, and cannot be molded again. **(34)** If a thermoset is heated after curing, it will burn. **(35)** Examples of thermosets used in engineering are:

- **Epoxy resins:** used in very strong adhesives.
- **Polyimides:** strong and flexible, used as insulators in some electric cables.

(5) **(36)** Two more categories of polymers are engineering plastics and elastomers. Engineering plastics are mostly thermoplastics that are especially strong, such as ABS and polycarbonate. **(37)** Elastomers are very elastic polymers which can be stretched by force to at least twice their original length, and can then return to their original length when the force is removed.

A) Comprehension

I - Vocabulary

Find the words in the reading which fit the definitions below.

I - 1 Technical Vocabulary

1. _____ : **(n.)**, a metallic solid or liquid that is composed of a homogeneous mixture of two or more metal elements.
2. _____ : **(n.)**, denoting substances, esp. synthetic resins that become plastic on heating and harden on cooling which are able to repeat these processes.
3. _____ : **(n.)**, a material, esp. a synthetic plastic or resin, that hardens permanently after one application of heat and pressure.
4. _____ : **(n.)**, a combination of two or more separate elements or parts; a mixture.
5. _____ : **(n.)**, a milky fluid found in many plants, which exudes when the plant is cut and coagulates on exposure to the air.
6. _____ : **(adj.)**, prepared or made artificially; not genuine; artificial.
7. _____ : **(v.)**, harden (rubber, plastic, concrete, etc.) after manufacture by a chemical process such as vulcanization; to vulcanize; to set.
8. _____ : **(n.)**, any natural or synthetic polymer having elastic properties, e.g. rubber.

I - 2 General Vocabulary

1. _____ : **(v.)**, to experience; be subjected to; to experience; to endure.
2. _____ : **(adj.)**, extremely small; minute.
3. _____ : **(adj.)**, of exceedingly great size, extent, or quantity; extremely large; enormous.
4. _____ : **(adj.)**, a covering for a wheel, usually made of rubber fitted around a wheel.
5. _____ : **(v.)**, to cause to extend from one place to another or across a given space; to lengthen; to widen.

II - Understanding the Passage

2.1 Questions on the Text

Answer these questions on the reading text.

a. What are the two main kinds of engineering materials?

b. What are the two subgroups of metals? Give some examples of each group.

c. What property Chromium can improve when added to steel?

d. Is brass an alloy? Why?

e. What types of materials are used for high temperature design?

f. What are the two main categories of plastics?

g. Can all plastics be shaped and reshaped?

h. What causes themosetts to set permanently?

2.2 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ Cast iron contains more carbon than steel.

b. _____ Chromium improves the properties of steel.

c. _____ Ceramics can withstand high temperatures.

d. _____ Plastics can be made from ceramics and wood.

e. _____ Latex is a manmade rubber.

f. _____ Thermosetting plastics can be machined.

g. _____ Thermosets can be reshaped.

2.3 Contextual Reference.

Answer the following questions about the referents.

a. In sentence **(2)**, '**they**' refers to: _____

b. In sentence **(5)**, '**the' former** refers to: _____

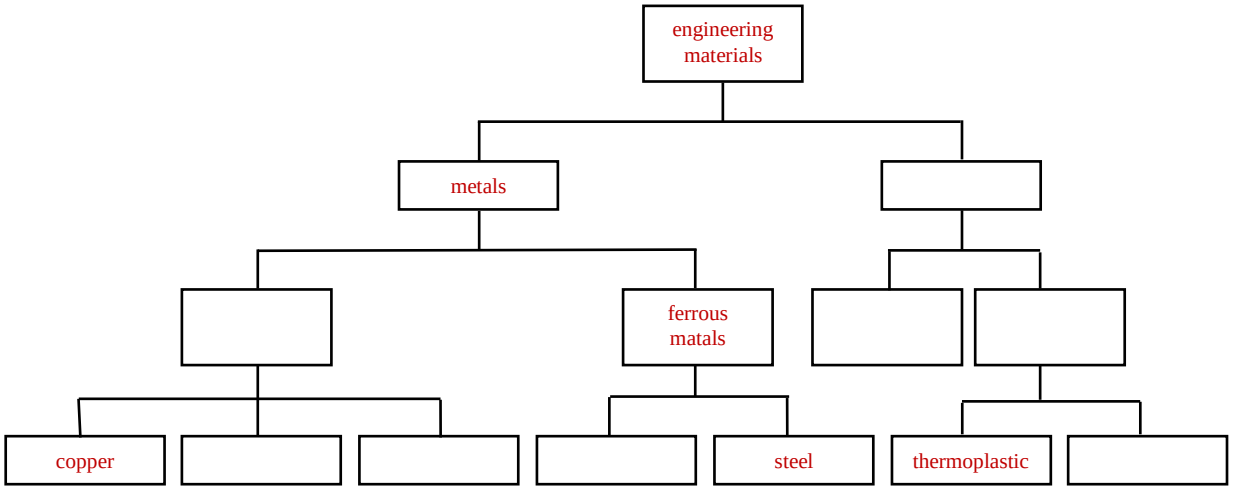
c. In sentence **(5)**, '**the' latter** refers to: _____

d. In sentence **(8)**, '**it**' refers to: _____

e. In sentence **(13)**, '**they**' (of methane) refers to: _____

2.4 Classification:

Draw in your notebook the diagaram below and complete it, using the information from the reading passage.



2.5 Rephrasing

Rewrite the following sentences replacing the bold underlined words with expressions from the text which have a similar meaning.

a. There are two kinds of **engineering** materials.

_____

b. Nickel steel is a **mixture** of iron, carbon and nickel.

_____

c. Chromium **can be included in** steel to provide a good cutting edge.

d. There are many **kinds** of steel used in industry**.**

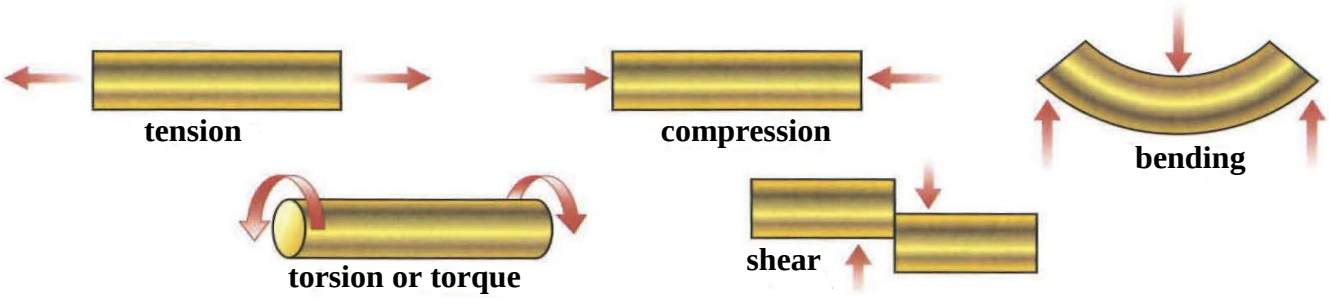
e. Ceramics are **used** by engineers where heat-resistant materials are needed.

f. Chromium steels **resist** corrosion.

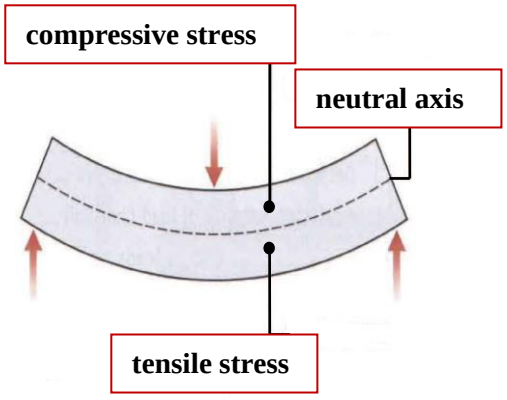
III - Materials Properties

A) Types of Forces and Deformations

Non-technical word	Technical term (noun)	Adjective used with the nouns stress, load and force	Initial deformation of component or member
Stretching	Tension	Tensile stress	It will **extend** (lengthened)
Squashing	Compression	Compressive stress	It will **compress** (shorten)
Bending	Bending	Bending stress	It will **bend**- we can also say it will **deflect** or flex. Beams usually **sag**, deflecting downwards. In some cases **deflection** or **flexure** is upward-the beam hogs.
Scissoring	Shear or shearing	Shear stress	It will deform very little, failing suddenly.
Twisting	Torsion or torque	Torsional stress	It will **twist**.



Bending comprises two opposite stresses: tension and compression. This is shown in the diagram of a simply supported beam. As a result of the bending force, the lower half of the beam is in tension and the upper half is in compression. These opposite stresses reach their maximum at the upper and lower surfaces of the beam, and progressively decrease to zero at the neutral axis - an imaginary line along the centre.



B) Types of Failure

The ultimate failure of a component or **structural member** depends on the type of force:

- In tension - it will **fracture**
- In compression- if it is thick, it will **crush** (squash). If it is **slender** (long and thin), it will **buckle**, bending out of shape
- In bending - it will fracture on the side of the component which is in tension, or crush on the side which is in compression, or fail due to a combination of both
- In shear- it will **shear** (break due to shear force)
- In torsion - it will fracture or shear.

When vertical members can no longer **resist** a load they either crush or buckle.

C) Properties of Materials

Now learn and understand the folowing desriptive words that are in bold.

Descriptive words	Examples
We can bend materials which are **flexible**.	Rubber is a **flexible** material.
We cannot bend something that is **stiff**.	Wood is a **stiff** material.
Something that is **brittle** breaks easily.	Glass is a **brittle** material.
It is difficult to break something that is **tough** or **strong**.	Concrete is a **tough**, **strong** material.
Something that is not strong is **weak**.	Cardboard is too **weak** to be used for walls.
A surface that is friction-free is **smooth**.	Glass is **smooth**.
Liquid can pass through something that is **porous**.	A paper filter is **porous**.
A surface that is uneven and not smooth is **rough**.	Concrete has a **rough** surface.
Something that compress when we push down on it is **hard**.	Concrete is very **hard**.
A material that returns to its original shape after it is pulled is **elastic.**	A rubber band is **elastic**.
A material that is very heavy in proportion to its volume is **dense**.	Lead is a **dense** material.

D) Exercises

Activity 1 Resistence to Tension

The question below contains a mistake about a technical fact. Can you find the mistake?

I was under the impression that concrete and steel bars were used together in reinforced concrete (RC) because concrete is good at resisting compression and poor at resisting tension, whereas steel is strong in tension. I also thought the steel always went at the bottom of an RC beam because that's the part that's in tension, whereas the top of the beam is free from stress. But if that's the case, when you see reinforcement being fixed in big RC beams, why are there bars both at the bottom and at the top?

Activity 2 Text Completion

Now complete a structural engineer's answer to the question in activity 1 using the words in the box. Look at A and B above to help you.

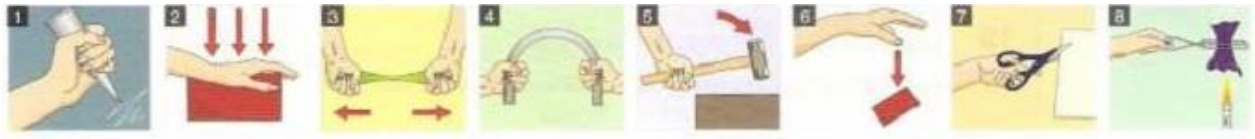
bending - compressive - deflect - fracturing - neutral - tensile
compression - crushing - deflection - hog - sag - tension

When a beam is subjected to **(1)** _____ stress, the bottom part is generally in tension, as you rightly say. But the top part is not 'free from stress', as you suggest. It's in **(2)** _____ . Only the horizontal centreline of the beam, a zone called the **(3)** _____ axis- is not stressed. It's also important to be clear about the strengths of concrete and steel. You're right that concrete is poor at resisting **(4)** _____ stress as it's prone to failure by **(5)** _____ suddenly. It's also true that concrete is good at resisting **(6)** _____ stress. But steel is much stronger than concrete, not just in **(7)** _____ as you point out, but also when it's compressed. So steel is often put in the tops of beams in cases where the beam is subjected to high levels of compression, meaning that the concrete requires reinforcing to prevent it from **(8)** _____ and failing. Another possible reason for a beam having steel in the top is to take tension. Why would you get tension in the top of a beam? It's true that most beams want to **(9)** _____ downwards because gravity causes them to **(10)** _____ , putting only the bottom of the beam in tension . But in some structures, there are beams or parts of beams that want to **(11)** _____ - being forced into upward **(12)** _____ .

Activity 3 Descriptive verbs

Match the actions with the verbs in the box.

bend - compress - cut - drop - heat - scratch - stretch - strike



_____ _____ _____ _____ _____ _____ _____ _____

Activity 4 Sentence building

Write answers to these questions using the prompts in brackets, not necessarily in the same order.

a. What's the difference between materials of compressive strength and tensile strength?
(strong / pulled / pressed)
The first material is strong when it is pressed, and the second is strong when it is pulled.

b. What's the difference between impact-resistant and impact-absorbent materials?
(soft / rigid / return / shape / not break) _____

c. What's the difference between a water-resistant and a water-proof watch?
(guarantee / keep out / water / not) _____

d. What's the difference between flammable and non-flammable materials?
(burn / not burn) _____

e. What's the difference between materials with tortional strength and materials with tensile strength?
(strong / streched / twisted material) _____

f. What's the difference between ductile and malleable materials?
(rolled / pulled / longer, thinner / shape / new shape) _____

Activity 5 Descriptive adjectives

Underline The two correct adjectives for each material.

a. A ceramic cup is **flexible / heat-resitant** and **hard / soft**.

b. A concrete floor is **rigid / flexible** and **brittle / tough**.

c. A rubber tire is **rigid / flexible** and **weak / strong**.

d. A fiberglass window frame is **heat-resistant / soft** and **rigid / flexible**.

e. A nylon rope is **rigid / flexible** and **strong / weak**.

f. The graphite in the middle of the pencil is **light / heavy** and **hard / soft**.

Activity 6 Descriptive adjectives

Match each sentence with its corresponding adjective.

1	☐	It's flexible.	**a**	When you heat it, it doesn't burn or deform.
2	☐	It's rigid.	**b**	When you drop it or strike it, it doesn't break.
3	☐	It's hard.	**c**	When you compress it, it doesn't break or deform.
4	☐	It's tough.	**d**	When you twist it, it doesn't break or deform.
5	☐	It's elastic.	**e**	You can't bend it.
6.	☐	It's heat-resistant.	**f**	You can bend it, and it doesn't break.
7	☐	It's strong in tension	**g**	You can stretch it and make it longer, but it doesn't break.
8	☐	It's strong in compression	**h**	When you pull it, it doesn't stretch or break.
9	☐	It has torsional strength	**i**	You can't scratch it or cut it.

Activity 7 Use of the verbs 'break' and 'bend'

Complete the sentences with bend or break and other words

a. Polyester is a tough material. You can't _____ it easily.

b. Concrete is a rigid material. It doesn't _____ easily.

c. Polycarbonate is a hard material. It _____ .

d. This glass is brittle. You _____ .

e. These plastic rulers are very flexible. They _____ .

Activity 8 Adjective spelling

The gapped words below all describe physical or chemical properties of substances. The meaning of each word is given on the right. Complete the words with the correct vowels **(a, e, i, o, u)**.

1	☐	Br_ttl_n_ss	How easily something can be broken.
2	☐	C_p_c_t_nc_	How well something holds an electrical charge.
3	☐	C_ nd_ct_v_ty	How well something allows heat or electricity to go through it.
4	☐	D_ns_ty	How much mass a given volume of a substance has.
5	☐	Fl_mm_b_l_ty	How easily something burns.
6	☐	L_m_n_nc_	How much light passes through or comes from a substance.
7	☐	P_rm_ _b_ 1_ty	How easily gases or liquids go through a substance.

Unit 2 Rush of New Uses of Plastics: Dim Future for Glass and Metal

(1) The revolution in plastics has moved out of the laboratory and into the marketplace, and according to chemists and entrepreneurs, for many products the days of glass and metals are numbered.

(2) For consumers, the first effects of the revolution can already be seen. A plastic automotive engine has been built, giving better fuel efficiency, and on the horizon are lightweight plastic batteries, fuel cells and paper-thin arrays of solar cells that can be pulled off a roll. Even the simple toothpaste tube is no longer so simple. Once made of lead, it is now composed of nine layers of plastics and other materials that, among other handy qualities, refuse to break open and ooze toothpaste even after repeated folding. Further signs of the revolution are snack bags and cooking pouches that are impossible to puncture except with a sharp knife or scissors. Industry experts expect the speed of the change to quicken. "When you look at costs of production, aluminum is at the top, glass is in the middle, and plastic is right at the bottom." Said one manufacturer. "In five years, you will hardly be able to find glass or metal in the supermarket."

(3) The age of superplastics has its origin in the last decade or so and is largely a result of fundamental insights into the nature of matter, most specially the electronic and physical properties of monomers. In 1977, scientists probing the secrets of electroconductive salts discovered that a plastic known as polyacetylene, usually an electrical insulator, would suddenly conduct electricity when treated with a vapor of bromine or iodine. That discovery touched off researcher worldwide. Metals conduct electricity because they unleash and transfer their electrons (tiny sub-atomic particles that carry what had long been considered an indivisible unit of nature, the negative electric charge. But physicists believe that conductivity in plastics may well be evidenced of a fractional charge). Work on conductive plastics has been described as "one of the hottest areas in modern physics." Dr. David Nairs, a chemist at the university of Pennsylvania, said the fabrication of lightweight fuel cells, batteries and solar cells was being vigorously pursued around the world. "you could literally cover the roof of a home with plastic solar cells, rolling them out like plastic wrap," he said in an interview.

(4) Chemical insights have also given rise to a new class of supertough and heat-resistant plastics. Fifteen years ago, for instance, chemists drawing on new knowledge of how molecules interact, devised a way to hook a sulfur-based monomer into long chains. Known as polysulfones, these turned out to have a high resistance to acids, bases, water and heat. The result was a new family of plastics. Udel, the brand name of a Union Carbide superplastic can withstand temperatures of 300 degrees Fahrenheit (149 degrees Celcius) and has a tensile strength of 10,000 pound per square inch, as against 32,000 p.s.i. for brass. It easily fills in for glass, stainless steel and nickel. Udel is widely used in medical instruments and milking machines, both of which must be sterilized before use. It can be found in products ranging from egg cookers to pacemakers and astronauts' helmets.

(5) Since the mid-1970's, even stronger (and more expensive) metal-like plastics have emerged that can take higher temperatures and stresses. Kevlar, five times stronger than steel is widely used to make bulletproof vests. The toughest metal-like plastic yet created was recently announced by scientists at DuPont de Nemours & co. known as Delrin ST, for supertough, it will according to Dupont officials, find its way into everything from automotive bearings and bicycle gears to typewriter parts. Perhaps the epitome of super-toughness is the plastic automotive engine. A New Jersey inventor said his patented plastic engine, built under contract to Ford Motor Co., will be used for the first time this winter in racing cars. It is about half the weight of an all-metal engine and much quitter. Moreover, because it is made of molded plastic, it needs less of the expensive machining so often used to shape metal parts. The next project, according to the inventor, is a plastic diesel engine for small airplanes.

(6) A bevy of new techniques is shaping the new plastics into useful products. Perhaps the most remarkable is a process known as "barrier coextrusion" in which different polymers, each with a unique quality are bound together into a single sheet that performs multiple tasks such as blocking the passage of light, oxygen, and flavor. An example is a potato chip bag, seemingly impervious to puncture. Its inner and outer layers block light moisture and large chemicals, while a middle layer blocks the migration of molecules such as oxygen. The final two layers tie the whole thing together. A pioneer of coextrusion, the

American Can Co., says these products weigh less, work better and are cheaper than metal-foil counterparts. At first limited to films, coextrusion has recently been adapted to make squeezable bottles. Coextrusion is also extending the shelf life of perishables. Containers of a widely distributed brand of fruit drink in a flexible plastic and metal package, are first sterilized by a blast of hot steam, then filled with fruit drink at a temperature of 195 degrees. After sealing, they have a shelf life of more than a year.

(7) Steel-like plastic is easy to make-but expensive. Greater demand will drive down the price, a trend clearly at work in the automotive industry, especially in fuel-conscious Europe. The amount of plastic in the typical European car has risen to almost 7 percent by weight, some models having as much as 10 percent plastic.

(8) A problem in all this is recycling. Within cars, for example, about 70 percent of their weight (mostly metal) can be recycled, but not plastic parts, a problem currently under attack by chemists. They feel that a solution to this problem is essential and well within the existing new possibilities of research now being done.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**, to cause to be less bright.
2. _____ : **(n.)**, arrangement.
3. _____ : **(v.)**, to pass or flow slowly, especially of a hick liquid.
4. _____ : **(v.)**, to make a small hole, usually with a sharp instrument.
5. _____ : **(v.)**, to examine closely.
6. _____ : **(v.)**, to cause to begin.
7. _____ : **(v.)**, release, allow to be free.
8. _____ : **(adv.)**, exactly, precisely as stated.
9. _____ : **(v.)**, to catch or connect and then hold.
10. _____ : **(n.)**, the part of a machine in which a turning rod is held.
11. _____ : **(n.)**, a thing or person that shows, to a very great degree, a quality or set of qualities.
12. _____ : **(v.)**, to cut wood or metal, usually to very precise specifications.
13. _____ : **(n.)**, a large group or collection.
14. _____ : **(adj.)**, not allowing to pass through.
15. _____ : **(v.)**, to fasten or connect together.
16. _____ : **(v.)**, to press in from opposite sides or around.
17. _____ : **(n.)**, the period a product remains fresh or useable in storage.
18. _____ : **(adj.)**, that which decays quickly.
19. _____ : **(n.)**, a general direction or course of development.

II - Main Ideas:

1. The main idea of this passage is:
   - **a.** Recent scientific discoveries have made possible the development of new plastics and processes.
   - **b.** The problem of recycling is one which must be solved before superplastics can be fully developed.
   - **c.** Because of the high cost of metal and glass as packaging materials, new plastics and processes must be developed.

2. Which of the following cause/result relationships is false?
   - **a.** Concern about fuel efficiency results in an increased use of plastics in cars.
   - **b.** A lower price for new plastics may result in greater demand for them.
   - **c.** Coextrusion makes possible the extended shelf life of certain perishable, resulting in new layered plastics.

III - Understanding the Passage

3.1 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

- **a.** _____ Electroconductivity is a prerequisite for plastic batteries and solar cells.
- **b.** _____ Superplastics have been developed in the past ten years.
- **c.** _____ Plastics and metals conduct electricity in much the same way.
- **d.** _____ Plastics used for medical instruments must be able to withstand high temperatures.
- **e.** _____ The supertough plastics tend not to be very heat resistant.
- **f.** _____ A sulfur-based monomer is the key to the new supertough heat-resistant plastics.
- **g.** _____ The primary problem with steel-like plastics is the difficulty of fabrication.
- **h.** _____ Coextrusion is limited to the production of films.
- **i.** _____ Chemists expect to be able to solve the problem of recycling plastics.

3.2 Implicit Information

Indicate by true or false those statements which can be inferred from the information in the passage. A statement may be true but not supported by information in the passage.

- **a.** _____ The primary advantage of plastics is cost.
- **b.** _____ Aluminum, the most expensive, commonly used packaging material is becoming more expensive.
- **c.** _____ The insulating properties of plastics have, in the past, limited its use in certain areas.
- **d.** _____ Conductivity, strength, and heat resistance are qualities which have, in the past, outweighed the higher cost of glass and metal as packaging materials.
- **e.** _____ Physicists are not sure why plastics conduct electricity.
- **f.** _____ A plastic engine would make automobiles cheaper.
- **g.** _____ The tensile strength of Udel is greater than that of nickel.
- **h.** _____ Newly developed products tend to become less expensive as a result of demand.
- **i.** _____ Steel-like plastic is still more expensive than steel.
- **j.** _____ The typical European car contains a greater percentage of plastics that does the typical American car.

3.3 Extra Vocabulary

Complete the second sentence in each pair by adding a word or words from the box below.

or so - may well be - as against - widely - to give rise

a. The age of superplastics has its origin in approximately the last decade.
The age of superplastics has its origin in the last decade _____ .

b. Udel has a tensile strength of 10,000 lb./in^2 compared to 32,000 p.s.i. for brass.
Udel has a tensile strength of 10,000 lb./in^2 _____ 32,000 p.s.i for brass.

c. Udel is used to a large degree in medical instruments.
Udel is _____ used in medical instruments.

d. Physicists believe that it is very possible that conductivity in plastics is evidence of a fractional charge.
Physicists believe that conductivity in plastics _____ evidence of a fractional charge.

e. Chemical insights have caused a new class of supertough and heat-resistant plastics to develop.
Chemical insights have also _____ a new class of supertough and heat-resistant plastics to develop.

3.4 Prediction

Complete the following passage by adding a word or phrase in the blanks. The word or phrase must fit grammatically and semantically.

Recent developments in the field of plastics include new types of plastics as well as techniques for processing them. The discovery of a _____ of inducing conductivity into plastics has opened the way _____ the development of many new products _____ batteries and solar cells. Previously, the insulating properties of plastics _____ their use for these products.

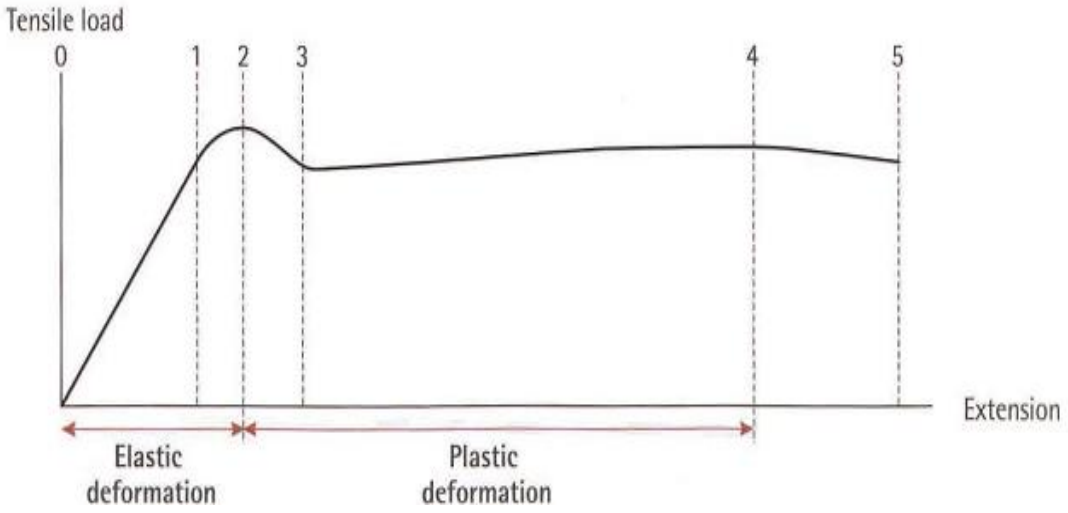
The new plastics also include _____ which can compete with metals and glass _____ strength and heat-resistance. Udel, the brand name of one of the "superplatics" is currently being used for medical instruments which _____ be sterilized _____ extremely high temperatures. Plastics have been developed which are _____ tough _____ they can replace metal _____ automobile engines.

Presently, these metal-like plastics are _____ very expensive but are expected to become cheaper _____ demand increases.

One of the most interesting new techniques for shaping plastics is "barrier coextrusion" _____ which several polymers, _____ with a unique quality, are bound together _____ one sheet. _____ , a single sheet may possess _____ qualities as heat resistance, ability to block moisture and oxygen, and strength. _____ the major problem of recycling, plastics are replacing glass and metal in more and more applications.

B) Testing of Materials

B - I The Tensile Test



The tensile strength and ductility of a material are determined by carrying out a tensile test. A standard test piece is fixed between two grips which are fitted to the testing machine. A load is applied to the test piece and the extension is recorded. Most modern testing machines have recorders which automatically produce a load-extension graph during the test. On the graph shown below distinct points can be marked off. These are as follows:

a) The elastic limit: This is the point up to which a material remains elastic. In other words, it is the point beyond which a material ceases to return to its original shape or size on removal of the load to which it is subjected. After the material takes on permanent set, i.e. it will not return to its original size, it is said to be plastic.

b) The yield point: This is the point at which the material suddenly extends without an increase in load.

c) The maximum load: This is the point at which the applied load reaches its maximum. After this point the phenomenon known as "necking" or "waisting" is observed. This is the phenomenon in which the specimen becomes much thinner prior to breaking.

d) The breaking point: This is the actual point at which the specimen breaks. The load at this point is less than that at the maximum load.

1. **Answer the following questions**

   a. What is the purpose of carrying out a tensile test?

   b. Explain the difference between a plastic and an elastic material.

   c. Define 'necking' and 'permanent set'.

   d. What is the difference between the elastic limit and the yield point?

   e. Does the specimen in a tensile test break at a load greater or smaller than the maximum load?

2. Match the descriptions with the corresponding points and stages of a tensile test, and reorder them.

1 ☐	**Points 0-1**	**a**	The test piece reaches its **yield point**.
2 ☐	**Point 1**	**b**	The test piece reaches the **limit of proportionality**. Beyond this point, length begins to increase at a slight greater rate than tension.
3 ☐	**Point 2**	**c**	The **elastic limit** is reached.
4 ☐	**Point 3**	**d**	The extension of the test piece is **proportional** to the increase in tension.
5 ☐	**Point 4**	**e**	This is the **fracture point**, where the test piece breaks in two.
6 ☐	**Point 5**	**f**	This is the ultimate tensile strength **(UTS)**.

B-II Exercises

Activity 1 Elasticity and Plasticity

Some materials can extend significantly, but still return to their original shape. A material's ability to do this is called **elasticity**. Rubber is an example of a very elastic material. It can be **elastically deformed** to a considerable extent.

If a material has very low elasticity, and is strong, engineers say it is stiff. If a material has low elasticity and is weak, it is described as brittle, that is, it fractures (breaks, due to tension) very easily. Glass is an example of a brittle material. Some materials can change shape significantly, but do not return to their original shape. We say these materials are **plastic**. Often, **plasticity** is described in specific terms. A material that can be **plastically deformed** by hammering or rolling, for example, lead (Pb) is **malleable**. A material that can be drawn out (stretched) into a long length, for example, copper (Cu) is **ductile**.

Activity 2 Definitions

Match the two parts (1-6) to (a-f) to make correct sentences. Look at the text above and at B-I to help you.

1 ☐	If a material is stiff	**a**	It is malleable and/or ductile.
2 ☐	If a material is brittle	**b**	It has low elasticity and low tensile strength.
3 ☐	If a material is plastic	**c**	It has low elasticity and high tensile strength.
4 ☐	If a material yields	**d**	It has been extended to a point before its elastic limit.
5 ☐	If a material fractures	**e**	It has been loaded beyond its ultimate tensile strength.
6 ☐	If a material is elastically deformed	**f**	It has been significantly plastically deformed, but not broken.

Activity 3 Materials Testing: Destructive tests

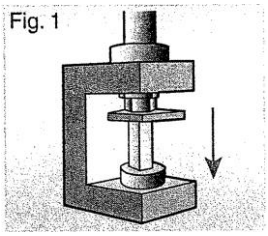
Read these descriptions of tests, and then fill in the gaps and write the figure number of each corresponding test.

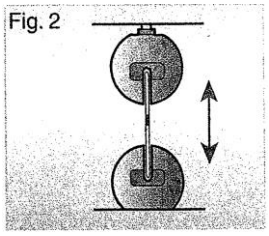
The purpose of the tensile strength test (**Fig.** ____) is to discover whether a material will ***deform*** (change shape) or break when it is pulled apart. The material is secured with two clamps, one at each end. The clamps are pulled apart with a specified force. The ***yield point*** (the point where the material deforms) and/or the ***breaking point*** (the point where the material breaks) is measured. This measurement shows you the tensile strength of the material.

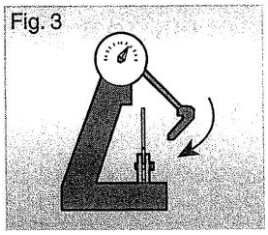
The aim of the impact-resistance test (**Fig.** ____) is to find out whether a material will bend or break when it is struck with force. The bottom of the material is placed in a clamp, so that it stands vertically. A hammer strikes the material with a specified force. The yield point and/or the breaking point is measured. This indicates the impact resistance of the material.

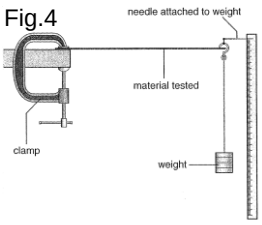
The objective of the compressive strength test (**Fig.** ____) is to find out if a material will deform or break when it is compressed. The material is secured in a clamp between a fixed head and a moving head. The moving head presses down on the material and the load is increased. The yield point and/or the breaking point are measured. This indicates the compressive strength of the material.

The aim of the rigidity test (**Fig.** ____) **(1)** _____(discover/to discover) if a material **(2)** _____ (deform/deforms) or **(3)** _____(breaking/breaks) when it **(4)** _____ (is bending/is bent) by a force. One end of the material **(5)**_____ (secures/is secured) in a clamp, so that the material **(6)** _____(holds/is held) horizontally with one end free. A weight **(7)** _____ (attaches/is attached) to the free end, and then the load **(8)** _____ (is increased/is increasing) by adding more weights. The breaking point **(9)**_____ (measures/ is measured). This **(10)**_____(shown/shows) us the rigidity of the material.









Activity 4 Sentence Building

Choose the right test from the box. Make sentences, using the past tense and the given words. The first one has been done for you.

impact-resistance - heat-resistance - tensile strength
compressive-strength - drop - elasticity - frame

a. aim / see / forks / bend / when / struck with force.
The aim of the fram was to see whether the forks would bend when they were struck with force.

b. purpose / find out / material / deform or break / when / pulled apart.

c. aim / discover / material / bend or break / when / hammered with force.

d. objective / find out / material / crack or deform / when / compressed.

e. purpose / discover / materials / break / when / stretched.

f. aim / find out / material / deform or melt / when / heated to 120 degrees Celcius.

Activity 5 Paragraph Completion

In a continuous paragraph, what is new in one sentence usually becomes given in the next. This exercise trains you to predict what comes next on the basis of what has already been given or is interpretable (understood) from the context. If you have any problems with any blanks, reread the information that precedes it and try again.

To measure tensile strength, a test specimen of uniform cross-section is clamped at each end and stretched until it breaks. _____ is defined as the stress or _____ necessary to _____ the sample at a constant rate of _____. _____ is calculated by dividing the maximum force by the original cross-sectional area. _____ usually varies from about 1,000 to 12,000 p.s.i. for most common commercial _____ Elongation, the increase in _____ of a sample at the breaking point, is also a useful property. _____ is associated with the separation of polymer molecules and their movement relative to other _____. As might be expected, highly crosslinked polymers have _____ elongation relative to _____ ones.

Activity 6 Descriptive Adjectives

Complete the test description using the nouns in the box.

Absorbency - ductility - durability - malleability - rigidity

a. In the _____ test, pieces of different materials were weighed before and after the test. Water was added and the volumes of water taken in by the materials were calculated from the weight increase.

b. In the _____ test, the plastic laminate is rubbed continuously by an abrasive wheel. The material is examined every 10 hours, and the deterioration of the material is measured. This testing provides an estimate of the plastic product's lifetime span.

c. The _____ test was carried out by means of a tensile test. A wire was stretched to breaking point, and the percent of elongation (lengthening) was calculated. After the test, the wire retained its changed shape when the load was removed.

d. The _____ test is similar to a flexibility test. A material is placed repeatedly under increased loads. The test determines whether any bending can be measured, and if so, how much.

e. In a test of _____, a sheet of the test material is placed on a doming block and is hit repeatedly with a metal punch. The test determines whether the material can be permanently deformed by compression into a new shape without cracking or tearing.

Unit 3 Polymerization Techniques

(1) In actual practice there are many different techniques used to carry out polymerization reactions, however, most involve one of four general methods of polymerization. These include the polymerization of the monomer or reactants in bulk, in solution, in suspension, and in emulsion forms. The bulk and solution methods are used for the formation of both addition and condensation type polymers, whereas suspension and emulsion techniques are largely used for addition polymerizations.

Bulk Polymerization

(2) This type of polymerization involves the reaction of monomers or reactants among themselves without placing them in some form of extraneous media such as is done in the other types of polymerizations. Two types of behavior are observed in bulk polymerizations. In one case, the polymer is soluble in the monomer during all stages of the polymerization and a monomer-soluble initiator is used. As polymerization progresses, viscosity increases significantly, and chain growth takes place in the monomer or polymers dissolved in the monomer until all of the monomer is consumed. In the second case, the polymer is insoluble in the monomer system. In such systems, the polymerization is believed to occur within the growing polymer chains since very high molecular weights are formed even though the polymer chain drops out of the monomer solution. One of the disadvantages of carrying out polymerization in bulk is the fact that the rise in viscosity can interfere with keeping the reaction conditions under control due to the difficulty of maintaining proper agitation and removing heat from exothermic polymerization reactions which give off heat. However, the process is widely used.

Solution Polymerization

(3) Solution polymerization is similar to bulk polymerization except that whereas the solvent for the forming polymer in bulk polymerization is the monomer, the solvent in solution polymerization is usually a chemically inert medium. The solvent used may be complete, partial, or nonsolvent for the growing polymer chain. When monomer and polymer are both soluble in the solvent, initiation and propagation of the growing polymer chains take place in the oil or organic phase. Because of the mass-action law, rates of polymerization in solvents are slower than in bulk polymerization and the molecular weight of the polymers formed is decreased. In another case, when the monomer is soluble in the solvent but the polymer is only partially soluble or completely insoluble in the solvent, initiation of the polymerization takes place in the liquid phase. However, as the polymer molecules grow, some of the propagation of polymers takes place within monomer swollen molecules which are beginning to precipitate from the reaction. When this occurs it again becomes possible to build up molecular weights because of the decreased dilution within the polymers. Thus, molecular weights as high as those possible with bulk polymerizations can be achieved in solution polymerizations provided that the polymer precipitates out of solution as it is formed and creates a propagation site. In the third case, in which the polymer is completely insoluble in the solvent and the monomer is only partially soluble in the solvent, rates of reaction are reduced and lower molecular weights, below those possible in bulk polymerizations, are formed. However, the formation of relatively high molecular weight polymers is still possible in such a system. In addition to the relative solubilities of monomer, polymer, and solvent in the system, the way in which the ingredients are fed to the system can also have a significant effect on how the polymerization proceeds, and hence the structure of the finished polymer.

Suspension Polymerization

(4) Often called “pearl” polymerization, this technique is normally used only for catalyst-initiated or free-radical addition polymerizations. The monomer is mechanically dispersed in a liquid, usually water, which is a nonsolvent for the monomer as well as for all sizes of polymer molecules which form during the reaction. The catalyst initiator is dissolved in the monomer and it is preferable that it does not dissolve in the water so that it remains with the monomer. The monomer and polymer being formed from

it remain within the beads of organic material dispersed in the phase. Actually, suspension polymerization is essentially a finely divided form of bulk polymerization. The advantage of the suspension polymerization over bulk is that it allows the operator to effectively cool exothermic polymerization reactions and thus maintain closer control over the chain building process. Other behavior is the same as bulk polymerization. By controlling the degree of agitation, monomer to water ratios, and other variables, it is also possible to control the particle size of the finished polymer, thus eliminating the need for reforming the material into pellets from a melt such as is usually necessary with bulk polymerizations.

Emulsion Polymerization

(5) This s a technique in which polymerizations are carried out in a water medium containing emulsifier (a soap) and a water soluble initiator. It is used because emulsion polymerization is much more rapid than bulk or solution polymerization at the same temperatures and produces polymers with molecular weights much greater than those obtained at the same rate in bulk polymerizations. The polymerization reaction in emulsion polymerization involves emulsifiers causing the reaction to take place within a small hollow sphere composed of film of soap molecules, called a micelle. Monomer diffuses into these micelles and control of the soap concentration, overall reaction-mass recipe, and conditions provide additional controls over the reaction. Polymerization techniques can have a significant effect on the number, size, and characteristics of the polymer molecules formed and will thus have a significant effect on the properties of the polymer. Thus, batches of a polymer such as polystyrene, which can be made by any of the four polymerization techniques described above, will differ depending on which type of polymerization method was used to make the material.

A) Comprehension

I - Vocabulary

I - 1 Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(n.)**, a chemical reaction in which the molecules of a monomer are linked together to form large molecules whose molecular weight is a multiple of that of the of the original substance.
2. _____ : **(n.)**, a relatively simple compound which can react to form a polymer.
3. _____ : **(n.)**, one of the substances involved in a chemical reaction, e.g. dilute sulphuric acid and zinc are the reactants in a reaction for making zinc sulphate and hydrogen.
4. _____ : **(n.)**, a simple combination of molecules without any by-products formed as the result of the combination. The molecules which combine do not decompose to produce fission products.
5. _____ : **(n.)**, a polymer formed by chemical condensation, i.e. by removal of small molecules such as H_2O, HCl, NH_3. The structural units (mers) have no structural identity with the monomers.
6. _____ : **(adj.)**, an exothermic reaction (change) is one in which heat energy is evolved, i.e. there is a rise of temperature in the surroundings.
7. _____ : **(n.)**, an electrically charged particle formed by an aggregate of molecules and occurring in certain colloidal electrolyte solutions, as those of soaps and detergents.

I - 2 General Vocabulary.

1. _____ : **(adj.)**, destroyed or expanded by use; used up.

2. _____ : **(v.)**, violent irregular action.
3. _____ : **(v.)**, fall from something.
4. _____ : **(adj.)**, enlarged in bulk as by absorption of moisture, the process of growth or the like; inflation; distention.
5. _____ : **(n.)**, multiplication by natural reproduction.
6. _____ : **(n.)**, a small, usually round object of glass, wood, stone, or the like.
7. _____ : **(n.)**, a smooth, rounded concretion formed within the shell of certain mollusks. An imitation of this.
8. _____ : **(v.)**, to pour and spread as a liquid; spread and scatter widely or thinly.
9. _____ : **(v.)**, to drive or send off in various directions.
10. _____ : **(n.)**, a set of instructions for making or preparing something, esp. a food dish.
11. _____ : **(n.)**, a quantity of material or number of things of the same kid or handed at the same time or considered as a group.

II - Understanding the Passage

2.1 Questions on the Text

Answer these questions on the reading text.

a. Is the know-how of bulk, solution, suspension, and emulsion polymerizations used by the other polymerizations methods?

b. What is the polymerization medium in bulk polymerization? Is it an advantage or a drawback?

c. Why high molecular weight polymers are relatively easy to obtain using bulk polymerization than using solution polymerization?

d. What are the main limitations of bulk polymerization?

e. What is the main difference between bulk and solution polymerization techniques?

f. What are the main governing parameters in solution polymerization?

g. Are suspension and emulsion polymerization methods more similar to bulk polymerization or to solution polymerization? Why?

h. What are the two main advantages of suspension polymerization over bulk polymerization?

i. Which of the polymerization techniques offer better control of polymerization reaction?

j. Does the polymerization method affect the performance of the prepared polymer?

2.2 True/False Questions

Study the following statements carefully and say whether are **true** (**T)** or **false** (**F)** according the information in the text and correct the false ones.

a. _____ Most polymerization techniques are based on the four types discussed in the passage.

b. _____ Bulk polymerization has no disadvantages when compared to the other types.

c. _____ Bulk polymerization is the simplest type.

d. _____ The principle difference between bulk and solution polymerization is the addition of a third ingredient, a solvent in solution polymerization.

e. _____ There is less control over molecular weight in solution polymerization than in bulk polymerization.

f. _____ Suspension polymerization is actually bulk polymerization taking place in a nonsolvent.

g. _____ Emulsion polymerization is the most complicated of the four types.

h. _____ The main reason for having various types of polymerization is that a particular polymer can be made by only one technique.

2.3 Implicit Information

Indicate by true or false those statements which can be inferred from the information in the passage. Be prepared to defend your answers.

a. _____ Other polymerization techniques are developments of the four discussed in the article.

b. _____ It is difficult to control bulk polymerization.

c. _____ The second type of bulk polymerization is not completely understood.

d. _____ Except under certain circumstances it is not possible to achieve as high molecular weight in solution as in bulk polymerization.

e. _____ Suspension polymerization has very specific applications.

f. _____ The nonsolvent in which the monomer is dispersed is used primarily to control variables.

g. _____ In emulsion polymerization, an increase in the reaction temperature results in an increase in the molecular weight.

h. _____ The greater the variety of polymerization techniques the greater the variety of polymer properties possible.

2.4 Contextual Reference

Answer the following questions about the referents in this paragraph.

Suspension Polymerization

(1) Often called “pearl” polymerization, **this technique is** normally used only for catalyst-initiated or free-radical addition polymerizations. **(2)** The monomer is mechanically dispersed in a liquid, usually water, which is a nonsolvent for the monomer as well as for all sizes of polymer molecules which form during the reaction.**(3)** The catalyst initiator is dissolved in the monomer and **it** is preferable that it does not dissolve in the water so that it remains with the monomer. **(4)** The monomer and polymer being formed from **it** remain within the beads of organic material dispersed in the phase. **(5)** Actually, suspension polymerization is essentially a finely divided form of bulk polymerization. **(6)** The advantage of the suspension polymerization over bulk is that **it** allows the operator to effectively cool exothermic

polymerization reactions and thus maintain closer control over the chain building process. **(7)** Other behavior is the same as bulk polymerization. **(8)** By controlling the degree of agitation, monomer to water ratios, and other variables, it is also possible to control the particle size of the finished polymer, thus eliminating the need for reforming the material into pellets from a melt such as is usually necessary with bulk polymerizations.

a. In sentence **(1) this technique** refers to _____

b. In sentence **(3) it** refers to: _____ and _____

c. In sentence **(4) it** refers to: _____

d. In sentence **(6) it** refers to: _____

2.5 Connectives

Complete the second sentence in each pair by adding a word or words from the list.

whereas - such as - provided that - the fact that - so that

a. The rise in viscosity can interfere with keeping reaction conditions under control. This is one of the disadvantages of carrying out polymerization in bulk.

One of the disadvantages of carrying out polymerization in bulk is _____ the rise in viscosity can interfere with keeping reaction conditions under control.

b. Solution polymerization is similar to bulk polymerization. The difference is that the solvent for the forming polymer in bulk polymerization is the monomer, but the solvent in solution polymerization is usually a chemically inert medium.

Solution polymerization is similar to bulk polymerization except that _____ the solvent for the forming polymer in bulk polymerization is the monomer, the solvent in solution polymerization is usually a chemically inert medium.

c. Thus, molecular weights as high as those possible with bulk polymerizations can be achieved in solution polymerizations if the polymer precipitates out of solution as it is formed and creates propagation.

Thus, molecular weights as high as those possible with bulk polymerizations can be achieved in solution polymerizations _____ the polymer precipitates out of solution as it is formed and creates propagation.

d. This type of polymerization involves the reaction of monomers or reactants among themselves without placing them in some form of extraneous media. In the other types of polymerizations the monomers and reactants are placed in some form of extraneous media.

This type of polymerization involves the reaction of monomers or reactants among themselves without placing them in some form of extraneous media _____ done in the other types of polymerizations.

e. The catalyst initiator is dissolved in the monomer and it is preferable that it does not dissolve in the water. This is done with the purpose of keeping it with the monomer.

The catalyst initiator is dissolved in the monomer and it is preferable that it does not dissolve in the water _____ it remains with the monomer.

2.6 Cohesion

Complete the following sentences using the words from the box below, and then reorder the sentences into a logical paragraph.

as - because of - provided that - or - when - however - thus - when - but

_____ **a.** _____, as the polymer molecules grow, some of the propagation of polymers takes place within monomer swollen molecules which are beginning to precipitate from the reaction.

_____ **b.** in another case _____ the monomer is soluble in the solvent _____ the polymer is only partially soluble _____ completely insoluble in the solvent, initiation of the polymerization takes in the liquid phase.

_____ **c.** _____ molecular weights as high as those possible with bulk polymerizations can also be achieved in solution polymerizations _____ the polymer precipitates out of the solution _____ it is formed and creates a propagation site.

_____ **d.** _____ this occurs, it again becomes possible to build up molecular weights _____ the decreased dilution within the polymers.

III - Structure of the text

The information in this passage is presented through a series of process description and comparisons of the processes. Complete the following diagram by listing the major characteristics of each process and its advantages and disadvantages.

	Characteristics	Advantages	disadvantages
Bulk			
Solution			
Suspension			
Emulsion			

B - Guided Writing

Stage #1 Sentence building

Join each of the groups of words below into one sentence, using the additional material at the beginning of each group. Omit the underlined words. Number your sentences and begin each one with a capital letter.

1. **in order to / , / ,**
   unbranched chains can pack closely together
   they pack together so that they can produce products
   these products are dense
   these products are stiff
   these products are heat-resistant

2. **and**
   cross-linked chains produce the strongest of all polymers
   they product the least soluble of all polymers.

3. **; / therefore / ,they / , / , / and**
   branched polymers have more voids than unbranched polymers
   branched polymers are more permeable to gases and solvents than unbranched polymers
   they are more flexible than unbranched polymers
   they are less dense than unbranched polymers

4. **; / therefore / , / they**
   cross-linked polymers will not melt
   cross-linked polymers are the most heat resistant of the 3 types

5. **ones**
   there are three common shapes
   these shapes are unbranched chains, branched chains, and cross-linked chains

6. **can**
   polymer molecules take shapes
   these shapes may be different

7. **kind of**
   each shape produces a final product
   these products are different

Stage #2 Paragraph building

Add **for example** to sentence 1, **on the other hand** to sentence 3 and **in addition to** sentence 4. Then, rewrite the seven sentences in a logical order to make a paragraph. Give the paragraph a suitable title.

Unit 4 Polymer Processing 1: Injection Molding

(1) Plastics are high-polymeric substances capable of flowing under heat and pressure into a desired final shape. **(2)** They can be divided into two broad categories, thermoplastics and thermosets, according to the effect of temperature on their properties.

(3) The molecules of thermoplastics such as polyethylene and nylon are long and branched. **(4)** Thus, they can be repeatedly softened and hardened by heating and cooling. **(5)** No chemical change takes place during this process. **(6)** When thermoset polymers are heated, however, a chemical change occurs which causes the molecules to "cure" or cross-link. **(7)** Thus, after it cures, a thermoset remains stable and cannot return to its original state. **(8)** Common examples of thermoset plastics are melamine, used in dinnerware, and urea, used in colored domestic electrical switches.

(9) There are numerous methods of processing each of these types of plastics. **(10)** However, one versatile process, injection molding, can be adapted for both by using a reciprocating-screw injection molding machine. **(11)** In this process, granular or powdered plastic is fed into one end of a horizontal cylinder by means of a feeding device known as the hopper. **(12)** The cylinder is heated by electric heaters located on its exterior. **(13)** Inside the barrel (cylinder), the plastic material is compressed and forced along the cylinder by the rotation of the screw. **(14)** The function of the screw is to soften (plasticize) the material by means of friction and by forcing it against the heated walls of the cylinder. **(15)** As a result, as the material progresses through the heated barrel with the screw, it changes from the solid to the molten, state. **(16)** When the plastic is sufficiently softened, the screw forces it out of the cylinder through a nozzle and into a metal mold. **(17)** If the material is a thermoplastic, the mold will be cool. **(18)** If it is a thermoset, it will be heated. **(19)** Pressure is held on the mold until the plastic solidifies. **(20)** Then, the mold is opened and the molten part is removed. **(21)** Meanwhile, the screw begins to rotate and moves backward for the next cycle.

A) Comprehension

I - Vocabulary

I - 1 Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**, of a liquid, gas, or electricity, move steadily and continuously in a current or stream.
2. _____ : **(adj.)**, having lateral extensions or subdivisions extending from the main part.
3. _____ : **(v.)**, undergo hardening (rubber, plastic, concrete etc.) by a chemical process: accomplished by the use of heat, radiation, or reaction with chemical.
4. _____ : **(n.)**, the shaping of rubber or plastic articles by injecting heated material into a mold.
5. _____ : **(adj.)**, move backwards and forwards in a straight line.
6. _____ : **(n.)**, a cylindrical tube forming part of an object such as a gun or a pen.
7. _____ : **(n.)**, to make or become plastic (moldable), esp. by heat or as by the addition of a Plasticizer.
8. _____ : **(n.)**, a cylindrical or round spout at the end of a pipe, hose, or tube used to control a jet of gas or liquid.

I - 2 General Vocabulary

1. _____ : **(adj.)**, very many; being or existing in great quantity.
2. _____ : **(n.)**, a funnel-shaped container for a loose bulk material such as grain, rock, or rubbish, typically one that tapers downward and is able to discharge its contents at the bottom.
3. _____ : **(v.)**, to press together; squeeze or force into less space.
4. _____ : **(n.)**, the resistance that one surface or object encounters when moving over another.
5. _____ : **(adv.)**, to an adequate degree; enough.

II - Main Ideas

In order to read effectively, it is essential to constantly keep in mind the main points the author is making. As you read the passage determine the main idea or point of each paragraph.

1. The function of paragraph **(1)** is:

   _____

2. The main idea of paragraph **(2)** is:

   _____

3. The main idea of paragraph **(3)** is:

   _____

III - Understanding the Passage

3.1 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ Plastics can be molded to any required shape.

b. _____ Polyethylene and nylon are made up of long and straight chains.

c. _____ Injection molding process can be used for both thermoplastics and thermosets.

d. _____ Curing and cross linking are two technical terms that can be used interchangeably for thermoplastics and thermosets.

e. _____ Curing is an irreversible process.

f. _____ Injection molding of thermosets requires extra energy as compared to thermoplastics.

3.2 Implicit Information

Indicate by true or false those statements which can be inferred from the information in the passage. Be prepared to defend your answers.

a. _____ The screw of an injection molding machine moves forwards and backwards.

b. _____ Once the thermosets are cured they cannot be softened again.

c. _____ The screw in the injection molding machine has two functions.

d. _____ The nozzle is situated at the end of the cylinder.

e. _____ Injection molding of plastics is a continuous process.

3.3 Contextual Reference

In order to avoid repeating a word an author uses pronouns and phrases to replace the original word. An understanding of these reference techniques is essential to effective reading. Answer the following questions about the referents.

a. In sentence **(2)**, '**they**' refers to _____ and **their** refers to _____
b. In sentence **(4)**, '**they**' refers to _____
c. In sentence **(5)**, '**this**' **process** refers to _____
d. In sentence **(7)**, '**it**' refers to _____ and **its** refers to _____
e. In sentence **(9)**, '**these types**' refers to _____
f. In sentence **(10)**, '**both**' refers to _____
g. In sentence (12), '**its**' refers to _____
h. In sentence **(14)**, '**it**' refers to _____
i. In sentence **(15)**, '**it**' refers to _____
j. In sentence **(16)**, '**it**' refers to _____
k. In sentence **(18)**, '**it**' refers to _____**; it** refers to _____

3.4 Rephrasing

Rewrite the following sentences replacing the underlined bold words with expressions from the text which have the same meaning.

1. Thermoplastics can be repeatedly **softened and hardened**.
_____ .
2. After it has **cured**, a thermoset remains stable and cannot return to its original state.
_____ .
3. When the plastic is sufficiently softened, the screw forces it out of the **cylinder** through a nozzle and into a metal mold.
_____
4. The **purpose** of the mold is to solidify and shape the plastic.
_____
5. Thermoplastics and thermosets are two **general classes** of plastics.
_____
6. Inside the injection molding machine the plastic granules are changed to **a viscous liquid**.
_____
7. Thermoplastics can be softened and hardened **again and again**.
_____
8. Injection molding **can be used with many different polymers including both thermoplastics and thermosets and it can make many different shapes**.
_____
9. Plastic granules are **supplied** to the injection molding machine by means of a hopper.
_____
10. In the injection molding of thermosets **a screw which moves forwards and backwards** is used.
_____
11. Plastics are **polymers with long chains of molecules**.
_____
12. The plastic is moved through the cylinder by the screw. **At the same time** it begins to melt
_____

B) Exercises

Activity 1 Injection Molding Machine

Label the diagram of a reciprocating-screw injection molding machine shown below.

- reciprocating-screw.
- mold.
- electric heaters.
- feed hopper.
- nozzle.
- cylinder.
- granular or powdered plastic.
- cavity
- motor
- melt

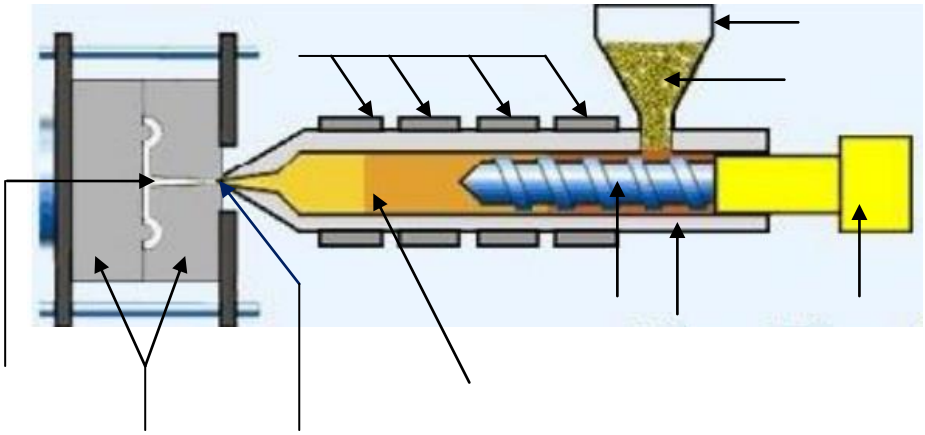


Figure 1

Activity 2 The Process of Injection Molding

The following diagram illustrates the main steps of an injection molding cycle.

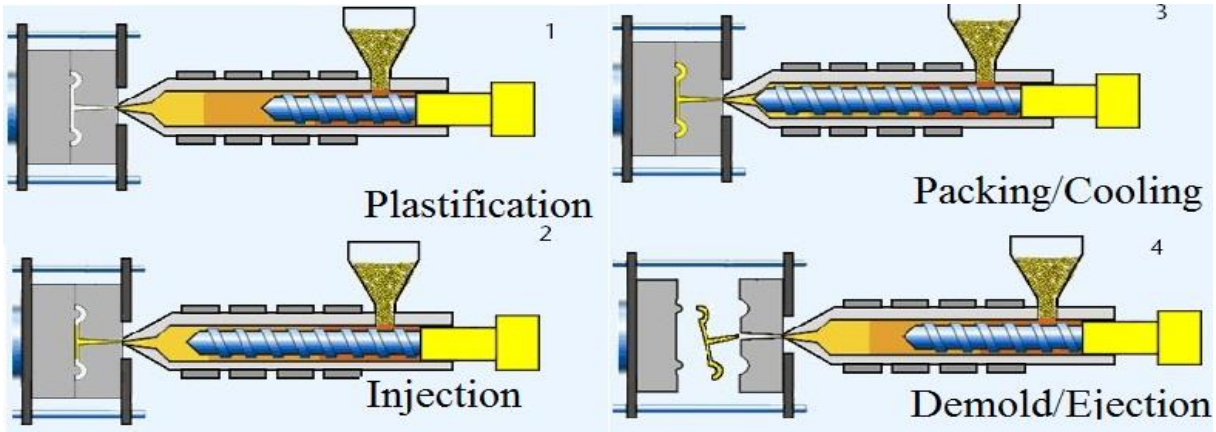


Figure 2

a. Answer the following question.

a.1 Why is heat used?

a.2 What is the function of the screw?

a.3 Which of the following items do you think are shaped using this process?

1 
2 
3 
4 

5 
6 

b. Rearrange these sentences into correct order according to figure 2.

Injection molding of plastic

A		The mold opens and the cold, hard, solid plastic shape is ejected.
B		The screw stops rotating and then a ram in front of the screw moves straight forward.
C	1	Small pieces (or pellets) of plastic are fed from the fopper into a cylinder.
D		The soft, warm plastic is pushed towards a nozzle by the ram.
E		The pellets are pushed along the cylinder by a rotating screw, and heated.
F		Inside the cavity, the plastic is cooled by the mold, and becomes hard.
G		The soft plastic is injected through the nozzle into a shaped cavity between the two halves of a mold.

c. Check your answers to the three questions in **a.**

d. Find words in **b.** which contain the letters 'ject'. Which one means ***thrown out*** and which one means ***pushed in***.

e. The functions of the injection molding machines parts.
Match the parts **(1-7)** used during the injection molding process with the description **(a-g)**.

1		pellets	**a**	An electric or-steam-heated device which warms the cylinder.
2		melt	**b**	Turning with a circular motion around a central point.
3		heater	**c**	To change from a solid to a liquid state.
4		rotation	**d**	An empty space.
5		nozzle	**e**	A small hole through which soft plastic is pushed.
6		mold	**f**	Small pieces of dry plastic used in the process.
7		cavity	**g**	A hollow container in two halves used to shape a material.

Activity 3 Language Spot

Look at figures 1 and 2 and complete these sentences, by using the active or passive forms of the verbs in brackets, as appropriate.

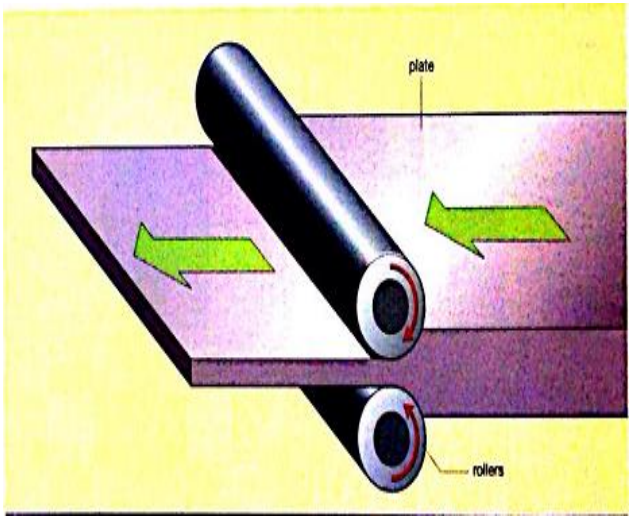
1. Plastic pellets _____ (store) in a hopper at the top of the machine.
2. The pieces of plastic _____ (transfer) from the hopper into a cylinder.
3. The plastic _____ (propel) along the cylinder by a rotating screw.
4. The heaters around the cylinder _____ (raise) the temperature of the plastic.
5. As a result, the soft, warm plastic softens and _____ (flow) more easily.
6. The plastic _____ (force) under pressure through a small nozzle.

Activity 4 Writing

Rewrite the paragraph below and improve it by changing some (but not all) of the verbs to the passive form. Where appropriate, delete the agent. Make any other necessary changes. Begin some sentences with ***first***, ***Next***, ***Now***, and ***Finally*** as appropriate.

The metal-Rolling Process

Someone adjusts the gap between the rollers to the correct width. Someone switches on the motor, and the heavy rollers begin to rotate in opposite directions. A worker heats the metal plate. Then something pushes the hot metal plate through the gap between the rollers. As the hot metal moves between the rollers, the rollers compress it to a thinner shape. The metal comes out from the rollers in the form of a metal sheet. Someone then cools the metal sheet.

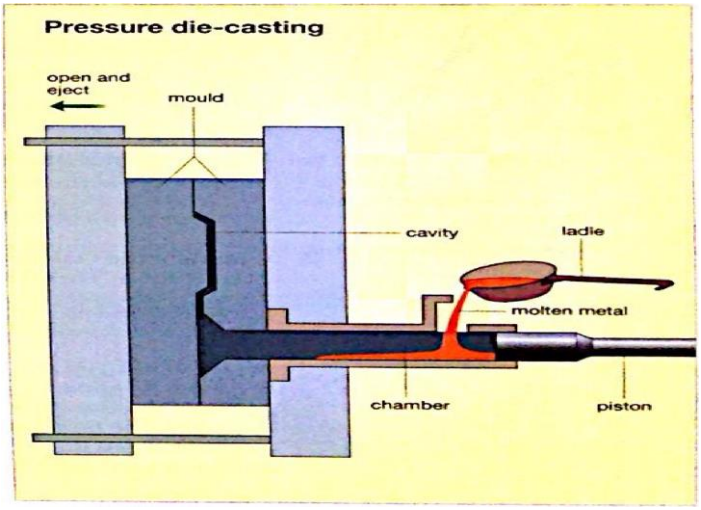


Activity 5 Process Description

Pressure-die casting used for metals is similar to injection molding for plastics. Study the figure and the notes below, and write an explanation of the process of pressure-die casting. Use First, Then, Next and Finally, and the passive where appropriate.
Begin; First, some metal is heated until it melts. Next the molten metal…

Pressure-die casting

- Heat metal until it melts.
- Poor molten metal into chamber.
- Piston moves along chamber.
- Piston pushes molten metal under pressure into cavity.
- Cavity is between two halves of mold.
- Molten metal fills cavity.
- Metal cools and becomes solid.
- Open mold.
- Eject solid metal component from mold.



C) Guided Writing

Stage # 1 Sentence building

Join each of the nine groups of words below into one sentence, using the additional material at the beginning of each group. Omit the underlined words. Number your sentences and begin each one with a capital letter.

1. **and**
   the plastic is softened by the heat
   the plastic is inside the mold
   the plastic takes the shape of the cavity
2. **two-piece**
   compression molding involves a mold
   the mold is made of steel
   the mold consists of 2 pieces

3. **then / , / and / ranging**
   the plastic is loaded into the cavity
   the plastic can be powdered or granular
   the 2 parts of the mold are brought together under pressure
   the pressures range from 2,000 to 10,000 psi
4. **finally / when / it**
   the part is ejected from the mold
   the part has solidified
5. **in order for / to take / , / , / , /**
   molding takes place
   the mold must be heated to between 280 degrees and 375 degrees Farenheit
   it is usually heated by electricity
6. **depending**
   the cure time depends on the size and thickness of the part
   it ranges from 20 seconds to 10 minutes
7. **whereas**
   injection molding is the preferred method of molding for thermoplastics
   compression molding is used principally for thermosets
8. **, / which / , /**
   the bottom is known as the cavity
   the bottom has the shape of the desired molded product
9. **it / , / however / to produce / such as /**
   compression molding can be used for thermoplastics
   it produces products
   one of these products is optical lenses

Stage # 2 Paragraph building

Re-write the 9 sentences in a logical order. Add the following 2 sentences in an appropriate place.

The top of the mold is known as the plunger.
Camera cases and radio and television cabinets are typical compression molded parts.

Then, write the sentences in correct paragraph form. Remember to indent the first line. Give your paragraph an appropriate title.

Stage # 3 Paragraph reconstruction

Read through your paragraph again. Make sure that you understand the process and know all words. Without referring to your previous work rewrite the paragraphs. Here are some notes to help you.

injection molding - thermoplastics - compression molding
thermosets - thermoplastics - optical lenses
involves - tow-piece mold
top - plunger
bottom - shape of desired product - cavity
mold - heated
plastic - loaded - cavity - mold - brought together
plastic - softened - heat - shape - cavity
cure time - depending on - size - thickness
part - ejected - solidified
camera cases - radio and television cabinets

Unit 5 Polymer Processing 2: Compression Molding

History and Introduction

(1) History has failed to establish definitely the date of origin of the art of molding. It may be said that the art of molding originated with prehistoric man, when he learned how to make pottery from clay, using the pressure of his hands to form the shape and the heat of the sun to harden the clay. The earliest application of compression molding as a manufacturing process was early in the nineteenth century, when Thomas Hancook perfected a process for molding rubber. Dr. Leo H. Baekeland's development of phenol-formaldehyde resins in 1908 gave the industry its first synthetic molding material which is even today one of the principal materials used in the compression molding process.

(2) Compression molding is used principally for thermosetting plastics, much less commonly for thermoplastics for which injection is the preferred method of molding. Thermosetting molding compounds are, in most cases, in powder, granulated or nodular form. When subjected to heat, they first become liquid, and then undergo an irreversible chemical reaction called cure or polymerization. In certain special applications, thermoplastics may also be processed by compression molding. These materials, when compression molded, become plastic under pressure, heat in a heated mold and flow out to the contour of the cavity. Molds must be arranged for rapid heating and cooling, since the molded articles cannot be removed from the mold until the material has been sufficiently cooled to harden.

Molding Thermosetting Plastics

(3) The details of the procedure of molding thermosetting materials can be covered by describing the molding of phenol-formaldehyde compounds since there are only minor differences in procedure required by other thermosetting materials. The most common method of heating molds for compression molding today is with electrical heating systems. They have the advantages of high efficiency; they are clean and simple to hook up; they are accurate and reliable; they are easily adjustable to 400°F. The pressures at which the presses operate are as high as 10,000 psi. The molding powder may be volumetrically fed, weighed, or shaped into preforms. The charge may be fed as cold powder, or preheated. Preheating shortens cure time, reduces the molding pressure required, and improves electrical properties. A typical mold is made into two parts which, when brought together, enclose a cavity representing the article to be molded. (see Fig. 1). The two parts are mounted on platens. These, in turn, are a part of a mechanical press which serves to open and close the mold and to apply pressure to its contents.

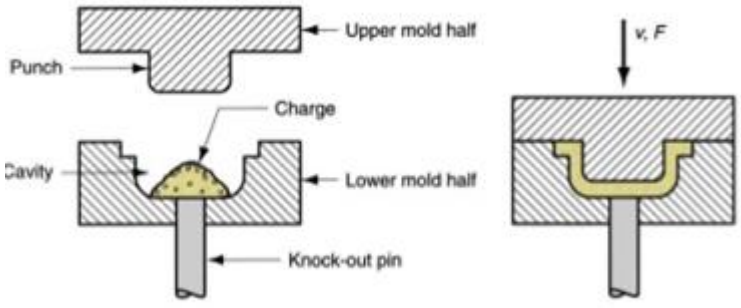


Figure 1 A two piece compression mold.

(4) Phenolic molding is carried out by inserting a predetermined amount of material into the lower half of the mold. The mold is closed under pressure. With heat and pressure, the material softens, and fills out the contours of the cavity created by the two halves of the mold. A slight clearance is allowed between the halves in order to permit a slight excess (flash) of the molding compound to escape; usually a clearance of 0.001 to 0.005 in. is sufficient. The material filling the cavity is held under heat and pressure until it hardens and then the mold is opened and the molded article is removed. Thermosetting materials,

hardened by a chemical change caused by the heat can be ejected after the proper curing cycle without cooling the mold. When molding thermoplastic materials, however, the molded article is hardened under pressure by cooling in the mold, i.e., by removing the heat source and circulating cold water through the mold. Another difference in molding thermoplastic molding compounds is that they cannot usually be preformed.

(5) Compression molding process for thermosetting compounds can be fully automated. Essentially, it involves a compression molding press equipped with a mold and additional equipment designed **(1)** to store a quantity of molding compound; **(**2) to meter, volumetrically or gravimetrically, exact charges of compound; **(3)** to deposit these charges into appropriate mold cavities; **(4)** to remove the finished article from the mold area following each cycle; **(5)** to remove any flash or granular molding material not ejected with the finished article. Once an automatic press has been placed into operation, it can run unattented except for periodic recharging of the storage container (hopper), and occasional adjustment in the control system to accommodate minor variations in compound, ambient temperature, and humidity.

Application

(6) The compression molding process is used principally for molding phenolic, urea, allyl, and melamine plastics. The size of the compression molded part may vary from small parts like buttons, to large parts such as trash barrels and bureau drawers, housing for adding machines, etc. It is customary to use molds with several cavities when small parts are molded.

A) Comprehension

I - Vocabulary

I - 1 Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(adj.)**, in the shape of a small round mass or lump.
2. _____ : **(n.)**, a depression, in a plastics-forming mold which forms the outer surfaces of the molded articles.
3. _____ : **(adj.)**, of or pertaining to measurement by volume.
4. _____ : **(n.)**, approximate shape and size of something before it becomes a final product.
5. _____ : **(n.)**, a flat metallic plate on which mold parts are mounted.
6. _____ : **(n.)**, the amount of space between the two halves of a mold.
7. _____ : **(v.)**, the excess of material that flows out of the mold cavity under pressure.

I - 2 General Vocabulary

1. _____ : **(n.)**, heavy, firm earth, soft when wet, becoming hard when exposed to heat.
2. _____ : **(v.)**, to be subject to.
3. _____ : **(v.)**, to connect a mechanism, and a source of power.
4. _____ : **(adj.)**, not able to be reversed.
5. _____ : **(adj.)**, able to be trusted; predictable or dependable.
6. _____ : **(v.)**, to put or set into, between, or among.
7. _____ : **(adj.)**, not supervised or looked after.

II - Main ideas

As you read the passage determine the main idea or point of each paragraph.

1. The main idea of paragraph **(1)** is: _____
2. The main idea of paragraph **(2)** is: _____
3. The main idea of paragraph **(3)** is: _____
4. The main idea of paragraph **(4)** is: _____
5. The main idea of paragraph **(5)** is: _____
6. The main idea of paragraph **(6)** is: _____

III - Understanding the Passage

3.1 Questions on the Text

Answer these questions on the reading text.

a. What was the first compression molded resin in the history?

_____

b. In what physical form can a resin for compression molding be?

_____

c. What are the thermosets for compression molding discussed in the passage?

_____

d. How are the molds in compression molding heated?

_____

e. What are the advantages of preheating the raw plastic in compression molding?

_____

f. What are the main differences between compression molding of thermoplastics and thermosets?

_____

g. How many stages there are in compression molding process?

_____

3.2 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ It can be said that compression molding process may have its origins in the art of making pottery from clay.

b. _____ Phenol-formaldehyde resins are thermosetting materials most often used in compression molding.

c. _____ Cure or polymerization is a chemical reaction causing thermosets to assume their final shape.

d. _____ One of the reasons electrical heating systems are used to heat compression molds is because they are very efficient.

e. _____ Materials preheated before entering the mold are molded at higher pressures and as a result have better electrical properties than the ones which have not been preheated.

f. _____ Platens are a part of mechanical press whose function is to open and close the mold and to apply pressure to its contents.

g. _____ “Flash” is the term used to refer to the clearance between the mold halves.

h. _____ Thermosetting materials are hardened by a chemical change caused by heat whereas thermoplastics need to be cooled in order to harden.

i. _____ Fully automated compression molding presses for thermosets can automatically adjust for variations in compound, ambient temperature, and humidity.

j. _____ Compression molding is used for molding articles of large variety of sizes.

3.3 Rephrasing

Rewrite the following sentences replacing the bold underlined words with expressions from the text which have a similar meaning.

a. Compression molding is used **principally** for thermosetting plastics, much less **commonly** for thermoplastics for which injection is the preferred method of molding.

_____

b. The **molded** articles cannot be **removed** from the mold until the material has been sufficiently cooled to harden.

_____

c. A typical mold is made into two parts which, when **brought together**, enclose a cavity representing the article to be molded.

_____

d. The **two parts** are mounted on platens.

_____

B) Polymer Processing Techniques

Plastics are made into shapes in many ways. Here are some of the processes used.

Extrusion: hot molten plastic is squeezed through a nozzle to make long lengths of special shapes like pipes.

Blow extrusion: used for making plastic films and bags.

Injection molding: lots of everyday articles like washers or bowls are made this way.

Blow molding: many bottles and toys are made this way.

Activity 1 **How do you think the plastic item in the main picture were shaped? There's a clue in the two smaller photos**

Extrusion blow molding is a method of making a hollow shape out of a thermoplastic. This shaping method is very useful for making things such as plastic bottles, petrol containers, jerry can and so on.

As its name suggests, extrusion blow molding consists of two separate processes:

The first one is extrusion process. This is very similar to the injection molding process. During extrusion, solid pellets, or small pieces, of plastics are heated, melted, pushed along a cylinder and extruded, or pushed out, into a mold.

The second process, blow molding, takes place inside the mold, where compressed air blows into the center of the molten plastic and expands it into a hollow shape such as a bottle. Let's look at the first process, the extrusion of molten plastic into the mold. As is seen in Figure 1, there is an extruder at the top left of the diagram. This operates like the injection molding cylinder. First of all, pellets of raw plastic are fed from the hopper into a large horizontal cylinder. Inside this cylinder, a large screw rotates. This rotation pushes the cold polymer pellets along the cylinder towards the right. There are heaters all along the sides of the cylinder. These heaters heat up the polymer pellets and melt them. The screw continues to push the soft, melted polymer along the cylinder. As can be seen from Figure 1, there is ninety-degree angle at the right-hand end of the cylinder. This angle, or bend, is inside the die in the top right-hand section of figure 1. Now the molten plastic flows downwards through the die, and is extruded, or pushed out, into the mold. So that's the end of the extrusion process. The second process is blow molding which consists of three stages. As shown in Figure 1, in the first stage, the hot, soft plastic is extruded down between the two halves of the open mold. The plastic is in the form of a long, hollow tube, called a parison. Then, as Figure 2 illustrates, the two halves of the mold close. Now the parison is inside the mold. The second stage is illustrated in Figure 2, as well. In this stage, compressed air is blown through the nozzle into the molten polymer parison. The air inflates the parison, and as a result, the soft plastic expands to fit the shape of the mold. The plastic is cooled by cold surfaces of the mold. This sudden cooling causes it to harden quickly in the shape of, in this case, a bottle. The third and final stage is shown in Figure 3. Here, after a cooling period, the two halves of the mold open, and the bottle is ejected from the mold onto a conveyor belt.

Activity 2 **Study the illustrations, and then rearange the notes of tables 1 and 2 below into the best order for a talk on extrusion blow molding.**

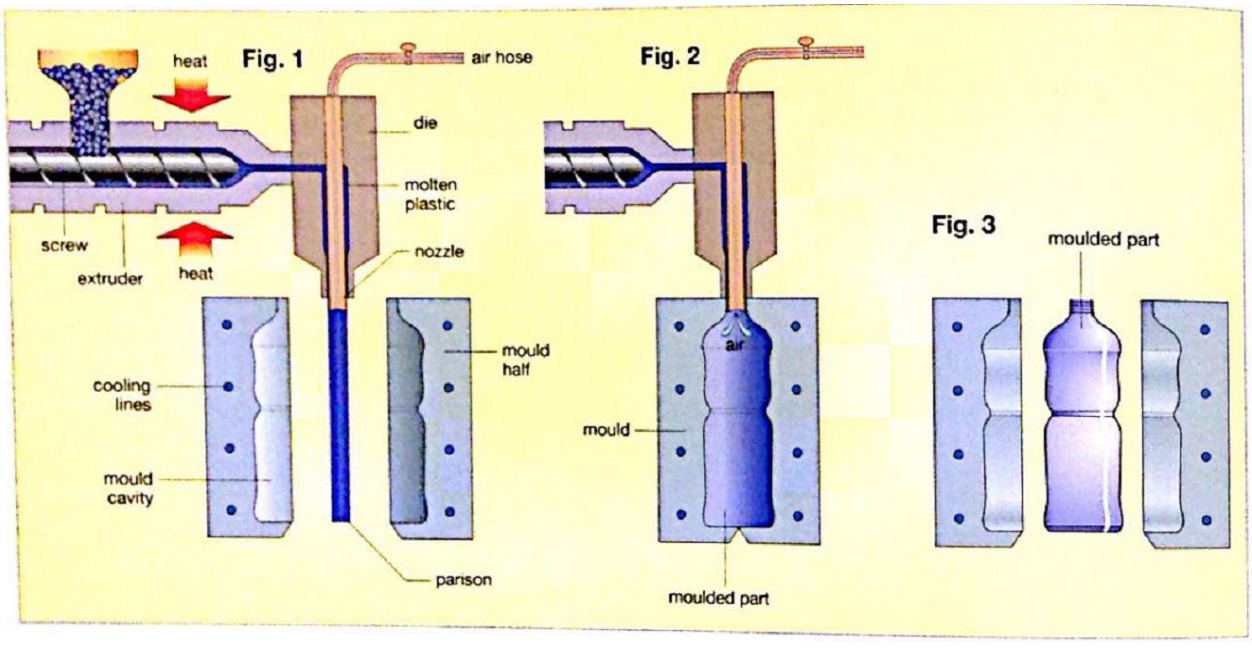


Table 1	The Extrusion Process (See Fig. 1)
☐	movement of warm, soft molten polymer along cylinder.
☐	extrusion of molten polymer into mold.
☐	heating and melting of polymer pellets.
☐	transfer of polymer pellets from hopper to cylinder of extruder.
☐	movement of cold polymer pellets along cylinder.
☐	rotation of screw.

Table 2	The Blow Molding Process (See Figs. 2 and 3)
☐	cooling of plastic bottle shape.
☐	expansion of polymer to fit shape of mold.
☐	blowing of compressed air into molten polymer.
☐	ejection of plastic bottle from open mold.
☐	inflation of molten polymer by compressed air.
☐	closure of two halve of mold with polymer inside.

Activity 3 Introducing Figures

Fill in the gaps with the words and phrases from the box below.

illustrates - shows - can be seen - is shown - is illustrated - can

a. As you _____ in Figure 1, there is an extruder at the top left …
b. As _____ in Figure 1, there is a ninety-degree angle …
c. As Figure 1 _____ the hot, soft plastic is extruded down …
d. Then, as Figure 2 _____ the two halves of the mold close.
e. The second stage _____ in Figure 2.
f. The third and final stage _____ in Figure 3.

Activity 4 Rotational Molding

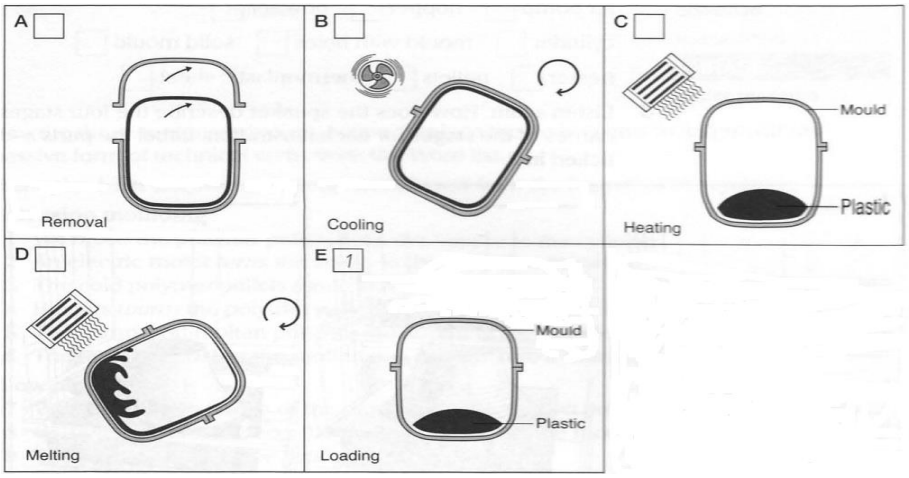
Read the text about the process of rotational molding and complete the text, using the active or passive form of the verbs in brackets. One gap can be filled with the active or passive form of the verb. Once finished put the pictures in the correct order.

Rotational molding is a high-temperature, low-pressure plastic forming process. It **(1)** _____ **(use)** heat and rotation (along two axes) to produce hollow, one-piece parts. The process is simple, but slow. It **(2)** _____ **(use)** for making large, hollow objects like oil tanks.

A quantity of plastic raw material, usually in powder form, **(3)** _____ **(load)** into the mold. The mold **(4)** _____ **(heat)** in an over while it **(5)** _____ **(rotate)**. The plastic raw material **(6)** _____ **(melt)** and **(7)** _____ **(coat)** the inside surface of the mold.

When the inside of the mold **(8)** _____ **(coat)**, it **(9)** _____ **(cool)**, usually by a fan. The cooling process takes between 10 and 20 minutes, depending on the size of the part and the thickness

of the coating. As it **(10)**_____**(cool)**, the molded object **(11)**_____**(shrink)** and comes away from the sides of the mold. This makes it easier to take out the object at the end of the cooling process.
At the end, the object **(12)**_____**(remove)**. By this stage, the object is cool enough to handle.



Activity 5 Forming Nouns From Verbs

Change these verbs in the box to nouns and write them in the table.

blow - cast - close - cool - eject - expand - extrude - heat - inflate melt - move - roll - rotate - transfer - propel

-ing:	**blowing**, _____ _____ _____ _____	
-ion:	_____ _____ _____ _____ _____ _____	
-ment:	_____	**-er:** _____
-ure:	_____	**no change:** _____

Activity 6 Vacuum Molding Process of Plastics

This is a presentation of how vacuum molding works. Vacuum forming, also known as vacuum forming or vacu-forming, is a process of making a shape out of a thermoplastic sheet. A thermoplastic sheet is a material that becomes soft when you heat it, and later on it becomes hard after you cool it. In vacuum forming, as in other processes of plastic molding, heat and cooling are important parts of the process.

As its names suggests, with vacuum forming, we have to create a vacuum in the mold in order to produce the molded object. As you remember, vacuum occurs when we suck the air out of the container. So sucking air out, or suction, is an important part of the process, and we use a simple air pump for this purpose. As is illustrated in Figure 2, there are some air-exhaust holes at the bottom of the mold. These are for sucking the air out.

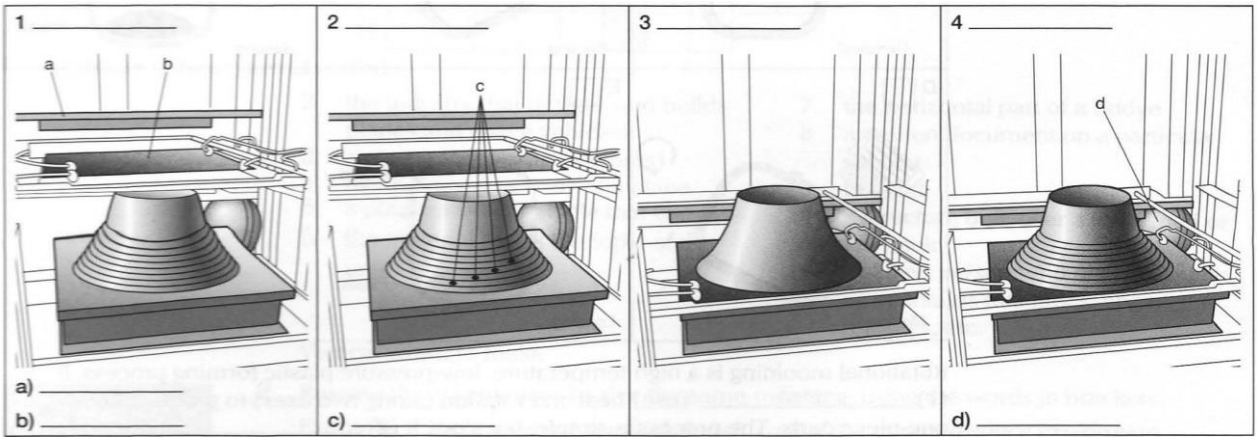
The first stage is heating. As illustrated in Figure 1, the heaters are situated above the machine and heat the thermoplastic sheet below them. The next stage is positioning. As can be seen in Figure 2, the thermoplastic sheet is moved to a position directly above the vacuum mold. The third stage is illustrated in Figure 3. Here, the thermoplastic sheet is stretched over the top part of the mold. It can be seen that the plastic material is stretching and becoming thinner. This is stretching stage. The fourth and final stage is shown in Figure 4. Here, the pump on the right-hand side of the machine is sucking the air out of the mold, and this suction is creating a vacuum. Finally in this vacuum forming stage, as Figure 4 clearly shows, the plastic sheet is sucked down over the mold.

Activity 7 Understanding Vacuum Process of Plastics

a. Tick the objects that are used in the process of vacuum forming.

☐ air pump	☐ hopper	☐ powder
☐ cylinder	☐ mold with holes	☐ solid mold
☐ heater	☐ pellets	☐ thermoplastic sheet

b. Write the names of the stages for each illustration (1-4), then label the parts (a-d) with the things that you ticked above.



c. Complete the notes on the vacuum processing.

- A thermoplastic sheet becomes _____ with heating and _____ with cooling.
- At the bottom of the vacuum mold, there are some _____ - _____ _____.
- The sheet is positioned _____ the heater and _____ the mold.
- When the sheet is stretched, it becomes _____ .
- The pump sucks out the air and this suction creates a _____ .

Activity 8 Passive and Active Voice

Rewrite the following sentences in the passive. Replace the active verbs in italics with the passive form of the technical verbs from the box below.

Example: The polymer pellets are **transferred** from the hopper to the cylinder.

blow - close - cool - eject - expand - extrude - heat - inflate
melt - move - roll - rotate - transfer - propel

Extrusion molding.

a. We ***move*** the polymer pellets from the hopper to the cylinder.

_____

b. An electric motor ***turns*** the screw along the cylinder.

_____

c. The cold polymer pellets ***move*** along the cylinder.

_____

d. Heaters ***warm*** the polymer pellets and turn them into a liquid.

e. The warm, soft molten polymer ***moves*** along the cylinder.

f. The machine ***pushes*** the molten polymer out into a mold.

Blow molding.

g. We ***shut*** the two halves of the mold with the molten polymer inside.

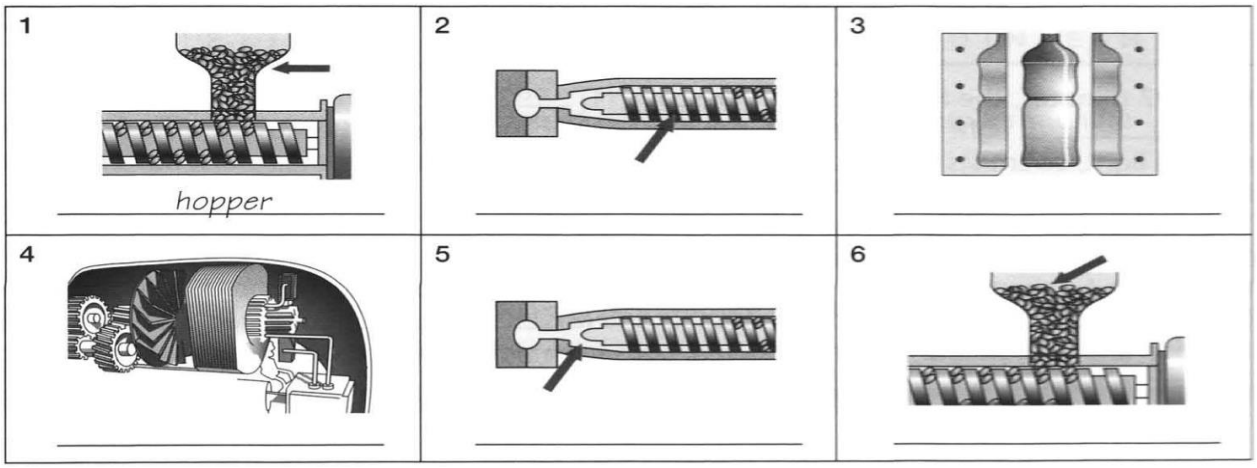
h. Compressed air ***blows up*** the molten polymer in the mold and makes it bigger.

i. The plastic bottle shape ***gets*** colder.

j. The machine ***pushes out*** the plastic bottle from the open mold.

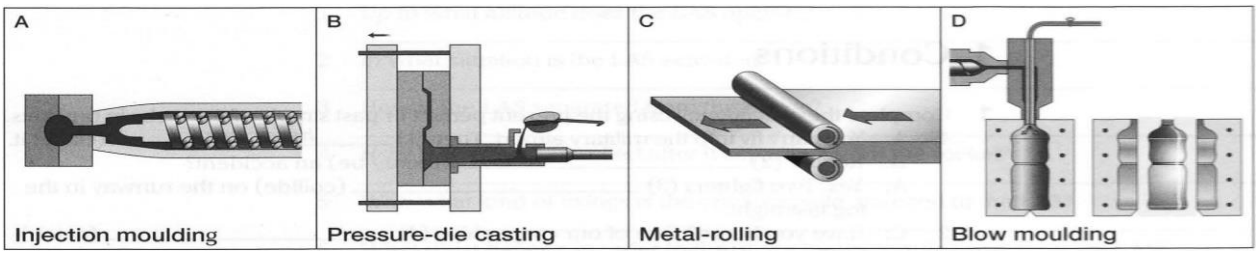
Activity 9 Extra Vocabulary

Label the pictures with nouns from the sentences a-j in activity 8.



Activity 10 Description of Materials Processing

Which of these processes do the sentences below describe? Write the process letters A-D next to the sentences.



a. The metal plate is first heated. ____

b. The object, e.g. plastic bottle, cools and is then ejected from the mold. ____

c. The warm softened polymer is moved along the cylinder by a rotating screw. ____

d. The molten metal is forced into the cavity between the two halves of the mold. ____
e. Compressed air is blown into the molten polymer and inflates it. ____
f. The mold opens and the hard, solid plastic object is ejected. ____
g. After the metal cools, the mold is opened and the metal component is ejected. ____
h. The metal sheet comes out from the rollers and is then cooled. ____
i. The molten polymer expands to fit the mold which may be in the shape of a bottle. ____
j. The molten metal is pushed along the chamber under pressure by the injection piston. ____
k. The metal plate is then pushed between the rollers, which compress it. ____
l. The molten polymer is pushed by the ram through the nozzle into the mold, and becomes hard. ____

Activity 11 Processing Steps

Write the three steps in the correct order for each process described in activity 10.

Injection molding: ___ ___ ___
Pressure-die casting: ___ ___ ___
Metal- rolling: ___ ___ ___
Blow molding: ___ ___ ___

Activity 12 Puzzle

Find the words in the puzzle and write them next to the definitions below.

P	O	L	Y	M	E	R	A	C	Y	F	G	X	W	J	Z	F	Y	W	P	I
R	O	L	L	E	R	U	Z	O	C	H	A	M	B	E	R	L	G	C	I	N
O	C	X	O	J	O	I	X	L	G	C	U	C	O	M	P	R	E	S	S	J
P	Z	I	F	E	X	P	A	N	N	I	O	N	I	Y	W	G	X	F	T	E
E	W	A	J	C	A	R	B	O	S	F	I	B	R	E	C	A	Z	U	O	C
L	S	O	F	T	E	N	F	K	U	Y	J	C	O	M	P	O	N	E	N	T

a. To make something soft. ____
b. An increase in size. ____
c. A plastic composite. ____
d. A cylinder used to flatten a material. ____
e. A disc that is pushed along a cylinder. ____
f. An enclosed space inside a machine. ____
g. To throw something out of a mold or machine. ____
h. One of several parts that make up a machine. ____
i. To move something in one direction, e.g. along a cylinder. ____
j. To press something so that it takes up less space. ____
k. To push something inside through a small hole. ____
l. A chemical compound used for making plastics. ____

Chapter 3

ENGLISH FOR SCIENCE AND TECHNOLOGY OF MEDICINE

Unit 1 The Kick-off Meeting

Harvey Jones, project manager at Fab Pharmaceuticals, is preparing a kick-off meeting to discuss the development and launch of CoolHead, a new medicine. Read the memo.

<Memo> Fab Pharmaceutical
From : Harvey Jones, project manager
To: Heads of departments
Re: 'CoolHead'- Kick-off meeting

Dear colleagues,

(1) The main reason I am writing to you today is to remind you that we still need you to propose people from your departments to work on our new soft gel capsule for headaches and to liaise with your departments. As you know, it will be a prescription drug, so people with experience in analgesics are the ones we'd most like to have on board.

(2) Here is an update on the project. Since the conclusion of our successful feasibility study, we have also obtained very encouraging preclinical data. This means that we can soon start with the clinical trials and are now ready to get the project team together. The kick-off meeting will take place on 6 March in the Intercontinental Hotel. More details will follow soon.

(3) You are probably aware that 'CoolHead' is just the working name of the new drug. The soft gel capsule will be followed soon afterwards by two other dosage forms also in the pipeline: patches and sugar-coated tablets. We plan to launch all of these products in Europe first and to apply for Food and Drug Administration (FDA) approval in the US the following year.

(4) We still need project team members from R&D, Regulatory Affairs, and QA. As far as Marketing is concerned, Carole Marks will be flying in from France. She'll give us more information on the marketing claims and a target patient profile. From Clinical Affairs in ltaly, Anna Edicola will present the clinical requirements. She, as well as Charley Wu from Production, will be connecting with us by video conference.

(5) I'd like to get the team members' names you propose, as well as their contact details, and a brief bio on each one from you this week. Then I can invite them to the meeting. Let me know if you foresee any major difficulties at this stage.

A) Comprehension

I - Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**, cooperate on a matter of mutual concern.
2. _____ : **(n.)**, an instruction written by a medical practitioner that authorizes a patient to be issued with a medicine or treatment.
3. _____ : **(n.)**, a medication that reduces or eliminates pain.
4. _____ : **(n.)**, capable of being accomplished or brought about; possible.
5. _____ : **(adj.)**, relating to or denoting the stage of drug testing that precedes the clinical stage.
6. _____ : **(n.)**, the act or process of testing, trying, or putting to the proof; an effort or attempt.
7. _____ : **(n.)**, an adhesive piece of drug-impregnated material worn on the skin so that the drug may be absorbed gradually over a period of time.

8. _____ : **(v.)**, introduce (a new product or publication) to the public for the first time.
9. _____ : **(adj.)**, to control or direct according to rule, principle, or law; to adjust to a particular specification or requirement.

II - True/False Questions

Are the following statements true or false?

a. _____ The most important reason for this memo is to give information about a new drug.

b. _____ Patients who want to buy this drug will not need to see a doctor first.

c. _____ There are three dosage forms planned at the moment.

d. _____ The company plans to sell the drug in Europe and the United States.

e. _____ Project members from Marketing, Production, and Clinical Affairs are already on board.

B) Grammar and Vocabulary Exercises

Activity 1 Special Technical Vocabulary

Match each term on the left with its definition on the right.

1 ☐	dosage form	**a**	Medicine bought in a pharmacy and requiring a written note from the doctor.
2 ☐	feasibility study	**b**	Future drugs, not yet on the market.
3 ☐	over-the-counter drug	**c**	The final form of the medicine ,e.g. tablet, powder, gel, spay, etc.
4 ☐	products in the pipeline	**d**	An investigation to determine the advantages, practicality, and profitability of a proposed project.
5 ☐	prescription drug	**e**	A product which can be sold without the patient seeing a doctor.

Activity 2 Providing Information

Insert the expressions from the useful phrases in the box in the gaps below.

you are probably aware that - As you know - As far as - The main reason is connected - here is an update on the project

(1) _____ I am writing to you is to get your input on a new product.**(2)** _____**,** we plan to market a new prescription drug for headaches.

But first, **(3)** _____ .The feasibility study has just been successfully completed. **(4)** _____ it will be marketed in Europe first. **(5)** _____ your input **(6)**_____, we need the financial data from your department as soon as possible.

Activity 3 In the Departments

Match what people are saying below (A-F) with the department they work in (1-6).

A. We compound the raw materials into drugs, package them, and put in the leaflets for the patients. We also keep careful records of all the steps in this process.

B. We find new substances to make new drug formulations or change existing dosage forms, for example, from tablets to capsules.

C. We compile the drug documentation and send it to the regulatory drug authorities so we can get authorization to market the product.

D. We plan the promotion and distribution of drugs which will be launched, and make decisions about the packaging or tablet color of new products.

E. We test or organize testing on live subjects, and make sure that our drugs are safe and effective for the patients.

F. We ensure that products meet the standards which the law requires, and contain the active ingredients advertised.

1	☐	Clinical affairs
2	☐	Marketing and sales
3	☐	Production
4	☐	R & D (Research and Development).
5	☐	Regulatory affairs
6	☐	QA (Quality assurance).

- Which department would you like to work in?

_____

- Which department would you then work with most often?

_____

Activity 4 Pharmaceutical Job Profiles

Read the following (a-h) job profiles and match the bold underlined words with the definitions (1-7) below.

a. I collect drug safety information about patients **on our medications**. I must report any **serious adverse events** to the health authorities.

b. When a company starts to test drugs on live **subjects**, I work closely with the doctors to make sure that the studies are done correctly.

c. I operate complex scientific instruments and perform tests to determine whether **ingredients** in liquids, powders, or tablets meet requirements.

d. It's my job to research, write, and edit clinical and study reports before we submit them to regulatory authorities. I summarize and interpret clinical data.

e. I co-ordinate and manage the cross-functional teams that develop and launch a drug. It's not easy to get people to meet deadlines.

f. According to European law, I am personally responsible for the quality of each product that leaves the production line. I must manage all the processes in production, QA, and the labs to make sure **Standard Operating Procedures (SOPs)** are followed.

g. My job is to make sure that suitable, clean containers are used to get the product from the company to the patient. In general, I check for compliance with **health regulations**.

h. In my work, I develop pharmaceutical dosage forms. At the moment, I am changing a tablet formulation into **ointment** and gel forms.

1. _____ taking our medicine.
2. _____ a substance in a drug.
3. _____ a description of a working method or process.
4. _____ a human or animal drugs are tested on.
5. _____ any health problem which starts while on a new medicine.
6. _____ rules or laws about health.
7. _____ an oily substance like a cream.

Now match the job profiles in (a-h) with the job titles (8-14) below.

8. _____ clinical research associate.
9. _____ formulation scientist.
10. _____ laboratory technician.
11. _____ medical writer.
12. _____ packaging technician.
13. _____ pharmacovigilance manager.
14. _____ project manager.

Activity 5 The Correct Verb

Underline the correct verb.

a. Companies must **conduct / report** serious adverse events to the health authorities.

b. New drugs are **tested / determined** on live subjects.

c. Laboratory technicians **operate / perform** complex scientific instruments and determine/perform whether liquids, powders, or tablets meet requirements.

d. Clinical research associates **report / perform** clinical trials. They must also summarize, **interpret / regulate** and process clinical data.

e. Regulatory Affairs **reports / submits** documents to regulatory authorities.

f. Formulation scientists **develop / summarize** pharmaceutical dosage forms.

Activity 6 Introducing Oneself

Fill in the gaps with the expressions in the box below.

I have been with this company for - I did research on - I received my - I used to work Assigned to this project - My professional background is in

Well, as you may know, I am from Milan and in case you are wondering, yes, like most Italians, I am a very good cook. **(1)** _____ pharmacology, and in 2005 **(2)** _____ master's degree at New York University and license to practice pharmacy in the United States. **(3)** _____ clinical methodology. As far as this project goes, I am the clinical trial manager **(4)** _____ and am supported by two clinical research associates, who will work with test centres in northern ltaly and in Slovenia. **(5)** _____ about three years and **(6)** _____ at Johnson & Johnson in their clinical department.

Activity 7 Useful Phrases for Introducing Oneself

Use the Useful Phrases above to fill in the gaps.

I am working on a project to - worked my way up - I was involved - I'm the I am responsible for - received - My name is - started as

Hi, everyone. Pleased to meet you all. **(1)** _____ Charley Wu, and **(2)** _____ plant manager at our manufacturing plant in Shanghai. I was also born and raised in China.

I first **(3)** _____ line worker and **(4)** _____ to packaging technician. I later studied in the UK and **(5)** _____ an MSc in Engineering there. More recently, **(6)** _____ in the initial conceptual design phase, and at present **(7)** _____ the planning and building of our second new pharmaceutical facility in Shanghai. In this new facility we will produce both liquid and solid dosage forms. In addition to this, at the moment **(8)** _____ build a new analgesics production line, and that is why I was asked to join this project.

Activity 8 Sentence Building

Put the words in the right word order to make logical sentences.

1. close, review Before we I'd like points to the action

   _____

2. needed be Charley's the will team new equipment describing

   _____

3. needs Each department me head get to to by back Friday

   _____

4. look at any need Finally, regulatory issues addressed that to be is going to Rasheed

   _____

5. from HR First will place in several pharmaceutical journals of all, job ads lris Berger

   _____

6. by the end to finish the other is dosage forms Walter of the month

   _____

Activity 9 Job Advertisement

Use the expressions in the box to fill in the gaps in the following job advertisement.

preferable - responsible for - essential to this job - years' experience required - is searching for - will need to be able to

JOB TITLE- CHEMIST

DESCRIPTION

CRO **(1)** _____ someone to co-ordinate and perform analytical testing for stability studies of new products. You **(2)** _____ review data in accordance with Good Manufacturing Guidelines. You will be **(3)** _____ checking laboratory documentation and chemical specifications. It is **(4)** _____ to use a wide variety of physical and chemical analyses to support shelf-life studies of patented pharmaceutical products.

REQUIREMENTS

- At a minimum a BS in Chemistry or a related science is **(5)** _____, an MSc is **(6)** _____.
- You should have at least three **(7)** _____ in pharmaceutical analytical techniques and test methods.

Activity 10 Extra Vocabulary

Each column contains a category and some terms listed under it. Cross out the term that does <u>not</u> fit in each category.

Non-production pharmaceutical professions	Dosage forms	What goes into drugs?	Pharmaceutical documentation
Clinical research associate	Capsule	Chemicals	Clinical reports
Formulation scientist	Gel	Formulation	Dossiers
Laboratory technician	Ointment	Ingredient	Marketing claims
Line worker	Prescription drug	Raw materials	Protocols
Pharmacovigilance manager	Sugar-coated tablets	Substances	Study reports

Unit 2 Substance Discovery and Product Development

Read the memo and the information about Mensamint™.

Caduceus Pharmaceuticals Ltd

Date: Tuesday
To: Pharmaceutical department- Chemists and Pharmacologists
From: John Keyes, Vice President R&D
Subject: Breakthrough in search for NCE for Mensapatch™ development

As some of you will already know, a new chemical entity has just been synthesized in our own labs, which we think may be useful in our Mensapatch™ development plans.

A meeting will be held tomorrow at 9.30 a.m. in conference room 308 to brainstorm ideas for this new substance, and to discuss the further development. Your participation would be appreciated.

MENSAMINT™

Mensamin™ is a new dosage form of Mensadent™ (obtainable with physician's prescription only). It uses the newly synthesized active substance mensagitatum (Latin origin: the mind moves/animates).

The formulation for adult patients is in lozenge form (or as Mensadent™ in chewing gum form for young patients), and the indication is to stimulate brain activity and thinking power.

Known side effects often include loss of sleep if taken in the late afternoon or evening. Occasionally, an increase in blood pressure may occur. Rare instances of heart palpitations and headaches have also been reported. It is not possible to overdose and mensagitatum is non-addictive.

A) Comprehension

I - Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**, combine, esp. chemically, (a number of things) into a coherent whole so as to form a new, complex product.
2. _____ : **(n.)**, a spontaneous group discussion to produce ideas and ways of solving problems.
3. _____ : **(n.)**, the administration of a drug or agent in prescribed amounts and at prescribed intervals.
4. _____ : **(adj.)**, producing an intended action or effect.
5. _____ : **(v.)**, raise levels of physiological or nervous activity in the body or any biological system.
6. _____ : **(n.)**, a secondary, typically undesirable effect of a drug or medical treatment.
7. _____ : **(n.)**, an example or single occurrence of something; a particular case.
8. _____ : **(n.)**, a noticeably rapid, strong, or irregular heartbeat due to agitation, exertion, or illness.
9. _____ : **(n.)**, a pain in the head.
10. _____ : **(v.)**, to administer too large a dose or too many doses to.
11. _____ : **(adj.)**, causing or tending to cause physiological or psychological dependence, as on a substance.

II - Questions on the Text

Answer the following questions on the reading text.

1. What is the meeting about, and what needs to be discussed?

2. What kind of product is Mensamint™?

3. What do patients have to do to obtain it?

4. What are the dosage forms of this product?

5. Are there any known side effects?

B) Grammar and Vocabulary Exercises

Activity 1 Research and Development (R&D)

Read the explanations and put the following words and expressions into the correct column.

Research: the process of testing chemical compounds, with the goal of finding a substance which has a beneficial effect on a targeted disease.

Development: the process of carrying forward scientific discoveries made during the research process, with the goal of producing a marketable drug.

analysis of disease - analytical testing - clinical trials - dosage forms - drug safety discovery - new chemical entities (NCEs) - target identification

Research	Development

- Which process takes longer, research or development? Why?

- What factors help pharmaceutical companies decide what drugs they should develop?

Activity 2 Asking Questions

These are answers to questions in an R&D meeting about a new chemical substance. Write your own version of these questions. Note: not every question is asked during the meeting.

1.

It is already available in lozenge and chewing gum form, but we hope to develop a time-release patch in the near future.

2. _____
We will have to test the bioavailability to be able to calculate dosages for non-intravenous routes of drug administration for this NCE.

3. _____
As you know, when substances are taken with alcohol or antibiotics, their chemical form could change and even cause harmful side effects. I'll keep you informed.

4. _____
Not completely. However, we do have a partner to help us develop a patch form which provides the desired effects for at least six hours.

5. _____
I'm afraid it may take a year or more before we can start the first tests on healthy humans.

Activity 3 Asking About Drug Discovery and Development

Put the correct form of one of the vocabulary items from the box into the sentences below.

chemist - dosage form - formulation - in-man study - prescription - toxicology

1. A specialist or expert in the scientific field of chemistry is called a _____. In the UK, this word is also used for the person who prepares and sells medicine, also known as a pharmacist in the US.

2. Using the right _____ is especially important when giving medicine to children, because they often have problems swallowing pills.

3. The science of poisons, including their source, chemical composition, action, tests, and even their antidotes, is what we call _____.

4. If a drug or medicine is not available 'over-the-counter', it normally means that a _____ from a physician is needed to obtain it from a pharmacy.

5. Chemists and pharmacologists are also interested in how the medicine is administered, so they often ask about its _____.

6. Before drugs or medicines can be made available to the public, they have to be tested on human beings. We call this an _____. It is also called a phase 1, stage 1 study, or clinical trial.

Activity 4 Minutes of the Meeting

A few days later, the participants received the minutes of the meeting. Put the paragraph in the correct order.

Minutes of Tuesday's brainstorming meeting

The Vice president of R&D began the meeting on time and welcomed all the participants. He also mentioned that Derek from Pharmacokinetics was out of town and was not able to attend.

1. _____ *Finally*, Brian asked if the new dosage form could be made with current technology.
2. _____ *Next*, there was some discussion about the time frame necessary for in-man studies.
3. _____ *Then* Marcus brought up the subject of the NCE's toxicity.

4. _____ Hilda *initially* asked what kind of formulation could be developed from the new NCE.
5. _____ *After that*, Frank asked about the bioavailability of the new chemical entity.

The meeting finished at 10.30 a.m. The next meeting for all participants, including Derek, will take place in one week. We will then decide how to proceed.

Activity 5 Sentence Building

Put the words in the right order to make questions and answers about substance discovery.

Question1 formulation kind we What of develop could ?

Answer 1 yet, know on We we're it don't but working

Question 2 about forms What the dosage ?

Answer 2 answer yet don't have We a complete to question that

Question 3 NCE this is What toxicity of the ?

Answer 3 about give the four can We weeks you answer in

Question 4 can study the When we in-man start first ?

Answer 4 six year and a half We from need to months will a

Question 5 are What effects kinds possible of side?

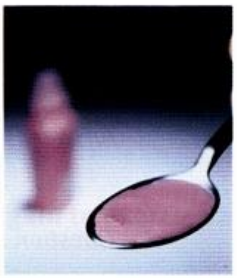
Answer 5 to still tests We running find are out

Activity 6 Dosage Forms

Match the words from the box with the pictures, and fill in the gaps in the following text with the correct dosage form.

dosage - drops - patch - pills - suppository - syrup - tablets

a. _____ **b.** _____ **c.** _____



d._____ **e.**_____ **f.**_____ **g.**_____

1. Calculating the correct _____ for some patients isn't always easy.
2. Children and older people often have trouble swallowing large _____ or _____.
3. Wearing a _____ may create problems for people with skin allergies.
4. Some medications are available in liquid form, such as _____ or _____
5. We often use a _____ to administer medication to babies or other patients who are not able to take drugs orally.

Activity 7 Survey on Dosage Forms

Read the phone conversion below about the results of a hospital in-patient survey on dosage forms for a new medication, then fill in the form below.

John Hi, Helen. Thanks for calling. Can I get a little bit of information on the patient survey you just completed in Switzerland about hospital in patient medication dosage forms?

Helen Sure, John, I've got most of the results right here. What do you want to know?

John I'm looking at a copy of your questionnaire now - how many patients were interviewed altogether? How many male and how many female?

Helen Well, we conducted the survey in four different hospitals and have results for nearly 2,000 hospital patients, most of whom were between 37 and 63, with an average age of 50. 54% were male, and 46% female.

John Right. Now what about the current oral dosage forms?

Helen 68% of them currently take either tablets, pills, or capsules for various ailments. 20% tablets, 26% pills, and 22% capsules.

John What dosage forms do they seem to prefer?

Helen Well, many patients find it difficult to swallow solid oral dosage forms and they prefer drops (12%) or syrup (8%.). Few patients would prefer aerosols (2%), creams (5%), ointments (2%), and patches (1%). Most patients, however, prefer gel tablets (30%) or capsules (32%), because they say they go down more easily.

John That's just what I was hoping to hear! Now could you just give me an idea of some of their chronic health problems?

Helen It may sound strange, but actually most of the patients were not in hospital because of their chronic health problems but were being treated for such things as broken bones, pneumonia, serious infections, or septic wound.

John Well, I'd still like to know if any of them had any other major health problems.

Helen Why don't I simply email you a copy of my final analysis later this afternoon?

John Good idea, then I can have a closer look at the results. Thanks again, Helen. See you.

Helen You're welcome, John. Goodbye.

Hospital In-patient Dosage Form Survey Results

1. Total number of in-hospital patients surveyed **(a)** _____ .

2. Male patients **(b)** _____ Female patients **(c)** _____ .

3. Average patient age **(d)** _____.

4. Which of the following oral dosage forms are the patients currently using?

tablet **(e)** _____ .	gel tablet **(f)** _____ .	capsule **(g)** _____ .	pill **(h)** _____.
solution _____ .	drops _____ .	syrup _____ .	others _____ .

5. Which of the following dosage form(s) do the patients favor?

oral dosage forms

tablet _____ .	gel tablet **(i)** _____ .	capsule **(j)** _____ .	pill **8%** .
solution _____ .	drops **(k)** _____ .	syrup **(l)** _____ .	other(s) _____ .

inhaled dosage forms

aerosol **(m)** _____ .	inhaler _____ .	other(s) _____ .

topical dosage forms

cream **(n)** _____ .	ointment **(o)** _____ .	liniment _____ .	lotion _____ .
gel _____ .	patch **(p)** _____ .	other(s) _____ .	

other dosage forms

nasal spray _____ .	eye drops _____ .	suppository _____ .

6. What kinds of side effects did the patients have with their current medication?
The following side effects were experienced:

allergic reactions	**794**	diarrhea	**29**	dizziness	**3**
fever	**75**	headache	**91**	indigestion	**422**
insomnia	**47**	itching	**70**	nausea	**253**
skin rashes	**59**	vomiting	**17**	other(s)	

7. Do the patients have any suggestions for other future forms of medication?
List all suggestions here:

_____

8. Do the patients have any of the following chronic health conditions?

asthma **791** anaemia **121** bronchitis **805** diabetes **83** heart condition **21**

Activity 8 Answers to Survey Questions

Answer the following questions using the information in activity 7.

1. How many patients were surveyed?

2. Were more male or female patients interviewed?

3. What kind of dosage form is most preferred by the patients surveyed?

4. What kinds of side effects were experienced by the least number of patients?

5. What chronic health conditions did most patients have?

Activity 9 Definitions of Dosage Forms

Match the dosage form on the left (1-10) to its definition on the right (a-j).

1	☐	aerosol	a	A very small amount of liquid that forms around shape.
2	☐	drops	b	A smooth, thick substance to rub on the skin for healing.
3	☐	inhaler	c	An oily liquid to rub on painful body parts to reduce pain.
4	☐	liniment	d	A medication on material or cloth placed on the skin.
5	☐	ointment	e	A small, round piece of medicine to be swallowed without chewing.
6	☐	patch	f	A container with a liquid that is administered in spray form.
7	☐	pill	g	A liquid in which another substance has been dissolved.
8	☐	solution	h	A solid medicine which melts slowly in the rectum.
9	☐	suppository	i	A sweet, liquid medicine taken with a spoon or cup.
10	☐	Syrup	j	A small device with medicine to breathe in through the mouth.

Unit 3 Quality Assurance and Auditing

(1) In the pharmaceutical industry, different quality assurance processes are required for each area of good practice (GxP). It is easiest to understand how good practice works in the area of manufacturing. The quality assurance process in good manufacturing practice (GMP) includes product quality control, sampling, and testing. Quality control ensures that the product quality remains high. The reason for interim testing, or product sampling, is to check the quality of pharmaceutical products. This is important to make sure that the product is suitable for its intended use and for sale. Endpoint testing is carried out at the end of every manufacturing process. This is to ensure that all procedures have been performed in compliance with industry and company standards.

(2) Documentation is important and necessary at every step of the processes, activities, and operations involved in drug manufacturing. If the documentation is not in order, or if the required specifications are not met, then the product is considered contaminated. Proper documentation not only enables traceability, but also allows a complete product recall from the market, if necessary.
Inspection and validation are required to prove that the manufacturing and testing equipment is functional. All operational methods and procedures must also be inspected for accuracy. Most companies do this voluntarily through internal audit processes.

(3) However, beyond the field of manufacturing, good practice must be adhered to in all processes in a pharmaceutical company. No process can be considered isolated from the others. For example, laboratory and manufacturing processes cannot be regarded separately. A holistic approach looks at all these environments to make sure that the entire process meets high industry standards.
Standard operating procedures (SOPs) are written and used by companies to make it easier for them to follow GxP. These are a set of written instructions to maintain performance and results. They are also the basis of every good quality assurance and quality control system.

A) Comprehension

I - Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(adj.)**, relating to medicinal drugs or their preparation, use, or sale.
2. _____ : **(n.)**, the state or fact of according with or meeting rules or standards.
3. _____ : **(n.)**, a detailed, exact statement of particulars, esp. a statement prescribing materials, dimensions, and quality of work for something to be built, installed, or manufactured.
4. _____ : **(v.)**, make (something) impure by exposure to or addition of a poisonous or polluting substance.
5. _____ : **(n.)**, the ability to verify the history, location, or application of an item by means of documented recorded identification.
6. _____ : **(n.)**, careful examination or scrutiny.
7. _____ : **(n.)**, to make something officially acceptable or approved, esp. after examining it.
8. _____ : **(n.)**, the quality or state of being correct or precise; precision; exactness.
9. _____ : **(n.)**, a thorough examination or evaluation.
10. _____ : **(adj.)**, dealing with or treating the whole of something or someone and not just a part.

II - True/False Questions

According to the text, which answer is not correct?

1. Why is product sampling carried out?
   - **a.** To introduce product quality.
   - **b.** To check product quality.
   - **c.** To make sure SOPs are followed.
   - **d.** To meet high industry standards.
2. Which aspect of drug manufacturing enables traceability?
   - **a.** Quality assurance.
   - **b.** Quality control.
   - **c.** Holistic approach.
   - **d.** Documentation.
3. Why do operational methods and procedures have to be validated?
   - **a.** To complete the quality assurance process.
   - **b.** To make sure products perform their intended function.
   - **c.** To complete the inspection process.
   - **d.** To isolate products of high quality.

B) Grammar and Vocabulary Exercises

Activity 1 Special Vocabulary

Complete the following sentences with the correct word or expression in the box.

validation - assurance - traceability - contaminated - product recall control - endpoint testing - holistic approach

1. The documentation required for all research processes and development steps ensures the _____ of a drug.
2. A _____ considers laboratory and manufacturing processes and environments together and not individually.
3. Quality _____ involves all manufacturing processes in GMP which make sure the goods produced are kept at high standards.
4. Quality _____ involves interim and product sampling procedures, which are carried out to check product quality.
5. At the end of every stage of a product's manufacturing process, _____ is done to maintain quality standards.
6. Even a product that has been marketed for years might have to be taken off the market in a _____ if serious adverse reactions occur.
7. Manufacturing processes and procedures must go through periodic _____ to guarantee that they are still of an acceptable standard.
8. _____ products are no longer pure and acceptable for sale or public use and, therefore, they must be returned to the manufacturer, in order to be destroyed.

Activity 2 Good Practice Definitions

Read the definition of 'good practice', then match the words with the correct abbreviations.

GxP : is an abbreviation for "good practice". The "x" is used to indicate the many different areas of "good practice" which are required by international regulatory authorities.

GAP, GCP, GDP, GLP, GMP, GRP, GSP.

auditing - clinical – documentation - laboratory manufacturing - research - safety

It's _____good practice.

Activity 3 Audit of a Laboratory

Complete the sentences with words from the box below.

non-compliance - checklist - finding - observe - up to date - short - updated - safety

1. Advance notice of this meeting was very_____.
2. _____procedures make sure that the health and well-being of laboratory workers are guaranteed.
3. Auditors generally watch or_____safety procedures in the lab.
4. To ensure that laboratory workers are asked certain questions about safety procedures, auditors use a _____ .
5. If any_____is observed during the audit, the department will be informed so they can take corrective action.
6. Standard operating procedures (SOPs) are _____on a regular basis, often after an audit has been carried out.
7. Scientists often read journals and go to international conferences, because they need to stay _____ in their scientific fields.
8. Any observation or_____noted by the auditors is categorized as either major, minor, or critical.

Activity 4 Accomplishing Tasks

Match the tasks on the left (1-8) with the phrases on the right (a-h).

1	☐	You state the reason for a memo.	a	Please send us ….
2	☐	You state the objective of a course of action.	b	This memo is to advise you that …
3	☐	You say the planned schedule.	c	Our goal is to ...
4	☐	You ask for verification of some information.	d	The laboratory procedures will be reviewed.
5	☐	You need to have a copy of something.	e	Please confirm ...
6	☐	You say which department in the company is involved.	f	Please make sure that …
7	☐	You say what areas will be audited.	g	The lab management department is scheduled for an audit …
8	☐	You say what should be done.	h	The timetable is as follows …

Activity 5 Internal Laboratory Audit

1. Read part of the internal audit report done on three laboratories at Berner Pharmaceuticals. There are five non-compliance areas which were observed by auditors Jacobs and Webber.

Berner Pharmaceuticals Ltd Internal Audit Report - Friday 13 June 2010

Purpose and area description: Annual audit of safety procedures in all laboratories.

Major facts: Although there were no serious instances of non-compliance, a number of incidents of undesirable conditions and practices were observed. These need to be corrected before the follow-up review in 30 days.

Observations:
a. Six laboratory technicians wore unsuitable clothing and safety equipment.
b. One lab assistant did not wash her hands after a procedure involving mice.
c. Times of the experiments were not entered on two of the daily lab reports.
d. Mice were transported in open cages (in public) to a second lab.
e. Improper disposal of toxic waste material was recorded.

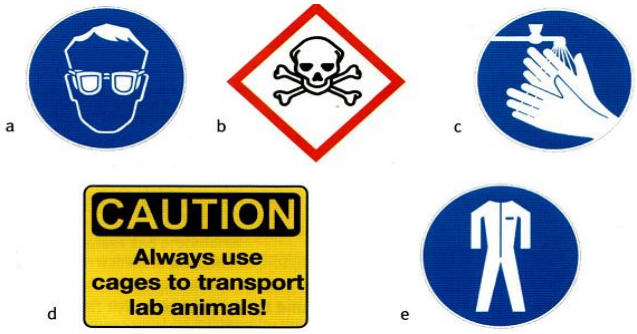
Follow-up: A review of the procedures in Labs 1, 2, and 3 will be carried out ...

2. Now match the areas of non-compliance found by the auditors with their observations.

Non-compliance areas			Auditors' observations	
1	☐	improper clothing/safety equipment	a	chemicals found in normal waste bins
2	☐	improper hygiene after handling animals	b	lab mice moved outdoors in open cages
3	☐	improper documentation	c	safety gloves too big, no safety goggles
4	☐	improper transportation of lab animals	d	no recording of experiment times
5	☐	improper disposal of toxic waste	e	hand-washing or sanitizing forgotten

Activity 6 Warning Signs

Read experts from Berner Pharmaceuticds' SOP on laboratory procedures (1-5). Then match them to warning signs (a-e).



1	☐	All toxic waste materials must be disposed of properly.
2	☐	Good sanitary hygiene must be practised by all lab staff.
3	☐	Protective clothing must be worn in the labs at all times.
4	☐	Lab animals must be transported in covered cages.
5	☐	Eye protection must be worn as signposted.

Activity 7 Standard Operating Procedures

Formulate SOP guidelines. Convert the following sentences.

Example: Use safety SOPs for working with laboratory animals.

Safety SOPs must be used for working with laboratory animals.

1. Perform all work with virus-infected animals in the bio-safety cabinet.

2. Use disinfectant on equipment following any experiments with laboratory animals.

3. Wipe up all chemicals spills in the laboratory immediately.

4. Wear laboratory gowns or lab coats, latex gloves, and safety glasses at all times.

5. Cover small biological agent spills with a paper towel and treat them with bleach.

6. Document all laboratory work in accordance with GLP.

Unit 4 Drug Testing, Safety and Regulatory Affairs

(1) In the preclinical stage of drug development, an investigational drug must be tested extensively in the laboratory. This is to ensure it will be safe to administer to humans. Testing at this stage can take from one to five years and must provide information about the pharmaceutical composition of the drug, its safety, and how the drug will be formulated and manufactured.

(2) Preclinical Technology: During the preclinical development of a drug, laboratory tests document the effect of the investigational drug in living organisms (in vivo), and in cells in a test tube (in vitro).

(3) Chemistry, Manufacturing and Controls (CMC)/Pharmaceutics: The results of preclinical testing are used by experts in pharmaceutical methods to determine how to best formulate the drug for its intended clinical use. For example, a drug that is intended to act on the sinuses may be formulated as a time-release capsule, or as a nasal spray. Regulatory agencies require testing that documents the characteristics-chemical composition, purity quality, and potency of the drug active ingredient, and of the formulated drug.

(4) Pharmacology/Toxicology: Pharmacology is the study of drugs and the body's reaction to drugs. Toxicotogy is the study of the potential risks to the body. The results of all testing must be provided to the FDA in the United States and/or other appropriate regulatory agencies in other countries in order to obtain permission to begin clinical testing in humans. Regulatory agencies review the specific tests and documentation that are required in order to proceed to the next stage of development.

A) Comprehension

I - Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(adj.)**, relating to or denoting the stage of drug testing that precedes the clinical stage.
2. _____ : **(v.)**, dispense or apply (a remedy or drug).
3. _____ : **(adj.)**, performed or taking place within a living organism.
4. _____ : **(adj.)**, performed or taking place in an artificial environment outside a living organism.
5. _____ : **(n.)**, a small soluble round or cylindrical container that encloses a dose of an oral medicine or a vitamin.
6. _____ : **(n.)**, a liquid preparation which can be forced out of a can or other container in tiny drops.
7. _____ : **(adj.)**, serving or intended to control or direct according to rule, principle, or law.
8. _____ : **(n.)**, inherent capacity for growth and development; potentiality; effectiveness.
9. _____ : **(n.)**, the science of drugs, including their composition, uses, mode of action and effects.

II - Questions on the Text

Answer the following questions on the reading text.

1. How long can it take to finish the preclinical stage?

_____

2. What needs to be documented in laboratory tests?

3. What do regulatory agencies require?

4. What is the difference between pharmacological and toxicological studies?

5. When can a pharmaceutical company start clinical testing in humans?

III – Word Searching

Find the word in the text which means:

a. receive, get: _____
b. demand : _____
c. make sure : _____
d. fix conclusively: _____
e. possible : _____
f. go on : _____

IV - Nouns and Verbs

Complete the table, and then fill in the gaps of the excerpt using the correct form of the words.

Verb		document		intend		inform
noun	permission		Administration		formulation	

First of all, it is the **(1)** _____ of the company to complete the preclinical trials by the end of the year. After that, regulatory agencies have to give **(2)** _____ to commence with the clinical testing in humans, which is also done at our company. But before that can happen, our scientists determine how to **(3)** _____ the active pharmaceutical ingredient into a suitable administration form. We have to **(4)** _____ each step of every test very thoroughly before the regulatory agencies give their approval to proceed to the next stage. The **(5)** _____ must show that the **(6)** _____ of the investigational drug is safe for our subjects.

B) Grammar and Vocabulary Exercises

Activity 1 Preclinical Development

Complete the sentences about preclinical development using the correct form of the verbs in the box below.

be administered - be conducted - be determined - be formulated - be provided - be used

1. We started the trial after tests on investigational drugs in vivo and in _____ vitro over a period of up to five years.
2. Last year, results of preclinical testing _____ to come up with the best formulation of the intended drug.
3. Extensive documentation must _____ to the appropriate regulatory authorities.
4. A drug intended to act on the skin can _____ as a cream.
5. Potential risks to humans _____ in toxicity studies.
6. The requirements of drug bioavailability determine how it will _____ to humans.

Activity 2 Building Sentences

Unscramble the words. Make questions or sentences to ask for and clarify information, make suggestions, and respond to suggestions. Note that each time there is one word you do not need.

1. fill in me Could some body is what on the problem there's please ?

_____.

2. correct does it the dogs Is responding that aren't to the drug.

_____.

3. need to figure we which animal group First, out is receiving what concentration.

_____.

4. could We consider testing group with but another animals of.

_____.

5. would know to prefer mini-pigs I use dogs instead of Personally,

_____.

Activity 3 Summary of a Meeting

Read the notes below and match the sentence halves to make a summary of the meeting.

Notes

The general health of the dogs was regularly checked. In addition, the overall appearance and behavior of each animal was assessed twice a day. On day 2, however, abnormalities regarding food consumption were observed shortly after administration in the high-dose group. The dogs' food consumption was lower, whereas their water consumption was higher. The dogs started retching and vomiting and were separated to allow close observation. No other clinical symptoms were observed, though. In comparison with the high-dose groups, animals in the low-dose and mid-dose groups showed no clinical symptoms at all.

1 ☐	The animals that showed clinical symptoms.	**a**	were checked twice a day
2 ☐	Clinical symptoms in the high dose group.	**b**	were separated to be watched more intensively
3 ☐	The general health and behavior of the dogs.	**c**	were found in the low- and mid-dose groups
4 ☐	No major clinical symptoms.	**d**	were discovered soon after administration

Activity 4 Linking Ideas

Use the word or phrase in brackets to link the two ideas. In some cases you will still have two sentences.

1. There were no clinical findings in the mid-dose group. The high-dose group animals showed clinical symptoms. **(while)**

_____.

2. The pulse rate was increased. The blood pressure was high. **(not only...but also)**

_____.

3. There were no clinical findings in the oral administration studies. There were clinical findings in the intravenous-dose studies. **(however)**

_____.

4. Mini-pigs are easy to handle. Rhesus monkeys are difficult to work with. **(whereas)**
_____ .
5. The drug was well tolerated by rats. It did not have any effect on blood pressure. **(furthermore)**
_____ .

Activity 5 Confusing Words

Put the correct words into the sentences. At least one word of each pair has been used in this unit.

Illness / diseases

1. There is a history of lung _____ in the family.
He missed five days of work because of _____ .

Sensitive / sensible

2. Dogs are more _____ to drugs than mini-pigs.
It was a _____ decision to cancel the trial.

Affect / effect

3. I felt the _____ of the new ointment right away.
The active ingredient currently being tested seems to _____ the kidneys.

Shortly / briefly

4. The adverse event occurred _____ after the injection.
The trial director spoke _____ to his staff about the current status of the trial

Activity 6 Additional Effects of Taking Drugs

Match each expression with its definition.

Adverse event - Serious adverse event (SAE) - Side effect

_____ **:** any unintended reaction caused by a drug or medical treatment. This term is used by the general public, but is often avoided by medical authorities.

_____ **:** an unwanted medical occurrence which a patient experiences during treatment. This may or may not be a side effect of a drug.

_____**:** an adverse event that threatens life, requires or prolongs hospitalization, or results in death.

Activity 7 Tasks of Departments

Tick the department which is responsible for each of the following tasks.

		Drug Safety	Regulatory Affairs
1	Reporting an adverse drug reaction to health authorities.	☐	☐
2	Submitting documents needed to obtain marketing approval for a drug.	☐	☐
3	Monitoring and evaluating suspected side effects.	☐	☐
4	Responding to a physician's report.	☐	☐
5	Compiling dossiers for submission to authorities.	☐	☐
6	Writing the drug information for the patient.	☐	☐

Activity 8 Symptoms Definitions

Match the following symptoms (1-7) with their definitions(a-g).

1 ☐	hypertension	**a**	sleeplessness
2 ☐	rash	**b**	general discomfort, bad feeling
3 ☐	palpitation	**c**	red, warm, and swollen
4 ☐	insomnia	**d**	you feel like you want to scratch
5 ☐	inflammation	**e**	heart racing
6 ☐	itching	**f**	high blood pressure
7 ☐	irritation	**g**	a lot of spots on the skin

Activity 9 Case Report

Connect the following sentence halves (1-5), then put them in the correct order to make a case report.

1 ☐	A report received from the patient's sister	**a**	the attending physician reduced the dosage to 10 mg per day.
2 ☐	After having taken *Mensamint*™, the patient experienced	**b**	and the symptoms cannot be ruled out.
3 ☐	A correlation between *Mensamint*™	**c**	headaches and insomnia.
4 ☐	The patient has now completely	**d**	indicated that she had a history of hypertension.
5 ☐	After examining the patient,	**e**	recovered and is back on stage.

Correct order: ___ ___ ___ ___ ___

Activity 10 Safety Information and Adverse Events

Complete the safety information and adverse event report to the FDA and to the local authorities using the phrases below.

1 :	A history of	**7 :**	correlation between
2 :	a report was received	**8 :**	showed evidence of
3 :	after examining the patient	**9 :**	suspected side effects
4 :	all symptoms had subsided	**10 :**	the patient reported
5 :	be ruled out	**11 :**	vital signs
6 :	was concomitantly taking		

(1)_____ from a physician indicating that a woman had fainted after developing a sudden, severe skin rash and inflammation all over her body. She was taken to hospital and regained consciousness 30 minutes later. **(2)** _____ not having had anything to eat but a chocolate candy bar 4 hours beforehand. In addition to small, red, itching spots all over her body, she also reported suffering from mild heart palpitations, headaches, and insomnia after starting on *Mensamint*™ three weeks previously. The patient **(3)** _____the following medication: Mimifem oral

contraceptive pill 0.2 mg daily. As to her emotional state after hospital admission, the patient **(4)**_____ hyperactivity, accompanied by confusion and a feeling of agitation. **(5)** _____, the attending physician discontinued *Mensamint*™ and administered a strong sedative. After 24 hours, **(6)**_____except for a mild skin irritation and the patient was released from hospital. Symptoms are **(7)**_____ of *Mensamint*™, although a **(8)** _____ her peanut allergy, *Mensamint*™ and this event cannot **(9)** _____ .

(10)_____: temperature l00°F (38.8°C); blood pressure 150/110.

Known allergies: peanuts, penicillin.

The patient has **(11)**_____hypertension , heart trouble, and insomnia.

Activity 11 Sell Approval of a Drug

In order to get approval to sell a new drug, a company has to compile detailed documentation with all the information required by the drug authorities. Match the following sections with their descriptions.

1	☐	Administrative Data
2	☐	Common Technical Document Summaries
3	☐	Quatity
4	☐	Non-clinical Study Reports
5	☐	Clinical Study Report

a	biological, chemical, and pharmaceutical documentation with manufacture, quality control, and testing data.
b	over views of quality, clinical, and non-clinical data.
c	documentation about clinical trials and post-marketing information.
d	general information, such as the marketing authorization application form, as well as product characteristics and labeling.
e	study reports, pharmacology, pharmacokinetics, toxicology, and reference.

Activity 12 Patient Information Leaflet (PIL)

Here is some information from the PIL for a new drug called *Pogolox*™. Match the following sentences halves used in the leaflet.

1	☐	*Pogolox*™ may cause	**a**	are allergic to any antibiotics.
2	☐	Tell your doctor right away if	**b**	your temperature continues to rise.
3	☐	You must not	**c**	operate machinery while taking this drug.
4	☐	Do not take *Pogolox*™ if you	**d**	this medicine can cause diarrhea.
5	☐	Stop use of *Pogolox*™ immediately	**e**	serious liver damage.
6	☐	Like all antibiotics,	**f**	if you experience any chest pain.

Unit 5 — Production and Packaging

A self-help group for cardiac diseases is visiting RRB Pharmaceuticals. Henry Naylor, a representative from Public Relations (PR), welcomes them. Listen and answer the questions.

(1) Good morning, ladies and gentlemen. On behalf of the Public Relations Department, I'd like to welcome you to RRB Pharmaceuticals. My name is Henry Naylor, and I work in the Public Relations Department here at RRB. Prior to your tour of the production facilities, I'll tell you a bit about the history of the company. When the company was founded in 1948, there were just 17 employees producing effervescent powder to flavor drinks. In the meantime, RRB Pharmaceuticals has grown to have about 28,000 employees worldwide. Nowadays, RRB is a research-driven, innovative pharmaceutical enterprise that develops new drugs, produces them, prepares them for sale, and markets them worldwide.

(2) Um. Excuse me. Can I take flash pictures?

I'm afraid not. As a matter of fact, we have to ask you to leave your cameras in the lockers at reception. Unfortunately, taking pictures is strictly forbidden and you are not allowed to smoke anywhere on the premises. And I would like to remind you that, for security reasons, your visitor's pass must be visible at all times.

(3) The clothing requirements didn't used to be as tough as they are nowadays. But, in the meantime, the regulations have become so strict that in the heart of some production areas staff members are wearing three layers of clothing and they can't recognize each other anymore. However, we won't be getting quite that far into the heart of it today. By the time we finish today, I hope to have answered all of your questions. But if you wish to ask anything during the tour, you can interrupt me at any time. Please remember, once you have entered the clean area it won't be possible to use the toilet facilities. So, while we're waiting for Stephanie Baker to pick you up for the actual tour, feel free to use the facilities at the end of the hall.

A) Comprehension

I - Technical Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(n.)**, buildings, equipment, or services that are provided for a particular purpose.
2. _____ : **(adj.)**, (of a liquid) giving off bubbles; fizzy.
3. _____ : **(n.)**, the distinctive taste of a food or drink.
4. _____ : **(adj.)**, (of a product, idea, etc.) featuring new methods; advanced and original.
5. _____ : **(n.)**, a small cupboard in a public area where you can keep things.
6. _____ : **(n.)**, a rule or directive made and maintained by an authority.

II - Questions on the Text

Answer the following questions on the reading text.

1. What did RRB produce originally?

   _____

2. What are the visitors not allowed to do?

   _____

3. What do they have to do?

   _____

4. When can the visitors ask their questions?

_____

III - Expressions of Time

Underline the most suitable expression to complete the sentences.

1. **In the past, / In the meantime**, requirements have reached a very high standard.
2. **When it was founded, / Nowadays**, the company only had one production site.
3. **In the meantime, / When** it was opened, they have developed a number of well-known products.
4. **While / During** you are waiting, you can look at these brochures.
5. **In the past, / Meanwhile**, our company is one of the ten largest drug companies in Europe.
6. **By the time / During** the safety film, I will give you more detailed information on the company.
7. **Once / While** the tour is finished, you will have seen the most important production areas.

B) Grammar and Vocabulary Exercises

Activity 1 Sentence Building

Put the words into the correct order to make sentences.

1. effervescent company to The used powder only produce

_____

2. and process uncomplicated simple The be production to used

_____

3. documented use clothing The didn't be specifications to

_____

4. regulations strict to company's The safety be didn't so use

_____

5. inspections didn't so authorities be There use many by to

_____

Activity 2 Safety Signs for Workplace

Now look at these signs. Match them to the terms below.

1	face mask	☐	5	Overshoes	☐
2	Hair covering	☐	6	Protective shoes	☐
3	Lab coat	☐	7	Rubber gloves	☐
4	overalls	☐	8	Safety goggles	☐

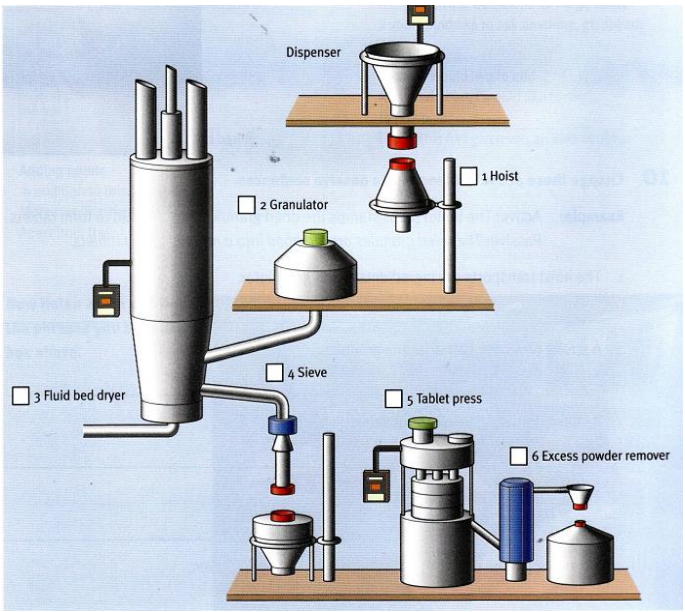
Activity 3 Safety Instructions for Workplace

Look again at the signs below, and give appropriate instructions for them.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Activity 4 Process Description

Look to the diagram and read the description of the tablet production process, then number the steps according to the diagram.

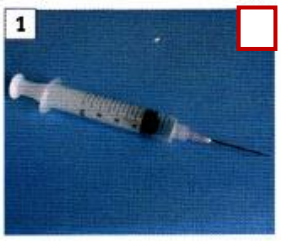


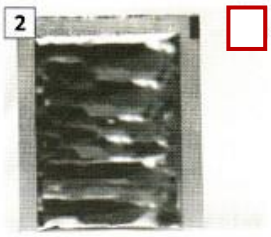
Tablet Production Process

1	☐	As the tablets go up a spiral, they are shaken, and the excess powder is vacuumed off. The pressed tablets are put into a drum and stored until it is time to coat them.
2	☐	In the granulator, the ingredients are mixed to create a wet mixture.
3	☐	The wet granules are pressed through a sieve on their way to the fluid bed dryer.
4	☐	The granules are air-dried.
5	☐	The dried granules are stamped into a mold to form tablets.
6	☐	Dry ingredients are weighed and transported to the granulator by the hoist.

Activity 5 Primary and Secondary Packaging Materials

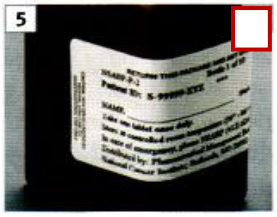
Are these primary or secondary packaging materials? Could they be both? Write P for primary, S for secondary, or B for both.

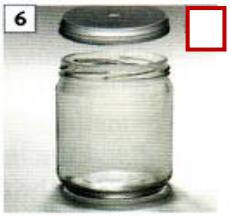




Primary Packaging: is the material which is in direct contact with the product.

Secondary Packaging: is any packaging material that is not in direct contact with the product.





Activity 6 Primary and Secondary Packaging Description

A. Match the types of packaging from activity 5 with their descriptions below.

1. A(n) _____ is an aerosol dispensing device which releases medication into the mouth of the patient. The medication is breathed deeply into the lungs, or stays in the mouth or throat.
2. A(n) _____ is a type of single-use plastic container, and is used for pharmaceutical products as well as for other consumer goods. The product is placed in the formed cavity and sealed by lidding foil. The product is removed by pushing it through the foil.
3. A(n) _____ is a needle attached to a plastic tube used for putting medicine into the body or removing blood.
4. A(n) _____ is a multi-use glass container with a twist-on lid. It can hold pharmaceuticals, or any kind of fluids or solids. It can be opened and closed several times until the contents are used up. Sometimes a desiccant is integrated into the cap so that the contents remain dry.
5. A(n) _____ is a small disposable bag containing an individual dose of the medicine. It often has a lengthwise perforation which can be torn open.
6. A(n) _____ is a piece of paper attached with adhesive to the primary packaging to identify it and give details concerning its ownership, nature, and/or use.

B. Which primary packaging would you recommend for the following medicine?

cough syrup - nose drops – ointments – suppositories - tablets

Activity 7 Process Description

Which of the verbs in the box are used with the following primary packaging forms? Why?

press - push through - remove - tear - twist

1. Syring _____ .
2. Sachet _____ .
3. Blister pack _____ .
4. Jar _____ .
5. Inhaler _____ .

CHILDPROOF VS. ELDERLY-ACCESSIBLE

A lot of research is done to make packaging *childproof*, i.e. a child cannot open it alone. However, at the same time, the elderly must have easy access to their medication, i.e. it needs to be *elderly-accessible*.

Activity 8 Childproof Packaging

Read the following text about childproof packaging and unscramble the letters in the brackets to find the correct word.

The latest **i** _____ **(1)** (vatinionson) in childproof packaging nowadays entail sophisticated **m** _____ **(2)** (sacnihmsem) that are physically easy to open, even for the **e** _____ **(3)** (dyelert) or infirm, but that require actions to be thought through in a way small children would not be **c** _____ **(4)** (aaclbep) of. Psychologists, **e** _____ **(5)** (gieneesrn), and designers have **c** _____ **(6)** (bocallradeto) and come up with the following state-of-the-art feature.

Now match each container system type to the action needed to use it.

1	☐	Slide	**a**	A closure must be pushed down before it can be unscrewed.
2	☐	Poke	**b**	A first layer must be peeled off a blister before the drug can be pushed through the second layer.
3	☐	Push-screw	**c**	A closure must be squeezed between two fingers before it can be unscrewed.
4	☐	Squeeze-screw	**d**	A container with three buttons that must be aligned in order to slide off the lid.
5	☐	Peel-push system	**e**	A tube that can only be released by an adult-length finger by pushing an internal catch.

Chapter 4

ENGLISH FOR ENVIRONMENTAL SCIENCE

Unit 1 Pollution

(1) Pollution is the degradation of natural environment by external substances introduced directly or indirectly. Human health, ecosystem quality and aquatic and terrestrial biodiversity may be affected and altered permanently by pollution.

(2) Pollution occurs when ecosystems cannot get rid of substances introduced into the environment. The critical threshold of its ability to naturally eliminate substances is compromised and the balance of the ecosystem is broken.

(3) The sources of pollution are numerous. The identification of these different pollutants and their effects on ecosystems is complex. They can come from natural disasters or the result of human activity, such as oil spills, chemical spills, nuclear accidents... . These can have terrible consequences on people and the planet where they live: destruction of the biodiversity, increased mortality of the human and animal species, destruction of natural habitat, damage caused to the quality of soil, water and air.

(4) Preventing pollution and protecting the environment necessitate the application of the principles of sustainable development. We have to consider to satisfy the needs of today without compromising the ability of future generations to meet their needs. This means that we should remedy existing pollution, but also anticipate and prevent future pollution sources in order to protect the environment and public health. Any environmental damage must be punishable by law, and polluters should pay compensation for the damage caused to the environment.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(adv.)**, existing or intended to exist for an indefinite period. Not expected to change for an indefinite time; not temporary.
2. _____ : **(n.)**, a level or point at which something would happen, would cease to happen, or would take effect, become true, etc.
3. _____ : **(v.)**, to settle (a dispute or a conflict) by making concessions.
4. _____ : **(n.)**, an occurrence that causes great distress or destruction.
5. _____ : **(n.)**, to cause or allow to run or fall from a container, esp. accidentally or wastefully.
6. _____ : **(n.)**, pertaining to a system that maintains its own viability by using techniques that allow for continual reuse.
7. _____ : **(v.)**, to foresee and act in advance of.
8. _____ : **(adj.)**, liable to or deserving punishment.

II - Main Ideas.

As you read the passage determine the main idea of each paragraph.

1. The main idea of paragraph **(1)** is: _____
2. The main idea of paragraph **(2)** is: _____
3. The main idea of paragraph **(3)** is: _____
4. The main idea of paragraph **(4)** is: _____

III - Understanding the Passage

3.1 Questions on the Text

Answer these questions on the reading text.

a. The damage caused by pollution might be irreversible. _____
- **a.1** true.
- **a.2** false.

b. The ecosystem: _____
- **b.1** can always cope with pollutants.
- **b.2** may not always be able to cope with pollution.

c. Pollution: _____
- **c.1** is always caused by humans.
- **c.2** may sometimes be caused by natural disasters.

d. An ideal solution to prevent pollution would be to: _____
- **d.1** refrain the development of some countries.
- **d.2** continue developmental projects.
- **d.3** take into consideration the future generations need to live in a healthy environment.

3.2 Cohesion

Complete the following sentences using the words from the box below, and then reorder the sentences into a logical paragraph about soil.

Fundamental - extremely - however - also - substances

_____ **a.** It is _____, an essential medium for growing crops.

_____ **b.** _____, this barrier is lost if soil is damaged or contaminated, with the consequence that the soil becomes a source of pollutants that can enter surface or groundwater and even damage the quality of air and consequently the health of plants, animals and people.

_____ **c.** Toxic _____ can be dangerous for individual species and have long-term effects on ecosystems.

_____ **d.** Soil _____ important for the environment, because water and vital substances such as vitamins, minerals and fires are stored and regenerated in it.

_____ **e.** And it has another _____ function: it acts as a barrier between the atmosphere and aquatic ecosystems.

B) Grammar and the Environment Vocabulary Exercises

Activity 1 Sentence Completion

Complete the following sentences using words from the box.

pollution - deforestation - warming - effect - biodiversity - recycle windmill - gases - used up - protection

a. There is a growing concern over the _____ of species habitat and _____.

b. The greenhouse _____ is an increase in the amount of carbon dioxide and other _____ in the atmosphere which is believed to be the cause of a gradual _____ of the surface of the earth.

c. The earth's resources are being _____ at an alarming rate.

d. The energy generated by the _____ is both very efficient and clean.

e. There have been many reports about _____ which is destroying large areas of tropical rain forest.

f. The Japanese _____ more than half their waste paper.

g. We're not doing enough to protect the environment from _____.

Activity 2 Definitions

Match the words with their definitions.

1	☐	Waste	**a**	Something created while producing or processing another product.
2	☐	Habitat	**b**	Water found under the ground.
3	☐	Groundwater	**c**	Substances that pollute the environment.
4	☐	By-product	**d**	Material that is no longer wanted because its valuable part has already been used.
5	☐	Medium	**e**	Natural environment where animals and plants grow.
6	☐	Pollutants	**f**	A substance which acts as a vehicle for a particular purpose.

Activity 3 Types of Pollutions

Complete the following sentences to get a small comprehensive text about types of pollution.

soil contamination - visual pollution - noise pollution - air pollution
radioactive contamination - light pollution - water pollution

Pollution is the release of chemical, biological, physical or radioactive substances in the environment. Among the main kinds of pollution are:

_____ : Due to the release of chemicals and particulates (solid particles forming dust) such as nitrogen oxides that create smog and hydrocarbons. Other examples of air pollution are carbon monoxide and sulfur dioxide.

_____ : Caused by industrial waste, agricultural drainage and sewage.

_____ : The most significant soil contaminants are heavy metals, hydrocarbons, herbicides and pesticides.

_____ : Caused by accidents in nuclear power stations and by the production and use of nuclear weapons.

_____ : Including roadway, aircraft and industrial noise and high-intensity sonars.

_____ : Including light trespass and over-illumination.

_____ : Referring to the presence of overhead power lines, motorway billboards or open storage of junk and municipal solid waste.

Activity 4 Writing Examples

Read again the text you finished above and fill in the table.

Type of Pollution	Examples
Air pollution	_____
Water pollution	_____
Soil contamination	_____
Noise pollution	_____
Light pollution	_____
Visual pollution	_____
Radioactive contamination	_____

Activity 5 Grammar

1. Expressing cause/result effects.

Read these sentences, then decide which part of the sentence talks about the cause and which part gives the result.

Example: oil **causes** pollution of rivers, lakes, and oceans.
(cause) ⟶ **(result)**

a. Waste oil is responsible for the most pollution.

b. Oil is sometimes spilled because of burst pipes.

c. Major oil tanker disasters account for slightly more oil pollution.

d. Accidents with ships are the result of ships hitting each other hitting sand and rocks below the water.

e. Accidents with ships happen because of human error.

f. A major oil spill can result in very serious damage.

2. Put the verbs in brackets in the correct form.

a. Oil that seeps naturally from the bottom of the ocean _____(account) for some water pollution.

b. In 1989, a major tanker disaster _____ (cause) serious damage to the environment.

c. Major oil spills _____ (result) in long-term damage to the environment.

d. An increase in the demand for oil in 1960s _____ (result) in large oil tankers.

e. Less oil pollution_____(be) the result of governments working together.

3. Use the notes below to write sentences to explain cause and result relationships.

a. Oil in sea water / the death of marine plants animals.

_____

b. Birds can't fly or feed / oil on their feathers.

_____

c. Pollution of the coast / a reduction in tourists.

_____

d. Contaminated drinking water / leaking oil pipes.

_____

e. The use of satellite technology / the quick detection of oil spills.

_____

4. Complete the sentences with "are allowed to" / "aren't allowed to" or "have to".

Example: We **have to** reduce our CO_2 emissions by 5 per cent by next year.

a. Factories _____ dump rubbish in the river. They can be fined if they do.

b. Manufacturers _____ follow strict environmental guidelines.

c. The government sets strict limits on landfill. We _____ send only 50 percent of our waste to landfill sites. We _____ recycle the rest.

d. Paint producers _____ use lead in their paint anymore because it's a health hazard.

e. We _____ exceed the permitted levels.

5. Complete the sentences with the correct verb.

Example: When fossil fuels are burnt, they **give** off CO_2, **give / take / send**.

a. We need _____ up our production process. **clear / take / clean**.

b. We are trying to _____ down the amount of packaging we use. **put / cut / bring**.

c. You can _____ down plastic and market it into a different product. **heat / cut / melt**

d. It's better to recycle glass bottles than to _____ them away. **throw / put / take**

e. Most hamburger boxes don't _____ down in the environment. **take / bring / break**

f. The EU will _____ in new legislation next year. **bring / put / call**

Activity 6 Vocabulary: Word Families

You can improve your vocabulary by learning word families, for example refine (v), refinery (n), refined (adj, unrefined (adj)).

1. Complete the table below. Use a good English-English dictionary if necessary.

verb	Noun	Adjective
pollute	1 _____	2 _____
	3 _____	technical
damage	4 _____	5 _____
6 _____	7 _____	(un)protected
8 _____	9 _____	transported
10 _____	11 _____	leaked
globalize	globe	12 _____
	environment	13 _____
14 _____	seepage / seep	
spill	15 _____	16 _____

2. Complete the sentences below with words from the table you completed above.

a. The natural place where plants and animals live is the _____.

b. If a pipe carrying oil burst, the oil causes _____.

c. Carbon dioxide is causing _____ warming.

d. New car _____ means that car engines are more efficient.

e. Oil companies produce oil but they also try to _____ the environment.

f. An oil tanker accident can cause serious _____ to the environment.

g. Industrial facilities have ways to stop _____ oil getting into water and soil.

h. In some places oil _____ slowly to the surface of the ground by itself.

Unit 2 — The Motor Car Pollution

(1) The American city of Los Angeles has its own peculiar air pollution problem, known as photochemical smog. This sort of smog differs from more common forms of smog in that it consists largely of oxidizing agents such as ozone and nitrogen oxides, whereas the main component of industrial smog is sulphur dioxid.

How is photochemical smog caused?

The Los Angeles basin, which includes several other large towns apart from Los Angeles itself, is surrounded on three sides by high mountains and on the fourth by the Pacific Ocean. This seaside location means that the basin is subjected to temperature inversions on over 300 days per year. The affluence of the pollution means that there is an extremely high density of traffic in the basin, producing enormous quantities of toxic fumes and pollutants which are prevented from dispersing upwards by the temperature inversion and are also trapped in horizontally by the mountains. In addition, the sun shines most of the time in Southern California, and the effect of ultra-violet light on the carbon monoxide, nitrogen oxides and hydrocarbons emitted by motor cars is to trigger off a number of complex chain reactions resulting in the presence of dangerous secondary pollutants such as ozone, aldehydes and ketones.

(2) But the primary pollutants are dangerous enough in themselves. Carbon monoxide is a highly poisonous gas which can be lethal in comparatively small doses. If inhaled, it has the effect of cutting off the supply of oxygen to blood, since its molecules combine with hemoglobin much more strongly and for longer periods than oxygen molecules do. Thus, even though exhaust fumes may contain less than 5% carbon monoxide, any prolonged inhalation significantly reduces the oxygen-carrying capacity of the blood, and soon causes headaches, sickness and even death.

(3) The relatively inefficient combustion of fuel and air in a car engine means that many hydrocarbons fragments are left unburned. These fragments (mainly methane and other alkanes) help to form smog and are believed to be carcinogenic.

(4) Nitrogen oxides are formed within the cylinders of an engine during fuel combustion. They are major components of smog and it is particularly difficult to deal with them in the engine. If more air is introduced into the cylinders to burn the carbon monoxide and hydrocarbons more efficiently, the temperature is raised and more nitrogen oxides are formed.

(5) There is one more toxic substance present in exhaust fumes. Lead compounds are added to petrol to raise its octane number and hence also the performance of the engine. The lead is emitted in tiny particles which take a long time to settle and, if breathed in, can accumulate in the body and cause lead poisoning.

(6) Pollution by exhaust fumes accounts for about 60% of all atmospheric pollution in industrialized countries like Britain, and many countries are now taking action to reduce it. Some government have brought in strict restrictions on the permitted amounts of lead additives in petrol and regular checks are made on the carbon monoxide content of exhaust fumes. But this pollution problem may solve itself sometime in the 21st century, once the world's oil-wells have all dried up.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(adj.)**, strange or unusual; special; distinct from others.
2. _____ : **(adj.)**, caused by the action of light on chemical substances.

3. _____ : **(n.)**, a mixture of smoke, fog, and chemical fumes. A sort of fog produced by smoke from fuels such as coal, oil, and gas.
4. _____ : **(v.)**, affected by; to cause to undergo the application (of); to expose or render vulnerable or liable (to some experience).
5. _____ : **(n.)**, an abundant supply of money, goods, or property; wealth.
6. _____ : **(v.)**, to catch; keep in; prevent from escaping.
7. _____ : **(v.)**, to give rise (to); set off; to cause; to bring about.
8. _____ : **(adj.)**, able to cause or causing death; deadly; fatal; mortal.
9. _____ : **(v.)**, to draw (breath) into the lungs; to breathe in.
10. _____ : **(v.)**, to gather or become gathered together in an increasing quantity; amass, collect; to build up.

II - Understanding the Passage

2.1 Questions on the Text

Answer these questions on the reading text.

a. Write down the three factors which contribute to the formation of photochemical smog in Los angeles.

- _____
- _____
- _____

b. List the four main pollutants present in exhaust fumes. State which two of them are directly toxic.

- _____
- _____
- _____
- _____

c. What differs the smog of Los Angeles from the common forms?

_____

d. What does carbon monodioxide cause if inhalated?

_____

e. How are nitrogen oxides formed inside the engine of a motor car?

_____

f. What actions some governments decided to carry out to reduce motor car pollution?

_____

2.2 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ Los Angeles smog is the same sort as the smog in New York.

b. _____ Warm air (e.g. air containing exhaust fumes) usually rises.

c. _____ Rich people tend to pollute the atmosphere.

d. _____ Carbon monoxide molecules easily attach themselves to hemoglobin.

e. _____ It is difficult to cut down pollution caused by carbon monoxide and hydrocarbons without increasing amounts of nitrogen oxides.

f. _____ Lead additives have been banned in many countries.

2.3 Asking Questions

Look at these questions.

- What effect can certain hydrocarbons have on people?
- How do certain hydrocarbons affect people?
- **(Answer: they can cause cancer)**

Now write more questions about the effects of these substances.

a. Carbon monoxide / the blood

_____

b. Lead / people

_____

c. Sunlight / exhaust fumes

_____

d. The geographical location of Los Angeles / the air temperature

_____

e. The introduction of more air into the cylinders of a car engine / the burning of the fuel

_____

2.4 Connectives

Look at the way these words in the box are used in the passage.

In addition - thus - hence - this - these - which (2)

These are connectives which join up ideas in a piece of writing. Choose from them to complete this passage.

As more and bigger oil tankers are built, the risks of a major oil pollution disaster at sea grow greater and greater _____ tankers, the biggest of _____ weighs over half a million tons, are extremely difficult to handle at sea. They can neither turn nor stop quickly and _____ are a particular threat to shipping in crowded waterways _____, once they run aground on rocks or on a sandbank, it is almost impossible to refloat them without spilling oil. The extent of _____

problem has been shown only too clearly in recent years by tanker wrecks off the coasts of France and Britain, in _____ huge quantities of oil poured into the sea and ruined fishing grounds and beaches, _____ depriving thousands of people their livelihood.

2.5 Cause and Effect Relationship

The relationship between cause and effect is expressed in several different ways in the passage.

- This seaside location means that the basin is subject to temperature inversions.
- ……the effect of ultra-violet light on the carbon monoxide……is to trigger off a number of complex chain reactions resulting in the presence of dangerous secondary pollutants……
- ……it has the effect of cutting off……
- ……any prolonged inhalation……..….causes headaches……

In short notes, an arrow, ⟶, is often used to link cause and effect.

Use the information in the passage to complete these notes. The first one has been done for you.

a. Seaside location of L.A. basin ⟶ temperature inversion.

b. Affluent population ⟶ _____

c. Ultra-violet light + CO, NO + hydrocarbons ⟶ _____

d. _____ ⟶ Secondary pollutants in air.

e. Breathing in CO ⟶ _____

f. _____ ⟶ Sickness, headaches and death.

g. Inefficient burning of fuel and air in car engine ⟶ _____

h. _____ ⟶ Cancer.

i. _____ ⟶ Lead poisoning.

Now construct sentences to express these ideas.

a. Accumulation of SO_2 in atmosphere ⟶ normal smog

_____

b. Smoking ⟶ lung cancer

_____

c. Exhaust fumes ⟶ vegetables at roadside unfit to eat.

_____

d. Reduction in oxygen supply to blood ⟶ death.

_____

e. Lead additives in petrol ⟶ increase in octane number.

_____

2.6 Adverbs

Notice-how these words are used in the passage to add to the meaning of adjectives and adverbs.

.....an **extremely high** density of traffic.....
.....a **highly** poisonous gas.....
.....in **comparatively** small doses.....
.....**much more** strongly and for **much longer** periods.....
.....the **relatively** inefficient combustion.....
.....it is **particularly** difficult.....

Some of the **adjectives** and **adverbs** in the passage below need a word adding to them to strengthen or clarify the meaning. Decide which, and then rewrite the passage including words from the examples above beside underlined words.

The presence of so many pollutants in the Los Angeles basin means that little effective farming can be done. Vegetables leaves are soon covered by a **thick** layer of smog deposit and are unfit for consumption. There is a **clear** difference between the condition of the trees on the far side of the hills and those inside the basin. Farming has always been regarded as a **healthy** outdoor occupation, but tests have shown that the incidence of lung disease among farmers in the area is **high**, a fact that can only be explained by the dirty air. It is certain that the long-term effects of constant exposure to **toxic** emissions such as lead and carbon monoxide can only be harmful.

B) Grammar and the Environment Vocabulary Exercises

Activity 1 Gas Emission

Add the headings in the box to the sections. Then underline the right verbs to complete the press release about a hybrid car.

Advantages - Need - Problems - Solution - Technology

a. Need. Greenhouse gas emissions, e.g. CO_2 and nitrous oxide, must be **(1)** ***reduced / improved*** to avoid global warming. Petrol engines **(2)** ***absorb / consume*** too much fossil fuel.

b. _____ . Electric-only vehicles can be **(3)** ***used / generated***, but their batteries are too heavy and their range is too limited.

c. _____ . Hybrid cars **(4)** ***propose / combine*** a petrol engine and an electric motor into one system. The motor **(5)** ***performs / provides*** high torque in the low rpm range, while the engine **(6)** ***delivers / propels*** extra power at the higher rpm range.

d. _____ .The hybrid car is **(7)** ***based / solved*** on two technologies, the gas/petrol engine, and the electric motor, with generator and battery.

e. _____ . Hybrids **(8)** ***withstand / emit*** less CO_2 than petrol vehicles. The engines can **(9)** ***run / transmit*** on gas, petrol or bio-fuel. The battery **(10)** **recharges / generates** itself, so no extra electrical cables are needed.

Activity 2 Extra Vocabulary

Match the two parts of the sentences.

1	☐	You can be fined	**a**	by using a heat recovery process.
2	☐	Our products minimize damage	**b**	for breaking pollution laws.
3	☐	Most plastics don't biodegrade	**c**	to the environment.
4	☐	We are hoping to use more energy	**d**	in the environment.
5	☐	We can save energy	**e**	from alternative sources.

Activity 3 Pollution in Oil Industry

Identify all the words and phrases that can fill each gap in these sentences. The number in brackets indicates the number of possible words / phrases.

A: cause - B: caused by - C: because - D: cause of - E: was caused by - F: the result of G: result in - H: as a result of - I: resulted from - J: resulted in - K: as a result L: due to - M: was due to - N: lead to - O: gave rise to

a. The oil spill in the sea was _____ oil leaking from a broken underwater pipe. **(4)**

b. The break-up of the riser _____ an explosion in the blowout preventer. **(3)**

c. The explosion took place _____ the safety valve failed to close properly. **(1)**

d. Without doubt, poor maintenace in the past _____ the failure of the valve. **(2)**

e. The oil spill will certainly _____ widespread pollution of the area. **(3)**

f. The main _____ damage to wildlife will be the oil that reaches the store. **(1)**

g. The disaster will certainly _____ the authorities investigating the accident **(2)**

h. The report will be published and _____ the guilty parties will be identified. **(1)**

Activity 4 Incineration

Complete the sentences for a presentation about incineration, using prepositions.

a. The aim **of** my talk this morning is to explain _____ incineration.

b. First _____ all, let's discuss the problem of waste.

c. Now I'd like to move _____ the main elements of the incinerator.

d. So now I'm going to talk you _____ the process of modem incineration.

e. Now I'd like to hand _____ Jan.

f. Jan will look _____ the question of pollution.

g. Thanks, Jan. Finally, I 'd like to conclude _____ showing this slide.

h. Thank you all _____ coming. Any questions?

Unit 3 The Greenhouse Effects

(1) Scientists have long been concerned about the cumulative effects of the increasing amounts of man-made pollutant expelled into the atmosphere. Although there is still disagreement on specifics, several recent studies agree on one point that carbon dioxide resulting from the burning of fossil (coal, oil, gas) fuels is warming the earth. The studies warn that the effects of climatic changes could be felt as early as the 1990's.

(2) The Environmental Protection Agency (EPA) in the US has predicted yearly temperature increase of nearly 7°F by the year 2040, a rise in sea levels of 2 feet by 2025 (thereby inundating some low lying areas in coastal cities), and drastic changes in rainfall patterns. Changes in precipitations amounts would directly affect agricultural areas everywhere in the world.

(3) A second study, based largely on computer models, produced similar predictions. It concluded that CO_2 concentrations could double in the late 21st century, increasing global temperatures by as much as 7°F. Many currently productive agricultural regions would dry out, shifting production to the worst.

(4) The process is irreversible, it would be impossible to reduce that amount of fossil fuels burned to any great extent, because the world is too dependent upon them. Research can only hope to predict the changes as accurately as possible and develop means of coping with them, it would be possible for certain areas to switch crops in order to remain productive. Also, recent research into plants genetics presents the possibility of new strains of plants being developed, better adapted to new climatic conditions.

(5) Of course all effects would not necessarily be bad. Some areas could benefit from more desirable climates. Growing seasons in some areas would lengthen and some deserts would receive more rainfall. In addition the increase in the amounts of CO_2 could increase the rate of photosynthesis, encouraging more vigorous plant growth.

(6) Researchers have known for nearly a century that the CO_2 content of the air has been steadily increasing, but the increase has been too small to cause noticeable climatic changes and plants and the oceans have been able to absorb the excess. Scientists fear that the amounts will soon surpass the ability of the plants and oceans to absorb it. As the excess becomes part of the atmosphere, it acts as a thermal blanket. It allows the sun's rays to pass through it, like the glass of a greenhouse, but blocks longer infrared, or heat, waves given off by the earth's surface from radiating back into space. Gradually, as CO_2 levels rise, the atmosphere gets warmer. It retains more water vapour, adding still another "greenhouse" gas that traps heat. Meanwhile, the temperature of the earth's surface rises, melting snow and ice. The water swells the oceans, because of both the runoff and the water's heat-induced expansion. At the same time, as the polar icecaps shrink, the planet's total reflectivity decreases with the result that the earth bounces less sun light back into space and heats even more.

(7) Because of the huge mass of the earth and the many variables involved, it is of course, impossible to produce a computer model which exactly duplicates the process. For example, scientists still do not know whether the ability of oceans to sack up CO_2 from the atmosphere is even close to the limit. They also are uncertain about the precise role of other atmospheric components, such as dust particles, increased cloud cover, and sulfur dioxide, all of which tend to produce a cooling effect. A more remote possibility, a major volcanic eruption could darken skies around the world for several years, as Krakatau did a century ago, or there could be unexpected fluctuations in the sun's radiation, perhaps a factor in past ice ages.

(8) Yet for all the unanswered questions, there appears to be little doubt among scientists that a troubling CO_2 building up is leading the earth into a period of major climatic uncertainty. At the very least, as the studies urge, the inhabitants of the planet must begin looking more seriously into how they might live in a new, hotter world.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(v.)**,to tell of something bad that may happen,or of how to prevent something bad.
2. _____ : **(adj.)**, increasing steadily in amount by one addition after another.
3. _____ : **(v.)**, to flood over in large amounts esp. so as to cover.
4. _____ : **(n.)**, a small representation or copy.
5. _____ : **(v.)**, to deal successfully with something.
6. _____ : **(n.)**, the permanent covering of ice at the north and south poles.
7. _____ : **(v.)**, to tell with force.

II - Main Ideas.

Which statement best summarizes the conclusion of this passage?

a. More research is necessary to find ways of reducing CO_2 levels in the atmosphere.

b. More research is necessary so that proper planning for changes done.

c. More research is necessary to determine whether or not CO_2 levels are likely to increase.

III - Understanding the Passage

3.1 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ Concern about environmental pollution is a recent phenomenon.

b. _____ In general, the studies discussed in the passage agree.

c. _____ A rise in ocean levels is one predicted result of increased levels of CO_2 in the atmosphere.

d. _____ It is possible to reduce the amounts of CO_2 being expelled.

e. _____ All predicted climatic changes are bad.

f. _____ Water and plants are able to lessen CO_2 levels.

g. _____ The ability of the oceans to absorb CO_2 has been surpassed

h. _____ The evidence so far is so contradictory that nothing can yet be done as far as our lives in relation to the climate are concerned.

3.2 Implicit Information

Indicate by true or false those statements which can be inferred from the information in the passage. A statement may be true but not supported by information in the passage.

a. _____ There is a direct relationship between rainfall patterns and agricultural productivity.

b. _____ A relatively small change in the average temperature can have a great climatic effect.

c. _____ A greater concentration of CO_2 would result in increased food production for the world because CO_2 encourages photosynthesis.

d. _____ Snow cover during the ice age lowered the average temperature.

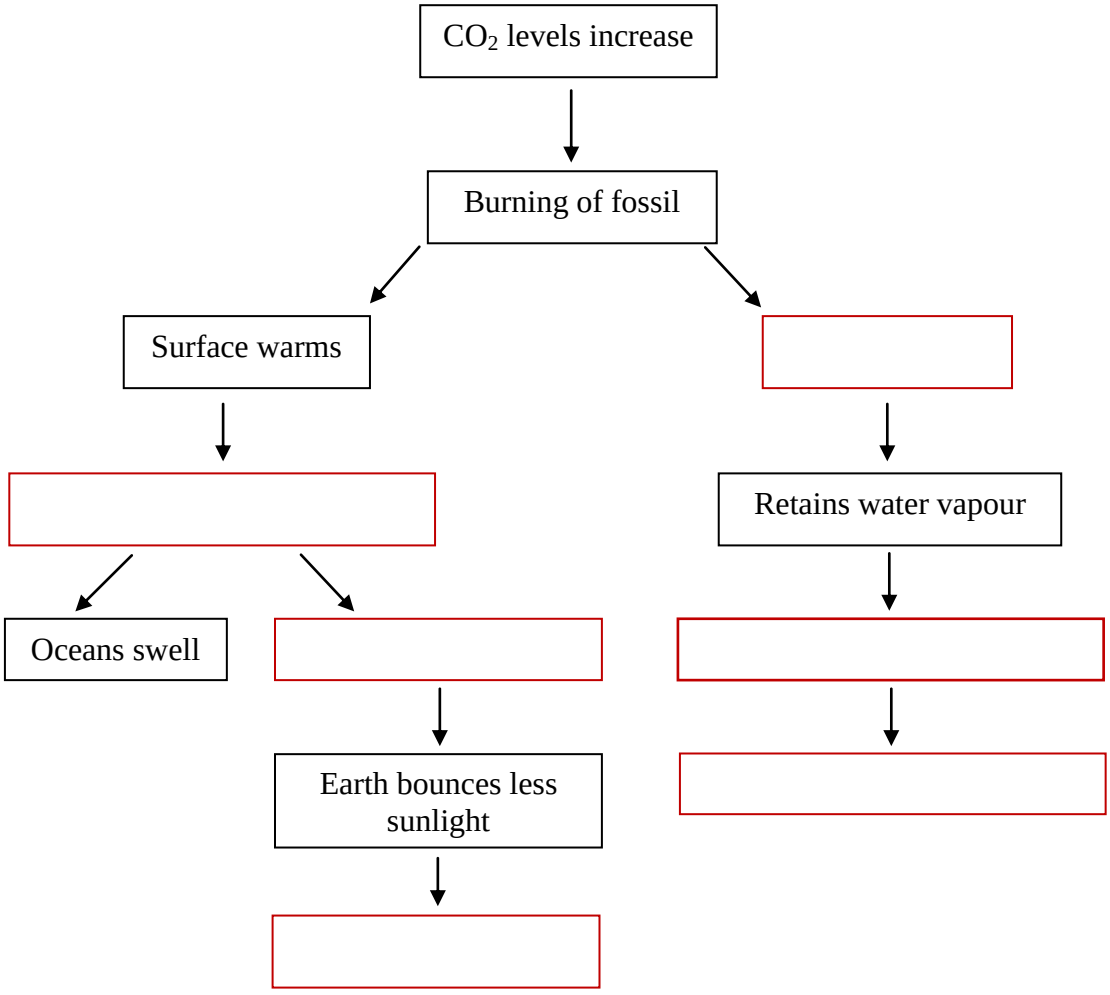
e. _____ Changes in the size of the polar ice cap affect yearly temperature averages.

f. _____ A volcanic eruption could mitigate the effects of increased CO_2 concentrations.

g. _____ A volcanic eruption is less likely to cause climatic changes than increased cloud cover.

III - Structure of the Text

Directions : Complete this flow chart of the process of warming resulting from the increase in CO_2 levels in the atmosphere.



B) Grammar and the Environment Vocabulary Exercises

Activity 1 Models

Fill in the gaps in this text with either "can" or "could".

1. With present technology we _____ recycle almost all domestic refuse. But in practice market forces determine what is worth recycling.
2. Successful plants in a number of countries show that refuse _____ be used as a fuel in power stations.
3. If we recycled most of our refuse, the increasing problem of waste disposal _____ be solved.
4. Sweaters _____ be produced from old plastic bottles. A company in the United States converts the waste plastic into polyester yarn. It takes twenty-five two-litre bottles to make a sweater.
5. At present we _____ not easily separate thermosetting plastics from thermoplastics.

Activity 2 Extra Vocabulary

Use the vocabulary provided in the box to complete each sentence. You may use a dictionary to help you.

decompose - landfill - raw material – reduce - transfer station compost - incinerator - nutrient - recycle - sanitation

a. Something that nourishes or feeds another living thing is called a _____ .

b. An area that is used as a dumping place for solid wastes and that is lined with heavy plastic or clay is called a _____ .

c. A _____ is a natural substance grown or taken from the ground.

d. Decayed materials such as leaves, grass, and some food waste that is used as a conditioner and fertilizer for soil is called _____ .

e. A place where trash is sorted for recycling or disposal is called a _____ .

f. A special furnace that is used for burning trash and rubbish is an _____ .

g. To _____ is to use materials from garbage or waste and use it again in its original or a changed form.

h. To change, to break down, rot or decay is another way of saying to _____ .

i. To get rid of wastes effectively and safely is called _____ .

j. To _____ means to make less in amount.

Activity 3 Pollution Vocabulary

1. **Define the following terms.**

Ecology: _____

Conservation: _____

Recycling: _____

Chemicals: _____

Endangered Species: _____

Valuable: _____

2. **Using the words you just defined, fill in the blank for each sentence using the correct vocabulary term.**

a. An _____ is a plant or animal that is having trouble living in a certain place and all of them may die soon.

b. When you save trash that can be reused to create something new, you are _____ .

c. A resource that is worth a lot is _____ .

d. The way the earth works with creatures and plants is called _____ .

e. _____ is not wasting valuable things.

f. Dangerous _____ are present in the air and water and may cause plants and animals to die.

Activity 4 **Contemporary Environment Vocabulary**

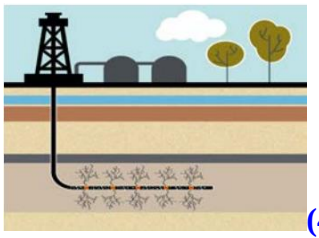
Add each of the following headings to its corresponding image.

flooding - melting ice cap - kinds of power generation - drought - fracking - forest fires
water crisis - extreme weather - sustainable energy - oil spill - carbon footprint

(1)_____

(2)_____

(3)_____



(4)_____

(5)_____

(6)_____

(7)_____

(8)_____

(9)_____

(10)_____

(11)_____

Activity 5 Climate Change Vocabulary

Match the words from the texts to the definitions below.

climate change - greenhouse gases - electrical appliances - carbon dioxide - atmosphere emissions - extinction - ecosystems - global warming - rise - greenhouse effect

a. The process in which gases in the atmosphere trap the sun's heat. _____

b. The types of gases that trap the sun's warmth in the atmosphere. _____

c. A greenhouse gas with the chemical name CO_2. _____

d. A change in the earth's climate over a period of time. _____

e. When the average temperature on Earth is getting hotter. _____

f. A verb or noun which is a synonym of increase. _____

g. The scientific word for 'air'. _____

h. Greenhouse gases caused by human activity. _____

i. A system of plants and animals living together. _____

j. When a type of plant or animal disappears completely. _____

k. Televisions, fridges and other electrical goods. _____

Activity 6 Saving and Recycling Materials

Complete the missing headings of the following web page using the words in the box.

Aluminium - Copper - Glass - Plastic - Rubber - Steel - Timber

1. _____ Scrap can be sorted using magnesium. If the metal is galvanised (coated with zinc) the zinc is fully recyclable. If it is stainless steel, other metals mixed with the iron, such as chromium and nickel, can also be recovered and recycled.

2. _____ Sorting is critical, as there are key differences between the clear and coloured material used in bottles and jars, and the high-grade material used in engineering applications, which contains traces of metals.

3. _____ Scarcity makes recycling especially desirable and justifies the cost of removing insulation from electric wires, which are a major source of scrap. Pure metal can also be recovered from alloys derived from it, notably brass which also contains quantities of zinc, and often lead and bronze which contains tin.

4. _____ The cost of melting down existing metal is significantly cheaper than the energy-intensive process of electrolysis, which is required to extract new metal from ore.

5. _____ Hardwood and softwood can be reused. However, the frequent need to remove ironmongery and saw or plane off damaged edges, can make the process costly.

6. _____ Tyres are the primary source of recyclable material. These can be reused whole in certain applications. They can also be groud into crumbs which have varied uses.

7. _____ An obstacle to recycling is the need to sort waste carefully. While some types can be melted down for reuse, many cannot, or result in low-grade material.

Activity 7 Climate Change Quiz

Circle the correct answer

a. What effect traps the heat next to the earth?

1. the refrigeration effect.
2. the greenhouse effect.
3. the hothouse effect.

b. What traps the heat next to the earth?

1. rainforests.
2. the greenhouse gases.
3. the wind.

c. What is the main way that carbon dioxide is made?

1. when it rains.
2. when fuel is burnt.
3. when there's a hurricane.

d. The idea that industrial societies can enjoy a good economy without destroying the environment is:

1. increase profit.
2. reduce employees number.
3. sustainable growth.

e. These are what we need to discover and develop in order to stop using fuels.

1. alternative energy sources.
2. bicycles.
3. coal and gas.

f. What is the main way that carbon dioxide is used?

1. when plants use it to make food.
2. when animals breath it in.
3. when fuel is burnt.

g. What is the main man-made greenhouse gas?

1. oxygen.
2. hydrogen.
3. carbon dioxide.

h. How can you do your bit if you want to stop global warming?

1. save energy by going to school by car.
2. save energy by having lots of rests.
3. save energy by using less electricity and petrol.

i. This is what needs to be done so we can take care of our planet.

1. make more cars.
2. raise awareness.
3. build new factories.

j. This is what we must do to show politicians we care about environment.

1. demonstrate.
2. drop liter.
3. travel.

k. What might happen if there is too much carbon dioxide in the atmosphere?

1. the temperature on earth may go up, so there will be global warming.
2. the temperature on earth may go down, so there will be global cooling.
3. the oceans may dry up, so there will be global drying.

l. Which of the following is true?

1. it's too late to stop global warming.
2. only politicians can make a difference to global warming.
3. everyone can do their bit to help stop global warming.

Unit 4 Rainforests as Economic Reserves

(1) Rainforests are essential to our life on Earth. They also provide a rich variety of economic resources that are used all over the world. This presents countries with a serious dilemma. Rainforests are used for a number of economic purposes, ranging from agricultural to urban and industrial use. The dilemma facing many rainforest-rich countries, including Australia, is that, as these economic demands grow, the planet's rainforests are placed under increasing threat of destruction. The economic resources provided by the world's rainforests are enormous. Here are just some of the more important ones.

Foods

(2) Nearly 50 per cent of the world's food supplies originate in rainforest areas. Items that we commonly buy from the supermarket, such as bananas, pineapples, mangoes, peanuts, macadamia nuts and cashews, all originated in rainforests. Many popular foods like rice, corn and maize also come from the rainforests, as do tea, coffee, cocoa and sugar.

Recreation

(3) Rainforests are becoming increasingly popular places for people to visit because they are seen as areas of wilderness and natural beauty. People take part in activities such as fishing, bush-walking, rock climbing and four-wheel driving. The overuse of rainforests for tourist activities has led governments to pass laws restricting activities in these forests. The Daintree region in northern Queensland is one area where the government has passed laws regulating rainforest activities.

Medicines and drugs

(4) Many medicines and drugs sold by the local pharmacist come from plants that grow in rainforests. For example, medicines used for travel sickness, headaches, stomach upsets, skin diseases and leukaemia all come from the rainforests. In fact, nearly 40 per cent of all medicines sold in chemists, originate from rainforests.

Industrial and building products

(5) Rainforests provide many products used by the community for urban development. These include timber converted into building materials for house framing, furniture, fencing, panel products and flooring. Rainforests also supply wood chips used in making cardboard, toilet tissue and the pulp used for some papers. Many industrial products also originate from the rainforests. Spices, rubber, oils, waxes, dyes and gums are just some examples. Even everyday products such as toothpaste, cosmetics, tires, paints and deodorants are produced from plants growing in rainforest areas.

Sustainable development

(6) Scientists believe that over 200,000 square kilometers of rainforest are being destroyed each year for economic purposes. Most people would acknowledge the economic importance of the world's rainforests. However, there needs to be a balance between the way we are currently using our rainforests and the future availability of these resources. This is now commonly being referred to as ecologically sustainable development. For example, conservationists, governments and industry groups believe that timber should be harvested from forests in a sustainable way. This should be done without permanently damaging the home of other plants and animals, the soil or rivers and creeks. This is a very complex task. It involves ensuring trees that are removed from the forest to be replaced by seedlings that will form part of the new forest.

(7) To conclude, since the rainforests are very crucial to support many aspects of our life, it is our duty to preserve them.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(n.)**, the condition of being in danger or at risk.
2. _____ : **(v.)**, arise; come from.
3. _____ : **(n.)**, excessive use.
4. _____ : **(v.)**, imped; to put a limit on; restrain.
5. _____ : **(v.)**, recognize; admit, make notice of.
6. _____ : **(adv.)**, at the present time; being in progress now.
7. _____ : **(v.)**, mention or allude to; assign to; to attribute to.

II - Understanding the Passage

2.1 Questions on the Text

Answer these questions on the reading text.

a. What is the dilemma faced by many rainforest-rich countries?

b. Are the economic resources provided by the world's rainforests extremely large in number?

c. What percentage of the world's food supplies originate in rainforest areas?

d. Why are rainforests becoming increasingly popular places for people to visit?

e. What activities do people do in rainforests?

f. What caused governments to pass laws restricting activities in rainforests?

g. What percentage of all medicines sold in pharmacies originate from the rainforest?

h. What do rainforests produce for urban development?

i. What are wood chips used for?

j. What is the area of rainforest being destroyed each year for economic purposes?

k. What is the thesis statement of the text above?

l. Does the writer give his argument on the topic?

2.2 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones.

a. _____ Rainforests are unimportant to our life on Earth.

b. _____ The economic resources which rainforests provide vary.

c. _____ Many rainforest-rich countries are facing a situation in which it is very difficult to preserve their rainforests.

d. _____ The economic resources provided by the world's rainforests are extremely small.

e. _____ Less than 50 per cent of the world's food supplies originate in rainforest areas.

f. _____ Rainforests are becoming more and more unpopular places for people to visit.

g. _____ Governments pass laws restricting activities in the forests due to the overuse of rainforests for tourist activities.

h. _____ More than 40 per cent of all medicines sold in pharmacies originate from rainforests.

i. _____ More than 200,000 square kilometers of rainforests are being destroyed each year for economic purposes.

j. _____ There needs to be a balance between the way we are currently using our rainforests and the future availability of these resources.

2.3 Contextual Reference

Study the following sentences and explanation, then answer the following questions about the referents for each sentence.

a. They also provide a rich variety of economic resources that are used all over the world. ***This*** presents countries with a serious dilemma.

b. Rainforests provide many products used by the community for urban development. ***These*** include timber converted into building materials for house framing, furniture, fencing, panel products, and flooring.

c. However, there needs to be a balance between the way we are currently using our rainforests and the future availability of these resources. ***This*** is now commonly being referred to as ecologically sustainable development.

1. ***This*** in sentence **N°1** refers to _____
2. ***These*** in sentence **N°2** refers to _____
3. ***This*** in sentence **N°3** refers to _____

2.4 Getting Information

Decide in which paragraph you can find the following information:

a. The economic purposes rainforests are used for.

_____

b. The percentage of the world's food supplies which originate in rainforests areas.

_____

c. Fruits originating from rainforests.

_____

d. Activities that people do in rainforests.

_____

e. Sickness and diseases which are treated with medicines from the rainforests.

f. Industrial products that originate from the rainforests.

g. Daily products which are produced from plants growing in rainforest areas.

h. The area of rainforests which are being destroyed each year for economic purposes.

B) Grammar and the Environment Vocabulary Exercises

Activity 1 Synonyms and Meanings

Study the following words, and then match them to their meanings or synonyms.

Words	Meaning
1. essential	**a.** participate
2. agriculture	**b.** illness
3. destruction	**c.** come from
4. enormous	**d.** druggist
5. originate	**e.** admit
6. wilderness	**f.** fundamental
7. take part	**g.** continue for a long time
8. pharmacist	**h.** huge
9. sickness	**i.** farming
10. timber	**j.** reap
11. sustainable	**k.** narrow river
12. acknowledge	**l.** ruination
13. balance	**m.** wild area
14. harvest	**n.** equilibrium
15. creek	**o.** wood

Activity 2 Reading a Graph

Study the following diagram and state whether the following statements are true or false according to the diagram.

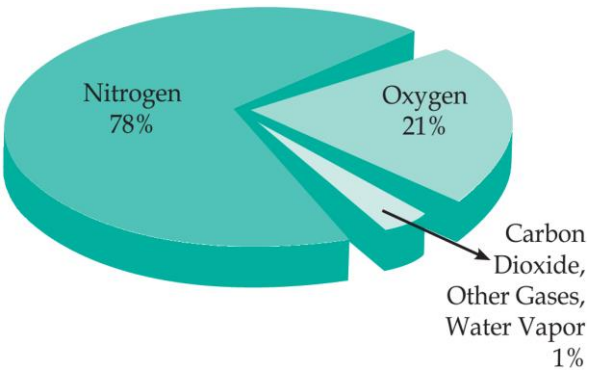
1. Most gas in the air is oxygen.

2. Oxygen is more than one fifth of the gases in the air.

3. Carbon dioxide is only 1%.

4. In the air, there is more nitrogen than oxygen.

5. There is less carbon dioxide than oxygen.



Activity 3 Poster

Identify the following poster and answer the questions below.

1. What is the poster about?

2. What is the function of the blue-topped bin?

3. What stuff is made of cardboard?

4. What should you do to all containers before throwing them in the bin?

5. What is the purpose of the poster?

Activity 4 Definitions

Complete each sentence with a preposition or leave a blank if no preposition is needed.

1. We must get ride _____ our waste in an acceptable way.
2. The new legislation will affect _____ everyone in the packaging industry.
3. Is it harmful _____ the environment?
4. Safe disposable _____ toxic substances is very important.
5. Ozone is not emitted _____ the atmosphere.
6. Radiation from the sun can be converted _____ electricity.
7. Incineration is better _____ the environment than landfill.
8. Our budget for environmental projects will have to increase _____ 10 per cent.

Activity 5 Definitions

Match the English definitions to their French equivalents.

1	☐	An environmental policy	**a**	Etre sans danger pour l'environnement
2	☐	The department of the environment	**b**	Un adversaire acharné (farouche)
3	☐	An advocate of the environment	**c**	Manifester pour
4	☐	To be environmental friendly	**d**	Réclamer
5	☐	Hard-core environmentalists	**e**	Etre soutenu par
6	☐	A staunch opponent	**f**	Un impôt écologique
7	☐	To demonstrate in favour of	**g**	Un défenseur
8	☐	A sentence	**h**	Les gazs d'échappement
9	☐	To forbid, to ban	**i**	Une politique environnementale
10	☐	An environmental tax	**j**	La détérioration de l'environnement
11	☐	To compaign for	**k**	Etre conscient de
12	☐	To be backed by	**l**	le ministère de l'environnement
13	☐	To be aware of	**m**	Interdire
14	☐	To claim	**n**	Faire compagne pour
15	☐	Environmental degradation	**o**	Une condamnation
16	☐	Exhaust fumes	**p**	Des écologistes inconditionnels

Activity 6 Translation

Translate the following French words and expressions to English.

1	L'élimination des déchets	**a**	_____
2	Une usine d'incinération	**b**	_____
3	Etre menacé de disparition (d'extinction)	**c**	_____
4	La protection de la faune	**d**	_____
5	Les ordures ménagères	**e**	_____
6	Anéantir une espèce	**f**	_____
7	Un groupe de pression	**g**	_____
8	En danger d'extinction	**h**	_____
9	Un emballage perdu	**i**	_____
10	Le règlement	**J**	_____
11	Sauvegarder	**k**	_____
12	Les bouteilles consignées	**l**	_____
13	L'effet de serre	**m**	_____
14	Economiser de l'énergie	**n**	_____
15	Le seuil du danger	**o**	_____
16	Menacer la survie	**p**	_____

Activity 7 Fill in the Gaps

Complete the sentences with a word from the box below.

recycling - pollution - environmentally - disposable - environmental dispose - recyclable - pollutants

Example: Most types of paper are **recyclable**.

1. There are six main air _____ .
2. We are setting up an _____ management system.
3. We need to find a better way to _____ of our waste.
4. It's an _____ friendly product.
5. We have an office-paper _____ scheme in our company.
6. _____ is having an effect on the world climate.
7. They manufacture cheap _____ cigarette lighters.

Activity 8 Sentence Building

Rearrange these words to form questions.

Example: plastic / how / be / can / recycled.

How can plastic be recycled?

1. You / limits / happens / if / permitted / the / what / exceed?

   _____ .
2. of / you / waste / how / products / your / dispose / do?

   _____ .
3. VOCs / explain / are / can / you / what?

   _____ .
4. affected / recent / your / been / by / company / much / legislation / has?

   _____ .
5. you / of / what / sources / use / other / energy / do?

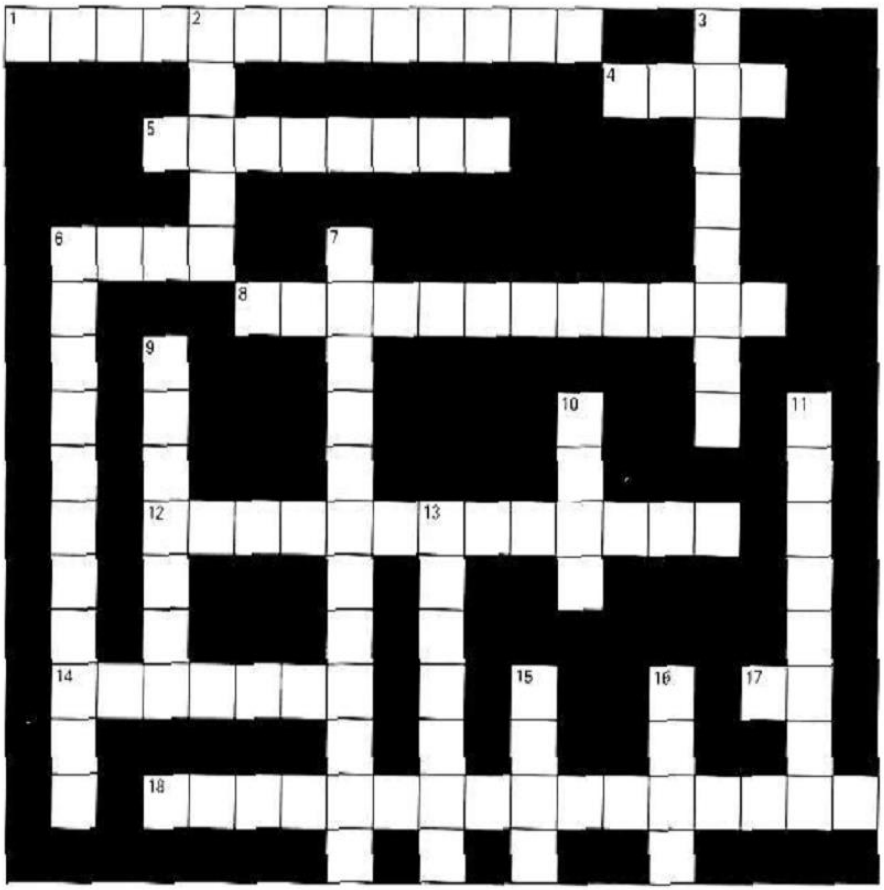
   _____ .
6. ways / environmentally / products / are / in / your / what / friendly?

   _____ .
7. does / ozone / environment / what / do / the / damage / to?

   _____ .
8. heat / explain / is / recovery / what / could / you?

   _____ .

Activity 9 Puzzle: Environmental vocabulary crossword



Across

1 CO_2. (6,7) (n).
4 A mixture of smoke and ozone. (4) (n)
5 They are found in paint and are bad for the environment. (8) (n)
6 What you may have to pay if you break a law. (4) (n)
8 A place where waste is put into a hole in the ground. (8,4) (n)
12 Able to break down naturally in the environment. (3,10) (adj.)
14 Gases released into the atmosphere from a running engine. (7) (n)
17 Abbreviation for polyethylene. (2) (n)
18 Energy generated from fast running water. (5,11) (n)

Down

2 A gas which can cause problem for people with breathing difficulties. (5) (n)
3 Made dirty with chemicals, rubbish, etc. (8) (adj.)
6 Coal, oil, etc. When burnt, they give off 1 across. (6,5) (n)
7 A method of disposing of waste by burning it. (12) (n)
9 Another word for waste. (7) (n)
10 In many countries petrol does not contain this anymore. (4) (n)
11 Waste water. (8) (n)
13 To use again in a different process. (7) (v)
15 A technical term for 5 across. (4) (n)
16 to release into the atmosphere. (4) (v)

Unit 5 Sustainable Development

(1) The best definition of sustainable development was presented by the report *Our Common Future* (also known as the Brundtland Report): "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations' needs": it focuses on two goals:

- To improve the quality of life for all of the earth's citizens.
- To stop using up the natural resources beyond the capacity of the environment to supply them indefinitely.

(2) Green development is generally differentiated from sustainable development in that green development prioritizes what its proponents consider to be environmental sustainability over economic and cultural considerations. In addition to that, sustainable development has underlying concepts: the concepts of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present needs. There is an additional focus on the present generations' responsibility to improve the future generations' life by restoring the previous ecosystem damage and resisting to contribute to further ecosystem damage.

(3) Sustainable development requires action on the part of world states, governments and people. The detrimental situation of the environment, the enormous stress upon our natural resources and the huge gap between developed and underdeveloped countries necessitate practical strategies to reverse the trends. The World Commission on Environment and Development suggested critical objectives for environment and development policies that follow from the concept of sustainable development:

- Reviving growth.
- Changing the quality of growth.
- Meeting essential needs and aspirations for jobs, food, energy, water and sanitation.
- Conserving and enhancing the resource base.
- Including and combining environment and economics considerations in decision-making.

A) Comprehension

I - General Vocabulary

Find the words in the reading which fit the definitions below.

1. _____ : **(adj.)**, able to be maintained or kept going, as an action or process.
2. _____ : **(n.)**, to expose or make vulnerable to danger, suspicion, scandal, etc.
3. _____ : **(adv.)**, without fixed or specified limit; unlimited; not precise or exact.
4. _____ : **(n.)**, a person who argues in favor of something, a supporter.
5. _____ : **(adj.)**, taking precedence (priority) over all other considerations.
6. _____ : **(v.)**, to prevail or have dominance over.
7. _____ : **(v.)**, to bring back into existence, use, or the like; reestablish.
8. _____ : **(adj.)**, causing loss or injury; damaging; harmful.
9. _____ : **(v.)**, to have need of; make necessary; depend upon.
10. _____ : **(adj.)**, inclined to find fault or to judge with severity, often too readily.

II - Main Ideas

As you read the passage determine the main idea of each paragraph.

1. The main idea of paragraph **(1)** is: _____
2. The main idea of paragraph **(2)** is: _____
3. The main idea of paragraph **(3)** is: _____
4. The main idea of paragraph **(4)** is: _____

III - Understanding the Passage

3.1 Questions on the Text

Answer these questions on the reading text.

a. Sustainable development refers to the harmony between the environment, society and economy: _____
- **a.1** True.
- **a.2** False.

b. Sustainable development stresses upon: _____
- **b.1** The relationship between man and development.
- **b.2** A development that takes into consideration the needs of future generation.

c. Action to implement the concept of sustainable development: _____
- **c.1** Is always caused by humans.
- **c.2** May sometimes be caused by natural disasters.

d. An ideal solution to prevent pollution would be to: _____
- **d.1** Refrain the development of some countries.
- **d.2** Continue developmental projects.
- **d.3** Take into consideration the future generations need to live in a healthy environment.

3.2 True/False Questions

Study the following statements carefully and say whether they are **true (T)** or **false (F)** according to the information in the text and correct the false ones..

a. _____ Green development and sustainable development have the same objective.

b. _____ The focus of sustainable development is to stop the overuse of natural resources.

c. _____ Everyone can contribute to the success of sustainable development.

d. _____ Sustainable development is a political decision for long term actions to protect environment.

B) Grammar and the Environment Vocabulary Exercises

Activity 1 Sustainable Development

Match each word of the list with its corresponding definition.

1. deforestation	6. resource
2. acid rain	7. development
3. endangered species	8. ecology
4. ecology	9. sustainable development
5. environment	10. desertification

Definitions:

_____ : The surroundings in which a person, animal, or plant lives. The natural world of land, air, plants, and animals.

_____ : The process of growing or developing. Synonymous words include: evolution, progress advance.

_____ : The scientific study of the distribution and abundance of life and the interactions between organisms and their natural environment.

_____ : Any physical or virtual entity of limited availability, or anything used to help one earn a living.

_____ : The degradation of land in arid and dry sub-humid areas, resulting primarily from human activities and influenced by climatic variations.

_____ : The conversion of forest(ed) areas to non-forested land, for uses such as: pasture, urban use, logging purposes, and can result in arid land and wastelands.

_____ : A pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but in the indefinite future.

_____ : The scientific study of the distribution and abundance of life and the interactions between organisms and their natural environment.

_____ : rain which contains large amounts of harmful chemicals as a result of burning substances such as coal and oil.

_____ : birds/plants/species animals or plants which may soon not exist because there are very few now alive.

Activity 2 **Extra Vocabulary**

Choose the words from the list to fill in the blanks.

ecology - organisms - environment - resources - deforestation - generations

1. Man's greed is threatening the _____ .
2. The extensive abuse of natural _____ threatens the very existence of future _____ .
3. One of the challenges that the world is facing is the issue of _____ which is the result of cutting down trees without even thinking of replacing them.
4. The term _____ refers to the study of the relationship between _____ and their natural environment.

Activity 3 Fill in the Blanks

Complete the gaps of the sentences with expressions from the box.

air pollution - emissions trading - carbon dioxide – desulphurization - sea level(s)
acid rain- climate change - greenhouse gases - hole (in the) ozone layer

1. The heating up of the atmosphere is caused by _____ _____.
2. The main cause of damage to trees is _____ _____. It has been estimated that more than 60% of forests are affected.
3. The _____ in the _____ over the South Pole and Australia has raised levels of ultraviolet radiation. This can cause severe sunburn.
4. _____ _____ is one of the emissions from a power plant burning fossil fuels.
5. Winters are becoming milder and wetter, and average temperatures year-round are increasing. These are two major signs of _____ _____.
6. Generators that pollute too much can buy credits or allowances from other companies in a system of _____ _____.
7. The emitting of harmful gases into the atmosphere is called _____.
8. The Netherlands is in danger of being flooded due to a rise in _____ _____.
9. A _____ _____is the equipment in a power plant which removes sulfur dioxide.

Activity 4 Expressing Future

Rewrite these statements to emphasise the future. Replace the words in italics with phrases using words in the box.

will - won't - going to - be able to - have to - need

Example: 1 The world is **going to** have to (or **will need to**) make a 40% reduction in emissions before 2040.

1. The world ***must*** make a 40% reduction in emissions before 2040.

_____

2. Our company ***can't*** meet the 20% target unless we convert to carbon capture.

_____

3. We ***can*** probably convert half of our power plants in the next ten years.

_____

4. The 2020 deadline is too tight. I'm sure we ***can't*** meet it.

_____

5. Companies ***mustn't*** continue consuming the same amount of energy in the future.

_____

6. Our company **doesn't have to** cut emissions by 50% . The target is 20%.

_____

7. In future we ***must*** obtain at least 50% of our energy from renewable sources.

_____

8. People ***don't need to*** stop flying completely, but they ***must*** do it less.

_____

Activity 5 Recycling

Fill in the gaps of the extract about recycling using the words from the box below.

remelted - biodegrade - Scrap - resources - glass - dumped - recyclable - garbage - recycle

Much of what we throw away could be used again. Recycling puts _____ to good use. Recycling helps preserve precious _____ because it saves on the use of raw materials and energy. It also reduces the pollution caused when the waste is _____ .

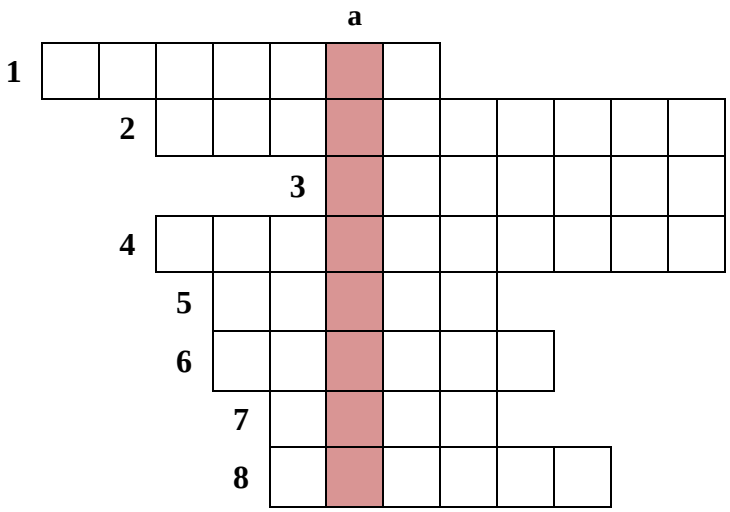
Glass can be remelted. This is better than making fresh _____ from raw materials, but it is even better to reuse the bottle whole. Metals can be recycled by being _____ and then used to make other new items. The metals to recycle from an ordinary household are aluminum and steel from cans. _____ from cars gives several different metals for recycling.

Paper is easy to _____ . Every home and office should have a paper recycling routine. Plastics are the worst problem because they do not _____ (breakdown) easily. They are also hard to recycle and cause harmful pollution when burned. It is important to use as little plastics as possible, and then only ones that are recyclable or _____ .

Activity 6 Puzzle

Complete this puzzle and find an essential function for most companies in column a.

1. What you do when you take and store a substance for a long period. You do it with carbon dioxide, for example, and pump it into the ground.
2. The type of gases which warm the earth's atmosphere.
3. Financial support from the state, usually for industrial purposes.
4. Energy source such as wind, the sun, etc.
5. A diagram with a horizontal and vertical axis.
6. The first element in CO_2.
7. The type of rain produced by some emissions from power stations and which badly affects trees.
8. To alter something or to make something different.



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