PHYSICS 218 Exam 1

Fall, 2005

Sections 807-809

Do not fill out the information below until instructed to do so!

Name:_____

Signature:_____

Student ID:_____

E-mail:_____

Section Number: _____

- You have the full class period to complete the exam.
- Formulae are provided on the last page. You may NOT use any other formula sheet.
- When calculating numerical values, be sure to keep track of units.
- You may use this exam or come up front for scratch paper.
- Be sure to put a box around your final answers and clearly indicate your work to your grader.
- **All work must be shown to get credit for the answer marked. If the answer marked does not obviously follow from the shown work, even if the answer is correct, you will not get credit for the answer. ONLY questions 8-15 can be marked without an explanation.**
- Clearly erase any unwanted marks. No credit will be given if we can't figure out which answer you are choosing, or which answer you want us to consider.
- Partial credit can be given only if your work is clearly explained and labeled.

Put your initials here after reading the above instructions:

Part 1: Multiple Choice and quick problems

The points per question are indicated. Please read ALL answers.

1. (2 points) The following conversion equivalents are given:

1 Euro= $ 1.24 1 liter = 2.11 pint 1 gallon=8 pint

In Europe the price of gas is approximately 1.4 Euro/liter; what is the price in $/gallon?

$$1.4\ \frac{€}{\ell} \times \frac{1\ell}{2.11\,pint} \times \frac{8\,pint}{1\,gal} \times \frac{\$1.24}{1€} = \$6.58/\text{gallon}.$$

2. (2 points) A person kicks a soccer ball into the air with speed V and at an angle Θ with respect to the ground. Under the influence of gravity, with magnitude *g*, the ball moves through the air and eventually hits the ground. Ignoring air resistance, at the top of its flight its acceleration is (show your work)

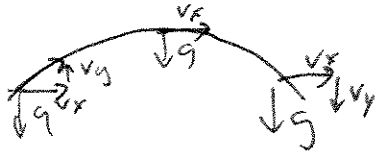
a) g pointing to the right

b) 0

c) g pointing down

d) VcosΘ

e) VsinΘ



3. (2 points) A particle undergoes uniform circular motion. The time that it takes the particle to travel around the circle is 5.0 s and the diameter of the circle is 5.0 meters. What is the magnitude of the average velocity when the particle completes one revolution?

$$a_c = \frac{4\pi^2 R}{T^2} = \frac{4\pi^2(5/2)}{5^2} = \frac{2\pi^2}{5}\ \frac{m}{s^2}$$

$\vec{V}_{ave} = 0$ b/c $\Delta\vec{x} = 0$

4. (3 points) The second hand of a clock is 16.0 cm long (from the center of the clock face to the tip of the second hand). What is the magnitude of the average velocity (not speed) of the tip of the second hand during a time interval of 15 seconds?

Starting from 12 o'clock.

$$\vec{V}_{ave} = \frac{\vec{X}(t) - \vec{X}(0)}{t - 0} =$$

$$\vec{V}_{ave} = \frac{16\text{ cm}\,\hat{x}}{15\text{ sec}} - \frac{16\text{ cm}\,\hat{y}}{15\text{ sec}}.$$

or 1.5 cm/sec 45°

5. (2 points) Shown in the figure above are the trajectories of four artillery shells. Each was fired with the same speed. Which was in the air the longest time?

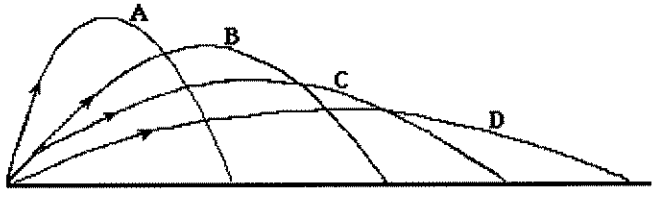
a) A

b) B

c) C

d) D

e) All were in the air for the same time.



Part 1 continued

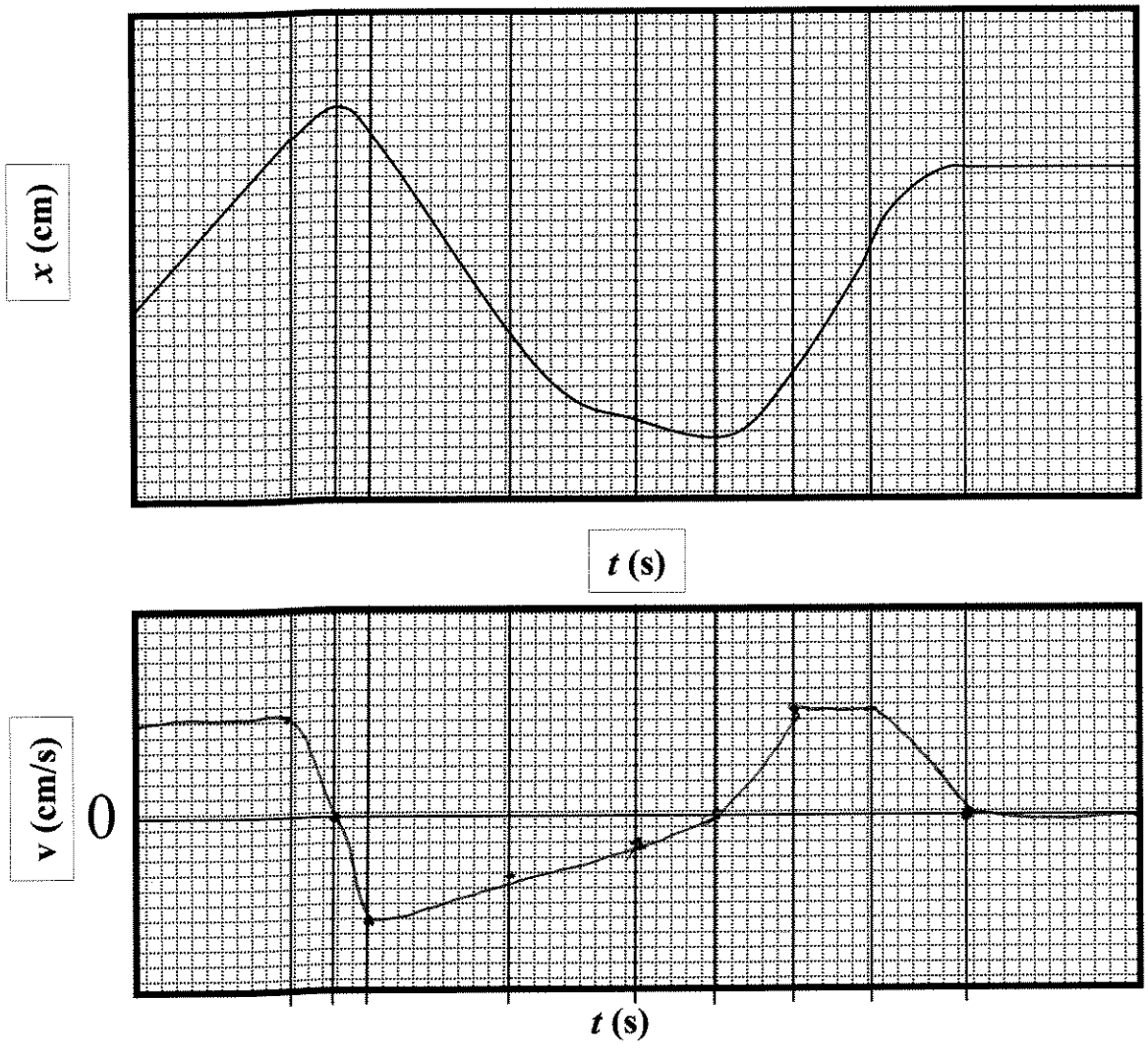
6. The figure shows a position (x) versus time (t) graph for the motion of an object along the x axis.

a) (8 points) For each section below indicate if a<>=0 and if v<>=0

	velocity	acceleration
A	>0	0
B	>0	<0
C	<0	<0
D	<0	0
E	<0	>0
F	<0	≃0 or >0
G	>0	>0
H	>0	=0
I	>0	<0
J	0	0

a) (4 points) Sketch the velocity vs. t graph below deduced from the position vs. t graph.

A B C D E F G H I J



Part 1 Continued

The displacement for an object is given by:

$$\vec{r}(t) = x(t)\,\hat{i} + y(t)\,\hat{j}$$

where

$$x(t) = d$$

$$y(t) = bt + ct^3$$

where ***r*** is position vector which is given in meters, ***t*** is the time which is given in seconds and ***b***, ***c*** and ***d*** are positive constants. At time ***t*** find the following:

7. (2 points) The instantaneous acceleration at time t

$\vec{v}(t) = (b + 3ct^2)\hat{j}$

$\vec{a} = 6ct\,\hat{j}$

8. (2 points) The average acceleration between t=0 and time t

$$\vec{a}_{ave} = \frac{\vec{v}(t) - v(0)}{t} = 3ct\,\hat{j}$$

9. (2 points) The instantaneous speed at time t

$v(t) = b + 3ct^2$

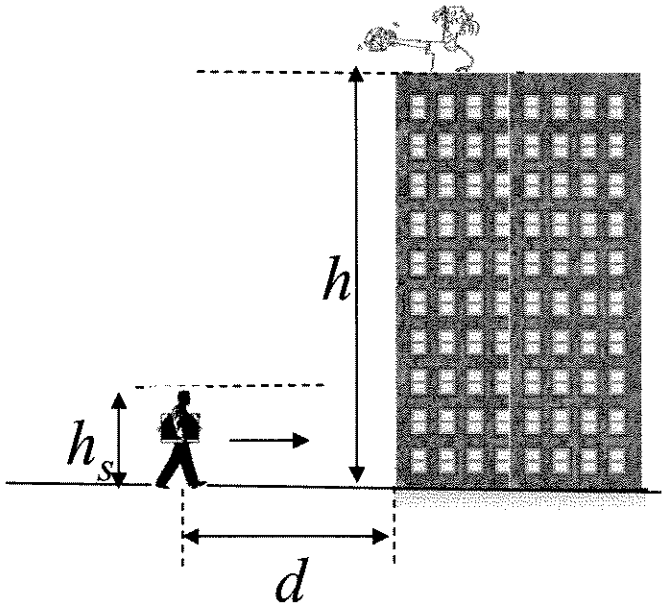
10. (1 point) The units of ***c*** $\frac{m}{s^3}$

Part 2: (20 points)

You are on the roof of the physics building (at its left edge as shown in the figure), a height h meters above the ground. You see professor Sinova, who is h_s meters tall is walking alongside the building at a constant velocity of v_s. (Give all your answers in terms of h, h_s, v_s, and g).

a) (10) How long does it take for the egg to reach Prof. Sinova's head?

b) (10) If you want to drop an egg on Prof. Sinova's head, at what distance d from the building should he be when you release the egg?



a) $y - y_0 = -h + h_s$

$v_{0y} = 0$

$v_y =$

$a_y = -g$

$t = ?$

$-h + h_s = -\frac{1}{2} g t^2$

$\Rightarrow t = \sqrt{\frac{2(h-h_s)}{g}}$

b) $d = v_s t$ or $d = v_s \sqrt{\frac{2(h-h_s)}{g}}$

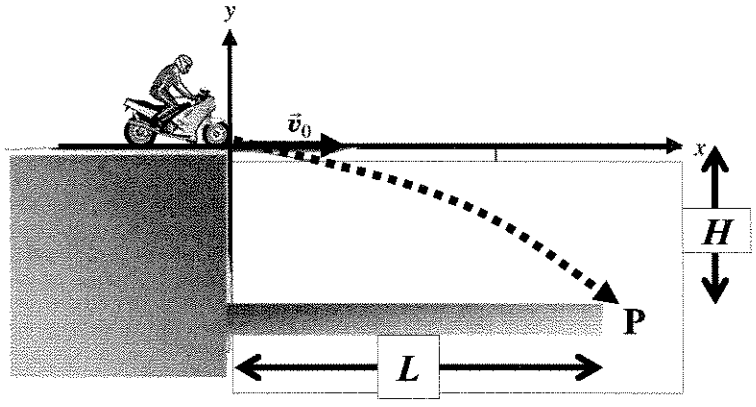
Problem 3: You are hired for a new Matrix movie! (25 points)

You have been hired as a physics expert and consultant for a new Matrix movie, "The Matrix: Re-wired." In one scene, Neo jumps horizontally off the top of a cliff to escape Morpheus. A horizontal ledge (length ***L***) juts out of the cliff a distance ***H*** beneath the top of the cliff. The stunt coordinator wants you to help make sure Neo passes the ledge (point P), as he falls. The acceleration due to gravity on the earth is ***g*** pointing down. You can ignore air resistance. Using the known variables, ***L***, ***H***, and/or ***g***, and the coordinate system shown on the figure find:

a. (10 pts) How much time does it take to travel from the top of the cliff to point P?

b. (8 pts) What is the minimum speed, V_0, that Neo must have before he leaves the cliff?

c. (7 pts) What his velocity at point **P**?



a) y-direct

$y - y_0 = -H$

$v_y =$

$v_{0y} = 0$

$t =$

$a_y = -g$

$-H = 0 - \frac{1}{2} g t^2$

$t = \sqrt{\frac{2H}{g}}$

x-direc

$x - x_0 = L$

$v_x = v_0$

$t =$

b) $v_0 = \frac{L}{t} = L\sqrt{\frac{g}{2H}}$

c) $v_y = -\sqrt{2gH}$

$\vec{v} = v_0 \hat{x} - \sqrt{2gH}\,\hat{y}$