PHYS 2101 Exam 1B → IMPORTANT NOTE ASWERS HERE FOR MULTIPLE CHOICE ARE FOR EXAM 1B. IF YOUR EXAM IS 1A THEN THE ANSWERS ARE THE SAME BUT THE CHOICES ARE DIFFERENT.

Monday, October 13, 2008
5:30-7:00 pm

Name:______________________________

ID:______________________________

Section (or instructor name):______________________________

WRITE ALL ANSWER TO MULTIPLE CHOICE QUESTIONS IN THE TABLE BELOW.

Answers to Multiple Choice questions (each question is 3.5 points)

MC1	
MC2	
MC3	
MC4	
MC5	
MC6	
MC7	

MC total________ /24.5

P1________ /10

P2________ /15

P3________ /20.5

P4________ /20

P5________ /10

Tot________ /100

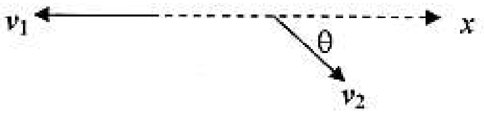
Useful constant: $g = 9.8\ \mathrm{m/s^2}$

Each multiple choice (MC) question is 3.5%. There are 7 questions: MC1 to MC7.

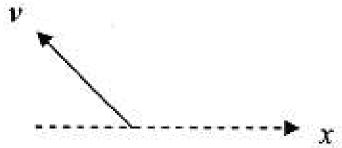
(MC1) Consider the equation $y = y_0 + v_0 t + \frac{1}{2}at^2$. Which of the following statements is correct?

(a) y is the final position at time t, y_0 is the initial position, and $y - y_0$ is the displacement from the initial position.
(b) y is the final distance from the origin at time t, y_0 is the initial distance from the origin and $y - y_0$ is the displacement from origin.
(c) y is the final distance from the origin at time t, y_0 is the origin, and $y - y_0$ is the displacement from the origin.
(d) y is the final position at time t, y_0 is the initial position, and $y - y_0$ is the distance from the origin.

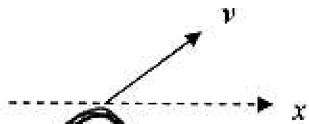
(MC2) Vectors v_1 and v_2 are shown below.



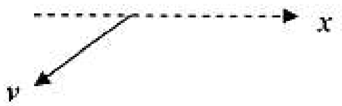
Which of the following choices below gives $v = -v_1 - v_2$?



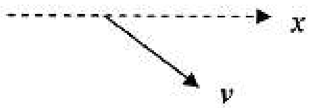
(a)



(b)



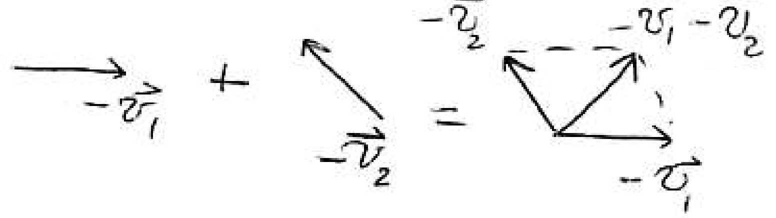
(c)



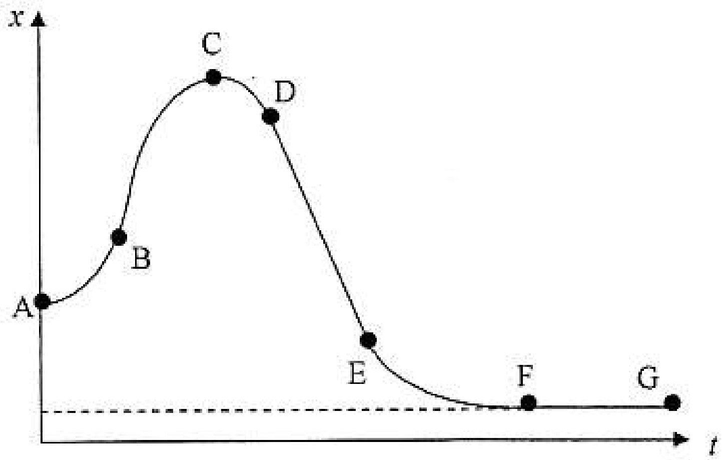
(d)

$-\vec{v}_1 - \vec{v}_2 = -(+\vec{v}_1) + (\ast\vec{v}_2)$

=



The graph below shows the position x against time t graph for a Mazda 6 car. **Use this graph to answer questions MC3, MC4 and MC5.**

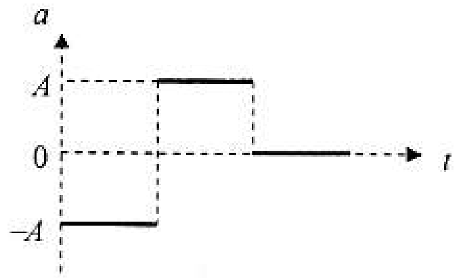


(MC3) In which intervals is the Mazda's velocity constant?
(a) Between A and B, D and E.
(b) Between B and D, E and G.
(c) Between A and C, C and F.
(d) Between D and E, F and G. → in both slope = const ⇒ $v = \text{const}$

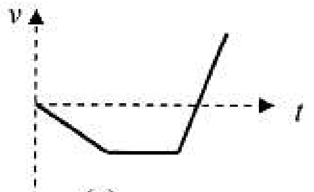
(MC4) In which interval is the Mazda moving in the negative direction?
(a) Between A and C.
(b) Between B and D.
(c) Between C and F. → it goes from larger x to smaller x
(d) Between F and G. ∴ negative direction

(MC5) In which of the following intervals is the Mazda accelerating (speed is increasing)?
(a) Between A and B, D and E.
(b) Between A and B, C and D. → slope is increasing between A and B
(c) Between D and E, E and F.
(d) Between B and C, F and G. ∴ v is increasing. At C the slope $= 0 \Rightarrow v = 0$ at C, ∴ it accelerates when it moves to D ∴ between C and D car is accelerating, ∴ speed increases.

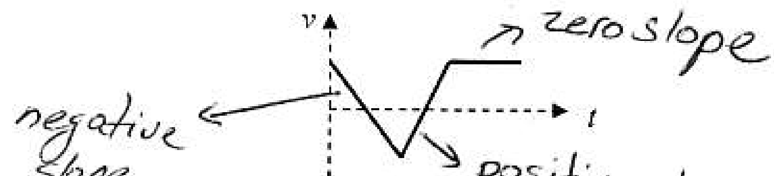
(MC6) Below is a graph of acceleration a against time t for a bird. In the graph, A is a positive number.



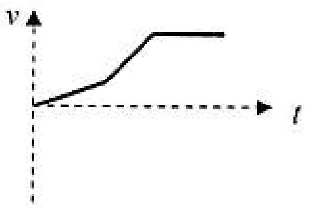
Which of the following graphs is a possible v against t graph for the bird, where v is velocity?



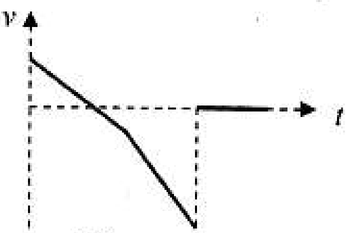
(a)



(b)



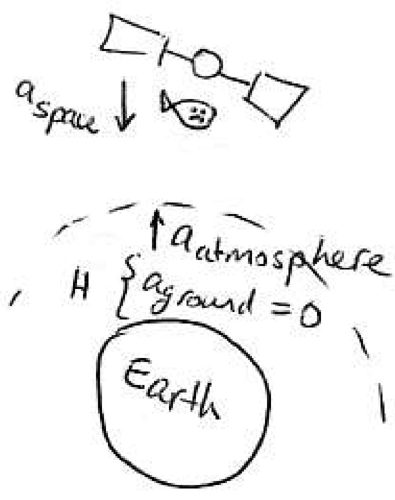
(c)



(d)

(MC7) You drop a dead fish from a satellite in space and it accelerates towards Earth. When the fish hits Earth's atmosphere, the atmosphere's resistance slows the fish down until it reaches height H above ground. After that, it falls to ground from height H with constant speed. What is the direction of the fish's acceleration when it leaves the satellite (a_{space}), when it is slowing down ($a_{atmosphere}$), and when it falls with constant speed (a_{ground})?

(a) a_{space} is down, $a_{atmosphere}$ is down and a_{ground} is zero.
(b) a_{space} is down, $a_{atmosphere}$ is up and a_{ground} is zero.
(c) a_{space} is down, $a_{atmosphere}$ is down and a_{ground} is down.
(d) a_{space} is up, $a_{atmosphere}$ is down and a_{ground} is down.



There are 5 problems: P1 to P5.

(P1) One year has 365 days. Find one second to units of years. **Give your answer in 2 significant figures.** **(10 points)**

$$1s = 1s \times \frac{1\,min}{60s} \times \frac{1\,hr}{60\,min} \times \frac{1\,day}{24\,hrs} \times \frac{1\,yr}{365\,days}$$

$$= 3.17 \times 10^{-18}\,yrs = \underline{\underline{3.2 \times 10^{-8}\,yrs}}$$

(P2) You are a policeman. You see a car accelerating uniformly from rest for a distance of 50.0m in 5 seconds. The speed limit in the road is 27.8m/s. Is the speed of the car above the speed limit after these 5s? **Show your work.** **(15 points)**

The car is <u>accelerating</u> <u>uniformly</u>, so

$x = x_0 + v_0 t + \frac{1}{2} a t^2$

$= 0 + 0 + \frac{1}{2} a t^2$ (where origin is chosen at initial position)

$\therefore 50 = \frac{1}{2} a (5)^2$

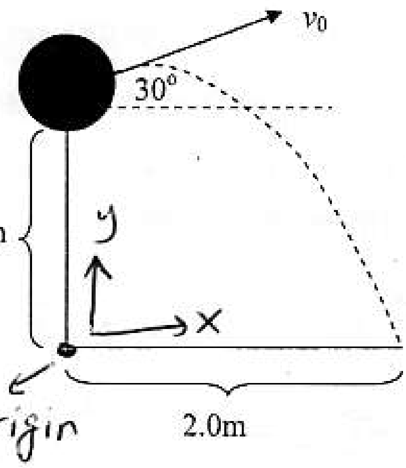
$\Rightarrow 100 = 25a \Rightarrow a = 4\,m/s^2$

$\therefore v = v_0 + at = 0 + (4)(5) = \underline{\underline{20\,m/s}}$

$\therefore$ <u>less than the speed limit</u>.

(P3) The figure below shows a ball thrown from a height 2.0m above ground at $\theta = 30^{\circ}$ above the horizontal with initial velocity v_0. The ball travels 2.0m horizontally before hitting ground. Calculate the initial velocity v_0 of the ball. **(20.5 points)**

See figure for choice of axes.



$v_x = v_0 \cos 30 = \frac{\sqrt{3}}{2} v_0 = 0.866 v_0$

$v_y = v_0 \sin 30 = \frac{1}{2} v_0 = 0.5 v_0$

x-axis $x = v_x t = \left(\frac{\sqrt{3}}{2} v_0\right) t \Rightarrow t = \frac{2x}{v_0\sqrt{3}}$

$x = 2, \therefore t = \frac{4}{v_0\sqrt{3}} = \frac{2.31}{v_0}$

y-axis $y = y_0 + v_{0y} t + \frac{1}{2} a t^2$,

$\therefore 0 = 2 + \left(\frac{1}{2} v_0\right) t + \frac{1}{2}(-9.8) t^2 = 2 + \left(\frac{1}{2} v_0\right)\left(\frac{2.31}{v_0}\right) - 4.9\left(\frac{2.31}{v_0}\right)^2$

$\therefore 0 = 3.155 - \frac{26.147}{v_0^2} \Rightarrow v_0^2 = \frac{26.147}{3.155} = 8.287$

$\therefore v_0 = 2.88 \text{ m/s} = 2.9 \text{ m/s}$

(P4) You are initially moving towards Muscat **(positive direction)** at 8.0m/s. You then accelerate uniformly at 2.0m/s^2 in the **negative** direction. **(20 points, 5 per part)**

(a) What is the magnitude of your velocity 6.0s after you started accelerating?

$v = v_0 + at = 8 - 2(6) = 8 - 12 = -4 \text{ m/s}$

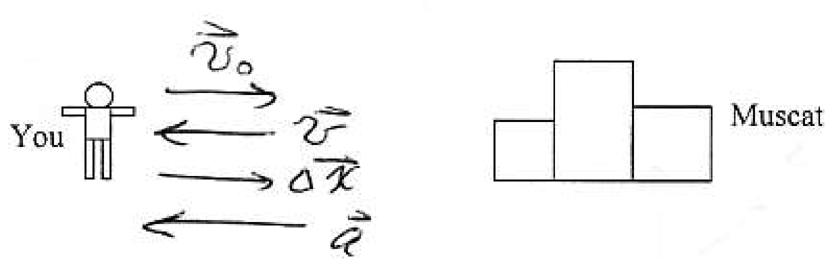
$\therefore$ magnitude is 4 m/s.

(b) Calculate the magnitude and direction of your displacement after these 6.0s.

$x = x_0 + v_0 t + \frac{1}{2} a t^2 = 0 + 8(6) + \frac{1}{2}(-2)(6)^2 = 48 - 36 = 12 \text{ m}$

since $x - x_0 = 12 - 0 = 12 \text{ m}$ is positive, $\therefore$ direction is positive (to Muscat)

(c) Draw **IN THE FIGURE BELOW** the following vectors: your initial velocity, your velocity after 6.0s, your displacement after 6.0s, and your acceleration.



(d) Calculate the total distance you traveled in these 6.0s.

Time to stop: $v = v_0 + at$ or $0 = 8 - 2t \Rightarrow t = 4 \text{ s}$

$\therefore x = 0 + 8(4) + \frac{1}{2}(-2)(4)^2 = 16 \text{ m}$ to stop.

Remaining time is 2s where you move in negative direction:

$x = x_0 + v_0 t + \frac{1}{2} a t^2 = 0 + 0 + \frac{1}{2}(2)(2)^2 = 4 \text{ m}$.

$\therefore$ total distance $= 16 + 4 = 20 \text{ m}$

(P5) You go East at 8.0m/s and then turn North and continue at 8.0m/s. The change of direction from East to North takes 2.0s. **(10 points, 5 per part)**

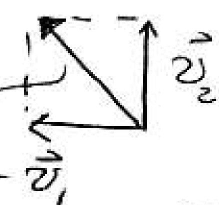
(a) Calculate the magnitude and direction of your average acceleration.

(b) Draw a diagram showing the directions of your initial velocity, final velocity and average acceleration.

(a) $\vec{a}$ is a vector ; $\vec{a} = \dfrac{\Delta \vec{v}}{\Delta t} = \dfrac{\vec{v}_2 - \vec{v}_1}{\Delta t}$ → vector substraction

$$\vec{v}_2 - \vec{v}_1 = \underset{\vec{v}_2}{\uparrow} - \underset{\vec{v}_1}{\rightarrow} = \underset{\vec{v}_2}{\uparrow} + \underset{-\vec{v}_1}{\leftarrow}$$

=



$$\text{magnitude} = \sqrt{v_2^2 + (-v_1)^2}$$

$$= \sqrt{8^2 + 8^2} = 11.3\,m/s$$

direction is 45° above $-\vec{v}_1$ (or above West).

$\therefore |\vec{a}| =$ magnitude of $a = \dfrac{11.3}{2} = \underline{\underline{5.7\,m/s^2}}$ $\underline{\underline{\text{at } 45^\circ}}$ $\underline{\underline{\text{above west}}}$.

(b)