Phys 2107 Physics for Engineering I

Test I *Date*: 07/10/2008 *Time*: 5:30-6:30

ID:	Name:		Sec:	Total score = 50
Q1	Q2	Q3	Q4	

Please check that you have 4 pages. Take $g = 10 m/s^2$.

1A. Starting at time t = 0, an object moves along a straight line with velocity in m/s given by $v(t) = 98 - 2t^2$, where t is in seconds. When it momentarily stops its acceleration (in m/s^2) is:

A) 0 B) –4.0 C) -28 D) 98 E) 49

1B. A car, initially at rest, travels 20 m in 4 s along a straight line with constant acceleration. The acceleration of the car (in m/s^2) is:

A) 0.4 B) 1.3 C) 2.5 D) 4.9 E) 9.8

1C. A projectile is fired over level ground with an initial velocity that has a vertical component of 20 m/s and a horizontal component of 30 m/s. The distance from launching to landing points is:

A) 40 m B) 60 m C) 80 m D) 120 m E) 180 m

1D.A particle moves at constant speed in a circular path. The instantaneous velocity and instantaneous acceleration vectors are:

A) both tangent to the circular path B) both perpendicular to the circular path

C) perpendicular to each other D) opposite to each other E) none of the above

1E. Let $\vec{a} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{b} = \hat{i} - 2\hat{j} + 3\hat{k}$. Then the scalar product $\vec{a}.\vec{b}$ equals:

A) -8 B) $\hat{i} - \hat{j} + \hat{k}$ C) 8 D) 11 E) 14

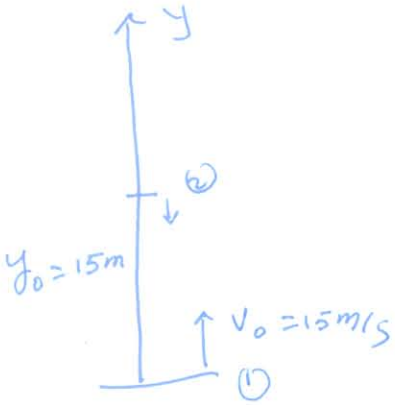
Total multiple choice questions worth **(15 points)**

Classical Problems

2. From the bottom of a $15m$ high cliff a stone is thrown upward with an initial speed $v_0 = 15m/s$. One second later another stone is dropped from the top of the cliff.

a) At what height from the bottom of the cliff the stones will meet?

b) What are their velocities then? **(7 points)**



$y_1 = 15t - 5t^2$

$y_2 = 15 - 5(t-1)^2$

$y_1 = y_2 \Rightarrow \quad t = 2s$ } (4)

a) $y_1 = 30 - 20 = 10m = y_2$

b) $V_1 = 15 - 10t = 15 - 20 = -5\,m/s$

$V_2 = -10(t-1) = -10\,m/s$ } (3)

3. Let $\vec{r} = x(t)\hat{i} + y(t)\hat{j}$ represents the position vector of a particle where $x(t) = 12t - 3t^2$ and $y(t) = -4t + t^3$ are measured in meters and t in second.

(a) Calculate the average velocity between the times $t = 1\ s$ and $t = 2\ s$.
(b) Find the velocity $\vec{v}$ when the particle reaches its maximum x coordinate.
(c) Find the acceleration in unit vector notation at $t = 1\ s$. **(12 points)**

a) $\vec{V}_{avg} = \frac{\Delta \vec{r}}{\Delta t} = \frac{\Delta x}{\Delta t}\hat{i} + \frac{\Delta y}{\Delta t}\hat{j} = \frac{(x_2 - x_1)}{\Delta t}\hat{i} + \frac{(y_2 - y_1)}{\Delta t}\hat{j}$, $\Delta t = t_2 - t_1 = 1s$

$= \frac{(24-12) - (12-3)}{1}\hat{i} + \frac{(-8+8) - (-4+1)}{1}\hat{j}$

(4) $\boxed{\vec{V}_{avg} = 3\hat{i} + 3\hat{j}}$

b) $x_{max} \Rightarrow \frac{dx}{dt} = 12 - 6t = 0 \Rightarrow t = 2s$

$\vec{V} = (12 - 6t)\hat{i} + (-4 + 3t^2)\hat{j}$

$= 0\hat{i} + (-4 + 12)\hat{j}$

(4) $\boxed{\vec{V} = 8\hat{j}}$

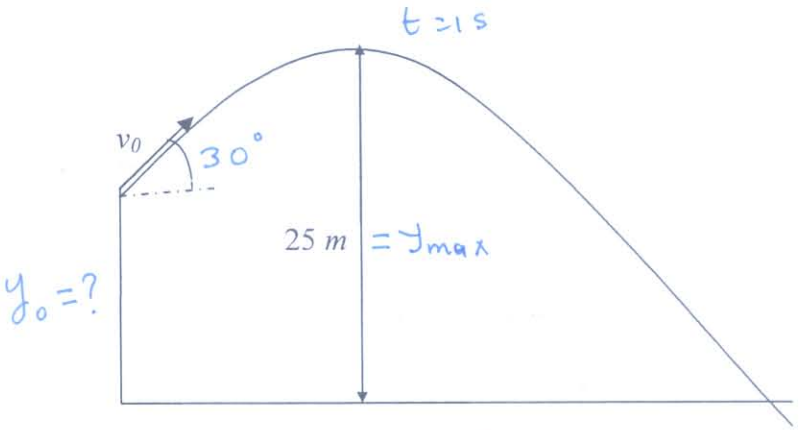
c) $\vec{a} = -6\hat{i} + 6t\hat{j}$

at $t = 1$

(4) $\boxed{\vec{a} = -6\hat{i} + 6\hat{j}}$

4. A ball is thrown upward from the roof of a building at an angle $\theta_0 = 30^\circ$ with the horizontal. One second later the ball reaches its maximum height $y_{max} = 25m$ from the ground.

(a) Find the initial speed of the ball.
(b) Find the height of the building.
(c) Find the time of flight.
(d) Find the distance from the base of the building to the point where the ball hits the ground **(16 points)**



$V_x = V_{0x} = V_0 \cos\theta_0$
$V_y = V_{0y} - gt = V_0 \sin\theta_0 - gt$

$x = V_{0x} t$
$y = y_0 + V_{0y} t - \frac{1}{2} g t^2$

(4) a) $V_y = 0 \Rightarrow V_{0y} = gt = 10 = V_0 \sin 30^\circ \Rightarrow \boxed{V_0 = 20 m/s}$

(4) b) $y_{max} = y_0 + \frac{V_{0y}^2}{2g} \Rightarrow 25 = y_0 + \frac{100}{20} \Rightarrow \boxed{y_0 = 20 m}$

(4) c) $y = 20 + 10t - 5t^2 = 0 \Rightarrow$

$t^2 - 2t - 4 = 0 \quad t_{1,2} = 1 \pm \sqrt{1+4} \Rightarrow t = 1 + \sqrt{5} \simeq 3.25$

(4) d) $x = V_{0x} t = 20 \cos 30 \times (1 + \sqrt{5})$

$\boxed{x = 56 m}$