Kuwait University

Physics Department
Physics 101

First Mid-Term Exam
Fall 2010
Monday, November 1st, 2010
12:30 p.m. – 1:45 p.m.

Student's Name: ……

Student's Number: ……Model Answer……

Choose your Instructor's Name:

Prof. Fikry El-Akkad	Dr. Ahmad Al-Jassar
Dr. Ya'qoob Makdesi	Dr. Hassan Ra'fat
Dr. Hala Al-Jassar	Dr. Fatma Al-Dossari
Dr. Abdul-Mohsen Ali	Dr. Hassan Manaa
Dr. Tareq Alrefae	Dr. Tarek Ramadan
Dr. Ashraf Zaher	

Grades:

#	Q1	Q2	Q3	Q4	P1	P2	P3	P4	P5	P6	P7	Total
Points												
	1	1	1	1	2	3	2	3	2	2	2	20

Important:

1. Answer all questions and problems.
2. Full mark = 20 points (4 Questions & 7 Problems).
3. Each question will be assigned 1 point.
4. No solution = no points.
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.
7. Mobiles and pagers are not allowed during the exam.
8. Programmable calculators, which can store equations, are not allowed.

GOOD LUCK

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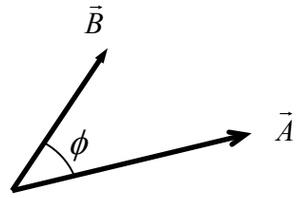
Q1. If $\vec{C} = \vec{A} \times \vec{B}$ and ϕ is the angle between $\vec{A}$ and $\vec{B}$, then $\vec{C} \bullet \vec{A}$ equals



(a) $AB \sin \phi$
(b) $AB \cos \phi$
(c) $AC \sin \phi$
(d) $AC \cos \phi$
(e) **Zero**

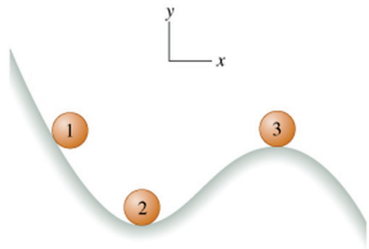
From the cross product properties, Vector ***C*** is perpendicular to both vectors ***A*** and ***B***; thus, the dot product of vectors C and A is zero.

Q2. An object is moving in a straight line along the x-axis. Which of the following equations best describes its motion, if after some time its average velocity is zero?

(a) $x = t^3 + 2t$
(b) **$x = t^2 - 4t$**
(c) $x = -2 + t$
(d) $x = 9 - t^2$
(e) $x = t^2 - 5$

Only answer **b** allows the displacement, Δx, to be zero after sometime ($t = 4$ s). For all other answers, there is no change in motion direction.

Q3. Which direction best approximates the direction of acceleration when the object is at position 2?



(a) **Straight up (↑)**
(b) Straight down (↓)
(c) Straight to the right (→)
(d) Downward to the right (↘)
(e) Downward to the left (↙)

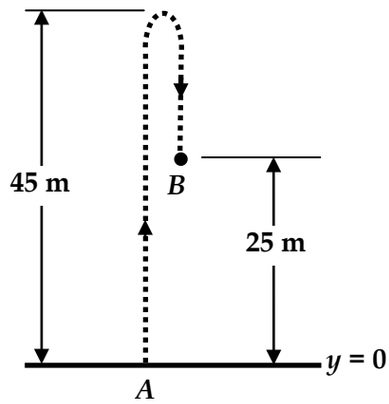
Only radial acceleration will exist at position 2, as the speed is maximum at this point (parallel acceleration is zero).

Q4. A projectile leaves the ground at 60° above the horizontal and feels no air resistance as it travels. Which of the following statements is true, while it is in the air?

(a) Its horizontal acceleration is equal to g
(b) Its speed is zero at its highest point
(c) Its velocity is zero at its highest point
(d) **Its acceleration is always downward and equal to g**
(e) Its acceleration is zero at its highest point

Only the vertical acceleration is constant and equal to g during projectile motion. Horizontal acceleration is always zero.

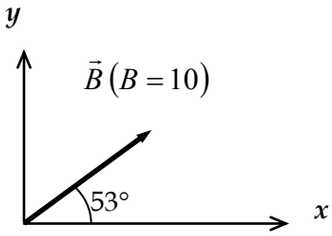
P1. A ball is thrown vertically up from point A and reaches point B along the path shown in the figure. Find the time required by the ball to reach point B if its average speed between A and B is 13 m/s. **(2 points)**



Distance from A to $B = \Delta s = 45 \uparrow + 20 \downarrow = 65$ m

Average speed $= \dfrac{\Delta s}{\Delta t} \Rightarrow 13 = \dfrac{65}{\Delta t} \Rightarrow \Delta t = 5$ s

P2. Find the magnitude of the vector $\vec{C} = \vec{A} + 2\vec{B}$, where vector $\vec{A} = 3\hat{i} - 4\hat{j}$, and vector $\vec{B}$ is given in the figure. **(3 points)**



$$B_x = B\cos\theta = 10\cos 53^\circ = 6$$
$$B_y = B\sin\theta = 10\sin 53^\circ = 8$$
$$C_x = A_x + 2B_x = 3 + 2(6) = 15$$
$$C_y = A_y + 2B_y = -4 + 2(8) = 12$$
$$C = \sqrt{C_x^2 + C_y^2}$$
$$= \sqrt{(15)^2 + (12)^2} = 19.21$$

P3. Three vectors $\vec{A} = 3\hat{i} - 4\hat{j}$, $\vec{B} = 5\hat{k}$, and $\vec{C} = 12\hat{k} + 9\hat{j}$. Find the angle between the vector $\vec{C}$ and the vector $\vec{D} = \vec{B} \times \vec{A}$. **(2 points)**

$$\vec{D} = \vec{B} \times \vec{A} = 5\hat{k} \times (3\hat{i} - 4\hat{j}) = 15\hat{j} + 20\hat{i}$$
$$\phi_{CD} = \cos^{-1}\left(\frac{\vec{C} \bullet \vec{D}}{CD}\right) = \cos^{-1}\left(\frac{9 \times 15}{\sqrt{12^2 + 9^2} \times \sqrt{15^2 + 20^2}}\right) = 68.9^\circ$$

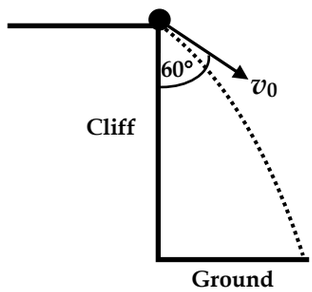
P4. Two cars *A* and *B* start racing from rest at *t* = 0 with constant accelerations of *a* and *a*/4, respectively. After 20 seconds the distance between the cars become 300 m. Find the acceleration of car *A*. **(3 points)**

$$\Delta x_A = v_{A0}t + \frac{1}{2}a_A t^2 = \frac{1}{2}at^2$$
$$\Delta x_B = v_{B0}t + \frac{1}{2}a_B t^2 = \frac{1}{2}\left(\frac{a}{4}\right)t^2 = \frac{1}{8}at^2$$
$$\Delta x_A - \Delta x_B = \frac{3}{8}at^2 \Rightarrow 300 = \frac{3}{8}a \times 20^2 \Rightarrow a = 2\ \mathrm{m/s^2}$$

P5. A balloon drops a stone above the ground while ascending at a constant speed of 9 m/s. The stone reaches the ground after 5 seconds. Find the height of the balloon when the stone reaches the ground. **(2 points)**

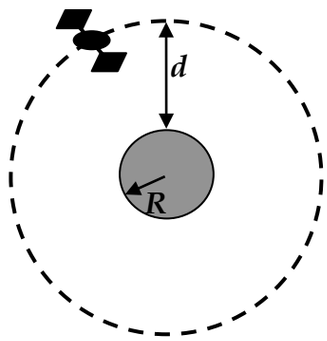
$$\Delta y = v_B t - \frac{1}{2} g t^2 = 9 \times 5 - \frac{1}{2} \times 10 \times 5^2 = -80 \text{ m}$$
$$H = 80 + v_B t = 80 + 9 \times 5 = 125 \text{ m}$$

P6. A stone is thrown downward from the upper edge of a vertical cliff with an initial velocity v_0 = 20.0 m/s directed at 60.0° with the face of the cliff, as shown in figure. The stone hits the ground 3.0 s after being thrown and feels no air resistance as it falls. Find the speed by which the stone will hit the ground. **(2 points)**



$$x_0 = y_0 = 0 \text{ , } v_{x0} = 20 \sin 60^\circ \text{ \& } v_{y0} = -20 \cos 60^\circ$$
$$v_x = v_{x0} = 17.32 \text{ m/s}$$
$$v_y = v_{y0} - gt = -10 - 10 \times 3 = -40 \text{ m/s}$$
$$v = \sqrt{v_x^2 + v_y^2} = 43.59 \text{ m/s}$$

P7. A satellite orbits the earth a distance d = 1.50 x 10^7 m above the surface and takes 4.89 hours for each revolution about the earth. The earth's radius is R = 6.38 x 10^6 m, as shown in figure. Find the acceleration of this satellite. **(2 points)**



$$a = \frac{4\pi^2 (d + R)}{T^2}$$
$$a = \frac{4\pi^2 (1.5 \times 10^7 + 6.38 \times 10^6)}{(4.89 \times 60 \times 60)^2} = 2.72 \text{ m/s}^2$$