Kuwait University

# Physics Department
# Physics 101

II

First Midterm Exam
Spring 2008
Wednesday, March 26th, 2008
12:30 p.m. – 02:00 p.m.

Student's Name: ……..……..……

Student's Number: ……MODEL ANSWER……

Choose your Instructor's Name:

| | |
|---|---|
| Dr. Ahmad A. Al-Jassar | Dr. Hala K. Al-Jassar |
| Dr. Adnan Al-Yaseen | Dr. Abdul-Mohsen Ali |
| Dr. Hasan Raafat | Dr. Ismaeel Sabbah |
| Dr. Tarek Ramadan | Dr. Tareq Alrefae |
| Dr. Ashraf Zaher | Prof. Fikry Al-Akkad |

Grades:

| # | Q1 | Q2 | Q3 | Q4 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Points | | | | | | | | | | | | | |

**Important**:

1. Answer all questions and problems.
2. Each question will be assigned 1 point.
3. Each problem will be assigned 2 points.
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.

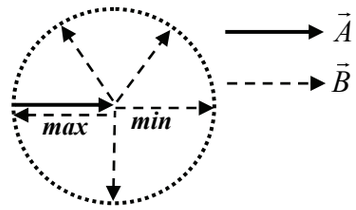
GOOD LUCK

# Part I: Questions (Choose the correct answer)

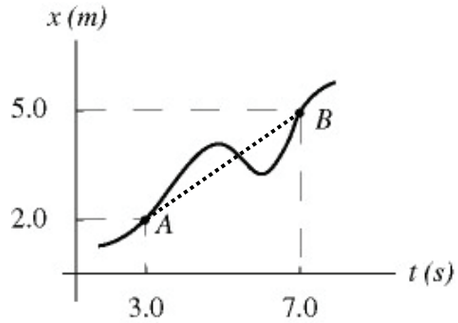
1. Which of the following statements about the difference of two vectors, $\vec{A}-\vec{B}$, is always true for any two vectors $\vec{A}$ and $\vec{B}$, if $|\vec{A}| = |\vec{B}| = 3$?

(a) $|\vec{A} - \vec{B}| = 0$
(b) $|\vec{A} - \vec{B}| = 6$
→ (c) $0 \le |\vec{A} - \vec{B}| \le 6$
(d) $|\vec{A} - \vec{B}| = 3\sqrt{2}$

From the figure, the maximum value is 6 when the angle between the two vectors is 180°, while the minimum value is zero when the angle is 0°.




2. An object is moving in a straight line (the *x*-axis). The graph shows the *x*-coordinate of this object as a function of time. Which one of the following statements is correct about the motion of the object between points ***A*** and ***B***?



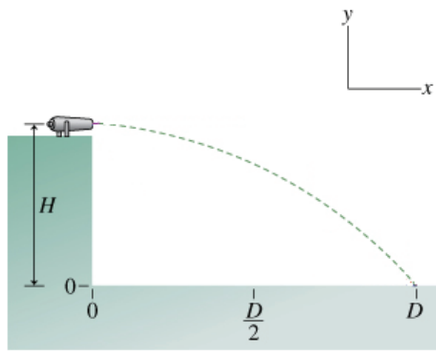

(a) both the average velocity and the average speed are equal to 0.75 m/s.
(b) the average velocity is 0.75 m/s, but the average speed is less than 0.75 m/s.
(c) both the average velocity and the average speed are greater than 0.75 m/s.
→ (d) the average velocity is 0.75 m/s, but the average speed is greater than 0.75 m/s.

The distance between ***A*** and ***B*** (solid line) is greater than the displacement (dashed line). Thus the speed is greater than the velocity which is equal to (5-2)/(7-3) = 0.75 m/s.

3. A canon ball is fired horizontally with a speed of 6 m/s from the top of a cliff, as shown in figure. If the speed at point ***D*** is 10 m/s, then the velocity at point ***D*** is:

(a) $6\hat{i} + 8\hat{j}$
→ (b) $6\hat{i} - 8\hat{j}$
(c) $6\hat{i} - 4\hat{j}$
(d) $8\hat{i} - 6\hat{j}$

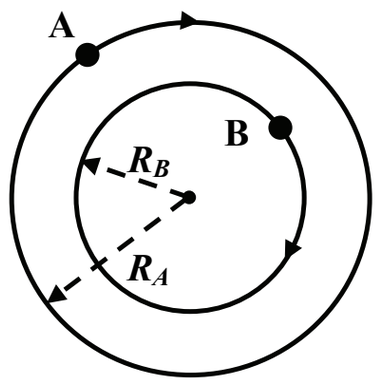
$v_x$ is constant = $6\hat{i}$ and $v_y$ must be downward ($v_y = -\sqrt{10^2 - 6^2} = -8\hat{j}$).
Thus $v = 6\hat{i} - 8\hat{j}$.




4. Two particles, **A** and **B**, are in uniform circular motion about a common center, as shown in figure. The acceleration of particle **A** is 8 times that of particle **B**. If $R_A = 2R_B$, then $v_A$ is:

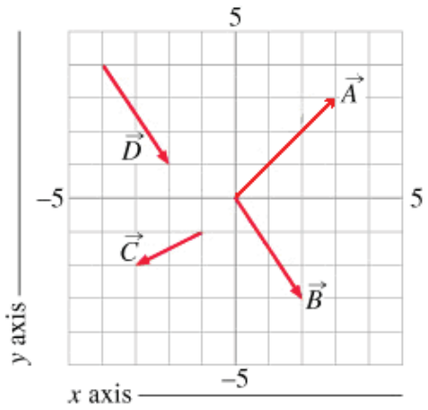
(a) 2 $v_B$
→ (b) 4 $v_B$
(c) 8 $v_B$
(d) 16 $v_B$

$a = v^2/R$. Thus $v = \sqrt{aR}$ and:
$\frac{v_A}{v_B} = \sqrt{\frac{a_A}{a_B} * \frac{R_A}{R_B}} = \sqrt{8*2} = 4$.



# Part II: Problems (solve the following problems)

1. For the vectors, shown in figure, find the ratio $|\vec{A}+\vec{B}|/|\vec{C}+\vec{D}|$.




$\vec{A}=+3\hat{i}+3\hat{j}$ $\quad \vec{C}=-2\hat{i}-\hat{j}$

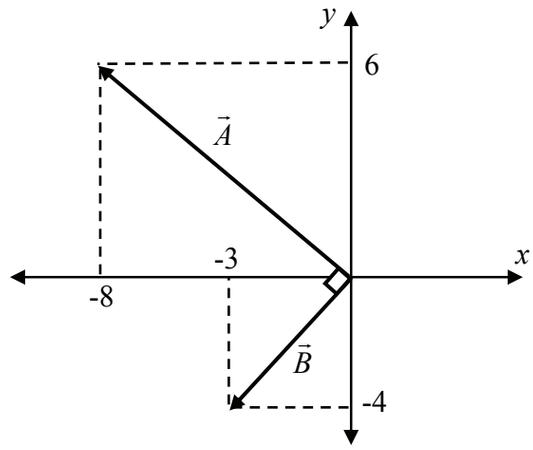
$\vec{B}=+2\hat{i}-3\hat{j}$ $\quad \vec{D}=+2\hat{i}-3\hat{j}$

$\vec{A}+\vec{B}=+5\hat{i}$

$\vec{C}+\vec{D}=-4j$

$$\frac{|\vec{A}+\vec{B}|}{|\vec{C}+\vec{D}|}=\frac{5}{4}=1.25$$

2. Two vectors $\vec{A}$ and $\vec{B}$ lie in the *x*-*y* plane, perpendicular to each other, and their cross product is $\vec{A}\times\vec{B}=+50\hat{k}$. If $\vec{A}=-8\hat{i}+6\hat{j}$, as shown in figure, find the angle (in degree) that vector $\vec{B}$ makes with the positive *x*-axis.




$\vec{A}\cdot\vec{B}=-8B_x+6B_y=0$

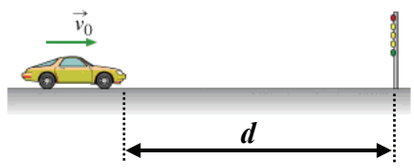
$\vec{A}\times\vec{B}=-8B_y-6B_x=50$

$B_x=-3$

$B_y=-4$

$$\theta_B=\tan^{-1}\frac{-4}{-3}=233.1^\circ \text{ or } -126.9^\circ$$

3. A man, driving a car at constant speed, $v_0$ = 20 m/s, hits the brakes and slows down uniformly when he sees the traffic light turns red, as shown in figure. The car is initially at a distance ***d*** = 25 m from the traffic light. Find the time (in s) needed for the car to stop exactly at the traffic light.




$$\Delta x=d=\frac{t}{2}(v+v_0)$$

$$25=\frac{t}{2}(0+20)$$

$t=2.5\,\text{s}$

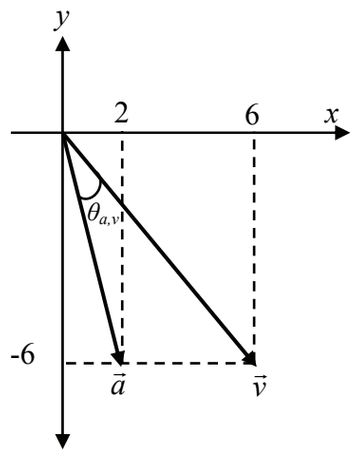
4. An object, moving in the *xy*-plane, has coordinates that vary with time according to:
$x = 2t + t^2$ and $y = 1 - 0.5t^3$
Find the component of the acceleration vector along the velocity direction (i.e. $a_{//}$) at $t = 2$ s.
**Hint:** $a_{//} = a\cos\theta$, where $\theta$ is the angle between the acceleration and velocity vectors.

$v_x = 2 + 2t \quad a_x = 2$

$v_y = -1.5t^2 \quad a_y = -3t$

At $t = 2$ s: $\vec{v} = 6\hat{i} - 6\hat{j}$ and $\vec{a} = 2i - 6\hat{j}$

Thus $a_{//} = a\cos\theta_{a,v} = \dfrac{\vec{a}\cdot\vec{v}}{|\vec{v}|} = \dfrac{6*2+6*6}{6\sqrt{2}} = 5.66\ \text{m/s}^2$

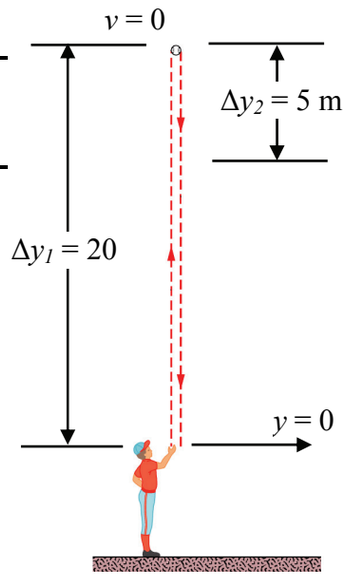



5. The boy, shown in figure, throws a ball vertically upward with an initial speed of 20 m/s. Find the **<u>average speed</u>** (in m/s) of the ball during the first 3.0 s of the motion.

At maximum height:
$v^2 = v_0^2 - 2g\Delta y_1 \Rightarrow 0 = (20)^2 - 2*10*\Delta y_1 \Rightarrow \Delta y_1 = 20\ \text{m}$

After 3 s:
$\Delta y_1 - \Delta y_2 = y_0 + v_0 t - 0.5*g*t^2$
$20 - \Delta y_2 = 0 + 20*3 - 0.5*10*3^2 \Rightarrow \Delta y_2 = 5\ \text{m}$

Thus:
$\text{Average speed} = \dfrac{|\Delta y_1| + |\Delta y_2|}{\Delta t} = \dfrac{20+5}{3} = 8.33\ \text{m/s}$



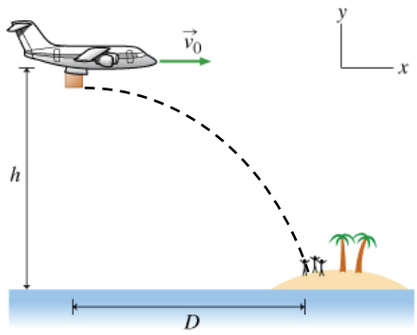

6. An airplane is delivering a package to a very small island, as shown in figure. The airplane is flaying horizontally at a height ***h*** = 720 m with constant speed $v_o$ = 360 km/h. Find the horizontal distance ***D*** (in m) at which the package should be dropped so that it will land on the island. (Neglect air resistance)

$v_{0x} = v_0$ and $v_{0y} = 0$

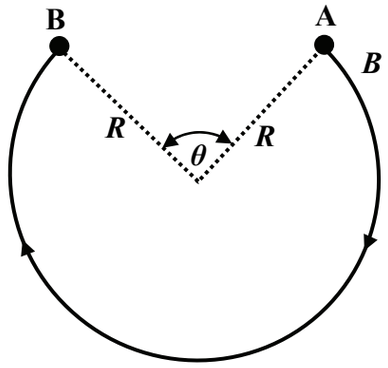
$y = y_0 + v_{0y}t - 0.5gt^2$

$-h = -720 = 0 + 0 - 0.5*10*t^2 = -5t^2 \Rightarrow t = 12\ \text{s}$

Thus
$D = v_{0x}t = 360*(1000/3600)*12 = 1200\ \text{m}$



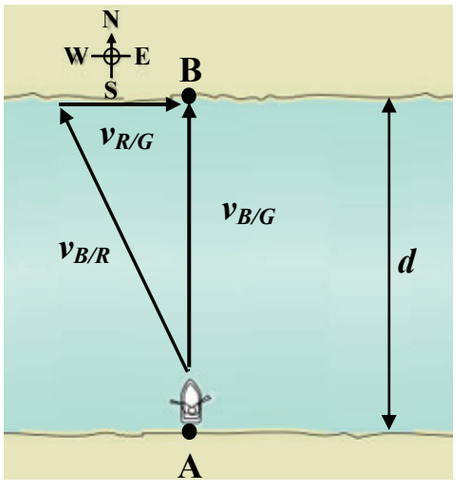
7. A small particle is moving in a uniform circular motion, as shown in figure, where ***R*** = 2 m. Find the magnitude of its velocity (in m/s) if the time required to move from point **A** to point **B** ($\theta = 90^\circ$) is $t = 6$ s.




$$\frac{3}{4}T = 6 \Rightarrow T = 8\ \text{s}$$

$$v = \frac{2\pi R}{T} = \frac{4\pi}{8} = 1.57\ \text{m/s}$$

8. A man in a motorboat is trying to cross a river from point **A** to point **B** that are a distance ***d*** = 180 m apart, as shown in figure. The velocity of the river with respect to the ground is 8 m/s due East. Find the direction of the motorboat velocity relative to the river if the time required to reach point **B** starting from point **A** is 30 s.




Define:
$v_{B/R}$ is the boat's velocity relative to the river,
$v_{B/G}$ is the boat's velocity relative to the ground, and
$v_{R/G}$ is the river's velocity relative to the ground,

$$t = \frac{d}{v_{B/G}} \Rightarrow v_{B/G} = \frac{d}{t} = \frac{180}{30} = 6\ \text{m/s}$$

$$\vec{v}_{B/G} = \vec{v}_{B/R} + \vec{v}_{R/g}$$

$$6\hat{j} = \vec{v}_{B/R} + 8\hat{i} \Rightarrow \vec{v}_{B/R} = -8\hat{i} + 6\hat{j}$$

Thus direction of $v_{B/R}$ is 53.13° W of N (36.87° N of W)