# Physics Department
# Physics 101

I

First Midterm Exam
Summer 2009
Thursday, July 16th, 2009
6:00 p.m. – 7:30 p.m.

Student's Name: ……..……..……..……

Student's Number: …..……MODEL ANSWER……

Choose your Instructor's Name:

Dr. Hala Al-Jassar
Dr. Adnan Al-Yaseen
Dr. Ashraf Zaher
Dr. Fatma Al-Dossari
Dr. Tareq Alrefae

Grades:

| # | Q1 | Q2 | Q3 | Q4 | P1 | P2 | P3 | P4 | P5 | P6 | Total / 16 | Total / 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.

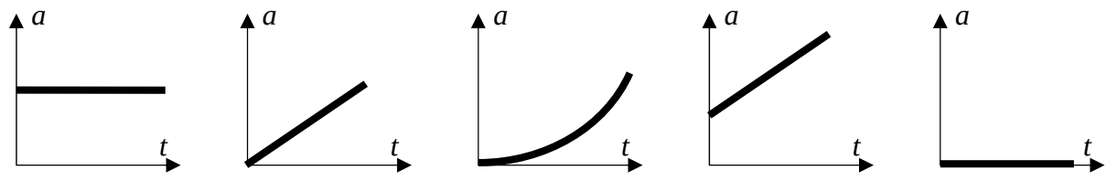
GOOD LUCK

# Part I: Questions (Choose the correct answer)

1. A vector of magnitude 20 is added to another vector of magnitude 25. Which of the following can be a valid answer for their sum?

(a) Zero.
(b) 3.
(c) **12.** ⟹ $\left|\left|\vec{A}\right|-\left|\vec{B}\right|\right| \le \left|\vec{A}+\vec{B}\right| \le \left|\vec{A}\right|+\left|\vec{B}\right|$
(d) 47.
(e) 500.

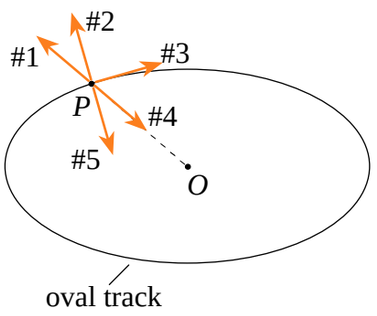
2. A particle is moving in a straight line, at a constant velocity of 20 m/s. Which of the following figures represents its motion?




(a) (b) (c) (d) **(e)**

Answer (e) as $a = 0$

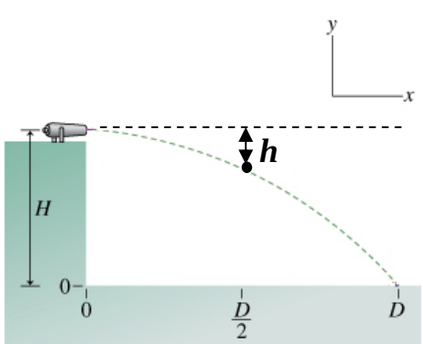
3. An object moves at a constant speed in a clockwise direction around an oval track. The geometrical center of the track is at point ***O***. When the object is at point ***P***, which arrow shows the direction of the object's acceleration vector?




(a) arrow **#1** (directly away from point *O*)
(b) arrow **#2** (perpendicular to the track)
(c) arrow **#3** (in the direction of motion)
(d) arrow **#4** (directly toward point *O*)
(e) **arrow #5 (perpendicular to the track)**

Answer (e) as $a$ must be perpendicular to $v$

4. A canon ball is fired horizontally from the top of a cliff at a height ***H*** as shown in figure. When the ball has travelled a distance ***D/2***, the value of ***h*** is:

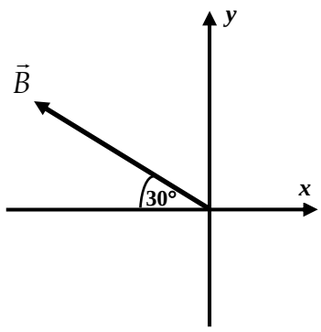



(a) ***H***/10.
(b) ***H***/5.
(c) ***H/4.***
(d) ***H***/3.
(e) ***H***/2.

Answer (c) as $y$ is proportional to $t^2$ while $x$ is proportional to $t$

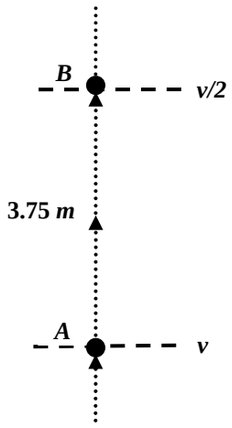
# Part II: Problems (solve the following problems)

1. Vector $\vec{B}$, shown in figure, has a magnitude of five. If vector $\vec{A} = 3\,\hat{i} + 6\,\hat{j}$, find the angle that vector $\vec{R} = \vec{B} - \vec{A}$ makes with the positive *x*-axis.




$$\vec{B} = -(5\cos 30^\circ)\,\hat{i} + (5\sin 30^\circ)\,\hat{j} = -4.33\,\hat{i} + 2.5\,\hat{j}$$
$$\vec{R} = \vec{B} - \vec{A} = (B_x - A_x)\,\hat{i} + (B_y - A_y)\,\hat{j}$$
$$= -7.33\,\hat{i} - 3.5\,\hat{j}$$
$$\theta = \tan^{-1}\frac{-3.5}{-7.33} = 180^\circ + \tan^{-1}\frac{3.5}{7.33} = 180^\circ + 25.5^\circ = 205.5^\circ$$

2. A stone is thrown vertically upward. On its way up, it passes point *A*, with speed *v*, and point *B*, 3.75 m higher than *A*, with speed *v*/2. Calculate the value of the speed *v* in m/s.

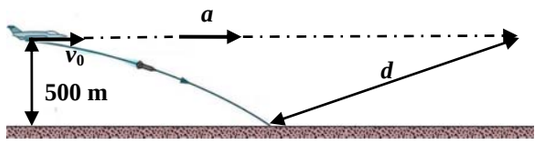



$$v^2 = v_0^2 - 2g\Delta y$$
$$(0.5v)^2 = v^2 - 2\times 10\times 3.75$$
$$0.25v^2 = v^2 - 75$$
$$0.75v^2 = 75 \Rightarrow v^2 = 100 \Rightarrow v = 10\,\text{m/s}$$

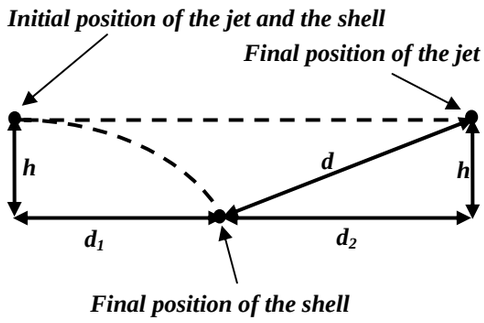
3. A particle, moving along the *x*-axis, has a position given by $x = 24t - 2t^3$, where *x* is in m, and *t* in s. What is the magnitude of the acceleration when the particle is momentarily at rest?

$$v = \frac{dx}{dt} = 24 - 6t^2$$
$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2} = -12t$$
$$\text{No motion} \equiv (v = 0) \Rightarrow 24 - 6t^2 = 0 \Rightarrow t = 2\,\text{s}$$
$$a = -12\times 2 = -24\,\text{m/s}^2 \Rightarrow |a| = 24\,\text{m/s}^2$$

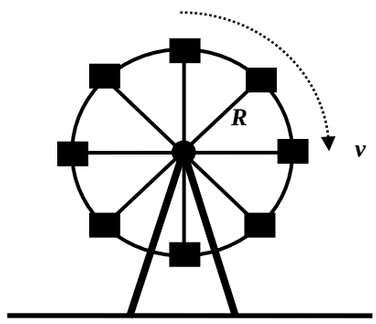
4. A fighter jet, flying horizontally at an altitude of 500 m, as shown in figure, drops a shell when its velocity was $v_0$ = 100 m/s and then accelerates away at a constant acceleration *a*. Find its minimum acceleration such that it will be at least at a distance ***d*** = 1300 m away from the position at which the shell hits the ground.




$$h = \frac{1}{2}gt^2 \Rightarrow 500 = 5t^2 \Rightarrow t = 10\,\text{s}$$
$$d_1 = v_0 t = 100 \times 10 = 1000\,\text{m}$$
$$d_2 = \sqrt{d^2 - h^2} = \sqrt{1300^2 - 500^2} = 1200\,\text{m}$$
$$d_1 + d_2 = v_0 t + \frac{1}{2}at^2 \Rightarrow 2200 = 1000 + 50a$$
$$\Rightarrow a = 24\,\text{m/s}^2$$

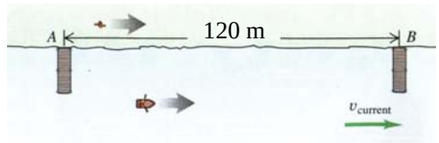



5. It is required to design a Ferris wheel, at an amusement park, such that it makes 6 revolutions per minute, while moving at a constant speed *v* = 3.14 m/s. Find the radius, *R*, of the Ferris wheel.




$$T = \frac{60}{6} = 10\,\text{s}$$
$$v = \frac{2\pi R}{T} \Rightarrow R = \frac{vT}{2\pi} \Rightarrow R = \frac{3.14 \times 10}{2\pi} \cong 5\,\text{m}$$

6. A man rowing a boat, at a constant velocity of 5 m/s relative to the water, makes a round trip from point *A* to *B* in the water, as shown in figure. The time taken to finish his round trip in the water is 15 s more than the time taken to make the same round trip on land when running at a constant velocity of 4 m/s relative to earth. Find the speed of the water, $v_{\text{current}}$, relative to earth.




$$t_{land} = \frac{2 \times 120}{4} = \frac{240}{4} = 60\,\text{s}$$
$$t_{water} = t_{land} + 15 = 60 + 15 = 75\,\text{s}$$
$$t_{land} = 75 = \frac{120}{5 + v_{current}} + \frac{120}{5 - v_{current}} = \frac{1200}{25 - v_{current}^2}$$
$$25 - v_{current} = 16 \Rightarrow v_{current} = 3\,\text{m/s}$$