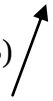
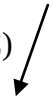
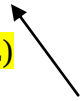
Exam #1 Physics 160-01

Name:_____ **Box #**_____

1) Given the two vectors drawn below, which answer best represents $3\vec{X} - 2\vec{Y}$?

A) 
B) 
C) 
D) 
E) 

2) Find the angle in degrees between the two vectors: $\vec{A} = -4\hat{i} + 2\hat{j} - 6\hat{k}$ and $\vec{B} = 2\hat{i} - 6\hat{j} + 1\hat{k}$.

A) 66.2^o
B) 108^o
C) $123.^o$
D) 1.98^o
E) 114^o

$$\vec{A}\cdot\vec{B} = \left|\vec{A}\right|\left|\vec{B}\right|\cos\theta = A_xB_x + A_yB_y + A_zB_z \Rightarrow$$

$$\theta = \cos^{-1}\left[\frac{A_xB_x + A_yB_y + A_zB_z}{\left|\vec{A}\right|\left|\vec{B}\right|}\right]$$

$$= \cos^{-1}\left[\frac{(-4)\cdot(2) + (2)\cdot(-6) + (-6)\cdot(1)}{\sqrt{(-4)^2 + (2)^2 + (-6)^2}\sqrt{(2)^2 + (-6)^2 + (1)^2}}\right]$$

$$= \cos^{-1}\left[\frac{-26}{47.9}\right]$$

$$= 123^o$$

3) A test rocket is fired straight up from rest with a net acceleration of 20 m/s^2. After 4 seconds, the engine turns off, but the rocket continues to coast upward. What maximum elevation does the rocket reach?

A) 327. m
B) 408. m
C) 160. m
D) 487. m
E) 320. m

This is a 1-D problem but with two time periods:
y_o=0m,
y_f=?m,
v_{oy}=0m/s,
v_{fy}=?m/s,
a_y=20m/s^2,
t=4s
First solve for the height and velocity after the acceleration:
$y_f=y_o+v_{oy}t+1/2a_yt^2$ => y_f=160m, $v_{fy}= v_{oy} + a_yt$ => v_{fy}=80m/s,
then look at next phase:
y_o=160m,
y_f=?m,
v_{oy}=80m/s,
v_{fy}=0m/s,
a_y=-9.8m/s^2,
t=?.

$v_{fy}= v_{oy} + a_yt$ => t = 8.2s
$y_f=y_o+v_{oy}t+1/2a_yt^2$ => y_f=487m.

4) An arrow is shot horizontally (in the positive x-direction) from the top of a building at a speed of 20.0 m/s. The arrow strikes the ground at a point 100m horizontally from the base of the building. What is the height of the building?

A) 122. m
B) 137. m
C) 98.0 m
D) 100. m
E) 60.0 m

This is a 2-D problem and must be analyzed in each dimension.
In the x- direction,
x_o=0m,
x_f=100m,
v_{ox}=20.0m/s,
$v_{fx}=v_{ox}$,
a_x=0m/s^2,
t=?.
In the y- direction,
y_o=?,
y_f=0m,
v_{oy}=0m/s,
v_{fy}=?,
a_y=-9.8m/s^2,
t=?.
To get the initial height we need to know the time (since the velocity in the x-direction is constant, and we know the distance), so look in the x-direction, we use $x_f=x_o+v_{ox}t+1/2a_xt^2$, with a_x=0 => t=5s.

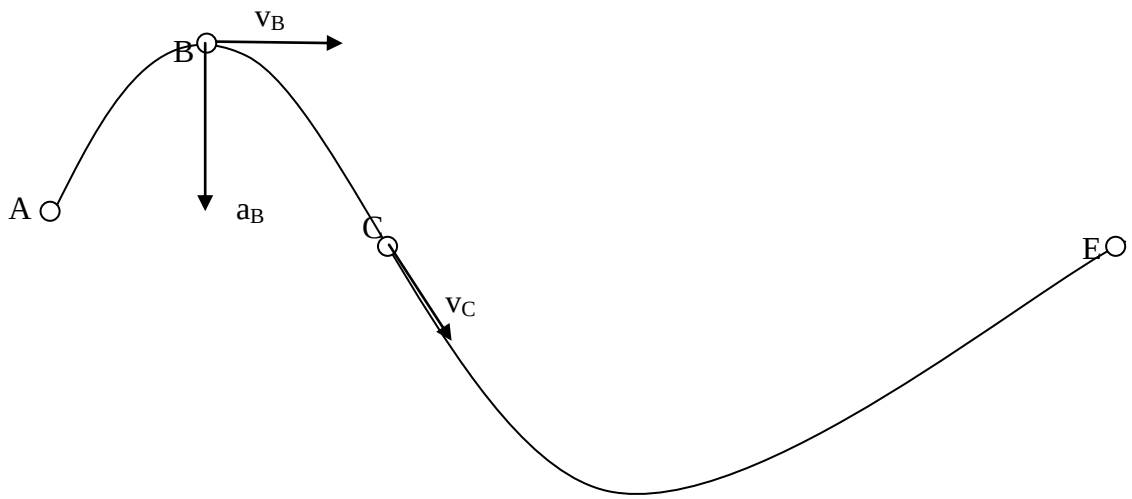
Then in the y-direction and use $y_f=y_o+v_{oy}t+1/2a_yt^2$ => y_0=122m.

5) A person is swimming across a river that is 300 m wide. They swim at a constant speed relative to the water of 0.3 m/s and in a direction straight across the river (perpendicular to the flow of water). When they reach the opposite shore, they notice that they have drifted 500 m downstream. What was the speed of the water relative to the ground?

A) 0.20 m/s
B) 0.50 m/s
C) 0.36 m/s
D) 0.18 m/s
E) 0.26 m/s

The swimmer covers the 300 m in 1000 s. In that same time, the river brings them downstream 500 m, so the river is flowing at 0.5 m/s.

An object moves along the track shown in the top-view diagram below. The object moves from point A to point E with constant speed.



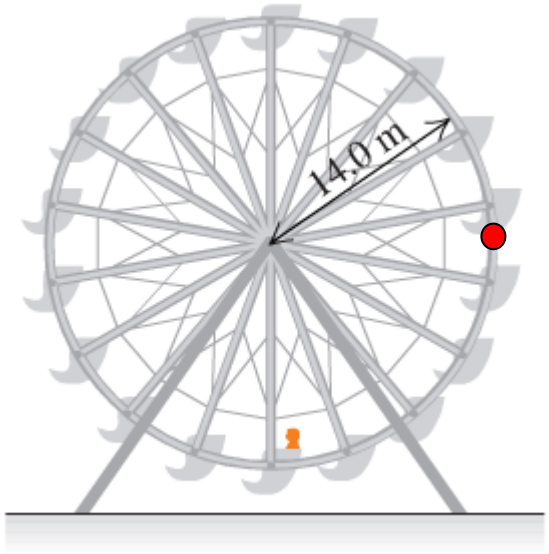
6) Which choice best represents the acceleration vector of the object at point B?

A)  B)  C)  D) E) Zero.

7) Which choice best represents the acceleration vector of the object at point C?

A)  B)  C)  D) E) Zero.

A person riding on a Ferris Wheel of radius 14.0 m. It takes 20s for the rider to all the way around the wheel.



8) At the middle point on the right, indicated by the circle, which choice best represents his acceleration?

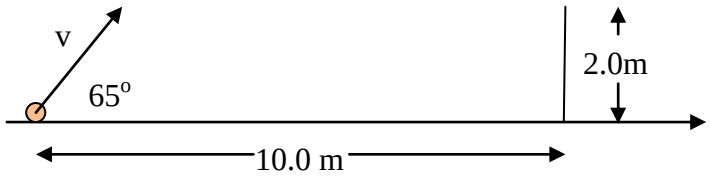
A)  B)  C)  D) E) Zero.

9) What is the magnitude of his acceleration?

A) 4.40 m/s^2
B) 1.38 m/s^2
C) 11.2 m/s^2
D) 9.9 m/s^2
E) 8.5 m/s^2

Since it is constant speed, the acceleration of the rider is given by a radial component, $a_R=v^2/r$. The velocity is given by the distance over the time, in this case the circumference of his path over the period: v = 2pir = 4.4m/s. Then a_R = 1.38m/s^2 .

10) A child wants to kick a ball a horizontal distance of 10.0 m over a fence 2.0 m high. They kick the ball at an angle of 65° above the horizontal. At what speed should they kick the ball so that it ***just*** passes over the fence?



A) 11.9 m/s
B) 12.7 m/s
C) 14.3 m/s
D) 15.6 m/s
E) 18.1 m/s

y_o=0m,
y_f=2.0m,
v_{oy}=vsin65 m/s,
v_{fy}=?,
a_y=-9.8m/s^2,
t=?.

and

x_o=0m,
x_f=10.0m,
v_{ox}=vcos65 m/s,
v_{fx}= " ,
a_x=0 m/s^2,
t=?.

From the x-data, we can get that 10.0 m = v cos(65) t and then solve for t and substitute back into the equation of motion in the y-direction:

$$t = \frac{10.0m}{v\cos(65)}$$

$$y_f = y_0 + v\sin(65)t + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)t^2 \Rightarrow$$

$$2.0m = 0m + v\sin(65)\left(\frac{10.0m}{v\cos(65)}\right) - 4.9\frac{m}{s^2}\left(\frac{10.0m}{v\cos(65)}\right)^2 \Rightarrow$$

$$2.0m - 10.0m\tan(65) = -4.9\frac{m}{s^2}\left(\frac{10.0m}{v\cos(65)}\right)^2 \Rightarrow$$

$$19.4m = \frac{2743\frac{m^3}{s^2}}{v^2} \Rightarrow v = 11.9\frac{m}{s}$$