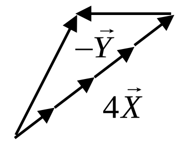
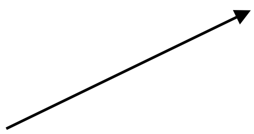
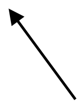
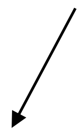
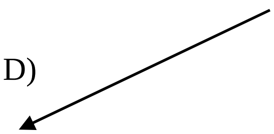
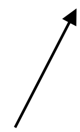
Exam #1   Physics 160-01

Name:______________________________ **Box #**________________

1) Given the two vectors drawn below, which answer best represents $4\vec{X}-\vec{Y}$?



A)  B)  C)  D)  E) 

2) Find the angle in degrees between the two vectors: $\vec{A}=2\hat{i}-4\hat{j}+6\hat{k}$ and $\vec{B}=3\hat{i}+6\hat{j}+1\hat{k}$.

A) 66.2°
B) 108°
C) 123.°
D) 1.98°
E) 114°
F) 46.4°
G) 73.2°
H) 83.0°
I) 10.9°
J) 76.3°
K) 103.7

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

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

$$=\cos^{-1}\left[\frac{(2)\cdot(3)+(-4)\cdot(6)+(6)\cdot(1)}{\sqrt{(2)^2+(-4)^2+(6)^2}\sqrt{(3)^2+(6)^2+(1)^2}}\right]$$

$$=\cos^{-1}\left[\frac{-12}{50.75}\right]$$

$$=103.7^{o}$$

3) The position of a car, in meters, is given by the equation:
$x = (4.0\,m/s)\cdot t + (2.3\,m/s^3)t^3 - 8.0m$. What is the instantaneous velocity at time t = 2s?

A) 4.0m/s
B) 28m/s
C) 8.8m/s
D) 11m/s
E) 6.9m/s
F) 32m/s
G) 18m/s
H) 4.6m/s
I) 8.6m/s
J) 6.1m/s

To get the instantaneous velocity, you first have to take the first derivative of the position function:

$$x = (4.0\,m/s)\cdot t + (2.3\,m/s^3)t^3 - 8.0m \Rightarrow$$

$$\frac{dx}{dt} = (4.0\,m/s) + 3(2.3\,m/s^3)t^2$$

and then put in t=2s:

$$\left.\frac{dx}{dt}\right|_{t=2} = (4.0\,m/s) + 3(2.3\,m/s^3)(2s)^2 = 31.6\,m/s$$

4) A test rocket is fired straight up from rest with a net acceleration of 30 m/s^2. After 2 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
F) 244. m
G) 184. m
H) 90.8 m
I) 1230. m
J) 54.5 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=30m/s^2,
t=2s
First solve for the height and velocity after the acceleration:
$y_f=y_o+v_{oy}t+1/2a_yt^2$ => y_f=60m, $v_{fy}= v_{oy} + a_yt$ => v_{fy}=60m/s,
then look at next phase:
y_o=60m,
y_f=?m,
v_{oy}=60m/s,
v_{fy}=0m/s,
a_y=-9.8m/s^2,
t=?.

$v_{fy}= v_{oy} + a_yt$ => t = 6.12s
$y_f=y_o+v_{oy}t+1/2a_yt^2$ => y_f=244m.

5) An arrow is shot horizontally (in the positive x-direction) from the top of a building at a speed of 25.0 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) 87.8 m
B) 78.4 m
C) 98.0 m
D) 100. m
E) 60.0 m
F) 122. m
G) 137. m
H) 108. m
I) 44.4 m
J) 67.1 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=4s.

Then in the y-direction and use $y_f=y_o+v_{oy}t+1/2a_yt^2$ => y_0=78.4m.

6) A person is swimming across a river that is 300 m wide. They swim at a constant speed relative to the water of 0.6 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 and direction of the swimmer relative to the earth?

A) 0.98 m/s @ 48^o downstream of across
B) 1.17 m/s @ 59^o downstream of across
C) 1.36 m/s @ 67^o downstream of across
D) 1.28 m/s @ 48^o downstream of across
E) 0.86 m/s @ 38^o downstream of across
F) 1.22 m/s @ 53^o downstream of across
G) 1.17 m/s @ 31^o downstream of across
H) 1.36 m/s @ 23^o downstream of across
I) 1.28 m/s @ 42^o downstream of across
J) 0.86 m/s @ 52^o downstream of across

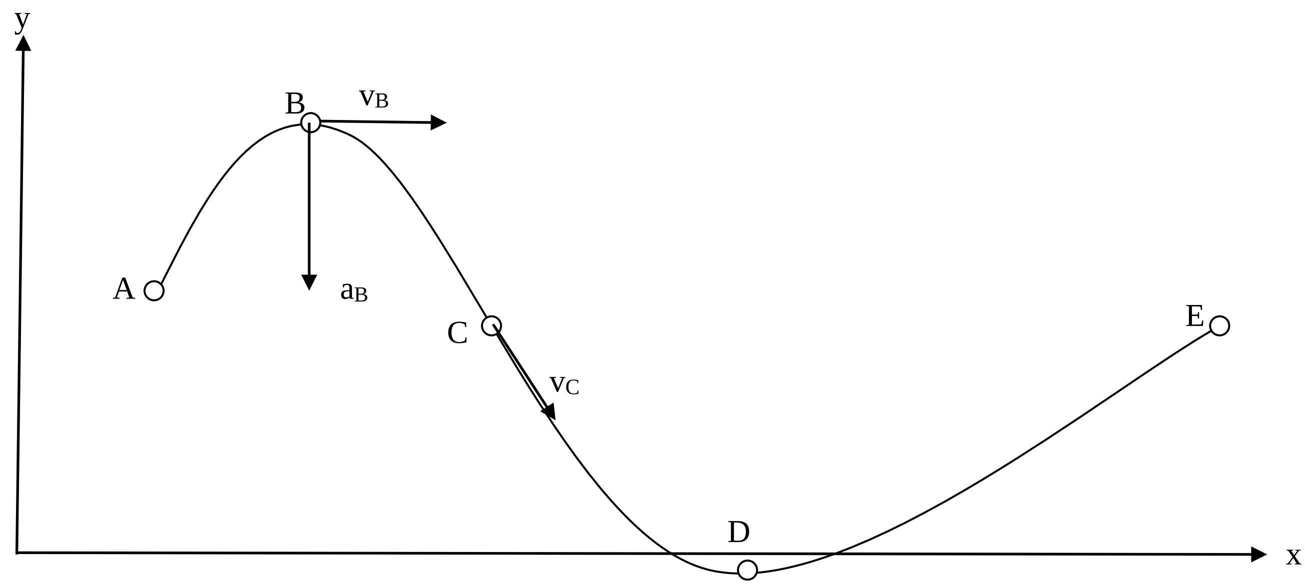
The perpendicular (to the water) speed of the swimmer is 0.6m/s and they travel the 300 m (in that direction), so it takes them 500s. In that same time, the river brings them downstream 500 m, so the river is flowing at 1 m/s. So, their velocity relative to earth is

$\vec{v}_{S/E} = \vec{v}_{S/W} + \vec{v}_{W/E} = 0.6\, m/s\ \hat{i} + 1.0\, m/s\ \hat{j}$,

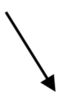
where the x direction is across the river and the y direction is downstream.

The speed is then the magnitude of the velocity: 1.17m/s and the direction is 59^o downstream of straight across.

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.



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

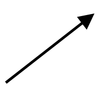
A) 

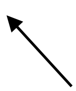
B) 

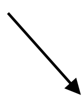
C) 

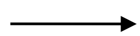
D) 

E) Zero.

F) 

G) 

H) 

I) 

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

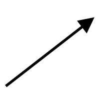
A) 

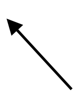
B) 

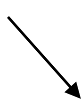
C)

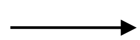
D)

E) Zero.

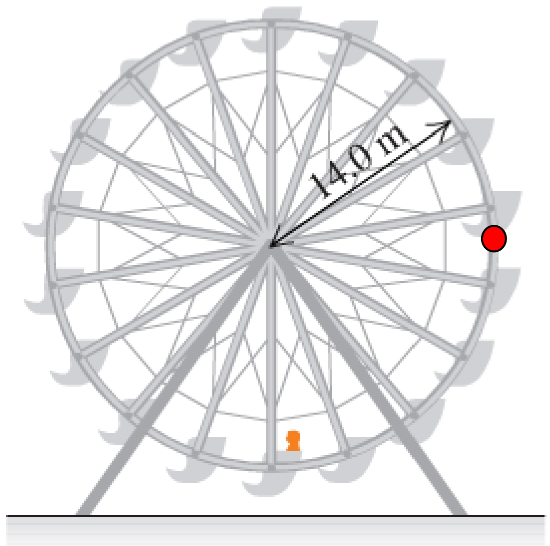
F) 

G) 

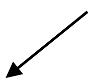
H) 

I) 

A person riding on a Ferris Wheel of radius 14.0 m. It takes 40s for the rider to all the way around the wheel at a constant speed.



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

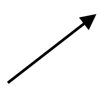
A) 

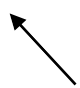
B) 

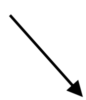
C) 

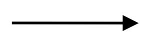
D) 

E) Zero.

F) 

G) 

H) 

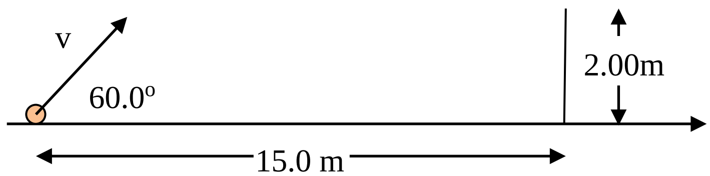
I) 

10) What is the magnitude of his acceleration?

A) 4.40 m/s^2
B) 0.44 m/s^2
C) 11.2 m/s^2
D) 9.80 m/s^2
E) 0.34 m/s^2
F) 1.40 m/s^2
G) 1.18 m/s^2
H) 0.20 m/s^2
I) 2.43 m/s^2
J) 8.51 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: $v = 2\pi r/T = 2.20$ m/s. Then $a_R = 0.34 m/s^2$.

11) A child wants to kick a ball a horizontal distance of 15.0 m over a fence 2.0 m high. They kick the ball at an angle of 60º 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
F) 9.95 m/s
G) 8.73 m/s
H) 13.6 m/s
I) 17.0 m/s
J) 10.6 m/s

y_o=0m,
y_f=2.0m,
v_{oy}=vsin(60)m/s,
v_{fy}=?,
a_y=-9.8m/s^2,
t=?.

and

x_o=0m,
x_f=15.0m,
v_{ox}=vcos(60)m/s,
v_{fx}= " ,
a_x=0 m/s^2,
t=?.

From the x-data, we can get that: 15.0 m = v cos(60) t and then solve for t and substitute back into the equation of motion in the y-direction:

$$t = \frac{15.0m}{v\cos(60)}$$

$$y_f = y_0 + v\sin(60)t + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)t^2 \Rightarrow$$

$$2.0m = 0m + v\sin(60)\left(\frac{15.0m}{v\cos(60)}\right) - 4.9\frac{m}{s^2}\left(\frac{15.0m}{v\cos(60)}\right)^2 \Rightarrow$$

$$2.0m - 15.0m\tan(60) = -4.9\frac{m}{s^2}\left(\frac{15.0m}{v\cos(60)}\right)^2 \Rightarrow$$

$$23.9m = \frac{4410\frac{m^3}{s^2}}{v^2} \Rightarrow v = 13.6\frac{m}{s}$$