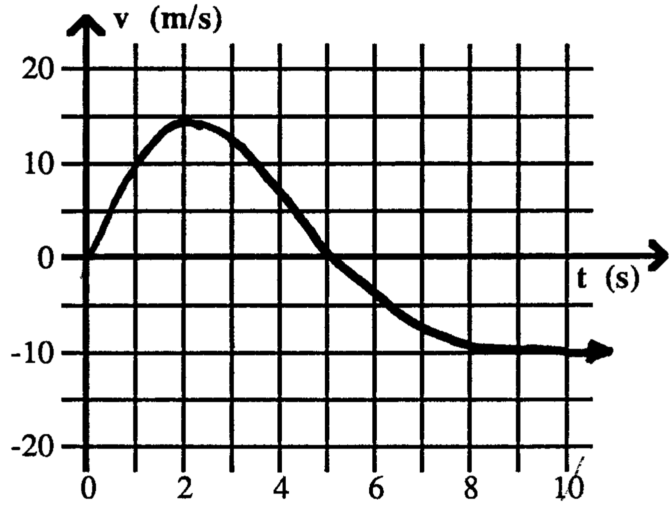
Name:____

Solve the following problems in the space provided. Use the back of the page if needed. Each problem is worth 20 points. You must show your work in a logical fashion starting with the correctly applied physical principles shown on the last page. Your score will be maximized if your work is easy to follow because partial credit will be awarded.

1. The velocity of an object as a function of time is shown in the graph at the right. Answer the following questions about the object's motion. Be sure to explain your reasoning for full credit.



(a)When is the velocity a maximum?
Reading the graph, the velocity peaks at
t = 2.0s.

(b)What is the maximum velocity?
Reading the graph, the peak velocity is
v = 15m/s.

(c)When is the velocity zero?
Reading the graph, the velocity is zero at
t = 0s and at t = 5.0s.

(d)When is the acceleration zero?
According to the definition of acceleration, the acceleration is the slope of the graph so, the acceleration is zero at
t = 2.0s and from about t = 8.0s to 10s.

(e) When is the acceleration a maximum?
The acceleration is maximum when the slope is the largest. This is near t = 0s.

(f)What is the maximum acceleration?
Using the definition of acceleration and applying it near t = 0s,

$$a \equiv \frac{\Delta v}{\Delta t} \approx \frac{10-0}{1-0} \qquad \boxed{a \approx 10 m/s^2}.$$

(g)When is the object the farthest away from its starting point?
According to the definition of velocity, the distance traveled is the area under the curve. The area is the largest when the velocity goes the zero at about t = 5.0s.

(h)How can you tell if the object will ever return to its starting point?
The distance traveled is the area under the curve. When the area above the curve from t = 0s to t = 5.0s is equal to the "negative area" from 5.0s onward then the object will be back at its starting point. This probably doesn't happen until after t = 10s.

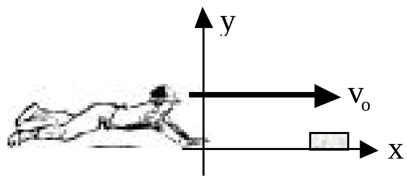
2. A runner stealing second base is running at 8.00m/s. Second base is 2.00m away. (a)Find the time for the runner to get to second base assuming she continues running at the same speed. (b)Find the time for the runner to get to second base if she uses a slide to decelerate uniformly to rest right at the base.

(a)If the speed is constant, then we can just use the definition of velocity,

$v \equiv \frac{\Delta x}{\Delta t} = \frac{x}{t} \qquad t = \frac{x}{v} = \frac{2.00}{8.00} \qquad \boxed{t = 0.250s}.$

(b)If the acceleration is constant we need to use the kinematic equations,

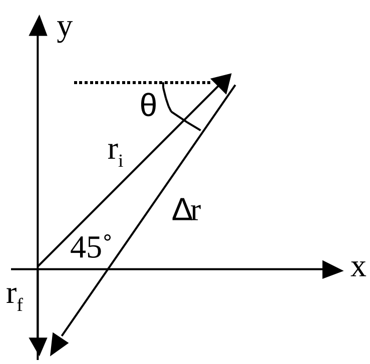
$x_o = 0m$
$x = 2.00m$
$v_o = 8.00m/s$
$v = 0m/s$
$a = ?$
$t = ?$



Using the kinematic equation without the acceleration,

$\frac{x - x_o}{t} = \frac{1}{2}(v_o + v) \qquad t = \frac{2(x - x_o)}{v_o + v} = \frac{2(2.00 - 0)}{8.00 - 0} \qquad \boxed{t = 0.500s}.$

3. A golf ball is resting 3.20m northeast of the hole. The golfer putts it and it comes to rest 0.400m due south of the hole. Find the displacement (magnitude and direction) of the golf ball caused by this putt.



Resovle the vectors into components,

$\vec{r}_i = 3.20\cos 45^\circ \hat{i} + 3.20\sin 45^\circ \hat{j} = 2.26\hat{i} + 2.26\hat{j}$

$\vec{r}_f = -0.400\hat{j}$

Use the definition of displacement,

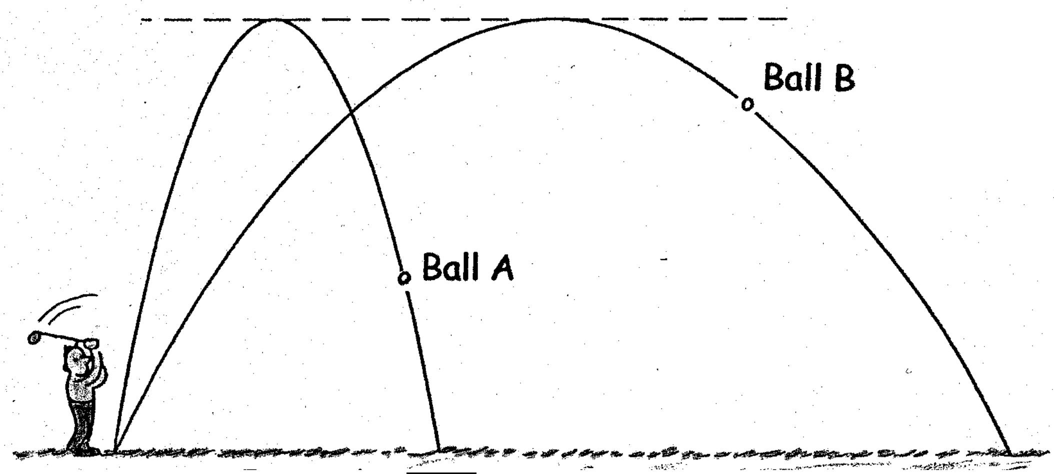
$\Delta\vec{r} \equiv \vec{r}_f - \vec{r}_i = (0 - 2.26)\hat{i} + (-0.400 - 2.26)\hat{j}$

$\Delta\vec{r} = -2.26\hat{i} - 2.66\hat{j}$.

Use the Pythagorean Theorem, $r = \sqrt{2.26^2 + 2.66^2} \qquad \boxed{r = 3.49m}.$

Use the definition of tangent, $\theta = \arctan\frac{-2.66}{-2.26} = \arctan(1.18) \qquad \boxed{\theta = 49.6^\circ}$ south of west.

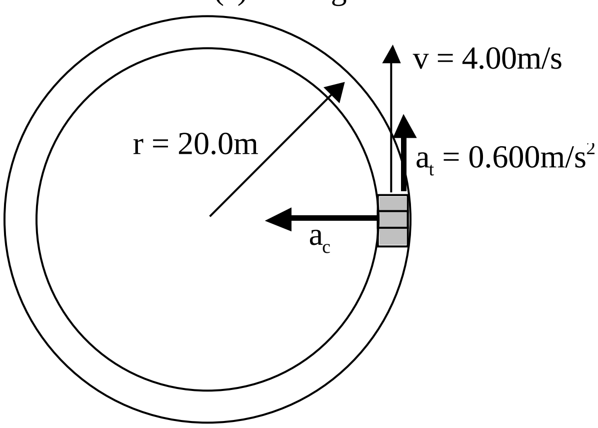
4. Pictured below are two possible trajectories of a golf shot. (a)State which shot will stay in the air the longest and (b)which will have the higher launch speed. Completely explain your reasoning for full credit.



(a)Both balls will remain in the air the **same** amount of time. Since they both go up to the same height and the vertical motion of a projectile is independent of the horizontal motion. The time in the air doesn't depend upon the horizontal motion, only the vertical motion.

(b)**Ball B** had the higher launch speed. Since they go to the same height, they both must have had the same vertical component of the initial velocity. Since ball B goes the furthest horizontally, it must have had the higher horizontal component. Adding the components of these vectors will give a higher launch speed for B.

5. A car whose speed is increasing at a uniform rate of $0.600 m/s^2$ travels along a curved road that forms a circle of radius 20.0m. At some point along the curve the car has an instantaneous speed of 4.00m/s. Find (a)the tangential component of the acceleration and (b)the radial component of the acceleration and (c)the magnitude of the total acceleration.



(a)The rate at which the speed is increasing is the tangential component of the acceleration, $\boxed{a_t = 0.600 m/s^2}$.

(b)The radial component is the centripetal acceleration,

$$a_c = \frac{v^2}{r} = \frac{(4.00)^2}{20.0} \qquad \boxed{a_c = 0.800 m/s^2}.$$

(c)Adding the vectors using the Pythagorean Theorem,

$$a = \sqrt{a_c^2 + a_t^2} = \sqrt{(0.800)^2 + (0.600)^2} \qquad \boxed{a = 1.00 m/s^2}.$$