Part I

1. Two footballs are kicked at the same angle above the horizontal but one leaves the ground with twice the speed. The faster one will travel

   (a) twice as high and twice as far.

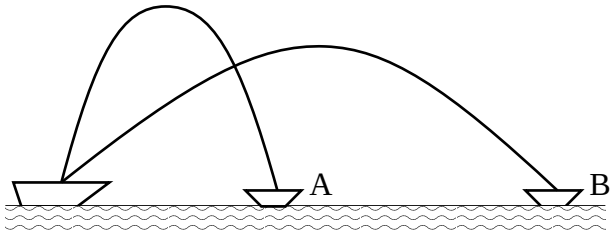
   (b) twice as high and four times as far.

   (c) four times as high and twice as far.

   (d) four times as high and four times as far.

   Answer: (d). The ball travels twice as fast in the vertical direction so it is in the air twice as long. Twice as fast and twice as long means that the ball travels four times as high and far.

2. A ship simultaneously tosses two water balloons at enemy boats. If the balloons follow the parabolic trajectories shown, which boat gets hit first?



   (a) A; (b) B; (c) both at the same time; (d) need more information.
   Answer: (b). Balloon B travels higher and therefore is in the air longer.

3. A projectile is launched at an angle above the horizontal and follows a parabolic trajectory reaching a maximum height at point P. If air friction is negligible which of the following statements about point P is correct?

   (a) The horizontal component of both velocity and acceleration are zero.

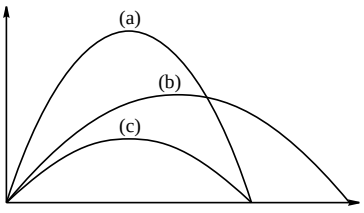
   (b) The vertical component of both velocity and acceleration are zero.

   (c) The horizontal component of velocity and the vertical component of acceleration are zero.

   (d) The vertical component of velocity and the horizontal component of acceleration are zero.

   Answer: (d). The horizontal component of acceleration is zero since gravity acts in the vertical direction only. The horizontal component of velocity is constant and not zero, but at the maximum height the vertical component is momentarily zero.

4. Three projectiles (a) (b) and (c) are launched with the same speed. Rank the the projectiles in order of increasing horizontal velocity.

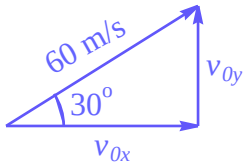


   Answer: (a) then (b) then (c). Since the speed is the same then then the increasing horizontal component of velocity corresponds to decreasing launch angle.

Part II

1. A golf ball is hit and leaves the ground at a 30^o angle above the horizontal with a velocity of 60 m/s. Sadly the ball strikes a tree which is in its path 50 m away and drops straight to the ground.

   (a) Find the horizontal and vertical components of the initial velocity.



$v_{0x} = 60\cos 30 = 52$ m/s

$v_{0y} = 60\sin 30 = 30$ m/s

   (b) How long was the ball in the air before it hit the tree?

   In the horizontal direction there is uniform motion so $\Delta x = v_x t \Rightarrow t = 50/52 = 0.96$ s

   (c) How high up the tree did the ball hit?

   How high up the tree is a vertical displacement $\Delta y = v_{0y}t + \frac{1}{2}a_y t^2 = 30(0.96) - \frac{1}{2}(9.8)(0.96)^2 = 24m$

   So it hits the tree 24 m up the tree.

   (d) With speed did the ball hit the tree? (careful: speed is the magnitude of the velocity vector)

   $v = \sqrt{v_x^2 + v_y^2}$ The horizontal component of velocity is constant so $v_x = 52$ m/s. The vertical component of velocity changes according to $v_y = v_{0y} + a_y t = 30 - 9.8 \times 0.96 = 20.6$ m/s. So $v = \sqrt{(52)^2 + (20.6)^2} = 56$ m/s

   (e) How far would the ball have traveled if the tree had not been in the way?

   $\Delta x = v_x t$ where t is the time it takes the ball to go up and down – ie when vertical displacement is zero. So $\Delta y = v_{0y}t + \frac{1}{2}a_y t^2 \Rightarrow 0 = 30t + \frac{1}{2}(-9.8)t^2 = t(30 - 4.9t)$

   $\Rightarrow t = 30/4.9 = 6$ s $\Rightarrow \Delta x = 52 \times 6 = 320$ m. So the ball would have traveled 320 m.