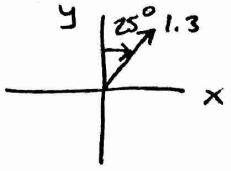
MULTIPLE CHOICE QUESTIONS

1. A vector has a magnitude of 1.3 and makes an angle of 25^o clockwise from the $+y$ axis. With the correct sign, what is the x-component of the vector?

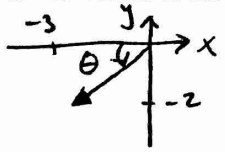
   (a) 0.55
   (b) 1.18
   (c) -0.55
   (d) -1.18



y-component:
$+1.3\cos 25^\circ = 1.18$

2. A vector has an x component of -3 and a y component of -2. Which of the following angles correctly describes the direction of this vector?

   (a) 34^o counter-clockwise from the $+x$ axis
   (b) 56^o counter-clockwise from the $+x$ axis
   (c) 34^o counter-clockwise from the $-x$ axis
   (d) 56^o counter-clockwise from the $-x$ axis



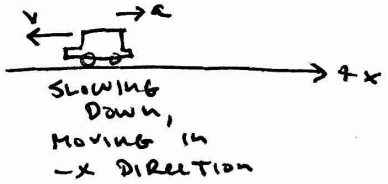
$\theta = \tan^{-1}\left|\frac{-2}{-3}\right| = 34^\circ$
COUNTER-CLOCKWISE FROM $-x$ AXIS

3. The equations for kinematics can only be used under which condition(s)?

   (a) Constant velocity
   (b) Constant velocity and constant acceleration
   (c) Constant acceleration
   (d) They can be used under any condition

4. A car's velocity points in the $-x$ direction, and has an acceleration in the $+x$ direction. Which of the following is true?

   (a) The car moves in the $+x$ direction and speeds up
   (b) The car moves in the $+x$ direction and slows down
   (c) The car moves in the $-x$ direction and speeds up
   (d) The car moves in the $-x$ direction and slows down



5. If a question were to state "A car speeds up at 5 m/s^2..." the number 5 is what type of quantity?

   (a) Displacement
   (b) Initial velocity
   (c) Final velocity
   (d) Acceleration

↑ ACCELERATION

6. Which of the following statements is always true about the peak of a projectile's trajectory?

   (a) The velocity is zero
   (b) The vertical velocity is zero
   (c) The horizontal velocity is zero
   (d) The acceleration is zero

HORIZONTAL VELOCITY DOESN'T CHANGE, BUT VERTICAL VELOCITY GOES TO ZERO.

ONLY X-DIRECTION

7. An object accelerates with $\vec{a} = (3.2\ \text{m/s}^2)\hat{i} - (1.5\ \text{m/s}^2)\hat{j}$. After 2s, what is the object's horizontal displacement?

   (a_x $\quad$ a_y)

   (a) 1.5m
   (b) 3.0m
   (c) 3.2m
   (d) 6.4m

$\Delta x = v_{0x}\cancel{t^0} + \frac{1}{2}a_x t^2 = \frac{1}{2}(3.2)(2)^2 = 6.4\text{m}$

8. A projectile moves through the air in the shape of a parabola. Which of the following statements is true about this motion?

   (a) The motion is always symmetric, due to being parabolic
   (b) The motion is symmetric, but only if the projectile starts and ends at the same height
   (c) The motion is symmetric, but only if the projectile is launched at 45°
   (d) The motion is never symmetric

9. An 5kg object at rest on a surface experiences a weight downwards of 49N, and an equal normal force of 49N upwards. These forces form an action-reaction pair as defined by Newton's third law.

   (a) True
   (b) False (BOTH ACT on SAME OBJECT.)

10. Newton's first law states:

    (a) An object will remain in its current state of motion unless acted upon by a force (2ND LAW)
    (b) The net force on an object is equal to the mass of the object multiplied by its acceleration
    (c) For any force one object could put on another, the other must put an equal and opposite force back on the first (3RD LAW)
    (d) None of the above

FREE-RESPONSE PROBLEMS

1. Consider two vectors: $\vec{A}$ has a magnitude of 2 and makes an angle of 50° clockwise from the $+x$ axis, and $\vec{B}$ has a magnitude of 5 and makes an angle of 30° counter-clockwise from the $+y$ axis.

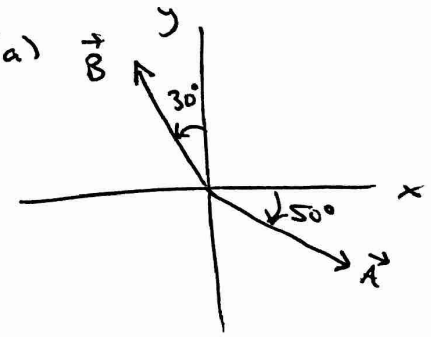
   a) Give both $\vec{A}$ and $\vec{B}$ in component form.

   b) Find the vector $-\vec{A} + 3\vec{B}$, and give it in vector notation.

   c) What is $\vec{A} \cdot \vec{B}$?

   d) What is $\vec{A} \times \vec{B}$?

(a)



$A_x = 2\cos 50 = 1.29$
$A_y = 2\sin 50 = 1.53$
$\vec{A} = 1.29\hat{i} - 1.53\hat{j}$

$B_x = 5\sin 30 = 2.5$
$B_y = 5\cos 30 = 4.33$
$\vec{B} = -2.5\hat{i} + 4.33\hat{j}$

(b) $-\vec{A} + 3\vec{B} = -(1.29\hat{i} - 1.53\hat{j}) + 3(-2.5\hat{i} + 4.33\hat{j})$

$= (-1.29 - 7.5)\hat{i} + (1.53 + 12.99)\hat{j}$

$= \boxed{-8.79\hat{i} + 14.52\hat{j}}$

(c) $\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z = (1.29)(-2.5) + (-1.53)(4.33) + (0)(0)$

$= \boxed{-9.85}$

(d) $\vec{A} \times \vec{B} = (1.29\hat{i} - 1.53\hat{j}) \times (-2.5\hat{i} + 4.33\hat{j}) = 5.59(\hat{i} \times \hat{j}) + 3.82(\hat{j} \times \hat{i})$

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{i} = -\hat{k}$

$= \boxed{-1.77\hat{k}}$

2. An object moves with the following position as a function of time:

$$x(t) = -(5\ \text{m/s}^3)t^3 + (2\ \text{m/s})t + 4\text{m}$$

a) What is the initial velocity of the object?

b) What is the displacement of the object from $t = 1\text{s}$ to $t = 3\text{s}$?

c) What is the average velocity of the object during the same time interval?

d) What is the average acceleration of the object during the same time interval?

(a) $v(t) = \frac{dx}{dt} = -2(5\,m/s^3)t^2 + (2\,m/s)$

$= -(10\,m/s^3)t^2 + 2\,m/s$

INITIAL VELOCITY IS AT $t=0$, SO:

$v_0 = v(0) = -(10\,m/s^3)(0) + 2\,m/s$

$= \boxed{2\,m/s}$

(b) $x(1s) = -(5)(1)^3 + (2)(1) + 4 = 1m$

$x(3s) = -(5)(3)^3 + (2)(3) + 4 = -125m$

$\Rightarrow \Delta x = x_f - x_i = (-125) - (1) = \boxed{-126m}$

(c) $v_{AV} = \frac{\Delta x}{\Delta t} = \frac{(-126)}{(3-1)} = \boxed{-63\,m/s}$

(d) $a_{AV} = \frac{\Delta v}{\Delta t}$, Δt IS STILL $3s - 1s = 2s$. USE $v(t)$ TO FIND Δv.

$v(1s) = -(10)(1)^2 + 2 = -8\,m/s$

$v(3s) = -(10)(3)^2 + 2 = -88\,m/s$

$\Rightarrow a_{AV} = \frac{\Delta v}{\Delta t} = \frac{(-88) - (-8)}{(2)} = \frac{-80}{2} = \boxed{-40\,m/s^2}$

$v_{0x} = 40\cos 37 = 31.9\ m/s$

$v_{0y} = 40\sin 37 = 24.1\ m/s$

3. A projectile is launched with an initial speed of 40 m/s at a launch angle of 37° from a building of height of 5m above the ground.

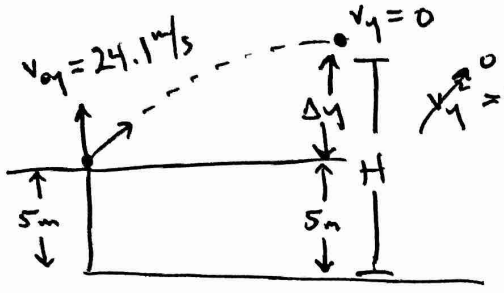
a) What is the maximum height of the projectile above the ground?

b) How long does it take the projectile to reach the maximum height?

c) How long is the projectile in the air for?

d) What is the range of the projectile?

(a)



$v_y^2 = v_{0y}^2 + 2a_y\Delta y \Rightarrow \Delta y = \frac{-v_{0y}^2}{2a_y} = -\frac{(24.1)^2}{2(-9.8)}$

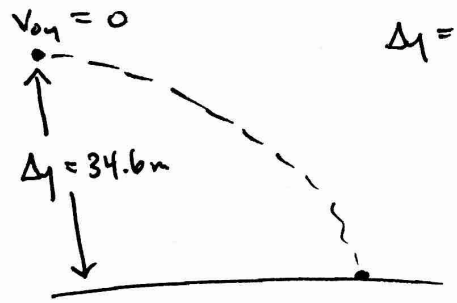
$= 29.6m$

$H = \Delta y + 5m = 29.6 + 5$

$= \boxed{34.6m}$

(b) $v_y = v_{0y} + a_y t_{up} \Rightarrow t_{up} = \frac{-v_{0y}}{a_y} = \frac{-(24.1)}{(-9.8)} = \boxed{2.46s}$

(c) DROPPING DOWN,



$\Delta y = v_{0y}t + \frac{1}{2}a_y t^2$

$\Rightarrow t_{down} = \frac{2\Delta y}{a_y} = \frac{2(34.6)}{(9.8)} = 7.06s$

TOTAL TIME OF FLIGHT:

$t_F = t_{up} + t_{down} = 2.46 + 7.06$

$= \boxed{9.52s}$

(d) RANGE: HORIZONTAL DISTANCE TRAVELLED.

SINCE $a_x = 0$, $\Delta x = v_{0x}t$

$\Rightarrow R = v_{0x}t_F = (31.9)(9.52) = \boxed{304m}$

4. A 4.7kg box is pulled to the right along a rough floor by a horizontal rope. While the box moves, the floor is putting a friction force on the box of 23N.

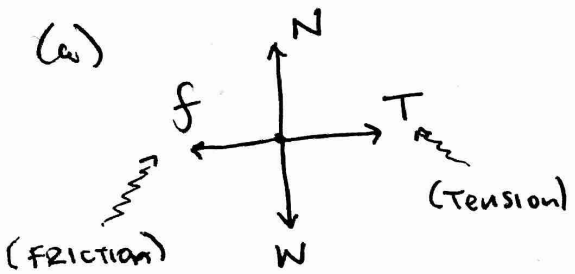
a) Draw the free body diagram of object

b) If the box moves with a constant velocity, what would be the tension in the rope pulling it?

c) If the box accelerates at 2.5 m/s^2, what would be the tension in the rope pulling it?

d) Suppose that the tension in the rope was 50N. How far would the box travel after 1.5s of pulling it?

(a)

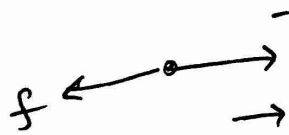


(b) IF VELOCITY IS CONSTANT, THEN $a=0 \Rightarrow \Sigma F = 0$

SO FORCES ARE BALANCED, AND

$$T = f = \boxed{23\text{N}}$$

(c) IF $a = 2.5\ \text{m/s}^2$ TO THE RIGHT, WHICH I WILL SAY IS POSITIVE,



$$\underbrace{T - f}_{\Sigma F} = \underbrace{ma}_{2.5\ \text{m/s}^2} \quad (23\text{N} \downarrow,\ 4.7\text{kg} \downarrow)$$

$$\Rightarrow T = ma + f$$

$$= (4.7)(2.5) + (23)$$

$$= \boxed{34.8\text{N}}$$

(d) AS BEFORE, $T - f = ma$

$$\Rightarrow a = \frac{T-f}{m} = \frac{(50)-(23)}{(4.7)} = 5.74\ \text{m/s}^2$$

$$\Delta x = \cancel{v_0 t}^{\,0} + \frac{1}{2}at^2 = \frac{1}{2}(5.74)(1.5)^2 = \boxed{6.5\text{m}}$$