<u>MULTIPLE CHOICE QUESTIONS</u>

NOTE: IN MY ORIGINAL SOLUTIONS, I SOLVED FOR THE Y-COMPONENT, NOT THE X-COMPONENT.

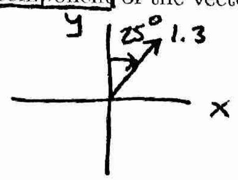
1. A vector has a magnitude of 1.3 and makes an angle of 25° clockwise from the $+y$ axis. With the correct sign, what is the $\boxed{x\text{-component}}$ of the vector?

   (a) 0.55

   [redacted]

   (c) −0.55

   (d) −1.18



[illegible]

X - COMPONENT:
$+1.3 \sin 25 = \boxed{0.55}$

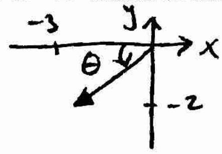
2. A vector has an x component of −3 and a y component of −2. Which of the following angles correctly describes the direction of this vector?

   (a) 34° counter-clockwise from the $+x$ axis

   (b) 56° counter-clockwise from the $+x$ axis

   (c) 34° counter-clockwise from the $-x$ axis

   (d) 56° counter-clockwise from the $-x$ axis



$\theta = \tan^{-1}\left|\frac{-2}{-3}\right| = 34°$

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

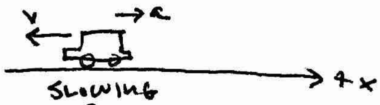
4. A car's velocity points in the $-x$ direction, and has an acceleration in the $+x$ direction. Which of the following is true?

   (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



SLOWING DOWN, MOVING IN −X DIRECTION

5. If a question were to state "A car speeds up at 5 m/s²..." the number 5 is what type of quantity?

   ACCELERATION

   (a) Displacement

   (b) Initial velocity

   (c) Final velocity

   (d) 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 <u>VERTICAL</u> VELOCITY GOES TO ZERO.

ONLY X-DIRECTION

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

   (a) 1.5m

   (b) 3.0m

   (c) 3.2m

   (d) 6.4m

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

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^o

   (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

    (b) The net force on an object is equal to the mass of the object multiplied by its acceleration — 2ND LAW

    (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^o clockwise from the $+x$ axis, and $\vec{B}$ has a magnitude of 5 and makes an angle of 30^o counter-clockwise from the $+y$ axis.

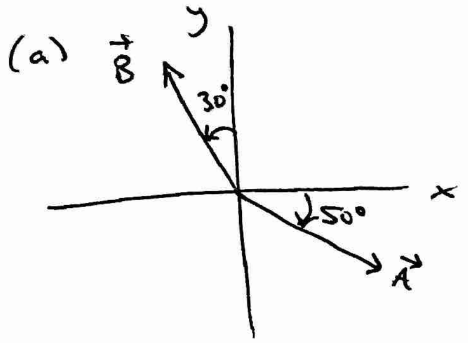
   a) Give both $\vec{A}$ and $\vec{B}$ in component form.

   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)



$A_x = 2\cos 50 = 1.29$

$A_y = 2\sin 50 = 1.53$

$\boxed{\vec{A} = 1.29\hat{i} - 1.53\hat{j}}$

$B_x = 5\sin 30 = 2.5$

$B_y = 5\cos 30 = 4.33$

$\boxed{\vec{B} = -2.5\hat{i} + 4.33\hat{j}}$

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

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

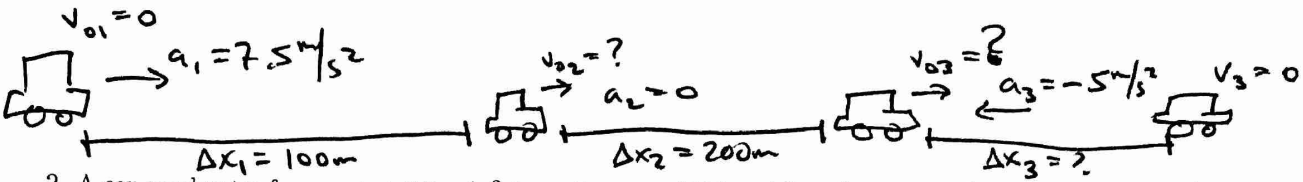
$= \boxed{-8.79\hat{i} + 14.52\hat{j}}$

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

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



2. A car accelerates from rest at 7.5 m/.s^2 for a distance of 100m. After, the car travels at a constant speed for 200m, before decelerating at 5 m/s^2 until stopped.

a) How long was the car accelerating for during the first 100m?

b) What was the maximum speed of the car during the motion?

c) How long did it take the car to stop once it started braking?

d) How far did the car travel while it was braking?

(a) $\left.\begin{array}{l} v_{01} = 0 \\ a_1 = 7.5\,m/s^2 \\ \Delta x_1 = 100m \end{array}\right\}$ $\Delta x_1 = \cancel{v_{01} t_1}^{\,0} + \frac{1}{2} a_1 t_1^2 \Rightarrow t_1 = \sqrt{\frac{2\Delta x_1}{a_1}} = \sqrt{\frac{2(100)}{(7.5)}}$

$= \boxed{5.16s}$

(b) MAXIMUM SPEED IS SPEED AT END OF ACCELERATION
$\Rightarrow$ SPEED FINAL DURING MOTION 1

$v_1 = \cancel{v_{01}}^{\,0} + a_1 t_1 = (7.5)(5.16) = \boxed{38.7\,m/s}$

(c) SINCE NO ACCELERATION DURING MOTION 2 $(a_2 = 0)$, INITIAL SPEED OF MOTION 3 THE SAME AS 2, $\Rightarrow v_{03} = 38.7\,m/s$

$\left.\begin{array}{l} v_{03} = 38.7\,m/s \\ a_3 = -5\,m/s^2 \\ v_3 = 0 \end{array}\right\}$ $\cancel{v_3}^{\,0} = v_{03} + a_3 t_3 \Rightarrow t_3 = \frac{-v_{03}}{a_3} = \frac{-(38.7)}{(-5)}$

$= \boxed{7.74s}$

(d) $\Delta x_3 = v_{03} t_3 + \frac{1}{2} a_3 t_3^2 = (38.7)(7.74) + \frac{1}{2}(-5)(7.74)^2$

$= \boxed{150m}$

$v_{ox} = 40\cos 37 = 31.9\text{ m/s}$

$v_{oy} = 40\sin 37 = 24.1\text{ m/s}$

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.

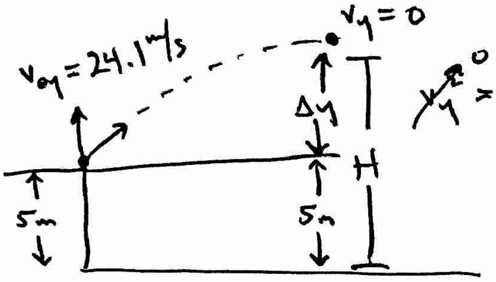
   a) What is the maximum height of the projectile above the ground?

   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)



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

$= 29.6\text{m}$

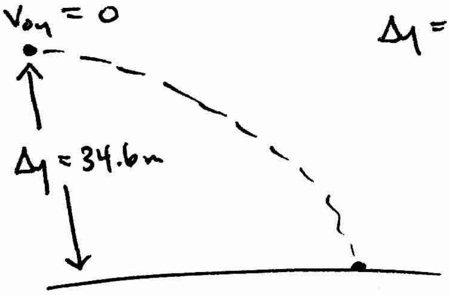
$H = \Delta y + 5\text{m} = 29.6 + 5$

$= \boxed{34.6\text{m}}$

(b) $\cancel{v_y}^{\,0} = v_{oy} + a_y t_{up} \Rightarrow t_{up} = \dfrac{-v_{oy}}{a_y} = \dfrac{-(24.1)}{(-9.8)} = \boxed{2.46\text{s}}$

NOTE: IN MY ORIGINAL SOLUTIONS, I FORGOT THE SQUARE ROOT.

(c) DROPPING DOWN,



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

$\Rightarrow t_{down} = \sqrt{\dfrac{2\Delta y}{a_y}} = \sqrt{\dfrac{2(34.6)}{(9.8)}} = 2.66\text{s}$

TOTAL TIME OF FLIGHT:

$t_F = t_{up} + t_{down} = 2.46 + 2.66$

$= \boxed{5.12\text{s}}$

(d) RANGE: HORIZONTAL DISTANCE TRAVELLED.

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

$\Rightarrow R = v_{ox}t_F = (31.9)(5.12) = \boxed{163\text{m}}$

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.

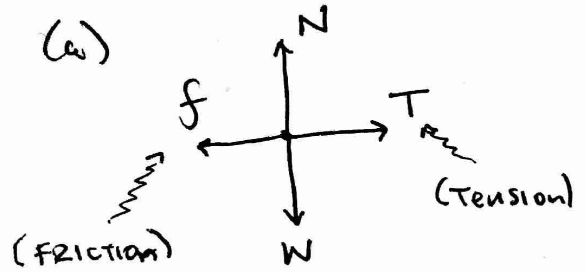
a) Draw the free body diagram of object

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)

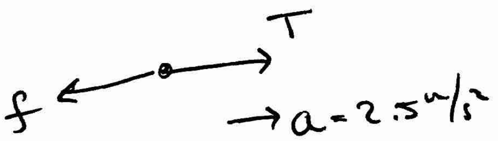


(b) IF VELOCITY IS CONSTANT, THEN $a = 0 \Rightarrow \Sigma F = 0$

SO FORCES ARE BALANCED, AND

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

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



$$\underbrace{T - \overset{23N}{f}}_{\Sigma F} = \overset{4.7kg}{m}\underset{2.5\,m/s^2}{a} \Rightarrow T = ma + f$$

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

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

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

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

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