



Projectile Questions

Name _____

BI _____

1] Describe how the the following features of a projectile vary with time:

a) the magnitude of the horizontal velocity

constant

b) the magnitude of the vertical velocity

changes at $-9.8 \frac{m}{s^2}$

c) the direction of the vertical velocity

decreases from up to zero to down

d) the direction of the horizontal velocity

constant

e) the magnitude of the acceleration

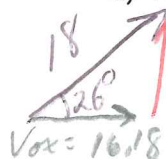
constant

f) the direction of the acceleration

constant

2] A 1.5 kg projectile is launched at 18.0 m/s from level ground. The launch angle is 26 deg above the horizontal.

a) What is the maximum height reached by this projectile?



$V_{oy} = 7.89$

$V_{fy} = 0$
 $V_{oy} = 7.89$
 $a_y = -9.8$
 $d_y = ?$

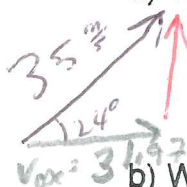
$\frac{V_f^2 - V_o^2}{2a} = d = 3.18m$

b) How fast will the projectile be travelling when it is at its maximum height?

$V_{fx} = V_{ox} = 16.2 \frac{m}{s}$

3] A projectile is launched over level ground at 35 m/s at an angle of 24 deg above the horizontal.

a) What is the time of flight of this projectile?



$V_{oy} = 14.24$

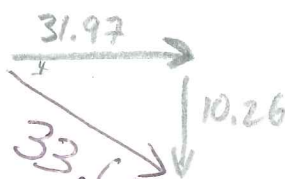
$d_y = V_{oy}t + \frac{1}{2}a_yt^2$
 $-V_{oy}t = \frac{1}{2}a_yt^2$

$\frac{-14.24}{-4.9} = t = 2.915$

b) What is the velocity of this projectile 2.5 s after launch?

$V_{fy} = ?$
 $V_{oy} = 14.24$
 $a_y = -9.8$
 $t = 2.5$

$V_f = V_o + at$
 $= -10.26$

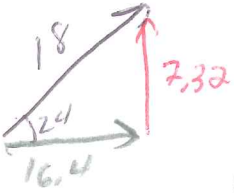


at 18° down from horizontal



4] A soccer ball is kicked over level ground with an initial velocity of 18 m/s, 24 deg above the horizontal.

a) How long does it take the ball to return to the ground?

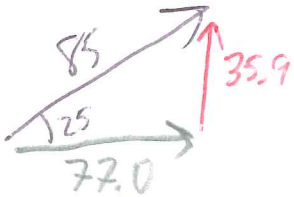


$$t = \frac{-V_{oy}}{\frac{1}{2}a_y} = 1.49 \text{ s}$$

b) What is the range of the ball?

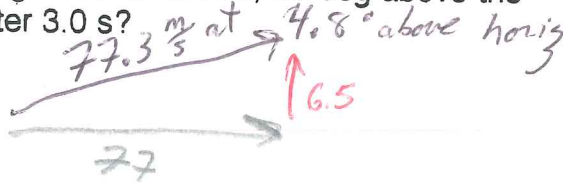
$$d_x = V_{ox} t = (16.4)(1.49) = 24.5 \text{ m}$$

5] A projectile is launched over level ground at 85 m/s, 25 deg above the horizontal. Calculate its speed after 3.0 s?

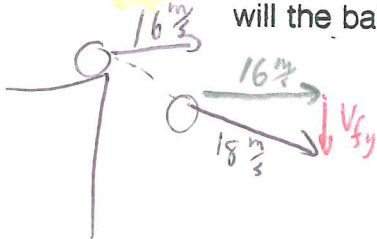


$$V_{fy} = V_{oy} + a_y t = 6.5 \text{ m/s}$$

$$V_{fx} = V_{ox} = 77.0$$



6] A ball is rolled off a horizontal roof at 16 m/s. After leaving the roof, how long will the ball take to reach a speed of 18 m/s?



$$\sqrt{18^2 - 16^2} = V_{fy} = 8.25 \text{ m/s}$$

$$\frac{V_{fy} - V_{oy}}{a_y} = t = 0.84 \text{ sec}$$

7] A marble rolls off a 0.75 m desk and lands 0.50 m from the base of the desk. How fast did the marble roll off the table?



$$d_y = V_{oy} t + \frac{1}{2} a_y t^2$$

$$-0.75 = -4.9 t^2$$

$$t = 0.39 \text{ s}$$

$$d_x = V_{ox} t + \frac{1}{2} a_x t^2$$

$$0.5 = V_{ox} (0.39)$$

$$1.3 \text{ m/s} = V_{ox}$$

8] At what speed must a ball be thrown upwards to reach a maximum height of 25 m?

$$V_{fy} = 0$$

$$d_y = 25$$

$$a_y = -9.8$$

$$V_{oy} = ?$$

$$\frac{V_{fy}^2 - V_{oy}^2}{2a} = d$$

$$V_{oy}^2 = V_{fy}^2 - 2a_y d$$

$$V_{oy}^2 = 0 - 2(-9.8)25$$

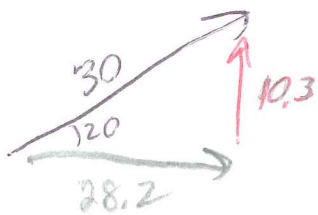
$$V_{oy} = \sqrt{490}$$

$$= 22 \text{ m/s}$$

Velocity / speed of a Projectile

2

- 1] A baseball is hit at an angle of 20 deg to the horizontal with a velocity of 30 m/s. What is the baseball's velocity 2.0 s after it was hit?

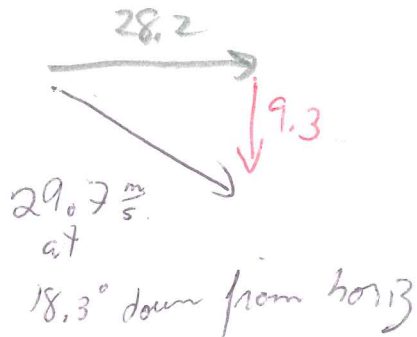


$$V_{fy} = V_{oy} + a_y t$$

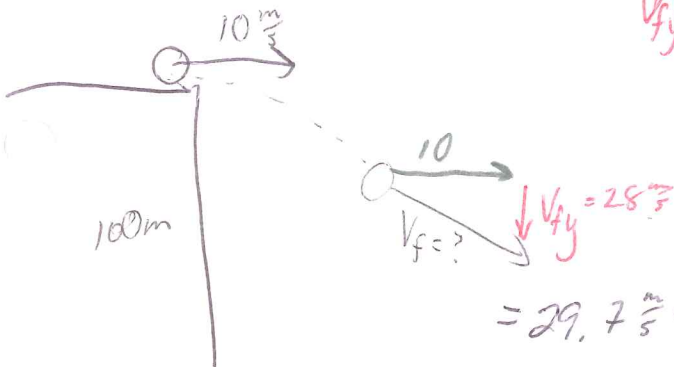
$$= 10.3 - 9.8(2)$$

$$= -9.3$$

$$V_{fx} = V_{ox} = 28.2$$



- 2] A boy throws a rock off a cliff that is 100 m high. He throws the rock with a horizontal velocity of 10 m/s. How fast is the rock moving after it has fallen 40 m?



~~$$V_{fy} = V_{oy} + a_y t$$~~

$$= -9.8$$

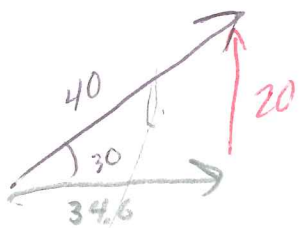
$$V_{fy}^2 = V_{oy}^2 + 2a_y d_y$$

$$V_{fy}^2 = 0 + 2(-9.8)(-40)$$

$$V_{fy} = 28.7 \frac{m}{s}$$

$$= 29.7 \frac{m}{s} \text{ at } 70^\circ \text{ down from horiz.}$$

- 3] A soccer ball is kicked with a velocity of 40 m/s at an angle of 30 deg to the horizontal. What is its velocity when it is 8.0 m above the ground? (on the way up and on the way down)

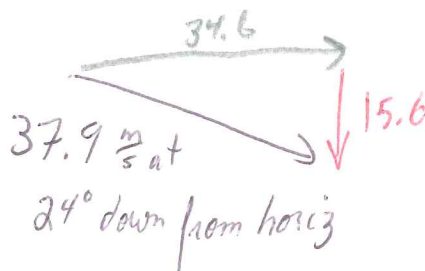
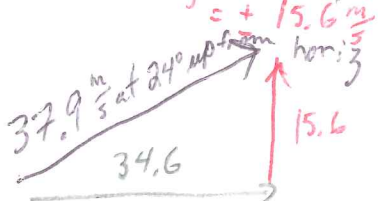


$$V_{fy}^2 = V_{oy}^2 + 2a_y d_y$$

$$= 20^2 + 2(-9.8)(8)$$

$$V_{fy}^2 = \sqrt{243}$$

$$= +15.6 \frac{m}{s}$$



3

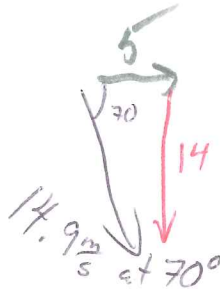
Projectile velocity questions:

- 1) What is the velocity (mag. and dir) of an object which is thrown at 5.0 m/s horizontally when it reaches the bottom of a 10.0 m high cliff?

$$V_{fy}^2 = V_{oy}^2 + 2a_y d_y$$

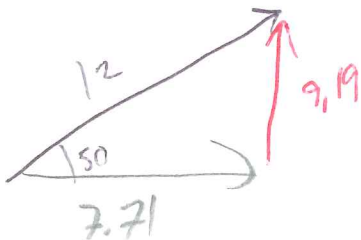
$$= \sqrt{2(-9.8)(-10)}$$

$$V_{fy} = 14 \frac{m}{s}$$



14.9 m/s at 70° down from horizontal

- 2) A cat is kicked on level ground with a velocity of 12 m/s at an angle of 50° to the horizon, what is its "hang time", range, max height, and at what times does it reach 2.0 meters height?



$$d_y = 0$$

$$V_{oy} = 9.19$$

$$a_y = -9.8$$

$$t = ?$$

$$\frac{-V_{oy}}{\frac{1}{2}a_y} = t = 1.88s$$

$$V_f^2 = V_o^2 = t = \sqrt{19}$$

$$d_y = 2 \quad 2 = 9.19t - 4.9t^2$$

$$0 = -4.9t^2 + 9.19t - 2$$

$$a_y = -9.8 \quad t = \frac{-9.19 \pm \sqrt{9.19^2 - 4(-4.9)(-2)}}{-9.8}$$

$$t = ?$$

$$t = \frac{-9.19 \pm \sqrt{45.3}}{-9.8} = \frac{-9.19 - 6.73}{-9.8}$$

$$\text{or } \frac{-9.19 + 6.73}{-9.8}$$

$$t = 1.62 \text{ or } 0.25 \text{ sec}$$

$$d_x = V_{ox}t = 14.5m$$

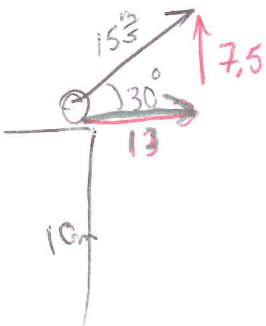
Max $d_y = ? \quad V_{fy} = 0$

$$V_{oy} = 9.19 \quad a_y = -9.8$$

$$\frac{(V_f^2 - V_o^2)}{2a_y} = d = 4.31m$$

Hang time: 1.88s
 Range: 14.5 m
 Max height: 4.31 m
 Time to reach 2.0m: 0.251 & 1.57s

- 3) A frog leaps at 15 m/s at 30° off a 10 m high cliff, how long is it in the air, how far from the base of the cliff does it land, what is its velocity when it reaches the ground, what is its max height?

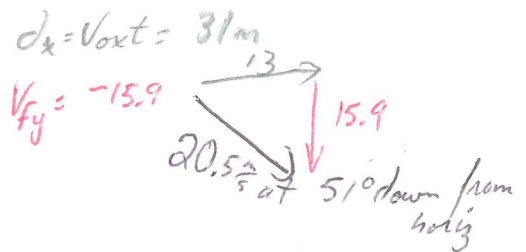


$$t = \frac{V_f - V_o}{a} = \frac{-15.9 - 7.5}{-9.8} = 2.39s$$

$$V_f^2 = V_o^2 + 2ad$$

$$= 7.5^2 + 2(-9.8)(-10)$$

$$V_f = 15.9 \frac{m}{s}$$



Time in air: 2.39 s ✓
 Range: 31.0 m ✓
 V_f: 20.5 m/s at 51° down from horizon.
 Max height: 12.9m

MAX: $d_y = ?$

$$V_{fy} = 0$$

$$a_y = -9.8$$

$$V_{oy} = 7.5$$

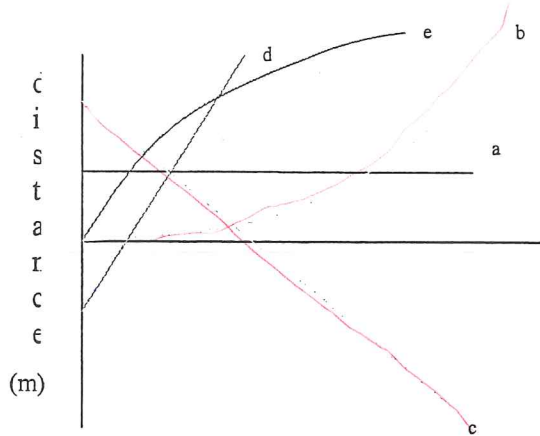
$$\frac{-7.5^2}{-19.6} = d_y = 2.86m \text{ from top}$$

$$+10$$

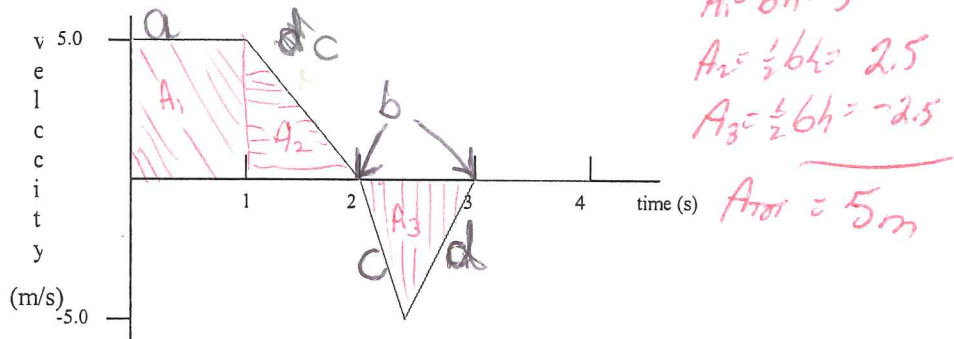
$$12.9m \text{ from base}$$

Graphs of Moving Objects

- 1) Using the graph below indicate which letter represents
- I. an object moving forward at constant velocity *d*
 - II. an object moving backward at constant velocity *c*
 - III. a forward accelerating object *b*
 - IV. a decelerating object *e*
 - V. an object at rest. *a*

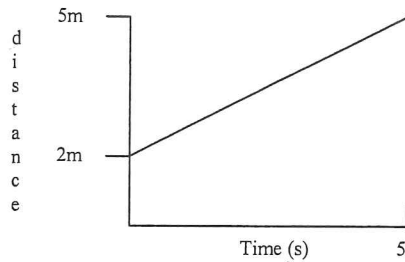


- 2) Calculate the total distance from the start for the object below.



- 3) Using the graph above label a segment representing
- a) constant positive velocity
 - b) at rest
 - c) deceleration
 - d) acceleration

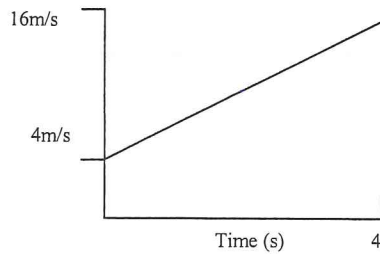
4) Determine the value of velocity on the graph below.



$$V = \text{slope} = \frac{\Delta d}{\Delta t}$$

$$= \frac{5 - 2}{5 - 0} = \frac{3\text{m}}{5\text{s}} = 0.60 \frac{\text{m}}{\text{s}}$$

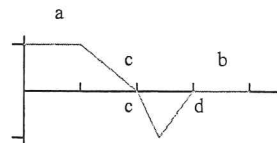
5) Determine the value of the acceleration on the graph below.



$$a = \frac{\Delta V}{\Delta t} = \text{slope}$$

$$= \frac{16 - 4}{4 - 0} = \frac{12 \text{ m/s}}{4 \text{ s}} = 3.0 \frac{\text{m}}{\text{s}^2}$$

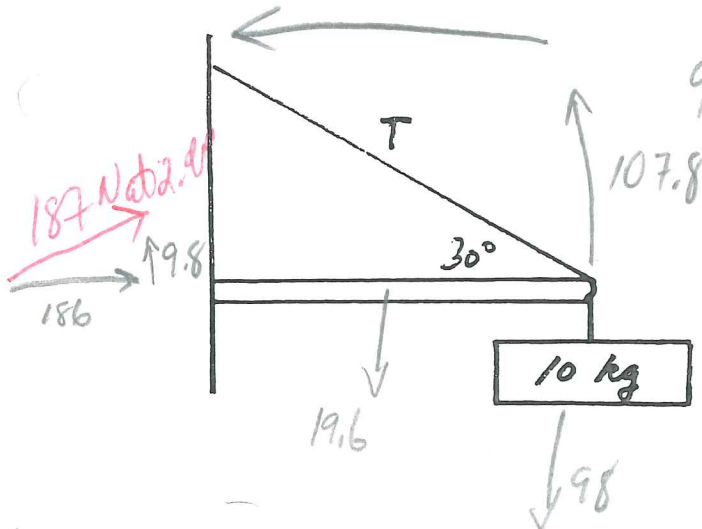
Answers: 1) I = d, II = c, III = b, IV = e, V = a. 2) 5.0m 3)
4) 0.6 m/s 5) 3.0 m/s²



CHAPTER 2 TEST THINGS TO KNOW????

- 1] know how to add and subtract vectors
- 2] know how to do plane questions $v_p + v_w = v_g$
- 3] know how to do swimmer (boat questions) $v_s + v_c = v_g$
- 4] know how to deal with 3 forces at a point (right-left-down)
- 5] know how to do pendulum questions
- 6] know how to find ramp components for mg and g
- 7] know how to do simple levers--- beams, meter sticks , tables, teeter-toters
- 8] know how to do level cantilevers---** force the wall exerts
- 9] know how to do **angled cantilevers
- 10] know how to do type1 projectiles
- 11] know how to do type 2 projectiles ~~****~~
- 12] know how to do **type 3 projectiles ~~****~~

8] The cantilever illustrated below has a mass of 2.0 kg. Find a) the tension T in the chain supporting the lever and b) ** the force the wall exerts on the bar.

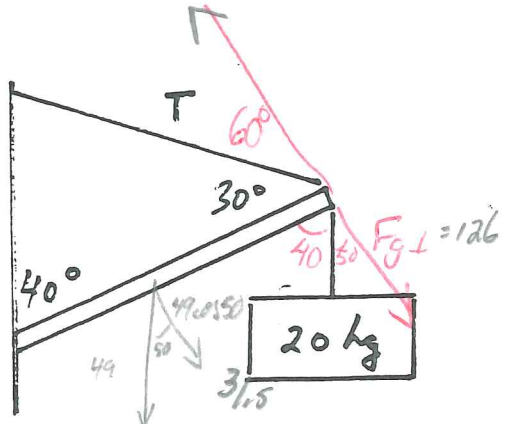


$$98x + \frac{19.6x}{2} = F_L x$$

$$98 + 9.8 = F_L = \frac{107.8}{\cos 60} = T = 216N$$

a) 216N
 b) ** 187N, 2.9° to horizontal

9] ** The cantilever illustrated below has a mass of 5.0 kg. Find T.



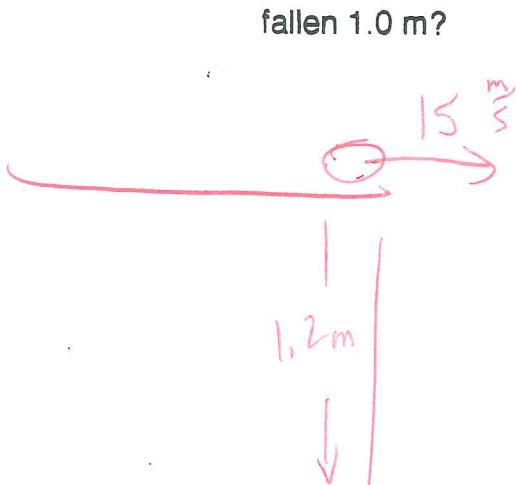
$$31.5x + 126x = F_L x$$

$$141.75 = F_L$$

$$\frac{F_L}{\cos 60} = T = 284N$$

** 283N

- 10] A ball rolls off a table at 15 m/s. The table is 1.2 m high. a) How long will the ball be in the air? b) what is its range? c) what is its velocity when it has fallen 1.0 m?

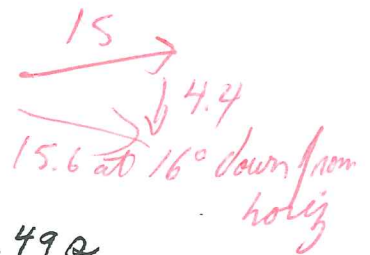


$$t = \sqrt{\frac{2d_y}{a_y}} = 0.495$$

$$d_x = v_{ox}t = 7.342 \text{ m}$$

$$v_{fy}^2 = v_{oy}^2 + 2a_y d_y$$

$$v_{fy} = 4.4 \text{ m/s}$$

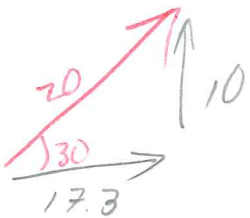


a) 0.49 s

b) 7.35 m

c) 15.6 m/s, 16.3° below horizontal

- 11] Batch hits a golf ball in the air. (really) The golf ball is hit at 20.0 m/s at an angle of 30 deg to the horizontal. a) how long will the ball be in the air? b) what is its range? c) how high will it go? d) what is its velocity at the highest point in its flight? e) what is its velocity after 1.5 s?

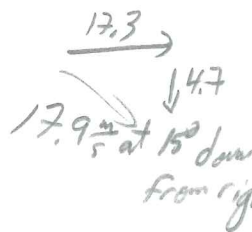


$$\frac{-v_{oy}}{\frac{1}{2}a_y} = t = 2.04 \text{ s}$$

$$d_x = v_{ox}t = 35.3 \text{ m}$$

$$d_y = \frac{v_{fy}^2 - v_{oy}^2}{2a_y} = 5.1 \text{ m}$$

$$v_f = \sqrt{v_{ox}^2 + v_{fy}^2} = v_{ox} = 17.3$$



a) 2.04 s

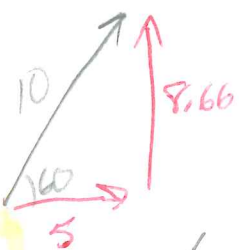
b) 35.3 m

c) 5.10 m

d) 17.3 m/s

e) 17.9 m/s, 15.2° below horizontal

- 12] **A shotput is put at 10.0 m/s at an angle of 60 deg to the horizontal. It is let go from a height of 2.0 m and lands on the ground. How far did it travel?



$$-d_y = v_{oy}t + \frac{1}{2}a_y t^2$$

$$-2 = 8.66t - 4.9t^2$$

$$0 = -4.9t^2 + 8.66t + 2$$

$$t = \frac{-8.66 \pm \sqrt{8.66^2 - 4(-4.9)(2)}}{-9.8}$$

$$t = \frac{-8.66 \pm 10.7}{-9.8}$$

Reject

$$t = 1.97 \text{ s}$$

OR

$$v_{fy} = ?$$

$$v_{oy} = 8.66$$

$$a_y = -9.8$$

$$d_y = -2$$

$$v_{fy} = \sqrt{8.66^2 + 2(-9.8)(-2)}$$

$$v_{fy} = 10.7 \text{ Reject}$$

$$\frac{v_{fy} - v_{oy}}{a_y} = t = 1.97 \text{ s}$$

$$d_x = v_{ox}t$$

** 9.9 m = 9.87 m

$$d_x = v_{ox}t = 9.87 \text{ m}$$