Physics 200 **Name:** _____

Mid-Term Review: Kinematics

Answers to part 1:

1. E
2. A
3. E
4. C
5. A
6. C
7. E
8. A
9. D
10. D
11. C
12. B
13. C
14. E
15. C

Answers to Part 2:

1. B
2. D
3. C
4. C
5. B
6. C
7. A
8. B
9. E
10. C
11. D

Solutions to Part 3:

1. With full afterburners, the F-16 fighter jet has an acceleration of 12.7 m/s^2. It requires a velocity of 170 miles/hour to take off.

a. How long does it take the F-16 to reach take off speed if it starts from rest?

$a = 12.7 \frac{m}{s^2}$

$V_i = 0 \frac{m}{s}$

$V_f = 170 mph = 75.9 \frac{m}{s}$

$t = ?$ solve for t w/o x

$V_f = V_i + at$

$75.9 = 0 + 12.7t$

$t = 5.98 s$

b. How long (answer in feet) does its runway need to be?

$x = V_i t + \frac{1}{2} a t^2 = 0 + \frac{1}{2}(12.7)(5.98)^2$

$x = 227 m = 745 feet \approx 2$ football fields

Not Much!

2. A pebble is dropped into a well. The splash is heard 1.5 seconds after it was released. Neglecting the speed of sound, how far down is it to water level?

$y_0 = 0$

$y = ?$

$V_i = 0$

$V_y = ?$

$a = -9.8 \frac{m}{s^2}$

$t = 1.5 s$

$y = y_0 + V_i t - \frac{1}{2} g t^2$

$y = 0 + 0 - 4.9(1.5)^2$

$y = -11.0 m$

3. A soccer ball is kicked straight up in the air and takes 6.0 seconds to come back to Earth. Find out how high it went. only 3.0 second to highest point

$y_0 = 0$ $y_0 = ?$
$y = ?$ $y = 0$
$v_i = ?$ $v_i = 0$
$v_f = 0$ $v_f = ?$
$a = -g$ going up $a = -g$ going down

$y = y_0 + v_i t - \frac{1}{2}gt^2$
$0 = y_0 + 0 - 4.9(3)^2$
$y_0 = 44.1\ m$

4. A stone is thrown vertically upward with a speed of +12.0 m/s from the edge of a cliff 75.0 m high. How much later does it reach the bottom of the cliff?

Going up
$y_0 = 0$
$y = ?$
$v_i = 12.0\ m/s$
$v_f = 0$
$a = -g$
$t = ?$

$v_f = v_i - gt$
$0 = 12 - 9.8t$
$t = 1.22s$
$y = y_0 + v_i t - \frac{1}{2}gt^2$
$y = 0 + 12(1.22) - 4.9(1.22)^2$
$y = 7.35\ m$

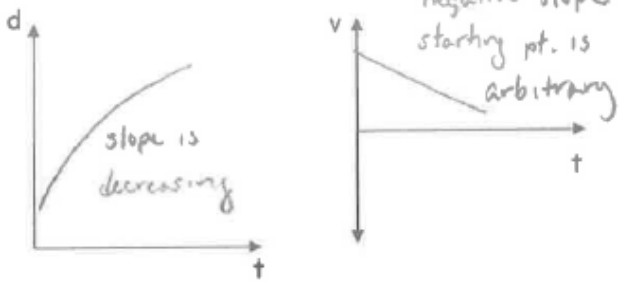
Going down
$y_0 = 0$
$y = -82.4\ m$
$v_i = 0$
$v_f = ?$
$a = -g$
$t = ?$
$y = y_0 + v_i t - \frac{1}{2}gt^2$
$-82.4 = 0 + 0 - 4.9t^2$
$t = 4.10s$
$+1.22s$
$5.32s$

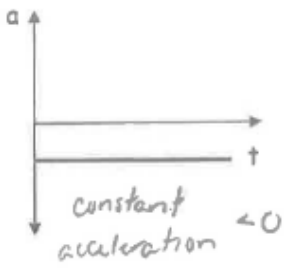
OR
$-75 = 12t - 4.9t^2$
quad formula

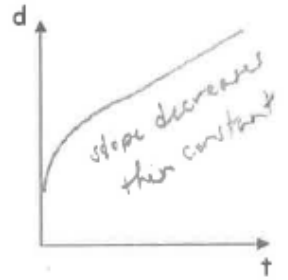
5. A speeding motorist traveling 35 m/s passes a stationary police officer. The officer

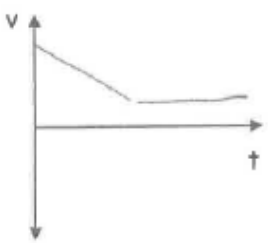
Graph Analysis (20 pts)

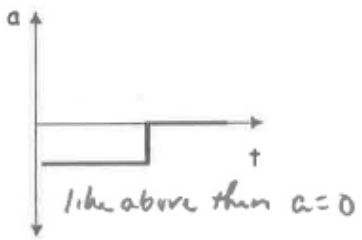
Using the information provided in one graph, complete the other 2.

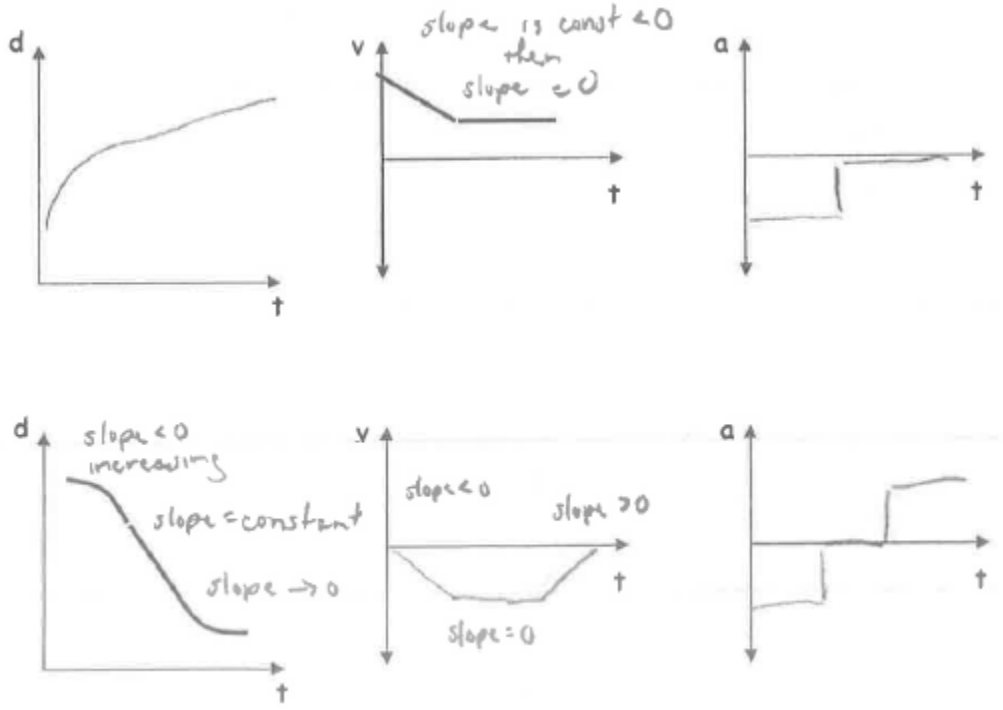












Solutions to Part 4:

5. A horizontal projectile is shot from desk height (1.0 meters). Is the time it takes to hit the ground dependent on the horizontal velocity? Why or why not?

No.

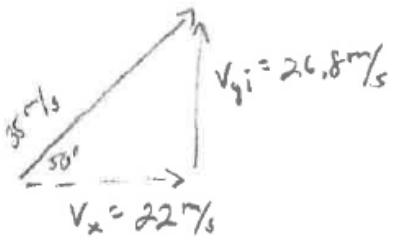
$x = v_x t$ $\quad y = y_0 - v_{yi}t - \frac{1}{2}gt^2$ ($v_{yi} = 0$)

$0 = 1 - \frac{1}{2}gt^2$

$t = 0.45\,s$

because the velocity is horizontal, it has no impact on vertical motion

6. An arrow is shot from ground level with speed of 35 m/s at an angle 50° above the horizontal. What is the vertical component of its velocity at its highest point? How far does it go? How long is it in the air? $V_y = 0$



$V_x = 22$ m/s

How far: $R = \frac{V_0^2 \sin 2\theta}{g} = 123$ m

How long: $V_y = V_{yi} - gt$

$0 = 26.8 - 9.8t$

$t = 2.73$ s

$\times 2$

5.46 s

OR

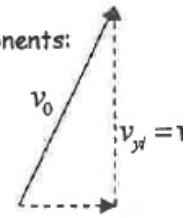
$x = V_x t$

$123 = (22)t$

$t = 5.59$ s

Good Stuff

Resolving into x & y components:



Range formula:

$$Range = \frac{v_i^2 \sin 2\theta}{g}$$

Horizontal motion:

$$x = v_x t = v_i (\cos\theta) t$$

Vertical Motion:

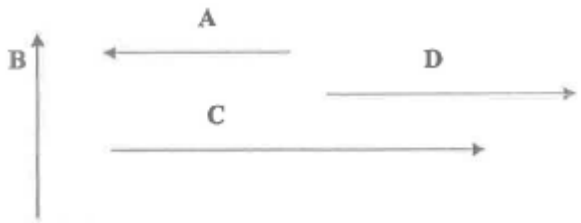
$$\Delta y = v_{yi} t - \frac{1}{2} g t^2 = v_i (\sin\theta) t$$

$$v_y = v_{yi} - gt = v_i \sin\theta -$$

Quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1. Find the vector sum of **A** + **B** + **C** + **D**. (6 pts) **A** = 3.0cm, **B** = 3.0 cm, **C** = 6.0cm, and **D** = 4.0cm



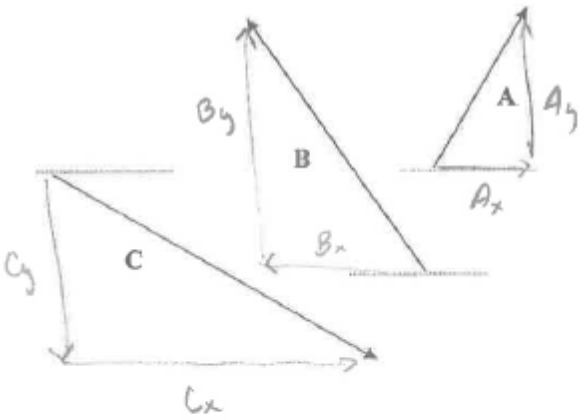
	x-comp	y-comp
$\vec{A}$:	-3	0
$\vec{B}$:	0	3
$\vec{C}$:	6	0
$\vec{D}$:	4	0
	7	3

$\sqrt{7^2+3^2} = 7.6$

$\theta = \tan^{-1}\left(\frac{y}{x}\right) = \tan^{-1}\left(\frac{3}{7}\right) = 23°$

2. Find the vector sum of **A** + **B** + **C**. (6 pts)

A = 3.0cm @ 45°
B = 3.0 cm @ 60°
C = 6.0cm @ 30°

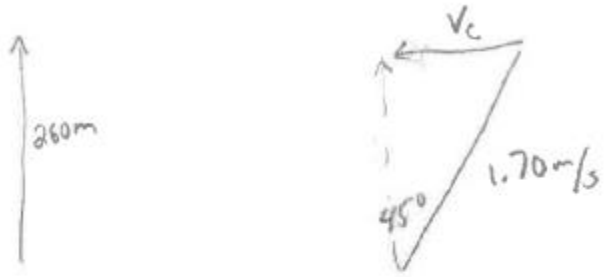


	x-comp	y-comp
$\vec{A}$:	2.1	+ 2.1
$\vec{B}$:	-1.5	+ 2.6
$\vec{C}$:	- 5.2	- 3.0
	-4.6	1.7

$\sqrt{4.6^2 + 1.7^2} = 4.90$

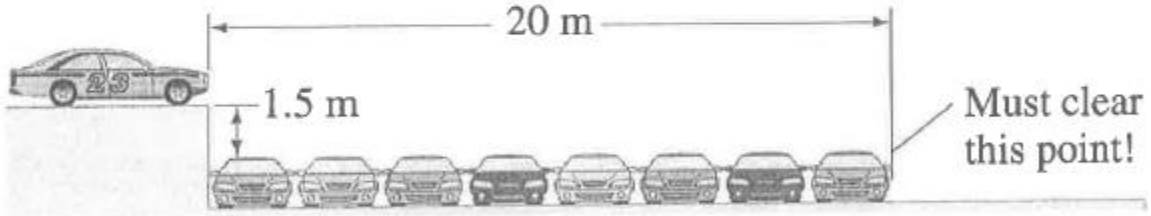
$\theta = \tan^{-1}\left(\frac{1.7}{4.6}\right) = 20°$ in quadrant 2

3. A boat, whose speed in still water is 1.70 m/s, must cross a 260-m-wide river and arrive at a point 0 m upstream from where it starts. To do so, the pilot must head the boat at a 45° upstream angle. What is the speed of the river's current? (6 pts)



$V_c = 1.70 \sin 45^\circ = 1.20 \frac{m}{s}$

4. What minimum speed will car #23 need to make this jump successful? (6 pts)



$y = 0$
$y_0 = 1.5$
$V_{yi} = 0$
$V_y = ?$

$y = y_0 + v_i t - \frac{1}{2} g t^2$

$0 = 1.5 + 0 - 4.9t^2$

$t = 0.55\,s$

$x = v_x t$

$20 = v_x (0.55)$

$v_x = 36 \frac{m}{s}$