Kinematics Test Open Ended Review Problems

Problem 1

Your friend has a good business idea, and he wants to make physics flash cards and sell them to other people. You want in on all this physics cash, so he asks you to make flash cards that use different representations to show motion. You need to make flash cards representing:

- Object moving in the positive direction, constant rate
- Object moving in the negative direction, constant rate
- Object moving in the positive direction, speeding up
- Object moving in the negative direction, speeding up
- Object moving in the positive direction, slowing down
- Object moving in the negative direction, slowing down
- Object turning around

Each card should show a word description, a complete motion diagram, position versus time graph, velocity versus time graph, and an example equation of something moving that way.

Problem 2

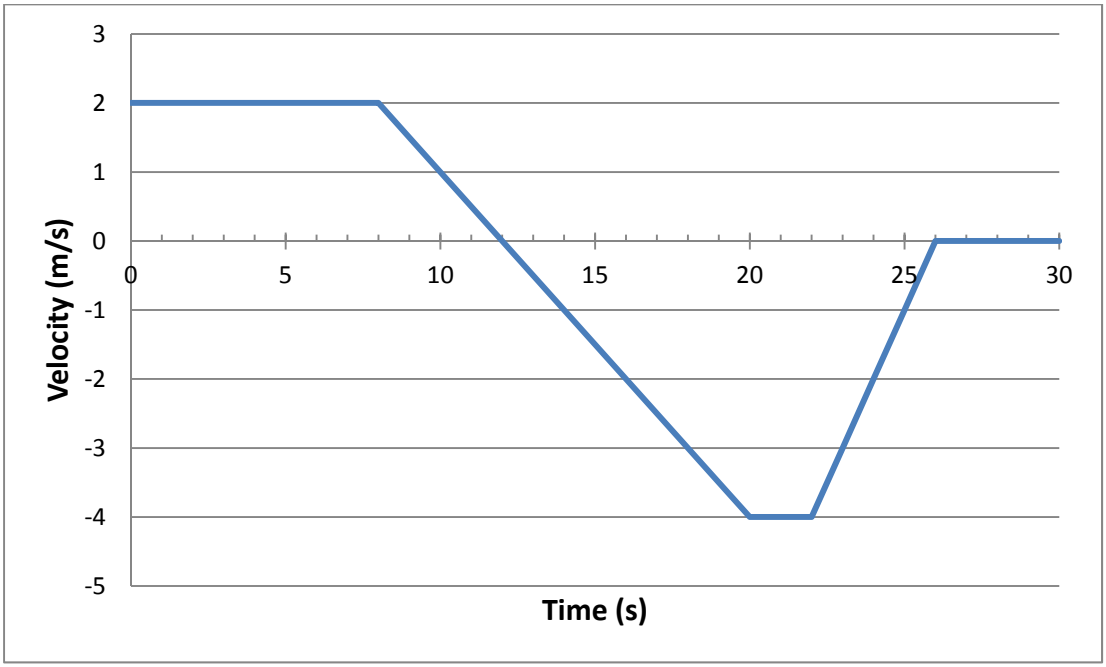
An engineer is trying to develop a new type of bullet proof cloth that would be used in clothing to protect anybody from police officers to civilians. From his tests and research she knows that a 5 mm thick sample of the material can slow down the bullet at a rate of 9600 m/s^2. If the bullet travels at 400 m/s, is this material thick enough to make safe bullet proof clothing? (Note that 1 m/s = 2.24 mph)

Problem 3

The Hamburglar is running away from Ronald, having stolen one too many BigMacs. He's got a 240 meter lead start on Ronald and is running at a pace of 4 m/s (can't run that fast after you eat that many burgers). Ronald is out on the hunt and is seeking compensation in blood, Mr. McDonald is chasing after the Hamburglar at a breakneck pace of 10 m/s.

a) Draw a picture that shows the situation
b) Create position versus time graphs for both of them and then create their corresponding mathematical expressions.
c) Find out when and where Ronald takes his pound of flesh from the Hamburglar.

Problem 4



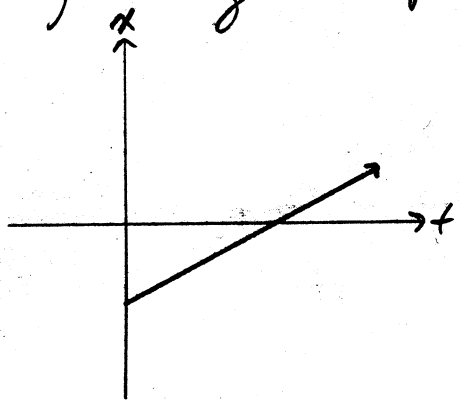
a) Describe the motion of the object in words
b) How far did the object move from 0 to 12 seconds?
c) If the object's initial position is 70 m, where is it at 22 seconds?
d) What is the object's acceleration from 22 seconds to 26 seconds?

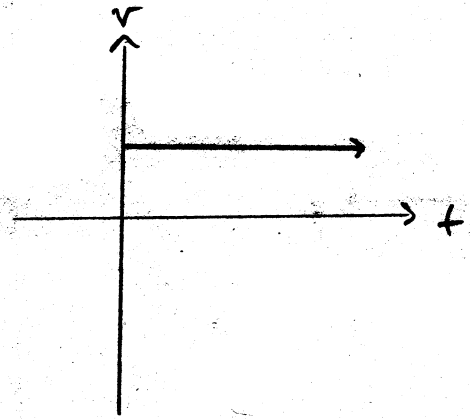
Problem 5

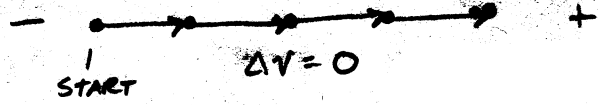
A fighter jet is trying to hit a test target with a bomb. The bomb is released at 90 m/s 25° below the horizontal. If the bomb needs to hit the target which is 900 meters away, how high must the plane be from the ground when it releases the bomb? What assumptions are you making?

Problem 1

- Object moving in the positive direction, constant speed

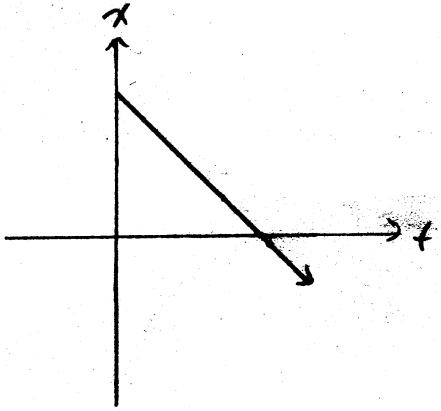


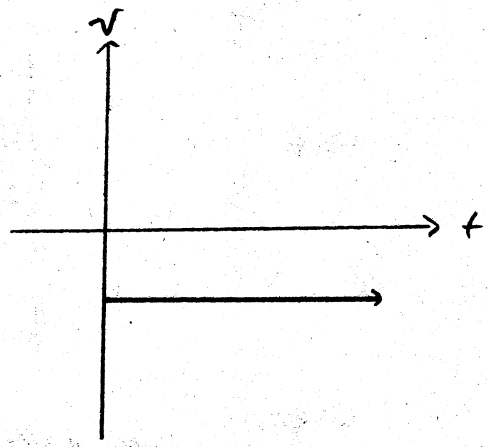


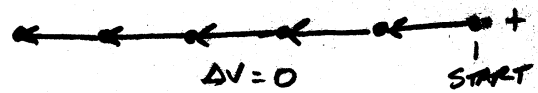


$x_f = (+10\frac{m}{s})t + (-15m)$

- Object moving in the negative direction, constant speed.

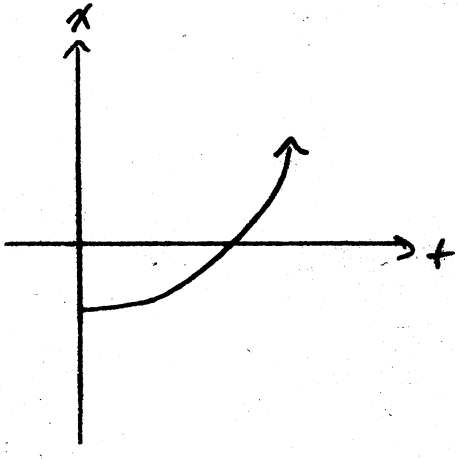


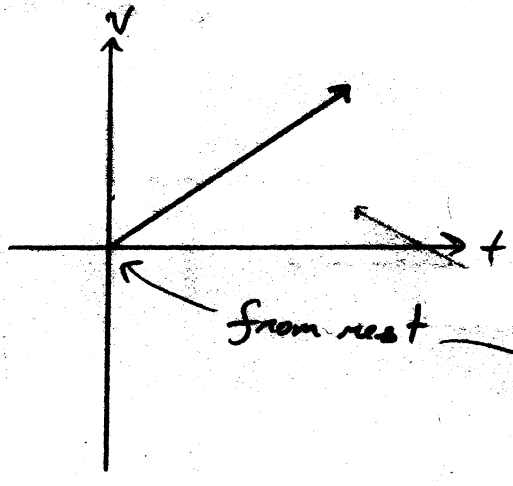


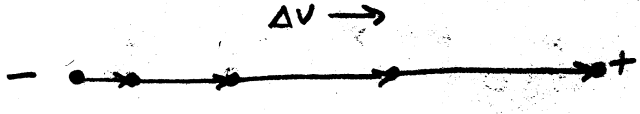


$x_f = (-5\frac{m}{s})t + (30m)$

- Object moving in the positive direction, speeding up

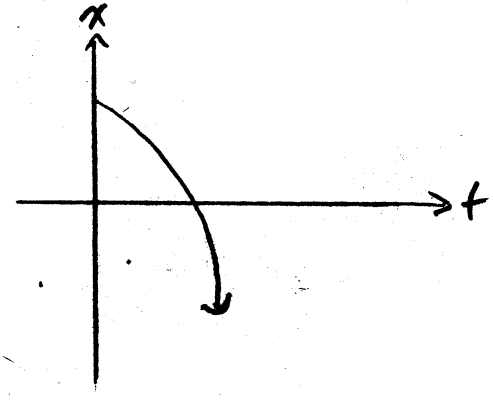


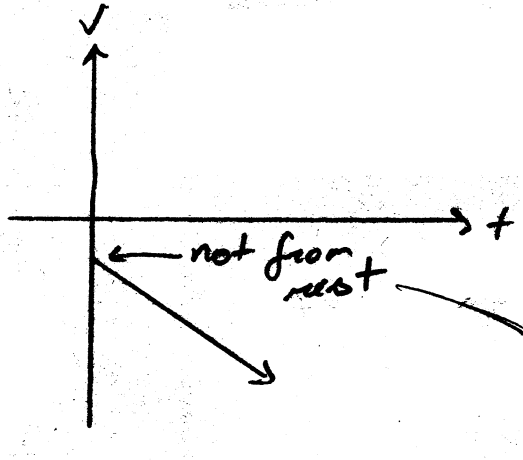


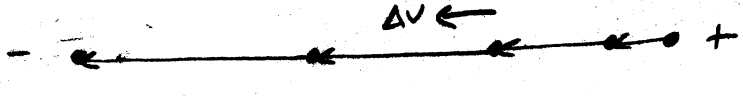


$x_f = \frac{1}{2}(+1\frac{m}{s^2})t^2 + (0\frac{m}{s})t + (-30m)$

- Object moving in the negative direction speeding up

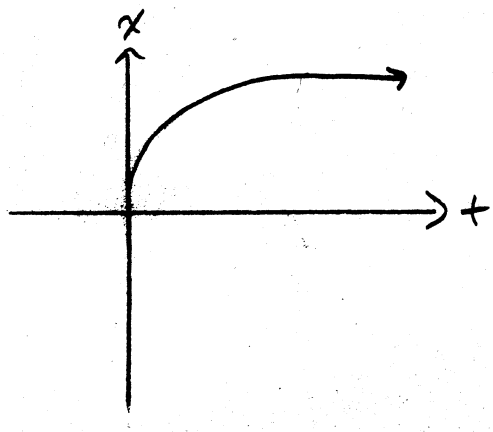


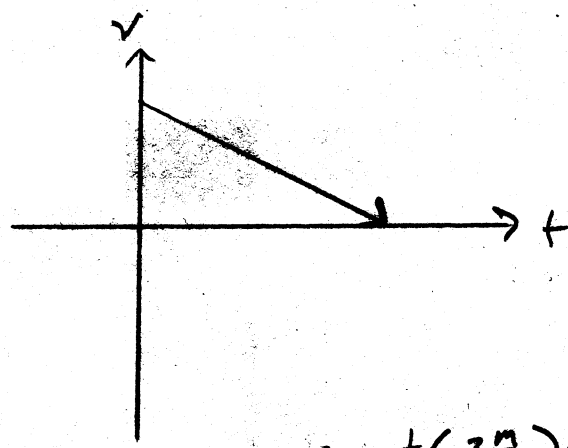


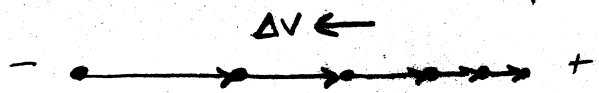


$x_f = \frac{1}{2}(-3\frac{m}{s^2})t^2 + (-2\frac{m}{s})t + 40m$

- Object moving positive direction, slowing down

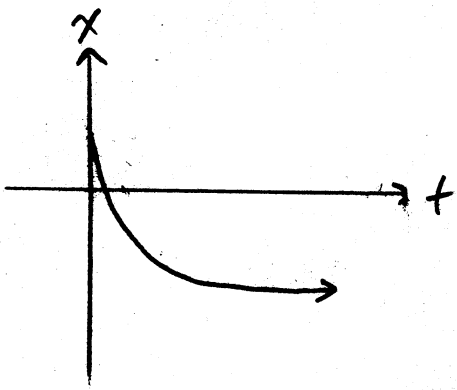


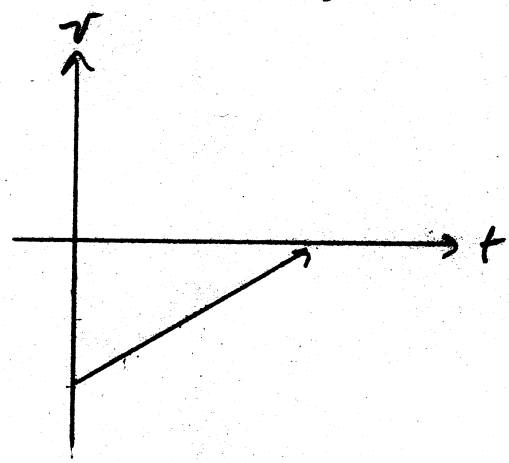


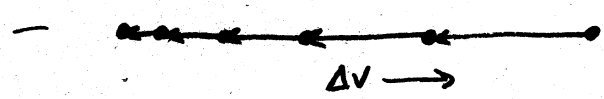


$x_f = \frac{1}{2}(-3\frac{m}{s^2})t^2 + (4\frac{m}{s})t + 6m$

- Object moving in the negative direction, slowing down

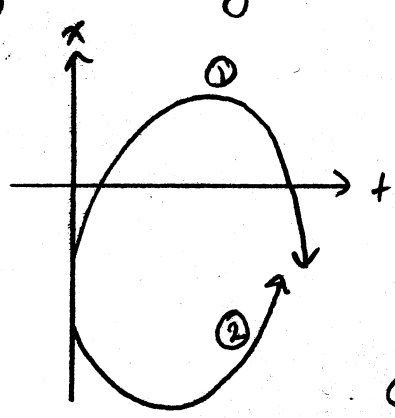


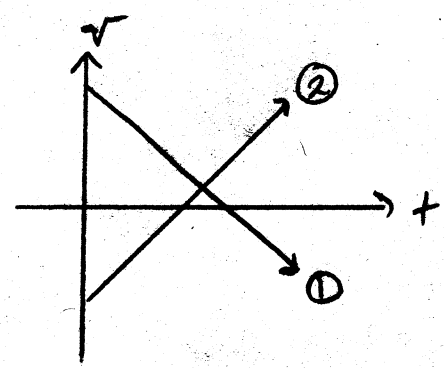


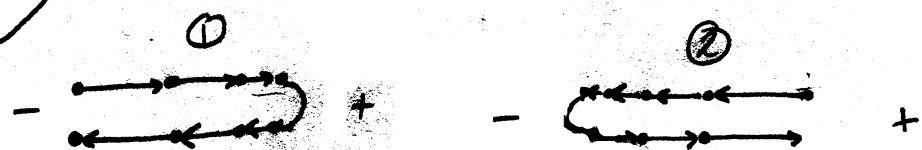


$x_f = \frac{1}{2}(+2\frac{m}{s^2})t^2 + (-3\frac{m}{s})t + 5m$

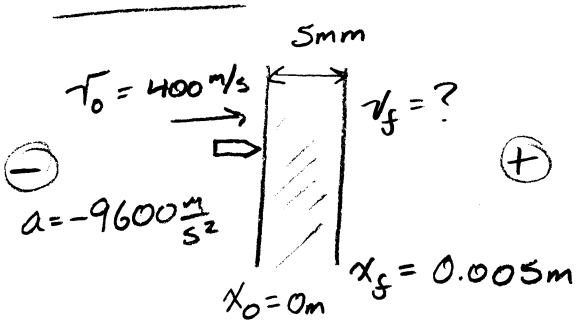
- Object turning around







Problem 2



zero!

$$v_f^2 = v_0^2 + 2a(x_f - x_0)$$

$$v_f^2 = (400\ m/s)^2 + 2(-9600\ m/s^2)(0.005m)$$

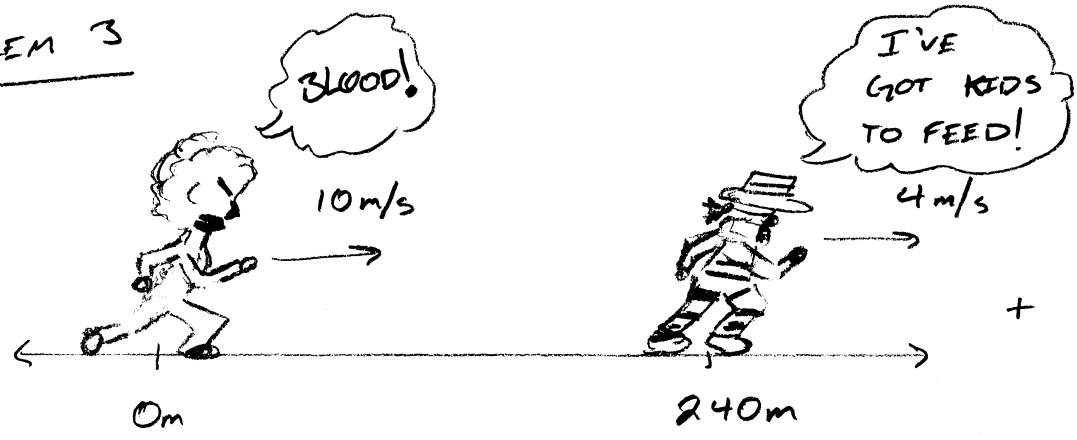
$$v_f^2 = 159904\ m^2/s^2$$

$$\boxed{v_f = 399.87\ m/s}$$

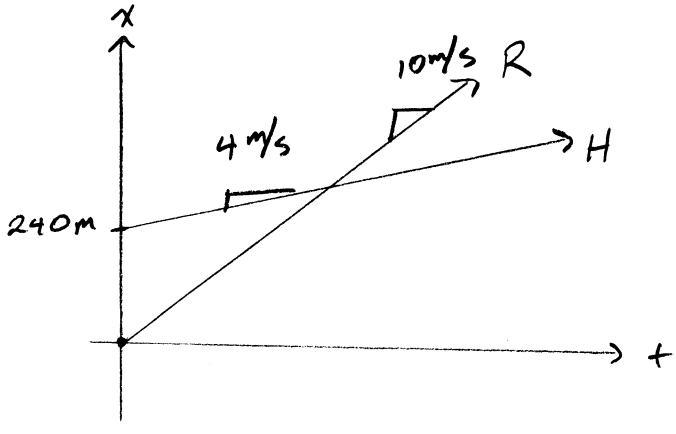
Totally not safe

Problem 3

a)



b)



c) no acceleration!

Ronald: $x_R = \frac{1}{2}at^2 + v_0t + x_0$

$$x_R = (10\ m/s)t + 0m$$

Hamburglar: $x_H = \frac{1}{2}at^2 + v_0t + x_0$

$$x_H = (4\ m/s)t + 240m$$

Finding time: $x_R = x_H$

$$(10\ m/s)t = (4\ m/s)t + 240m$$

$$-(4\ m/s)t \quad -(4\ m/s)t$$

$$(6\ m/s)t = 240m$$

$$\boxed{t = 40s}$$

Finding where:

$$x_R = (10\ m/s)(40s)$$

$$= \boxed{400m}$$

$$x_H = (4\ m/s)(40s) + 240m$$

$$= \boxed{400m}$$

Problem 4

a) 0–8s: Moving + dir, constant speed 2 m/s

8–12s: Moving + dir, slowing down

12–20s: Moving − dir, speeding up.

20–22s: Moving − dir, constant speed −4 m/s

22–26s: Moving − dir, slowing down

26–30s: Stopped

b) Δx = Area between line & axis

$= (8s)(2\frac{m}{s}) + \frac{1}{2}(4s)(2\frac{m}{s}) = 16m + 4m = \boxed{20m}$

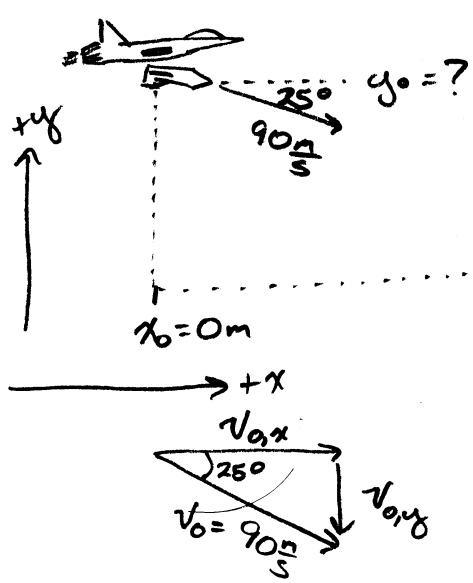
c) $\Delta x_{0-22s} = 16m + 4m + -16m + -8m = -4m$

$\Delta x_{0-22} = x_f - x_0 \Rightarrow -4m = x_f - 70m$

$\boxed{x_f = 66m}$

d) $a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t_f - t_0} = \frac{0\frac{m}{s} - (-4\frac{m}{s})}{26s - 22s} = \frac{+4\frac{m}{s}}{4s} = \boxed{+1\frac{m}{s^2}}$

Problem 5



$a_x = 0\frac{m}{s^2}$

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

$v_{0,x} = 90\frac{m}{s}\cos 25° = 81.56 m/s$

$v_{0,y} = 90\frac{m}{s}\sin 25° = -38.03 m/s$ ← negative because arrow is 'down'

x-dir	y-dir
$x_f = \frac{1}{2}a_x t^2 + v_{0,x}t + x_0$	$y_f = \frac{1}{2}a_y t^2 + v_{0,y}t + y_0$
$900m = (81.56\frac{m}{s})t$	$0m = \frac{1}{2}(-9.8\frac{m}{s^2})(11.03s)^2 + (-38.03\frac{m}{s})(11.03) + y_0$
$\boxed{t = 11.03s}$	Solve for y_0:
	$\boxed{y_0 = 1015.6m}$