ANSWERS!!!

Motion Graphs

1a. *(Point D… has the slope of greatest magnitude… it is steepest! And the slope of a position time graph tells you the velocity)*

1b. *(Point B to Point D…. the magnitude of the slope of the line tangent to the curve increases between these two points)*

1c. (A to B, and D to F… the magnitude of the slope of the line tangent to the curve is decreasing)

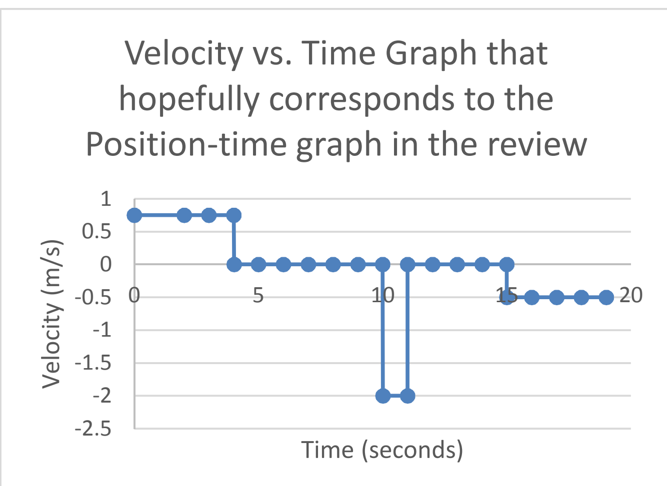
1d. (At point B, before B the slope was positive indicating a positive velocity, thus moving right…. After B the slope is negative indicating a negative velocity, thus moving left.)

1e. *(B to F… the slope of the tangent line is negative, indicating a negative velocity, thus moving left…. As we approach f the slope is nearing zero indicating that we are coming to a stop by the time F is reached.)*

2a. The object is at rest during B and D… the slope is zero during these sections indicating zero velocity.

2b. The velocity during section C is equal to the slope of that section, the rise was -2m and the run was 1s so the slope was -2m/s.

2c.



2d. Since the given graph was Position vs. Time and displacement is defined as the change in position….. the final position was -2m and the initial position was -1m so the change in position is -2m – (-1m) = **-1m.. the answer is -1m.**

2e. The total distance is 7m. (it moved 3m during section A, moved 2m during section C, and moved 2m during section E.)

3a.The displacement is found by finding the area "under the curve." Rectangle a has an area of 6m, Triangle B and area of 2m, Triangle C -2m, Rectangle D -2m, and Triangle E -1m…. so the displacement is +3m when those quantities are summed. You must pay attention to the signs because displacement is a vector so direction matters.

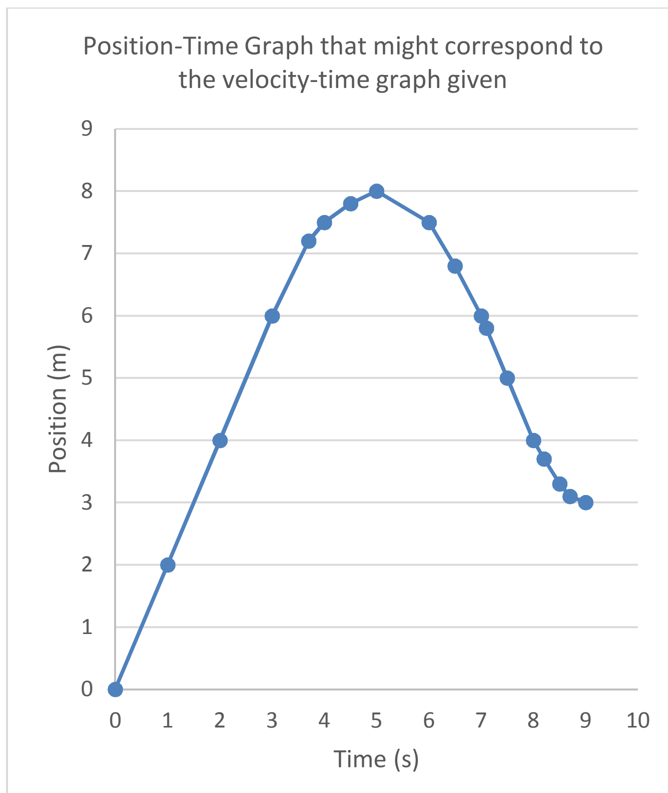
3b. The total distance is found by adding the lengths found when finding the area…. But ignoring the negative signs because distance is a scalar and direction doesn't matter.

3c. The slope of a velocity time graph is the acceleration. Wherever it is steepest is where the acceleration has the greatest magnitude… so during section E….. 2m/s^2.

3d. The object changes direction when its velocity changes sign, so right at 5 seconds. Before five seconds it had a positive velocity, after 5 seconds it had a negative velocity.

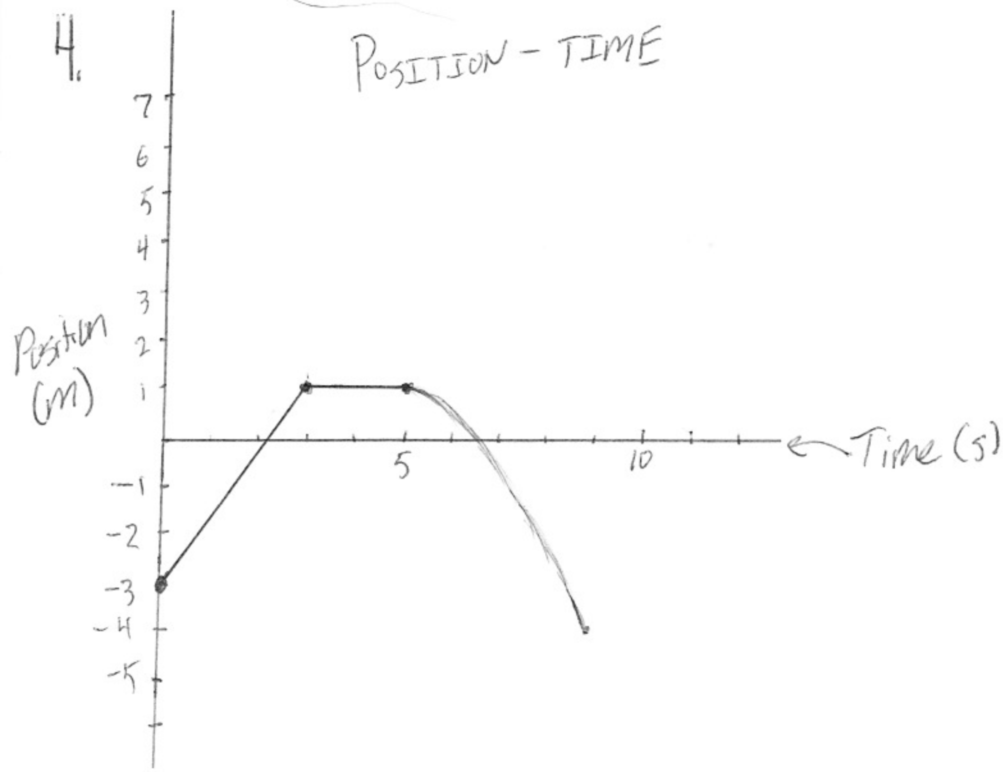
3e. The object is moving to the left if its velocity is negative. Look at the graph. It is moving to the left during sections C, D, and E…. because that is when it has negative velocities according to the graph scale.

3f.

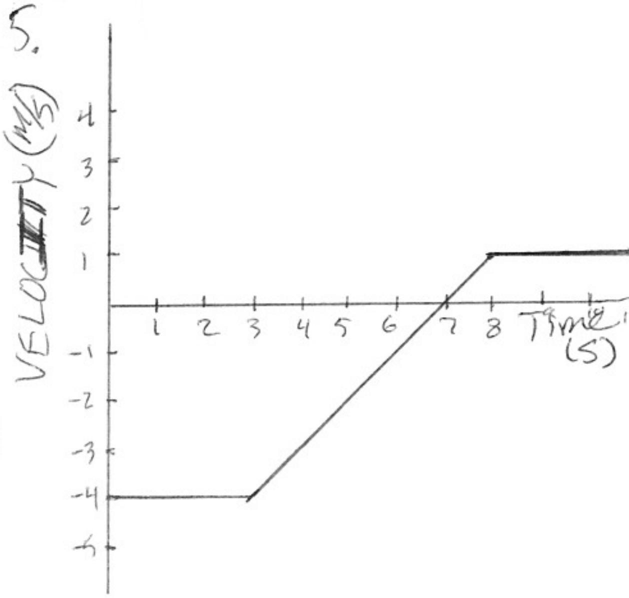


So… hopefully linear for 0-3 seconds indicating constant velocity…. Also linear from 7-8 seconds for the same reason. Curvy elsewhere indicating we have acceleration.

4.



5.



III LAB QUESTIONS

a. A GATE VELOCITY

$V_A = \frac{\Delta X}{t_A} = \frac{1.5\,cm}{0.0309\,s} = 48.5\,\frac{cm}{s}$

b. B GATE VELOCITY

$V_B = \frac{\Delta X}{t_B} = \frac{1.5\,cm}{0.0100\,s} \quad 150\,\frac{cm}{s}$

c. Average velocity

$V_{avg} = \frac{\Delta X}{t_{AB}} = \frac{0.30\,m \cancel{cm}}{\bigcirc}$ ← TOTAL ~~DISTANCE~~ DISPLACEMENT ← OOPS FORGOT THAT!!! ← TOTAL TIME

SO.....

$V_{avg} = \frac{V_A + V_B}{2} = \frac{48.5 + 150}{2} = 99.25\,\frac{cm}{s}$

d. Acceleration

$a = \frac{\Delta V}{t} = \frac{V_B - V_A}{t_{AB}} = \frac{150 - 48.5}{\bigcirc}$ ← DARN IT!

SO.....

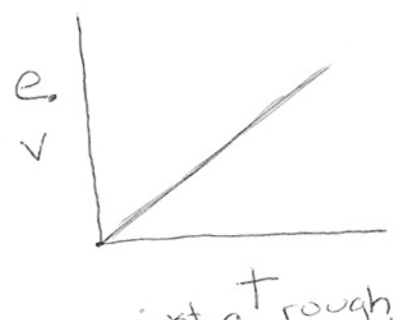
$V_f^2 = V_0^2 + 2a\Delta X$

B, A, TOTAL DISPL.

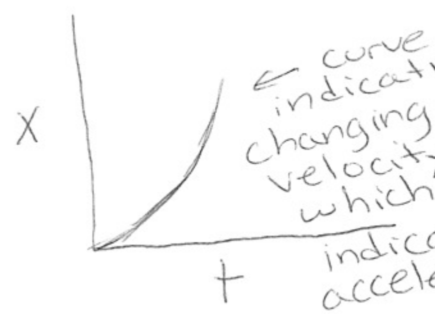
$\underset{cm/s}{150^2} = \underset{cm/s}{48.5^2} + 2a\underset{cm}{(30)}$ ← unit agreement!

$335.8\,\frac{cm}{s^2} = a$

e.



just a rough sketch... ideally slope would correspond to acceleration, but without a scale... oh well



← curve indicating changing velocity... which ~~is~~ indicates acceleration

PROBLEM SOLVING

65.

$v_0 = 15\frac{m}{s}$
$\Delta y = -2m$
$a = -9.8\frac{m}{s^2}$
$t = ?$

$$\Delta y = v_0 t + \frac{1}{2}at^2$$
$$-2 = 15t + \frac{1}{2}(-9.8)t^2$$
$$0 = 2 + 15t - 4.9t^2$$

solve for time by using the QUADRATIC FORMULA or by using your graphing calculator.

$\boxed{t = 3.19s}$ ONLY THE POSITIVE ROOT MAKES SENSE

66.

$a = -9.8 m/s^2$
$V_0 = 20 m/s$
$\Delta y = -10m$
$V_f = ?$

$$V_f^2 = V_0^2 + 2a\Delta y$$
$$V_f = \sqrt{V_0^2 + 2a\Delta y}$$
$$V_f = \sqrt{(20)^2 + 2(-9.8)(-10)}$$
$$\boxed{V_f = -24.4\frac{m}{s}}$$

DIRECTION

b. $t = ?$

$$\Delta y = V_0 t + \frac{1}{2}at^2$$
$$-10 = 20t + \frac{1}{2}(-9.8)t^2$$
$$0 = 10 + 20t - 4.9t^2$$
$$\boxed{t = 4.53s}$$

YES, YOU COULD HAVE USE THE V_f YOU FOUND IN PART A .... BUT WHAT IF YOU GOT THAT WRONG? ... IT'S NICE TO USE GIVENS THAT HAVEN'T BEEN MESSED AROUND WITH.

67.

PART 2 IS THE ROCKET SLOWING DOWN BECAUSE IT IS IN FREE FALL

$V_{TOP} = 0 = V_f$
$a = 9.8 m/s^2$
$\Delta y = ?$
$V_0 = +900 m/s$

$$V_f^2 = V_0^2 + 2a\Delta y$$
$$0 = 900^2 + 2(-9.8)\Delta y$$
$$\boxed{413265m = \Delta y}$$

MUST FIND THE SPEED OF THE ROCKET HERE

$$V_f = V_0 + at$$
$$V_f = 0 + 30(30)$$
$$= 900\frac{m}{s}$$

THE final velocity of part 1 becomes the initial velocity of part 2.

PART I. ROCKET FIRING.

$a = +30 m/s^2$
$t = 30s$
$V_0 = 0\frac{m}{s}$
$\Delta y = ?$

$$\Delta y = \cancel{V_0 t} + \frac{1}{2}at^2$$
$$\Delta y = \frac{1}{2}(30)(30)^2$$
$$= \boxed{13500m}$$

This is how much altitude is gained while the rockets fire.

c. V-t Graph Sketch!

a. $\text{TOTAL ALT} = 13500m + 413265m$
$= \boxed{54827m}$

b. Total Time in air

$t_{total} = 30s +$ Time for rocket to come back down after it runs out of fuel

$= 30 + 197.6s$
$= \boxed{227.6s}$

$t = ?$
$a = -9.8 m/s^2$
$V_0 = 900 m/s$
$\Delta y = -13500m$

$$\Delta y = V_0 t + \frac{1}{2}at^2$$
$$-13500 = 900t - 4.9t^2$$
$$t = 197.6s$$