**Unit 1 Measurement in Physics and 1-D motion**
**IB 1.1, 1.2, 2.1 Review Worksheet Answers** **Name:** _____

1. **Convert between Scientific Notation and Standard Notation**

| | | | | | |
|---|---|---|---|---|---|
| a. | 0.00000978 L | **$9.78 \times 10^{-6}$ L** | d. | $6.130 \times 10^{-9}$ m | **0.000 000 006130 m** |
| b. | 837,100,000 $cm^3$ | **$8.371 \times 10^{8}$ $cm^3$** | e. | $1.2552 \times 10^{7}$ J | **12,552,000 J** |
| c. | 0.005930 g | **$5.930 \times 10^{-3}$ g** | f. | $1.05 \times 10^{9}$ Hz | **1,050,000,000 Hz** |

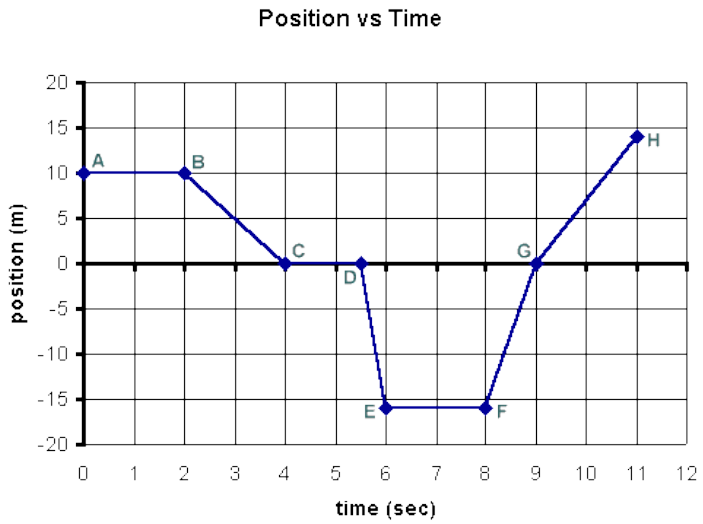
2. **Perform the following conversions using dimensional analysis. (Factor label method.) Show your work.**
   a. 78.92 $m^3$ to L

$$78.92\ m^3 \cdot \left(\frac{100\ cm}{1\ m}\right)^3 \cdot \frac{1\ mL}{1\ cm^3} \cdot \frac{1\ L}{1000\ mL} = \mathbf{78{,}920\ L}$$

   b. 3.97 $m/s^2$ to $ft/min^2$

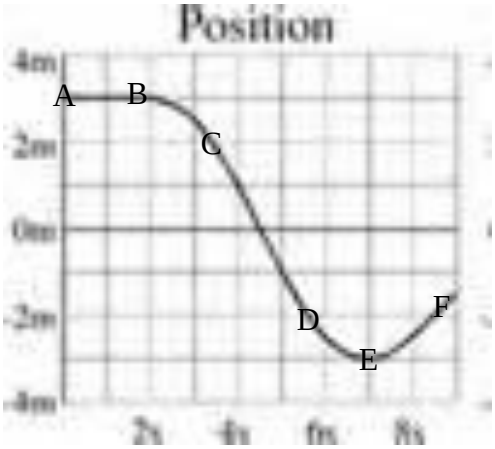
$$\frac{3.97\ m}{1\ s^2} \cdot \left(\frac{60\ s}{1\ min}\right)^2 \cdot \frac{100\ cm}{1\ m} \cdot \frac{1\ in}{2{,}54\ cm} \cdot \frac{1\ ft}{12\ in} = \mathbf{4.69 \times 10^4\ ft/min^2}$$

3. **For each time interval (e.g. A to B), describe the motion represented by the following position versus time or velocity versus time graphs.**
   a.



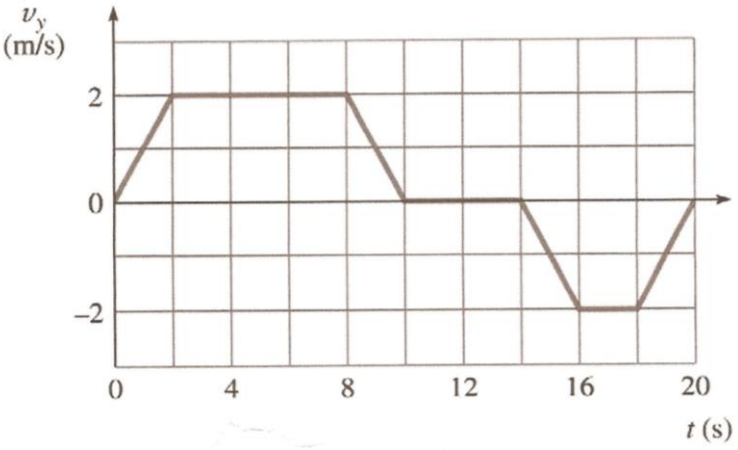

**Answers in bold are min required answers.** Non-bolded are more complete answers.
**A to B: At rest** at a position 10 m to the right of origin**.**
**B to C: Moving with a slower constant negative velocity** at -5 m/s for 2 seconds to move from a position of 10 m to the right of the origin to the origin**.**
**C to D: At rest** at the origin.
**D to E: Moving with a fast constant negative velocity** at -32 m/s for 0.5 sec to move from the origin to a position 16 m to the left of the origin.
**E to F: At rest** at a position 16 m to the left of the origin
**F to G: Moving with a fast constant positive velocity** at 16 m/s for 1 sec to return to the origin from 16 m to the left of the origin.
**G to H: Moving with a slower constant positive velocity** at 7 m/s for 2 seconds to move from the origin to 14 m to the right of the origin.

b.



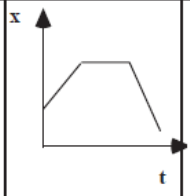
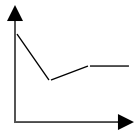
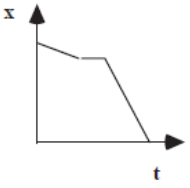
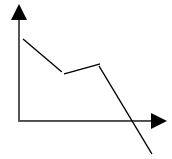
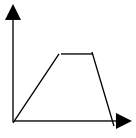
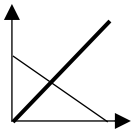
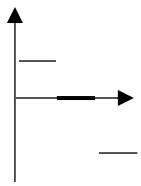
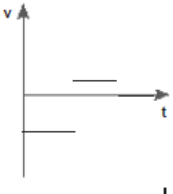
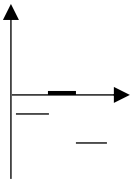
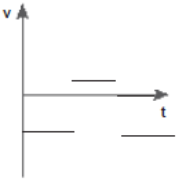
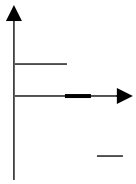
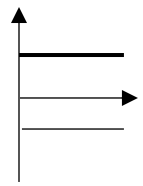

**A to B: At rest** 3 m to the right of the origin
**B to C: Negative constant acceleration moving left speeding up**
**C to D: Moving with a constant negative velocity** moving past the origin
**D to E: Positive constant acceleration moving left slowing down**
**E to F: Turning around at E continuing with a positive constant acceleration but now moving right speeding up**

c. **A to B: Positive acceleration moving right speeding up**

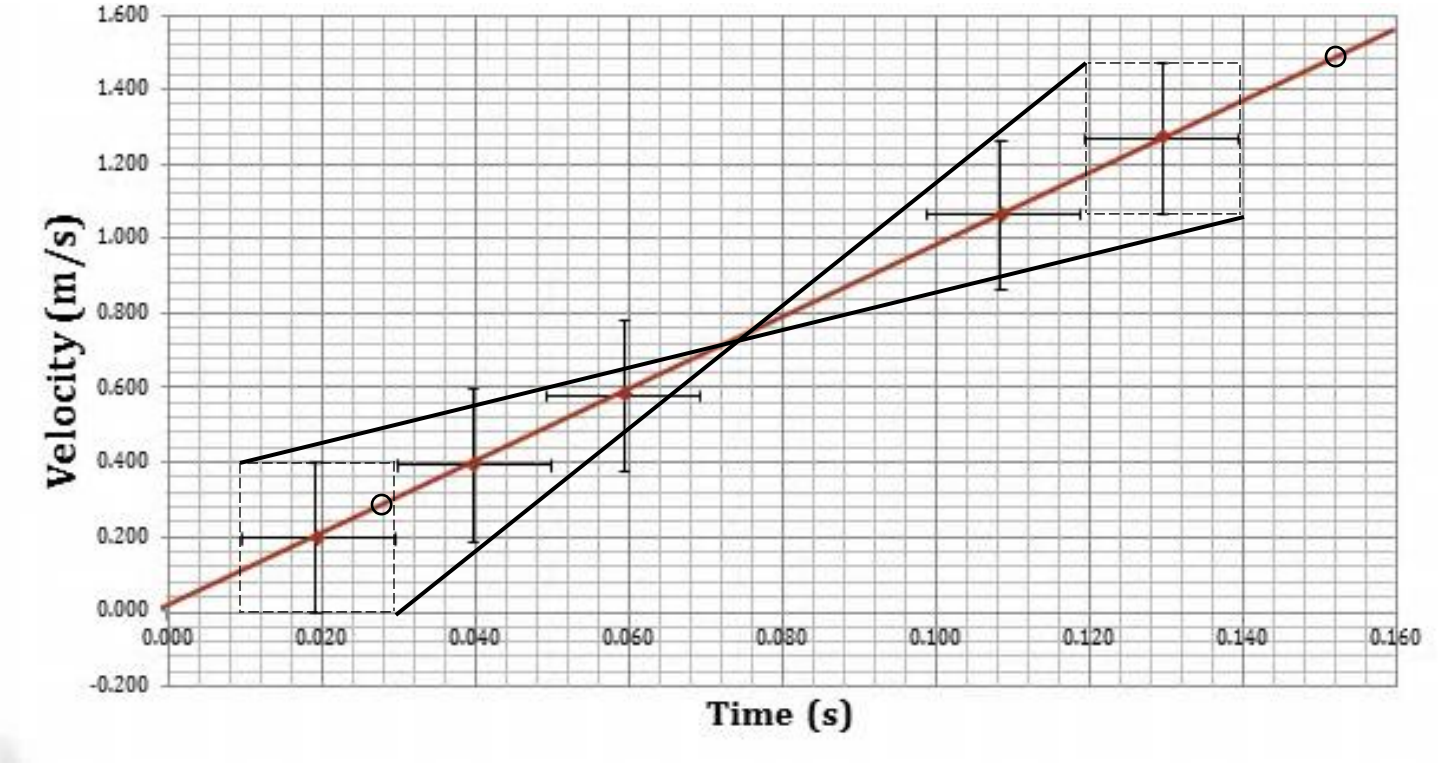



**B to C: Moving with a constant positive velocity of 2 m/s**
**C to D: Negative acceleration moving right slowing down**
**D to E: At rest for 4 seconds**
**E to F: Negative acceleration moving left speeding up**
**F to G: Moving with a constant negative velocity of -2 m/s**
**G to H: Positive acceleration moving left slowing down**

**4. Complete the following table by drawing the x vs t and v vs t graphs or describing the motion as needed.**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| x vs. t graph |  |  |  |  |  |  |
| v vs. t graph |  |  |  |  |  |  |
| Written Description | Object moves with constant positive velocity<br>Then stops.<br>Then moves with constant negative velocity | Object moves with constant negative velocity, turns around then moves with slower constant positive velocity, then stops. | Object moves slowly with constant negative velocity, stops, then continues on faster with a constant negative velocity | Object moves with constant negative velocity, turns around moving with a slower constant positive velocity, then turns around again moving with a slightly more negative constant velocity | Object moves with constant positive velocity for 4 seconds. Then, it stops for 2 seconds and returns to the initial position in 2 seconds. | Object A starts 10m to the right of the origin and moves to the left at 2 m/s.<br>Object B starts at the origin and moves to the right at 3m/s. |

5. **Consider the following graph. Determine the equation of the best fit line. Then use a min and max line to assess the uncertainty in the slope and intercept of the best fit line. See https://www.youtube.com/watch?v=5Nl39d5D7lo for help. (Note that he uses actual data points because they happen to lie directly on the line. In general, do not use data points, but choose points ON THE LINE)**




**For Best Fit line:**

Points I chose: (0.0280,0.2800) and (0.1520, 1.4800)

m = (1.4800 – 0.2800)/(0.1520 – 0.0280) = 1.200/0.124 **m = 9.6774 m/s$^2$**

1.4800 = (9.6774)(0.1520) + b **b = 0.00903 m/s**

**Data points: first (0.019, 0.200) last (0.129, 1.270) Errors: $\Delta x = 0.01$ $\Delta y = 0.2$**

**Max line: 2 points from error boxes (0.029, 0.000) (0.119, 1.470)**

m = (1.470 – 0.000) / (0.119 – 0.029) = 1.47/0.09 **m = 16.333 m/s$^2$**

1.470 = (16.333)(0.119) + b **b = -0.4737 m/s**

**Min line: 2 points from error boxes (0.009, 0.400) (0.139, 1.070)**

m = (1.070 – 0.400)/(0.139 – 0.009) = 0.67/0.13 **m = 5.1538 m/s$^2$**

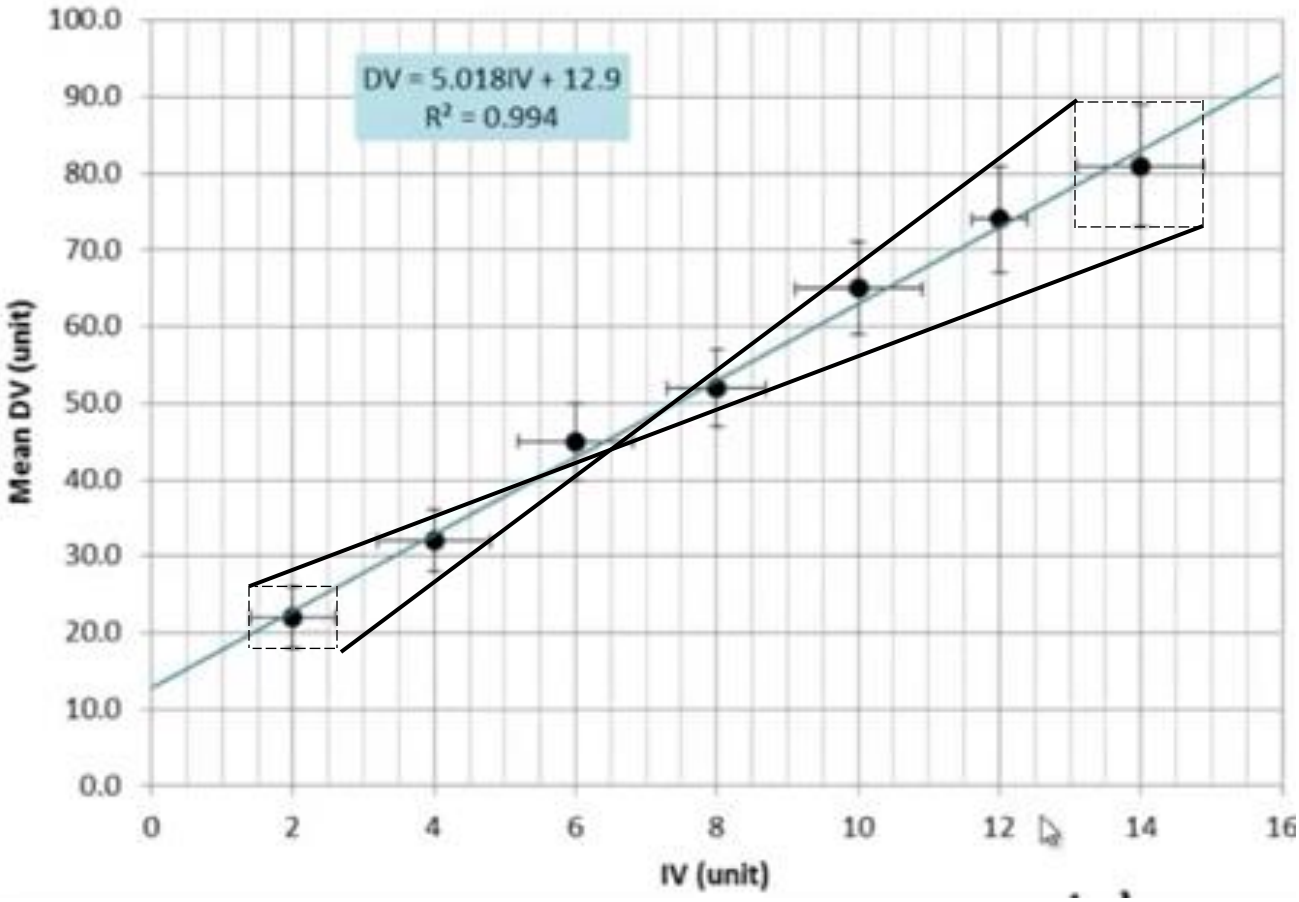
1.070 = (5.1538)(0.139) + b **b = 0.3536 m/s**

**Error in the slope: (16.3333 – 5.1538)/2 $\Delta m = 5.59$ Round to 1 sigfig = 6 m/s$^2$**

**Error in intercept: (0.3536 - -0.4737)/2 $\Delta b = 0.41365$ Round to 1 sigfig = 0.4 m/s**

**Best fit line eqn with error and rounded slopes and errors: $y = (10 \pm 6\ m/s^2)\ x + (0 \pm 0.4\ m/s)$**

**b. Try another one. The best fit line is already completed here. Assess the uncertainty in the gradient and intercept. Then see: https://www.youtube.com/watch?v=Bkp6nHoS_p4 to check your answer.**




**Max line 2 pts: (2.6, 18) (13.1, 89)**

m = (89 – 18) / (13.1 – 2.6) = 71/10.5 **m=6.7619**

89 = 6.7619*13.1 + b **b = 0.419**

**Min line 2 pts: (1.3, 26) (14.8, 73)**

m= (73 – 26) / (14.8 – 1.3) = 47 / 13.5 **m=3.4815**

73 = 3.4814*14.8 + b **b = 21.474**

**Error in slope: 6.7619 – 3.4815 / 2** **$\Delta$m = 1.64 round to 1 sigfig = 2 (or 1.6)**

**Error in intercept: 21.474 – 0.419 / 2** **$\Delta$b = 10.5 round to 1 sigfig = 10**

**Best fit line equation with uncertainties and rounded to match uncertainties:**

**DV = (5 $\pm$ 2 ) IV + (10 $\pm$ 10) or DV = (5.0 $\pm$ 1.6) IV + (10 $\pm$10)**

6. **Given the following values, determine the indicated quantities with their uncertainties.**
   **A = 15.3 ± 0.3**
   **B = 3.54 ± 0.05**
   **C = 0.046 ± 0.008**

   a. **Q = A + B** Q = 15.3 + 3.54 = 18.84
   $\Delta Q = \Delta A + \Delta B$ $\Delta Q = 0.3 + 0.05 = 0.35$ round to 1 sigfig = 0.4
   Round Q to 0.1 dp **Q = 18.8 ± 0.4**

   b. **Q = AC** Q = 15.3 * 0.046 = 0.7038
   $\frac{\Delta Q}{Q} = \frac{\Delta A}{A} + \frac{\Delta C}{C}$ $\frac{\Delta Q}{0.7038} = \frac{0.3}{15.3} + \frac{0.008}{0.046}$ $\Delta Q = 0.1382$ round to 0.1 or 0.14
   Round Q: **Q = 0.7 ±0.1 or 0.70 ± 0.14**

   **c. Q = $B^2$**
   $\frac{\Delta Q}{Q} = 2\left(\frac{\Delta B}{B}\right)$

7. **Estimate the following to a one sigfig order of magnitude. Justify your answer. (NOTE: any answer in the same kind of ball park ± one order of magnitude is correct, as long as you have an argument to back your assertion.)**
   a. The average number of hairs on a person's head.
   # hair follicles in a square centimeter? ~100 – 1000
   # $cm^2$ surface of hair coverage on head.,, if roughly a cube with each side 10 cm, and 4 faces covered…~400 $cm^2$ or 4 x $10^{4 \text{ or } 5}$ hairs on a person's head (40,000-400,000) or **about 1 x $10^5$ hairs**

   b. The number of pages in an encyclopedia set that fills a 1 m wide two shelf bookcase.
   Probably 90% of the width is page with 10% for covers and bits of space between books. Slick book pages are thinner than printer paper reams. Easily twice as thin, so 1000 pages for each ~ 5 cm... for 90 cm. so 18,000 pages per shelf x 2 = 36,000 pages so **about 4 x $10^4$ pages**

   c. The number of carbon atoms in a newborn baby.
   10 lbs ~ for a newborn.. 500 g /lb 5000 g Let's say 3/4 of that is water and inorganic stuff, with about 1000 g being organic stuff. Carbon makes up about half of organic compounds so about 600 g carbon. (12 g/mole) so ~50 moles 50 x 6 x $10^{23}$ so **about 3 x $10^{25}$ C atoms in a newborn**

## 8. Solve the following problems with no acceleration.

a. Calculate the total displacement and the total distance of a mouse walking along a ruler, if it begins at the position x = 5cm, and then does the following:
- It walks to x = 12cm
- It then walks a displacement of -8cm
- Lastly, it walks to the location x = 7cm

**Displacement = 2 cm  Distance = 18 cm**

b. Find the average velocity (in m/s) of a bicycler that starts 150 meters north of town and is 1200 meters north of town after 30.0 minutes.

**0.583 m/s**

## 9. Solve the following constant acceleration problems.

a. A boat moves slowly inside a marina with a constant speed of 1.50 m/s. As soon as it leaves the marina, it accelerates at 2.40 $m/s^2$. How fast is the boat moving after accelerating for 5.00 s? How far has the boat traveled in this time?

**13.5 m/s  37.5 m**

b. A rocket blasts off and moves straight upward from the launch pad with constant acceleration. After 3.0 s the rocket is at a height of 77 m. What are the magnitude and direction of the rocket's acceleration? What is its velocity at this time?

**17 $m/s^2$  51 m/s**

## 10. Solve the following freefall problems.

a. You shoot an arrow into the air. Two seconds later the arrow has gone straight upward to a height of 30.0 m above it's launch point. What was the arrow's initial velocity? How long did it take for the arrow to first reach a height of 15.0 m above its launch point?

**24.8 m/s  0.702 s**

b. A gull ascending straight upward at 5.20 m/s drops a shell when it is 12.5 m above the ground. What are the magnitude and direction of the shell's acceleration just after it is release? Find the maximum height above the ground reached by the shell. How long does it take for the shell to reach the ground? What is the velocity of the shell at this time?

**– 9.81 $m/s^2$ down, like all freefall, however, it's velocity is temporarily positive, directed upward, but slowing down until it reaches its max height:  13.9 m**
**2.21 sec  – 16.5 m/s**