**Physics 181**
**Spring 2020**
**Exam 1 Practice Problems**

SOLUTIONS

Correctly state the final answers and errors properly rounded.

1.) $0.9823 \pm 0.3281 \frac{m}{s}$

$1.0 \pm 0.3 \ m/s$

2.) $109.345 \pm 1.604 \frac{cm}{s^2}$

$109 \pm 2 \ cm/s^2$

3.) $313.2451 \pm 19.4130 \ cm$

$310 \pm 20 \ cm$

Propagate errors for the following functions.

4.) $Q = 16x^3$

$S_q = |q| \sqrt{\left(\frac{3S_x}{x}\right)^2} = (16x^3)\left(\frac{3S_x}{x}\right) = \boxed{48x^2 S_x}$

5.) $A = B + D^3$

$\boxed{S_A = \sqrt{(S_B)^2 + (3D^2 S_D)}}$

6.) $L = 5z(\underbrace{x + y^2}_{A})$

$A = x + y^2$

$S_A = \sqrt{(S_x)^2 + (2y S_y)^2}$

$\boxed{S_L = |L| \sqrt{\left(\frac{S_z}{z}\right)^2 + \frac{(S_x)^2 + (2y S_y)^2}{(x + y^2)^2}}}$

Example of an experimental question.

7.) **Density of Water**

a. Using proper tools, take data measurements and fill out the following table. Do not subtract the mass of the dry cylinder. (NOTE: this table is filled out to provide

an example for the review. In an exam, you would be asked to take data and record units. The information in red here would not be provided in an experimental question on an exam)

| total mass ( g ) | volume ( mL ) |
|---|---|
| 68.00 | 9.5 |
| 70.00 | 11.6 |
| 72.00 | 13.5 |
| 74.00 | 15.7 |
| 76.00 | 17.5 |
| 78.00 | 19.6 |

b. Derive a value for the density of water, $\rho$. Explain how you arrived at this answer.

$\rho = m/V$. If we plot mass as the independent variable & volume as the dependent, then slope $= V/m \Rightarrow \rho = \text{slope}^{-1}$

$\therefore \rho = 0.9943$ from 2D stats

c. Calculate the error, $S_\rho$, on your density, $\rho$. Then, properly report your answer.

$\rho = \text{slope}^{-1}$

$$S_\rho = |\rho| \sqrt{\left(\frac{S_{slope}}{slope}\right)^2} = \left(\frac{1}{slope}\right)\left(\frac{S_{slope}}{slope}\right) = \frac{S_{slope}}{slope^2}$$

$\therefore S_\rho = S_{slope}$ from 2D stats $= 0.0105$ $\rho = 0.994 +/- 0.011$ g/mL

d. Using the accepted density for water, calculate your percent difference.

$\rho_{accepted} = 0.99823 \frac{g}{mL}$

$$\%\ diff = \left|\frac{exp - acc}{acc}\right| = \left|\frac{0.994 - 0.99823}{0.99823}\right| \times 100\%$$

$\%\ diff = 0.39\ \%$

e. Perform a precision vs. accuracy test, then comment on the reliability of your experimental procedure and types of errors present.

$|X_{acc} - X_{exp}| \ ?\ S_x$

$|0.99823 - 0.994| \ ?\ S_m\ 0.011$

$|0.00423| < 0.011$

systematic errors are negligable. our answer can be considered accurate

f. Derive a value for the mass of the dry cylinder, $m_{cyl}$, and the associated error. Formally report your answer.

For the dry cylinder, volume = 0 (y-axis)

$y = 0 \rightarrow 0 = mx + b \rightarrow x = -b/m$

Then, $S_x = |x| \sqrt{\left(\frac{S_b}{b}\right)^2 + \left(\frac{S_m}{m}\right)^2}$

Example of non-experimental problems (further application of experimental concepts used in lab, similar to the Questions section in each report).

8.) You are located 15 meters away from a stationary firetruck, which suddenly turns its sirens on. If sound travels at a speed of 343 m/s, how long does it take the sound wave to reach you?

$x = vt \rightarrow t = x/v$

$t = \frac{15\ m}{343\ m/s} = 0.04\ s$

9.) You measure the density of an unknown metal ring to be $\rho = 7.78\ g/cm^3$. What metal is the ring most likely comprised of? Justify your answer.

| Metal | Density ($g/cm^3$) |
|---|---|
| Iron | 7.87 |
| Copper | 8.96 |
| Silver | 10.49 |

They should show a % diff calc for each. whichever has the lowest % diff is your answer

Iron: $\left|\frac{7.87 - 7.78}{7.87}\right| \times 100 = 0.0114\ \%$

Copper: $\left|\frac{8.96 - 7.78}{8.96}\right| \times 100 = 0.13\ \%$

$\therefore$ metal is most likely Iron