Lab Write-ups

When writing a lab, **do not use a title page**. At the top of the page in the left corner, place your name, with your lab partner(s)'s name(s) underneath. In the center, write the title of the lab and in the right corner, write **the date(s) on which the experiment was conducted**.

Each lab should contain the following sections in the write-up (in this order):

Introduction: This section indicates the purpose for doing the lab and outlines any theory or explanation required for the lab (including equations). It is written in paragraph form.

including what the variables represent in your lab.

Equipment: This is just a list of equipment used for the lab. Do not include pencil and paper unless they were actually used to *conduct* the lab.

Procedure: This explains what was done during the lab. If the procedure is given to you, you do not need to repeat it. Reference it (e.g. See attached handout for procedure). You may also include diagrams of the equipment set up if necessary or convenient.

Data and Calculations: Data is any measurement or observation used in the experiment. If, for example, you start measuring one end of an object at the 10.00 cm mark on the ruler and find the other end at 16.35 cm, you must record **both** of these values. Often your data will be organized in tables.

Calculations include any graphs you produce. If a calculation is repeated several times, just show one example. However, all slope and percent difference calculations must be shown, or calculations involving error analysis.

Sources of Error: Lists sources of random and systematic errors. List all precision measures of all devices used. Be quantitative with sources of errors wherever possible (how big is the error likely to be?) Try to pick out the most important source of error. Discuss whether or not the results are expected or not. Try to explain any anomalies.

Conclusion: The conclusion is concise, specific and quantitative if possible. The conclusion refers back to the purpose of the lab and answers it by giving the specific results supporting your conclusions.

Discussion: Answers to questions answered in the lab are placed here. If you have written the procedure, you would also suggest how you may change the procedure were you to do it again or if you had more time.

Discussions and conclusions are SEPARATE sections! The discussion will typically take half a page (or more) but the conclusion will usually be 1/3 of a page or less.

N.B. Labs are due one week after they have been conducted **in class**. If you require time outside of class to complete the lab, or if you miss the lab day, you must complete the lab within 1 week. Labs not handed in by the due date will receive a zero. You will hand in one lab per lab group for all formal labs.

Uncertainties

- Limitation of the equipment
  - List precision measures of each measuring device used.
    - accuracy of equipment – smallest division of measurement on the scale
      - e.g. meterstick 1 mm.
        stopwatch 0.01 s

* unless different in manual.

- precision measure – $\pm \frac{1}{2}$ accuracy (analog)
  $\pm$ acc (digital)

- Limitation of method
  - how you use the device
    e.g. parallax
    friction
    reaction time

} assign reasoned values to these uncertainties

Error Analysis

$a \pm \delta a$ Q calculated from $a, b, c, \ldots$

$\delta Q = ?$

Adding / Subtracting

$a = 2.0 \pm 0.1$ cm

$b = 3.0 \pm 0.2$ cm

$Q = a + b$

$= (2.0 \pm 0.1\text{cm}) + (3.0 \pm 0.2\text{cm})$

$= 5.0 \pm 0.22$ cm (0.22: 1 digit)

$= 5.0 \pm 0.2$ cm

$\delta Q = \sqrt{(\delta a)^2 + (\delta b)^2}$

$= \sqrt{(0.1)^2 + (0.2)^2}$

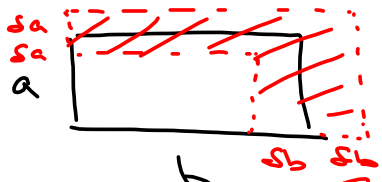
$= 0.22$

Same for + and −

$Q = b - a$

$= 1.0 \pm 0.2$cm

Mult / Div.



$a = 2.0 \pm 0.1\ cm$

$b = 3.0 \pm 0.2\ cm$

Fractional or % uncertainties

$$\frac{\delta Q}{|Q|} = \sqrt{\left(\frac{\delta a}{a}\right)^2 + \left(\frac{\delta b}{b}\right)^2}$$

$$Q = ab$$
$$= (2.0 \pm 0.1\ cm)(3.0 \pm 0.2\ cm)$$
$$= 6.0 \pm 0.5\ cm^2$$

$$\frac{\delta Q}{6.0\ cm^2} = \sqrt{\left(\frac{0.1}{2.0}\right)^2 + \left(\frac{0.2}{3.0}\right)^2}$$
$$= 0.083$$
$$\delta Q = 0.5\ cm^2$$

$$Q = \frac{b}{a}$$
$$= 1.5 \pm 0.1$$

Powers (roots)

$Q = a^2$ $\quad a = 2.0 \pm 0.1\ cm$

$Q = (2.0 \pm 0.1\ cm)^2$

$= 4.0 \pm 0.4\ cm^2$

$\delta Q = |n| x^{n-1} \delta x$ if $Q = x^n$

$\frac{\delta Q}{\delta x} = |n| x^{n-1}$

$Q = \sqrt{a} = a^{\frac{1}{2}}$

$= 1.41 \pm 0.07\ cm^{\frac{1}{2}}$