Lab: <Title here>
Date: MMM. DD, YYYY
Course: Sphxx

Name: <First & Last>

Partners: <First & Last>
<First & Last>
<First & Last>

Theory:

Attention to precision, accuracy and reliability in any investigation is extremely important. Small errors from reading a tool's scale or a lack of reliability with any of the equipment can cause major errors in one's data, resulting in poor lab results, potentially generating evidence that wrongly supports or refutes a hypothesis.

In this particular lab, two types of scales were used to measure mass; an electronic scale and a triple beam balance. A force meter was uses to measure the force of gravity acting on a number of different masses. Before the investigation was started, the equipment was carefully calibrated. Six observations were made with masses, ranging from 50g to 200g.

The precision of the measurements were recorded for each tool. The percent error was calculated for each measurement, and the average percent error was calculated for each tool; the force meter, the triple beam balance and the electronic scale.

Formula:

$$P.E. = \frac{m.v. - a.v.}{a.v} \times 100$$

where $m.v.$ represents measured value and $a.v.$ represents the accepted value.

Finally, the force of gravity was plotted against the accepted value for the mass. It was expected that the force of gravity should be directly correlated to the amount of mass placed on the force meter. The slope of the Force v.s. mass was also found. The theoretical formula for the force of gravity is defined as

Formula:

$$F_g = mg$$

where F is in Newtons(N) and g is the accepted value for the acceleration due to gravity ($9.8 m/s^2$)

Purpose:

To practice proper measurement techniques and to become familiarized with the error analysis methods and techniques.

Apparatus:

- 1-electronic scale
- 1-triple beam balance
- 1-force meter
- Various masses, ranging from 50g to 200g
- 1-retort stand with clamp

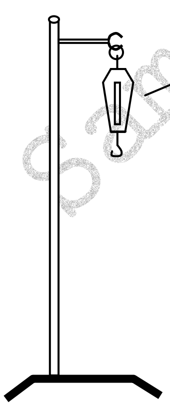


Figure 3: Force meter

Figure 1: Retort Stand

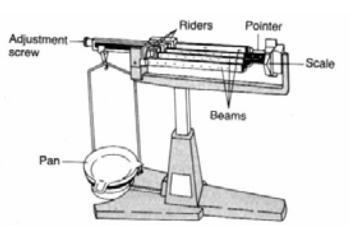


Figure 2- Triple Beam Balance
http://www.middleschoolscience.com/balance.jpg

Procedure:

1. Retort apparatus was set up as demonstrated in the apparatus section
2. A 50g mass was placed on the triple beam balance and its mass was recorded
3. The same 50g mass was placed on the electronic scale and its mass was recorded.
4. The 50g mass was then placed on the force meter and the force of gravity acting on the mass was recorded.
5. The precision of all three instruments were record
6. Steps 1-4 were repeated using 100g, 120g, 170g, and 200g
7. A plot of the force vs. the accepted mass was made and a line of best fit was traced on the plot
8. Two convenient points were selected on the line of best fit in order to calculate the slope of the line.
9. The slope of the line of best fit was calculated.
10. Percent error calculations between accepted and measured values for mass were performed on the measurements from both the electronic and triple beam balance scales.
11. Percent error calculations between accepted and measured values for force were performed on the measurements from the force meter.

Observations:

The table below contains the following measured values from steps 1-5 of procedure

- force (force meter)
- mass (triple beam balance)
- mass (electronic scale)
- mass (accepted values)
- precision of each measured quantity

F (N)	m (kg) Accepted	m (kg) Balance Beam	m (kg) Electronic Scale
______	precision	______	______

Insert any graphs here

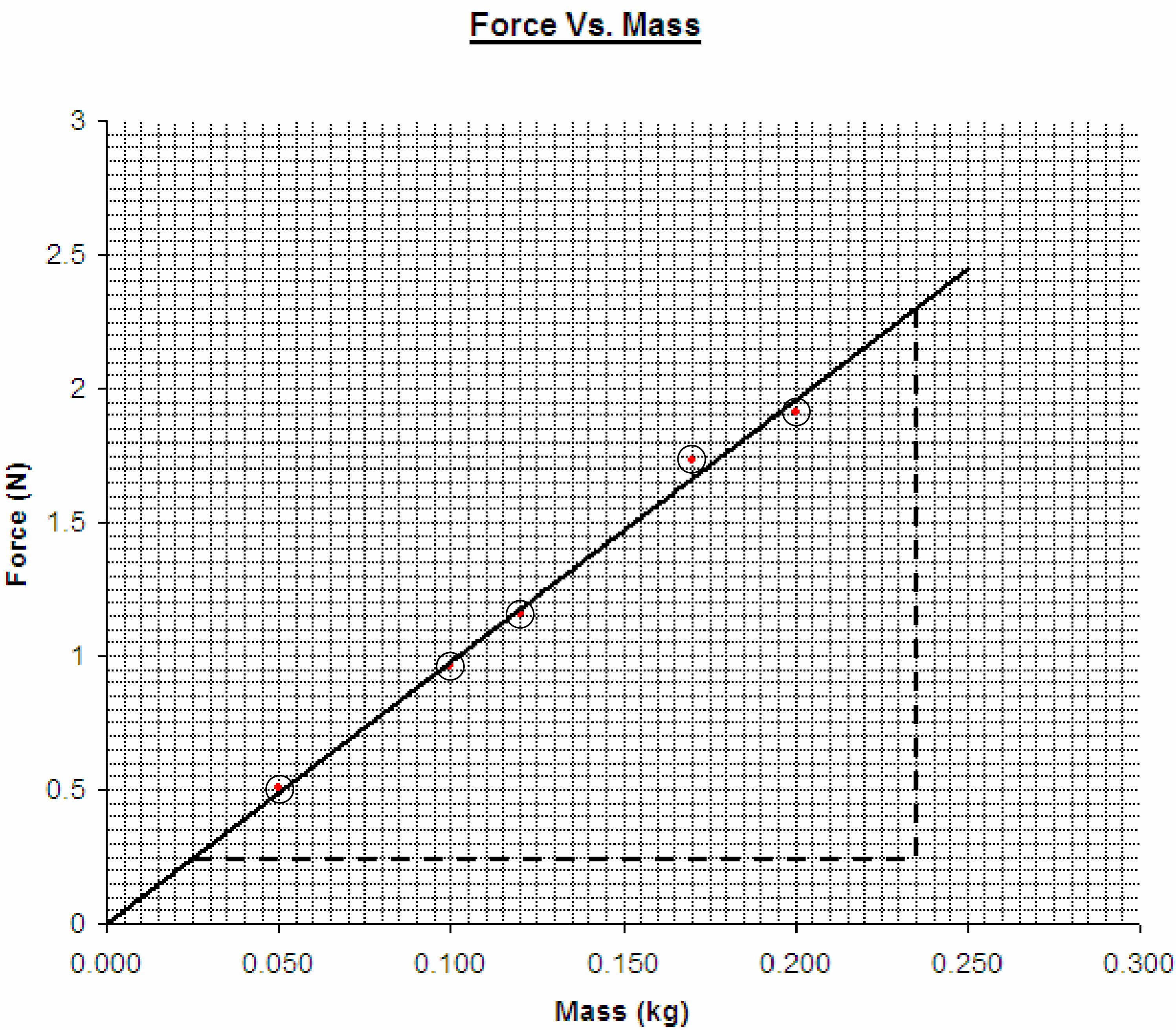
NOTE:

- All graphs are to be placed BETWEEN the OBSERVATION and CALCULATION section. NOT AT THE END! Leave blank pages if you must!

- NO CALCULATIONS are to appear on the graph itself.

- If a slope calculation is require, you MUST include your two slope points

- See example on the next page


Force Vs. Mass
3
2.5
2
1.5
1
0.5
0
Force (N)
0.000
0.050
0.100
0.150
0.200
0.250
0.300
Mass (kg)

Calculations:

all calculations should occur in this section, including the calculations required for the questions. Hence, every calculation requires a detailed header. Calculations should be done in Given, RTF, Formula and Solution format. Each calculation should have some descriptive heading for example

Slope calculation for Force vs. Mass plot

<table>
<tr>
<td><u>Given</u>
$x_1 = 0.025kg$
$x_2 = 0.235kg$
$y_1 = 0.25N$
$y_1 = 2.30N$</td>
<td><u>RTF</u>
Slope</td>
<td><u>Formula</u>
$m = \frac{\Delta y}{\Delta x}$</td>
</tr>
<tr>
<td colspan="3"><u>Solution</u>
$m = \frac{\Delta y}{\Delta x}$
$= \frac{y_2 - y_1}{x_2 - x_1}$
$= \frac{0.230 - 0.25}{0.235 - 0.025}$
$= 9.76N/m$
Therefore the slope of the Force vs. mass graph is $9.76N/m$</td>
</tr>
</table>

NOTE: READ THIS VERY IMPORTANT NOTE UNTIL YOU FULLY UNDERSTAND IT… UNLESS YOU LIKE TO DO MORE WORK THEN NECESSARY!!!!!!

You do not have to show full solution for every single calculation, just **ONE** per **<u>unique</u>** calculation.

Example: You have **<u>six</u>** percent error calculation for the Force meter, the balance beam, and the electronic scale. You only need to show full solution for the **FIRST** calculation for the Force meter, for the balance and for the electronic scale. The rest of the calculations you can simply record them in a table. In other words, you only show **three** full solutions, the rest go in a table. That reduces the number of full solutions from **18** to **3**.

Conclusions:

This investigation focused on measurement and analysis skills, specifically exploring the concepts of accuracy and precision, as well as direct and indirect correlation. This investigation highlighted the importance of accurate and reliable measurements and proper calibration of the equipment.

It was found that the most unreliable and least precise tool was the force meter. Its relatively unrefined scale made it difficult to make precise measurements. The electronic and triple beam balance scales also showed a degree of unreliability, as both devices gave inconsistent values for the masses. Calibrating the triple beam balance proved to be difficult, and occasionally would require a recalibration at some point during the experiment. These difficulties seemed to imply that there were mechanical flaws with the scale itself. The electronic scale also appeared to have inconsistencies. Several times during the course of the investigation, the electronic scale gave different readings for the same mass. Also, the scale would not zero correctly after removing a mass. The lack of reliability may be due, in part, to over uses of the scale. It should be noted that scale had a significant amount of dirt on the surface, which implies that dirt could also have been trapped in the most sensitive parts of the weighing mechanism, resulting in unreliable measurements.

Error analysis on the electronic scale showed that the average percent error between the accepted and measured values for mass was xx%. Error analysis on the triple beam balance found the average percent error between accepted and measured values for mass to be xx%.

The graph of the Force of Gravity vs. Mass did show a linear direct relationship between Force and Mass. However, there was significant error in the readings since many of the points did not land on the line of best fit. The slope of the Force vs. Mass graph gave a value of xx m/s^2 for the acceleration due to gravity which has a percent error of xx% compared to the accepted value of $9.8 m/s^2$.

Finally, error analysis on the force meter showed that the average percent error between the accepted and measured values for force was xx%.

Most of the reliability issues were a result of faulty or inaccurate equipment. In order to improve the reliability of the measurements, new or properly serviced equipment should be used, especially in regards to the force meter, which was the least precise tool used in the investigation. Furthermore, increasing the number of trials would improve the overall results. With only six trials, one exceptionally poor measurement would drastically affect the overall error observed. With additional trials, the impact of one poor measurement would be less significant.

Questions: in this section both the **full question** and solution must be here. Everything must be written in complete sentences in 3rd person past tense.