Name:____________________ ID No.:_____________ Date:______

Section:___________________ Score:______________

Preparatory Physical Science(PHSC 001)
Experiment No. 2
Measurement of Forces

Objectives

- The student will be familiar with weight measurement of a mass in earth's gravitational field
- The student will be familiar with measurement units
- The student will be familiar of how to plot a graph
- The student will be familiar with working with group of forces
- The student will be familiar with addition and subtraction of group of forces
- The student will be able to calibrate a spring balance

Methodology

This lab uses basic principles of measuring weights/forces of different masses using balance springs, and working with addition and subtraction of a group of two forces acting on an object using Newton's second law and basic vector addition. Making a scale for a non calibrated spring scale is done by loading it with mass pieces.

Key Terms

Mass Weight Net Force Calibration

Theory

The ***mass*** (m)of an object is the amount of matter in the object and is a measure of the inertia of the object. The ***weight*** (W)of an object is the force of gravity acting on it. Weight and mass and weight are not the same. The weight is a vector quantity directed downward always and has a unit of Newton (N), the mass is a scalar quantity and is measured in kilogram. Because the weight is a measure of the force of gravity, it can be calculated from Newton's second law of motion,

$$F = ma \ldots\ldots\ldots\ldots\ldots\ldots..(2.1)$$

Or

$$W = mg \ldots\ldots\ldots\ldots\ldots\ldots..(2.2)$$

Where ***g*** is the acceleration due to gravity and has an approximate value of 9.8 m/sec^2. The weight of the object never changes in a given location even if it is at rest (not moving). So it is always given as $w = mg$.

Force is any kind of a push or a pull on an object. When you push a box, you are exerting a force on it. When a hammer hits a nail, or truck pulling a small car, a force is being exerted. Figure 2.1 shows examples of exerted forces on objects.

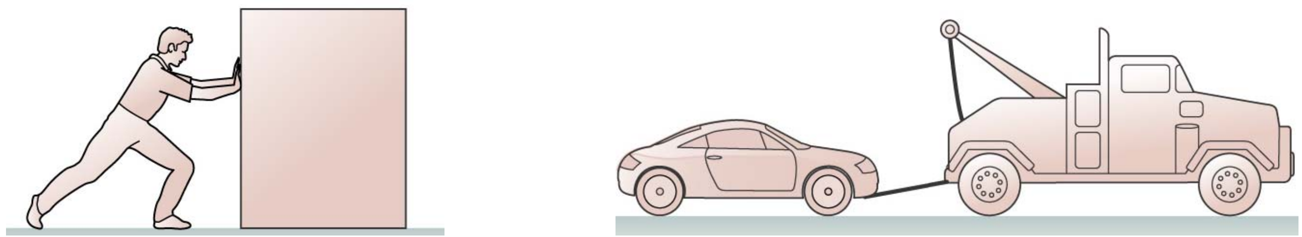


Figure 2.1 Examples of a force acting on an object.

Sometimes there are more than one force acting on an object. In this case we must apply simple arithmetic for finding the resultant or the net force. The ***net force*** or $\sum \boldsymbol{F}$, with the symbol $\sum$ stands for "sum of", and $\boldsymbol{F}$ stands for force, is the vector sum of all forces acting on the object. Two or more forces in the same direction add up and forces in opposite directions subtract. Convenience is used to give positive sign for forces to the right of the origin of coordinate system and a negative sign to a force to the left of the origin. Upward forces are positives and downward forces are negatives.

Materials and Equipments

- Support base
- Support rod, 600mm
- Support rod, m. hole, 100mm
- Double clamp
- Weight holder, 10g
- Slotted weight, 10g, and 50g
- Spring balance, 1N, and 2N
- Non calibrated spring balance
- Board marker pen

Part A: measuring the weight of a mass in earth's gravitational field with a spring balance.

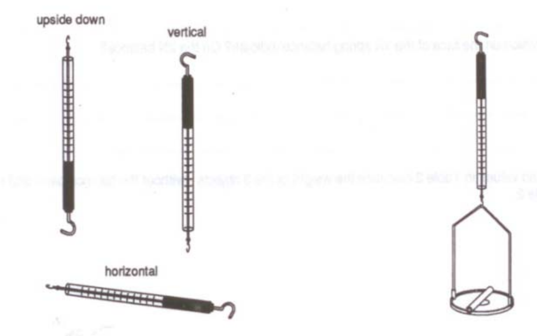


Figure 2.1 spring balance

1. Hold the 2N balance spring as in Figure 2.1 : first vertically, then horizontally, and finally upside down. Observe the spring balances' indicator scale carefully. In either case the indicator must be on the zero point level; if it is not then hold the spring in the vertical position and adjust the indicator by loosening the screw at the top and turning the hook until the indicator points exactly at the zero mark
2. Set up the apparatus as shown in Figure (2. 1). Insert the spring balance in the "blind hole" of the short support.
3. Clamp the spring balance vertically upward and make sure its reading indicator is set to zero.
4. Hang the weight holder (m=10g) on the spring balance and note its weight W on the spring indicator.
5. Apply Eq.(2.2) to find the weight of the 10g weight holder and compare your result with measured value in step 3.

6. Add a 10g weight to the weight holder and note the indicated value on the spring's indicator. Apply Eq.(2.2) to find the theoretical weight value.

7. Repeat step 5 for up to 100g.

8. Record your data in Table 1.

9. Plot on a graph of Force F (N) on the vertical y-axis versus mass m(g) on the horizontal x-axis and find the slop (use the correct units).

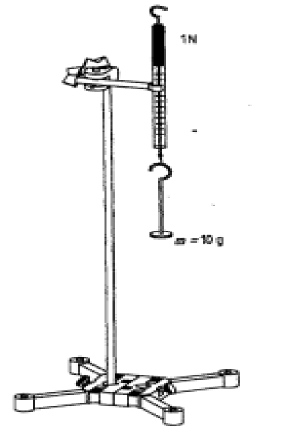
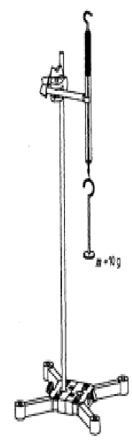


Figure 2.2: Set up to measure weights

Part B: Calibrating a spring balance (making spring balance's scale)

1. In this part you will be given an unmarked spring balance and asked to ***calibrate*** it i.e, to make marks on it.
2. Set up the apparatus for this part as shown in Figure (2.3). Hang and secure the spring balance in the blind hole of the short support rod . Make sure that the spring balance cannot slip downward.
3. Set the zero mark about 1 cm below the green sleeve and mark its location with the board marker pen on the transparent part of the casing.
4. Hang the 10g weight holder on the spring balance. The weight of the holder is about 0.1 N. Mark the position of the indicator.
5. Increase the mass in 10 g increments and mark the location of each division.
6. Label the markings with the corresponding values for the weight (force) in newtons.



. ***Figure 2.3: Calibration of a spring balance***

Part C: Addition and subtraction of forces

1. Set up the apparatus as shown in Figure (2.4). Make sure that the balances are always in a vertical position. First hang the weight holder on the 1N spring balance and place a 10g mass piece on it (total mass is 20 g). Note the force F_1. Hang the 2N spring balance upside down on the hook of the 1N spring.
2. Pull the 2N spring balance downward several times in steps. For each step note and record the values of F_1 and F_2. F_1 represents the total value of W and F_2 together.
3. Complete table 2 for at least 5 data values .

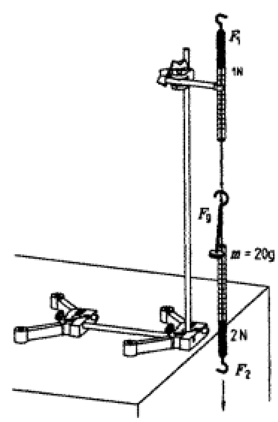


Figure2.4: Set up for addition and subtraction of forces

Table 1: Weight measurement

Mass (grams)	*Scale reading F (Newton)*	$W = mg$
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		

Table 2: addition and subtraction of forces

m = 20 g, F_g= 0.2 N

F_1*(Newton)*	F_2*(Newton)*	F_g*(Newton)*
0.2	*0.0*	*0.2*

Calculations

Part A: Slope of graph = $\frac{\Delta F}{\Delta m}$ = N/kg (m/sec^2)

Acceleration of gravity $g = slope =$ $m/\sec^2$

Part C:

$$F_1 = F_2 + F_g,$$
$$F_2 = F_1 - F_g$$

Questions

1. What kind of curve in Part A do you obtain? Is it linear or nonlinear? If it is linear, then express it in the standard mathematical form: $y = mx + b$. Find b

2. What is the mass of a 100N weight?

3. In your own words, describe the following statement: $1N = 1kg\, m/\sec^2$

4. In your own words describe the relationship between the three forces F_1, F_2, and F_g in part C.

5. How large would be the difference (F – F), in part C, be if no mass were hanging on the 1N spring balance?

References

1. Wolfgang Spengler, "*PHYWE-Document Series, Student Experiments/Physics Mechanics Part 1-5*"
2. R. D. Knight, " PHYSICS, for scientists and engineers, a strategy approach", Pearson Addison Wesley, 2004.