Teacher packs in Experimental Science

PHY Pack 2

Determination of Centre of Gravity of Irregular lamina using the Plumb-line Method

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Curriculum areas covered:

Physics Project: Centre of gravity

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Title: Determination of Centre of Gravity of Irregular lamina using the Plumb-line

Target group: DBE Students

Also suitable for: SHS students

Duration of Activity: 25-30 minutes plus discussion time

Learning outcomes: At the end of the lesson, the student should be able to

1. Knowledge and Understanding (KN)	KN1	Explain centre of gravity of a lamina
2. Cognitive Skills (CS)	CS1	Describe the steps involved in the determination of centre of gravity of irregular lamina
3. Key Skills (KS)	KS1	Follow the steps in performing an experiment.
	KS2	State the precautions that must be taken to ensure good results in an experiment.
4. Practical Skills (PS)	PS1	Record observations made and tabulate results.
	PS2	Trace correctly plumb-line on a card board using a rule and a pencil

A. Teacher's Guide

Overview
Students are expected to determine the Centre of Gravity of irregular objects. They are also expected to observe critically the intersection of the plumb-lines which indicate the centre of gravity of the irregular object.

Aim
This experiment is to help learners determine the centre of gravity of irregular objects.

Practical Skills Developed

1. correct tracing of plumb-lines on the cardboard using a ruler and pencil
2. critical observation of plumb-lines
3. Correct location of intersection of plumb-lines.

Equipment/Materials

- cardboards of different shapes
- thread
- nail
- pencil
- rule/straight edge
- load (e.g. stone, wood, etc)

Advice to Tutors
1. ensure that all electrical fans are switched off and windows/shutters closed to minimize the effect of wind on the experiment
2. make provision for general class discussion on the experiment

Sample Assessment Questions with Answers

1. Explain the term "centre of gravity of an object". (KN1)
   (**Answer:** All bodies are attracted towards the centre of the earth with a force which is equal to its weight. The point in the body at which the weight appears to be concentrated is called its centre of gravity.)

2. List the steps involved in determining the centre of gravity of an irregular lamina. (CS1)
   (**Answer:** Steps:
   (a) Create three holes close to the edges of the irregularly shaped cardboard
   (b) Suspend the object to swing freely on a needle or nail through one of the holes created
   (c) Attach a plumb line to the needle or nail and mark its position on the cardboard with the help of a rule or a straight edge

(d) Repeat steps 3 and 4 for the remaining holes, marking the positions of the plumb-lines carefully
(e) Locate the intersection of the three lines drawn; this indicates the centre of gravity of the object (irregular shaped object)

3. If you are given a cardboard in a shape of a trapezium, how would you determine its centre of gravity? (PS1)

(**Answer:** Refer to answer in Q2.)

4. What precautions would you take to ensure good results? (KS2)

Answer: The holes must be small and yet free to swing on the nail.
The thread must be very thin.
The experiment must be performed in still air.
A sharp pencil must be used to draw the lines.

B. Student Guide

Purpose:

The purpose of this experiment is to determine the centre of gravity of irregular laminar using the plumb line method

Background Information

The force of gravity acts on all bodies on earth. Every bit of mass in a body has weight. The whole weight seems to be concentrated at a point inside or outside the body. This point is the centre of gravity of the body. The weight of a body or object acts through its centre of gravity.

Definition: The Centre of gravity of an object is the point through which the total weight of the body can be considered to act.

The point where the total mass of the body seems to act is the centre of gravity. The centre of gravity of all bodies can be determined by balancing the body on a knife edge or by suspension with a plumb line from several points. In most cases, the centre of gravity of a body lies in the body itself, but in few cases such as the horse-shoe magnet, the retort stand, Bunsen burner, wine glass and conical flask, the centre of gravity lies outside.

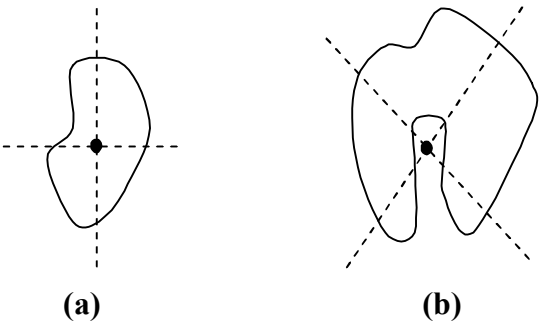

Figure 1: Diagrams showing **(a)** irregular lamina with centre of gravity in the body **(b)** an irregular lamina with the centre of gravity within the body.

For the centre of gravity to lie outside the body itself, as shown in Figure 1(b), the body will balance at any point along a vertical line passing through the centre of gravity of the body.

Importance of Centre of Gravity

1. Manufacturers often try to make their goods with the centre of gravity as low as possible in order to make them very stable. This is more common when it is the narrow part of the body that is intended for use, for example the retort stand, Bunsen burner, wine glass, conical flask, etc. They do this by making the goods heavy at the bottom and giving them a broad base.
2. A tight rope walker often carries a weighted pole or an umbrella to help keep his centre of gravity very low and vertically above the rope.
3. It helps in the designing of vehicles such as cars and buses by keeping their centre of gravity very low. This is done by placing the engine very low in the car.
4. Knowledge of the importance of keeping a low centre of gravity helps passengers in small boats realise that standing up in order to change seats can be dangerous as this raises the centre of gravity and can make the boat less stable.

Equipment/ Materials

- cardboards of different shapes
- thread
- nail
- pencil
- rule/straight edge
- load (e.g. stone, wood, etc)

Other requirements
Notebook, pencil, pens for recording

Experimental Procedure

1. Cut an irregular shape from cardboard
2. Make three holes close to the edges of the irregularly shaped cardboard

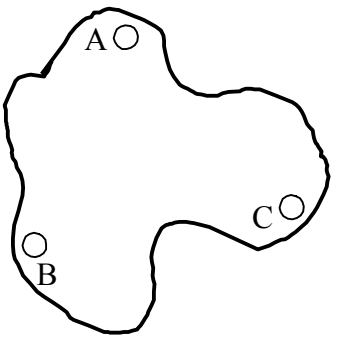

Figure 1: An irregular object.

3. Suspend the object to swing freely on a needle or nail through one of the holes created

4. Attach a plumb line to the needle or nail and mark its position on the cardboard with the help of a rule or a straight edge

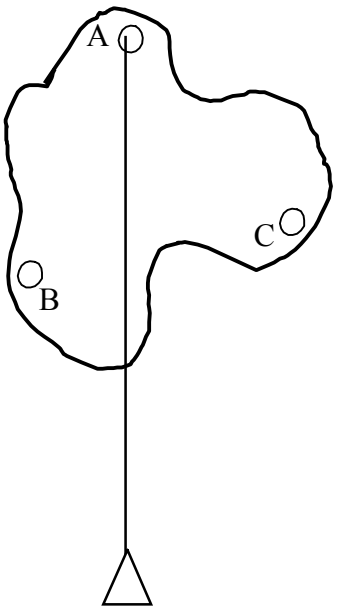

Figure 2: Plumb-line attached to object

5. Repeat steps 3 and 4 for the remaining holes, marking the positions of the plumb-lines carefully

6. Locate the intersection of the three lines drawn; this indicates the centre of gravity of the object.

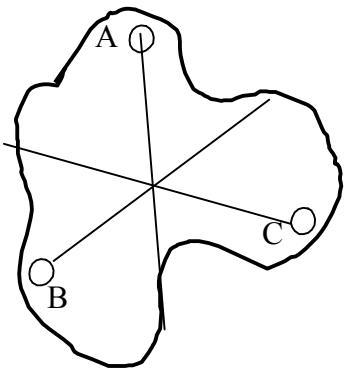

Figure 3: Intersection of lines to indicate center of gravity

C. Assessment – Student's sheet

On completion of the experiment, you should be able to answer the following questions:

1. Explain centre of gravity of an object. (KN1)

2. List the steps involved in determining the centre of gravity of an irregular lamina. (CS1)

3. If you are given a cardboard in a shape of a trapezium, how would you determine its centre of gravity? (PS1)

4. What precautions would you take to ensure good results? (KS2)

D. References and Other Useful Links

a. Abbot A. F. (1980), *Ordinary Level Physics*, 3rd Edition, Heinemann Books International, London.

b. Moss G. L. (1963), *Ordinary Level Practical Physics*, Heinemann Books International, London.

c. Nelkon M. and Parker P., (1987), *Advanced Level Physics*, Heinemann Educational Publishers, London.

E. Health and Safety/Precautions

a. The load for the plumb-line should not be too heavy to pull down or remove the nail or needle
b. The line should be drawn with a straight edge/rule
c. The nail or pin should be firmly fixed to the wall or board
d. The plumb-line shouldn't be swinging at the time the lines are being drawn.