

Physics I

010

03/Nov/2001 08.30am - 11.30am

REPUBLIC OF RWANDA



RWANDA EDUCATION BOARD

ORDINARY LEVEL NATIONAL EXAMINATIONS 2000/2001

SUBJECT : PHYSICS I

DURATION : 3 HOURS

INSTRUCTIONS:

This paper consists **THREE** sections A, B and C.

Attempt **all** questions in section A. **(55 marks)**

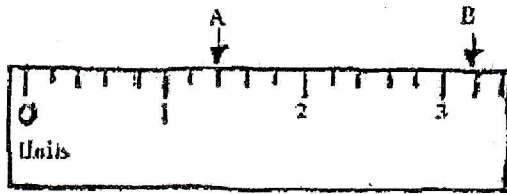
Answer **any three** questions in section B. **(30 marks)**

Answer **only one** question in section C. **(15 marks)**

You may use a calculator and a mathematical instrument.

SECTION A: ANSWER ALL QUESTIONS.**(55 marks)**

1. The scale on the figure below is in units;



(a) Determine the reading at A and B.

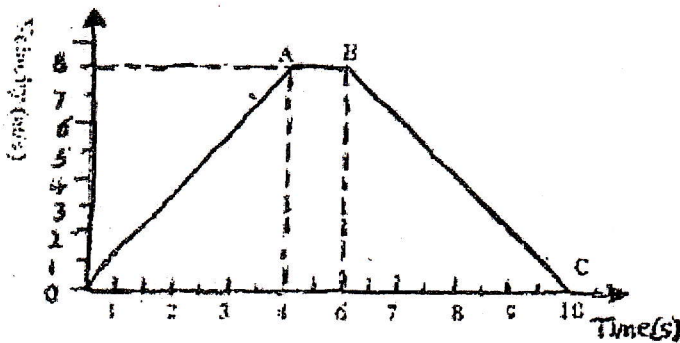
(1 mark)

(b) Calculate the length of AB

(1.5 marks)

2. The mass of a substance is 500g and its density is 300kg/m^3 .

3. Calculate the volume of the substance and express the answer in cm^3 .

(2 marks)

(a) Calculate the acceleration between OA, AB and BC.

(2.5 marks)

(b) Calculate the total distance moved by the body.

(1 mark)

4. a) State three kinds of forces.

(1.5 marks)

b) Mention three characteristics of forces as a vector.

(1 mark)

c) State two effects of a force.

(1 mark)

5. a) Define the term diffusion of gasses.

(1 mark)

b) What is the difference between the molecules of water and water vapour?

(1 mark)

6. a) Define the term pressure.

(1 mark)

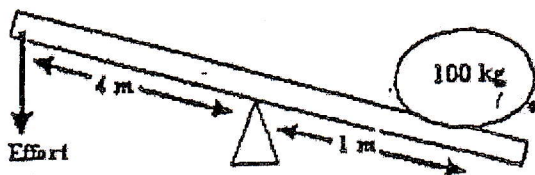
b) A stone exerts a pressure of 500Nm^2 on a surface. If the stone is 0.5kg, calculate the area of the stone in contact with the surface.

(1 mark)

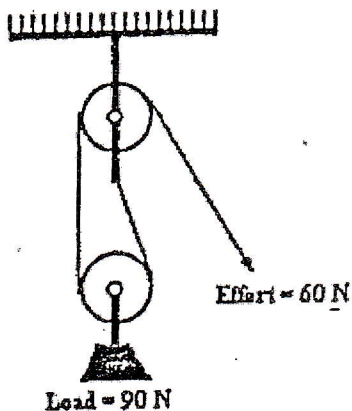
7. a) Define the term efficiency of a machine.

(1 mark)

- b) The diagram below shows a lever system. Calculate the minimum effort to move the mass of 100 kg. (1 mark)

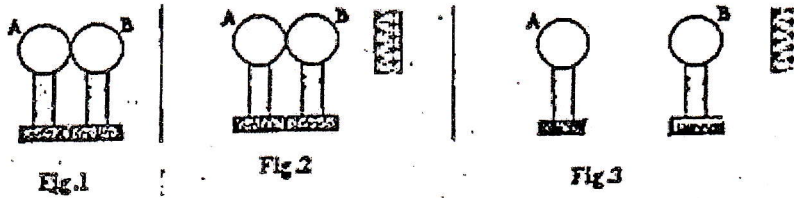


- c) i) In the pulley system below, an effort of 60N lifts a load of 90N through a vertical distance of 4cm. calculate the efficiency of the system if the effort moves 8cm. (1 mark)



- ii) Give two reasons why the efficiency in the pulley system is less than 100%. (1 mark)
8. a) i) Mention the heat effect that makes mercury a good choice for use in the thermometer. (1 mark)
- ii) Why does a doctor shake a clinical thermometer before taking the temperature of a patient? (1 mark)
- b) State three differences between evaporation and boiling. (3 marks)
- c) Ice must be pure before being used to determine the lower fixed point of the scale of a thermometer. Why? (1.5 marks)
9. a) Define the term energy and state its standard unit. (1.5 marks)
- b) State the three types of energy changes which occur when a torch (which contains cells) is switched on. (2 marks)
- c) What is the source of energy in an engine of a moving car? (1.5 marks)
10. a) State two factors that determine the magnitude of up thrust in liquids. (1 mark)
- b) An object completely immersed in pure water displaces 40cm^3 of water. Calculate the weight of the object in water if the weight of the object in air is 2N. (2.5 marks)
11. a) State two actions between electric charges (1 mark)

- b) Two uncharged insulated conductors are in contact as shown in fig.1 below. A positively charged rod is brought near the conductor as shown in fig.2. The conductors are separated while the charged rod is still near the conductors. (See fig.3)



Copy fig.2 and fig.3 and show the charges on spheres A and B in each case. (3 marks)

12. Given three magnets with poles $A \rightarrow A'$, $B \rightarrow B'$ and $C \rightarrow C'$,

- a) Copy the table and complete what happens when respective poles are brought together as shown. (3 marks)

	Pole B	Pole B'	Pole C	Pole C'
Pole A	Attract			
Pole A'				Repel

- b) If A is a south pole, identify other poles. (2.5 marks)

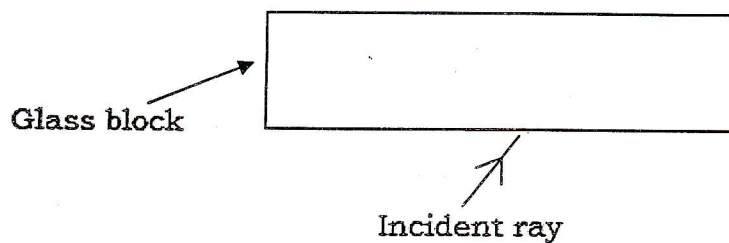
13. (a) What is meant by the term luminous body? Give one example of a luminous body. (1.5 marks)

- (b) On a hot day, a boy lights a cigarette using a lens;

- i) What type of lens does the boy use? (1.5 marks)

- ii) With aid of a diagram, show how the lens lights the cigarette. (2 marks)

- (c) Copy the figure below and complete the path of the incident ray through the glass block.



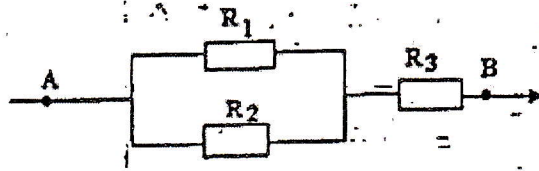
(1.5 marks)

14. a) What is meant by the term centre of gravity of a body? (1 mark)

- b) What does stability of a body depend on? (1 mark)

- c) State one advantage and one disadvantage of friction in cars. (1 mark)

15. a)



If $R_1 = R_2 = R_3 = 12\Omega$, calculate the total resistance between A and B.

(2.5 marks)

b) State the use of a fuse in an electrical installation.

(1 mark)

SECTION B: Answer any three questions.

(30 marks)

16. a) What is meant by the term:

i) Latent heat of fusion

(1 mark)

ii) Latent heat of vaporization

(1 mark)

b) State two factors which affect the rate of evaporation of a liquid without heating it.

(1 mark)

c) The temperature of water is recorded every minute as the water is heated from 23°C to boiling point 98°C . The heat is maintained until half of the water evaporates.

i) Sketch the shape of the temperature time graph of the heated water.

(2 marks)

ii) If the mass of water is 2kg, how much heat energy is required to evaporate the water completely? (Specific latent heat of steam = 2260000J/Kg and specific heat capacity of water = 4200J/Kg)

(5 marks)

17. a) What is:

i) An electric generator?

(1.5 marks)

ii) An electric motor?

(1.5 marks)

b) Compare a dry cell (torch battery) and an accumulator (car battery). What are the advantages of:

i) An accumulator over a dry cell?

(3 marks)

ii) A dry cell over an accumulator.

(2 marks)

c) On an electric iron it is labeled 1000W, 220V.

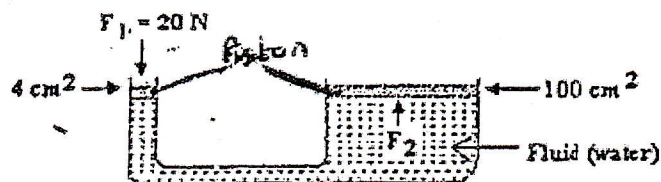
i) What do these figures mean?

(1 mark)

ii) Calculate the current which flows in the iron if there is no other resistance.

(1 mark)

18. a) Use a diagram to show the formation of an image of an object in a pin-hole camera.
List the properties of the image formed. **(5 marks)**
- b) Use a diagram to show the formation of an image in a convex lens when the object is between the focal point and lens. **(3 marks)**
- c) A person sees clearly objects which are near but cannot see objects which are far.
- i) What is this eye defect (problem) called? **(1 mark)**
- ii) How is this eye defect corrected? **(1 mark)**
19. a) A boy runs up the stair. Explain how you may determine his power. **(5 marks)**
- b) Which type of energy does the boy use to run up stairs? **(1 mark)**
- c) A man lifts 50kg of beans through a vertical height of 2m in 5s.
Calculate;
- i) The minimum force required **(1 mark)**
- ii) The work done **(1.5 marks)**
- iii) The power of the man **(1.5 marks)**
20. a) Briefly explain how a hydraulic press works. Use a labeled diagram to make your answer clear. **(7 marks)**
- b) Where is transmission of pressure in liquids applied in cars? **(1 mark)**
- c) Calculate the force F_2 .



Section C: Answer only one question.

(/15 marks)

21. You are provided with the following apparatus: a spring balance, an object, a beaker of known weight, water and eureka-can. Outline how you can verify Archimedes' principle. Use diagrams to make your answer clear.
22. You are provided with: Pins, soft board, a plane mirror, a ruler, a set square and protractor. Briefly describe how you can verify laws of reflection of light. Use a diagram to make your answer clear.
23. A student experimented on elongation (increase in length) of a spring when different forces were hooked (one at a time) on the spring. The table below shows the result obtained.

Force (N)	0.00	1.00	2.00	3.00	4.00	5.00
Increase in length (cm)	0.00	1.50	3.00	4.50	10.00	14.00

- a) Represent this information on a graph
- b) What is the maximum force that makes the spring lose its uniform elasticity?
- c) What is the relationship between the force and the increase in length before the spring's elastic property exceeds the limit?
- d) Find the rate of increase in length before the spring loses its elasticity?

END

ANSWERS TO ORDINARY LEVEL PHYSICS PAPER 2000/2001

SECTION A:

1. a) Point A is 1.4 units and point B is at 3.2 units

b) Length of AB = 3.2 - 1.4 = 1.8 units

2. Density = $\rho = \frac{m}{v} \Rightarrow v = \frac{m}{\rho} = \frac{0.5 \text{ kg}}{800 \text{ kg/m}^3} = 625 \times 10^{-6} \text{ m}^3$

3. (a) From O to A, the speed goes from 0 m/s to 6 m/s in 4s so the acceleration is:

$$a = \frac{\Delta v}{t} = \frac{6-0}{4} = 1.5 \text{ m/s}^2.$$

From A to B the speed remains constant then acceleration is $a_2 = 0 \text{ m/s}^2$.

From B to C, the speed increased from 6m/s to 0 m/s in 4s so the acceleration is;

$$a = \frac{\Delta v}{t} = \frac{0-6}{4} = -1.5 \text{ m/s}^2.$$

(b) Total distance moved: $S = S_1 + S_2 + S_3 = 12 + 12 + 12 = 36 \text{ m}$ where;

$$S_1 = \frac{1}{2} a_1 t_1^2 = \frac{1}{2} (1.5) (4)^2 = 12 \text{ m}, S_2 = vt_2 = 6 \times 2 = 12 \text{ m and}$$

$$S_3 = \frac{1}{2} a_3 t_3^2 + vt_3 = \frac{1}{2} (-1.5) (4)^2 + 6 \times 4 = 12 \text{ m}$$

Or the space of length of the journey is the surface of the trapezium OABC:

$$S = \frac{6 \times (10 + 2)}{2} = 36 \text{ m}$$

4. a) Electrostatic force, Magnetic force, and Gravitational force, nuclear force, electrical force

b) The direction of force, intensity or point of application

c) - When an object at rest (static effect) is acted on by a force, it tends to move.

- If a force acts on an object which is already moving (dynamic effect) the force can change its motion by either increasing or decreasing the speed of the object or change the direction of its motion. A force may move the particles of which a body is composed and thus change its shape.

5. a) Diffusion is the movement of gas molecules due to its properties of expandability.

b) Water molecules are less energetic than those of water vapor (which is under pressure)

6. a) Pressure (symbol " p ") is the force acting normally per unit area applied in a direction perpendicular to the surface of an object. Its SI unit is Pa

b) $p = \frac{F}{A} \Rightarrow A = \frac{F}{p} = \frac{mg}{p} = \frac{0.5 \times 10}{500} = 0.01 \text{ m}^2$

7. a) The efficiency of a machine is obtained by the relation; $n = \frac{W_u}{W_r}$. Where n is the efficiency, W_u is useful work done by the machine and W_r is work done on the machine. Efficiency is a measure of how well a machine works.

b) Principle of equilibrium: $Ed_e = Ld_1 \Rightarrow E = \frac{Ld_1}{d_e} = \frac{100 \times 10 \times 1}{4} = 250N$

c) i) $n = \frac{MA}{Vr} = \frac{Ld_1}{Ed_e} = \frac{90 \times 4}{60 \times 8} = \frac{3}{4} = 75\%$

- ii) - The effect of friction
 - The energy output of the machine can never be more energy input
 - Weight of the pulley on the top.

8. a) i) Mercury is a good thermometric liquid because :

- It expands regularly
- It's a good conductor of heat and soon reaches the same temperature as its surroundings.
- It has a high boiling point (357°C).
- It has a small heat capacity, so it takes only a little heat from hot objects.
- It has a high coefficient of cubical expansivity.

ii) After use, the doctor shakes the thermometer to force all mercury back into the lower bulb

b)

Boiling (Vaporization)	Evaporation
Occurs at the surface and inside the liquid	Occurs only at the surface
Occurs when the liquid attains its boiling point due to pressure	Occurs at all temperature below the boiling point
Temperature does not change during boiling	Temperature may change during evaporation.

c) Ice must be pure because impurities affect the melting point. The greater the amount of impurity present, the lower the melting point and the greater boiling point.

9. a) Energy is the capacity to do work or transfer of heat energy, it has the same units as work and heat. i.e Joule.

b) Chemical energy, Electrical energy, Light energy and heat energy.

c) Chemical potential energy in petrol.

10. a) Density of fluid and the volume of the object.

b) Upthrust: $B = \rho Vg = 1000 \times 40 \times 10^{-6} \times 10 = 0.4N$

Weight of the object in water $W = W_a - B = 2 - 0.4 = 1.6N$

11. a) Like charges repel and unlike charges attract each other. This is called the basic law of electrostatic charges.

b)

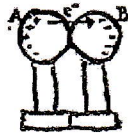


Fig 2

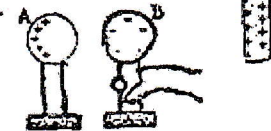


Fig 3

12. a)

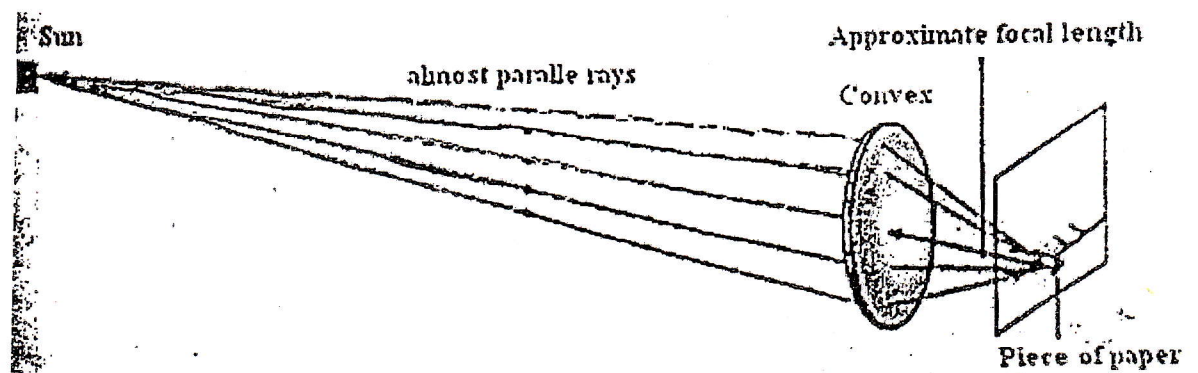
	Pole B	Pole B'	Pole C	Pole C'
Pole A	Attract	Repel	Repel	Repel
Pole A'	Repel	Attract	Attract	Repel

b) If A is a south pole the A¹ is the north and B is the north hence B¹ is the south. If A¹ is a north pole then C¹ is the north and C is the south.

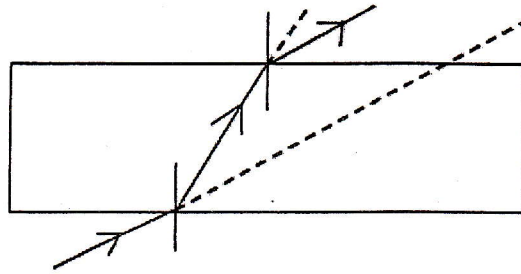
13. a) A luminous body is anybody that provides direct or indirect light. E.g the sun

b) i) Converging lens

ii)



c)



14. a) The centre of gravity is the average location of the weight of an object. The centre of gravity is defined as the point of application of the resultant force due to the earth's attraction on it.

b) The stability of a body exists when the centre of gravity of the body is as close as possible to the ground and vertically through the centre falls within the base of support body.

c) - Friction is very important because the car uses it to slow down.

- It is also a nuisance because it wears the car tire, causes unnecessary heat and undesirable noise and lowers efficiency of machines such as cars, Lorries and buses. This means that they use more fuel in order to move because they have to overcome friction in addition to their weight.

15. a) Total resistance: $R = R_1 + \frac{R_2 R_3}{R_2 + R_3} = 12 + \frac{12 \times 12}{12 + 12} = 18\Omega$

b) The fuse protects the plant against fire or unforeseen surge caused by short circuit.

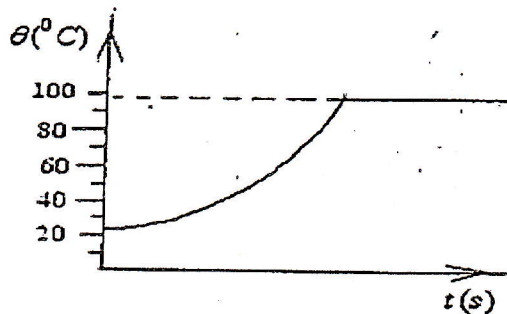
SECTION B

16. a) i) The specific latent heat of fusion (melting) is the amount of energy required to convert 1kg of a substance from solid to liquid (or vice versa) without a change in temperature of the surroundings, all absorbed energy goes into the phase change.
- ii) Likewise, the amount of energy required to convert 1kg of a substance from liquid to gas (or vice versa) without a change in the external temperature is known as the specific latent heat of vaporization (boiling) for that substance.

b) Factors affecting the evaporation of a liquid are:

- The liquid surface
- The movement of air above the liquid.

c) i)



ii) The heat required to evaporate water:

$$Q = mc\Delta\theta + mL_v = 2 \times 4200 \times (100 - 23) + 2 \times 2260000 = 5150 \text{ KJ}$$

17. a) i) An electric generator is a device that can transfer any forms of energy into electrical energy.

ii) An electric motor is an electrical device that transforms electrical energy into other forms of energy.

b) i) Advantages of a dry cell battery:

- It is lightweight
- portable and it is cheap.

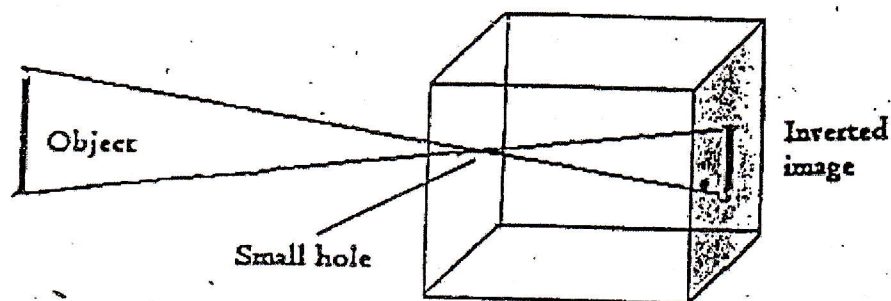
Advantages of an accumulator:

- low internal resistance
- more durable
- rechargeable.

c) i) 1000W is the power, 220V is the potential difference.

ii) Current: $i = \frac{P}{U} = \frac{1000}{220} = 4.6\text{A}$

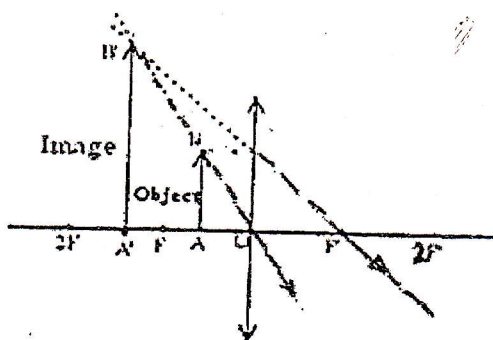
18. a) Image formed in a pinhole camera



Nature of the image formed:

- it is upside down (inverted image)
- it is reversed (left to right)
- it is less bright (the clarity of the image will depend on the position of the object and on dimensions of the pierced pinhole)
- it has a different size to the lamp object (enlarged image is larger than actual object while reduced image is smaller than object)

b) The object is located in front of F, the object is located in front of the focal point (F), Object between lens and (F), the image is behind the object, virtual, erect and larger than object.



- c) i) Nearsightedness of myopia
 ii) Using a diverging lens.

19. a) Power developed or rate of doing work is obtained by dividing work done by time taken.

$$\text{i.e. } W = \frac{w \times h}{t} \quad W = \frac{wd}{t} = \frac{mgd}{t}$$

b) The energy used is mechanical energy from muscles.

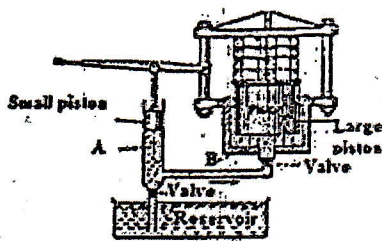
c) i) The minimum work required to lift a bag of 50kg, is the weight of the work i.e

$$w = mg = 50 \times 10 = 500\text{N}$$

ii) The actual work, $W = Fd = 500 \times 2 = 1000\text{J}$

iii) $P = \frac{W}{t} = \frac{1000}{5} = 200\text{W}$.

20. a) Hydraulic press is a hydraulic mechanism for applying a large lifting or compressive force. It is the hydraulic equivalent of a mechanical lever. When a small force F is applied to small area, A , of a movable piston, it creates a pressure, $P = \frac{F}{A}$. This pressure is transmitted to and acts on a larger movable piston of area A which is then used to compress.



Pressure applied to small piston
Pressure transmitted by fluid

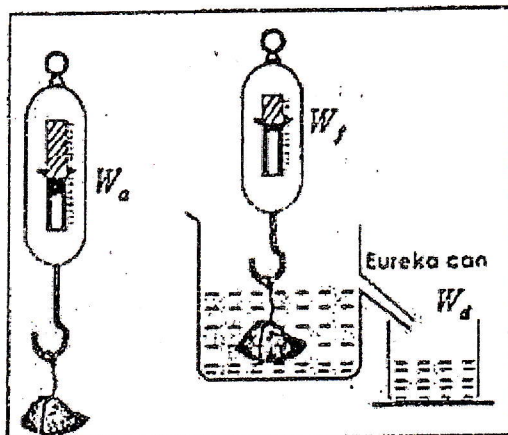
b) The fluid pressure from the master cylinder is transferred equally to all the brake shoes which point to the wheel.

c) $P = \frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow F_2 = \frac{F_1 A_2}{A_1} = \frac{20 \times 100}{4} = 500\text{N}$.

SECTION C.

21. Experimental Verification of the principle of Archimedes

- Place a Eureka can (over flow vessel) on a table and place a beaker under its spout as shown in the figure below.



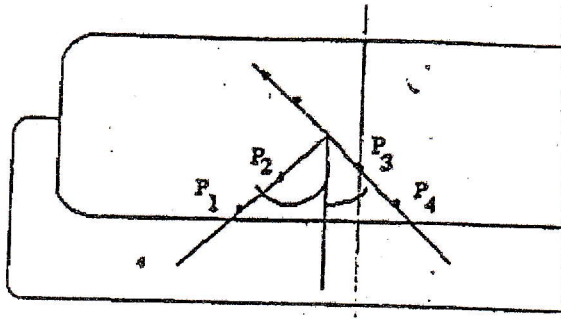
- Pour the water into the can till the water starts overflowing through the spout.
- When the water stops dripping, replace the beaker by another one of known weight:
- Suspend a stone with the help of a string from the hook of a spring balance and record the weight of the stone: W_a
- Now, gradually lower the body into the Eureka can containing water and record its new weight in water when its fully immersed in water
- When no more water drips from the spout, weigh the beaker containing water
- The apparent loss of weight of the body, or the up thrust on the body equals the weight of the water displaced. i.e *When a body is totally or partially immersed in a fluid, it experiences an up thrust equal to the weight of the fluid displaced.*

22. Reflection in a plane mirror

Procedure:

- Support the mirror vertically on one side of the rectangular block
- Draw a line perpendicular to the plane mirror on a plain paper placed on the soft board. Mark this line NO.
- By the use of a protractor, draw an angle of 30° from NO,
- Erect two pins, P1 and P2 on the line corresponding to 30° . Call this line P1P2 and meets the mirror at O.
- By looking into the mirror, place two pins P3 and P4 to be in line with the images of P1 and P2.

- Call this line P3P4, to meet the mirror at O.
- Measure the angle between P3P4 and NO. Comment on the results.
- Compare the two angles that are P1ON and P3ON.

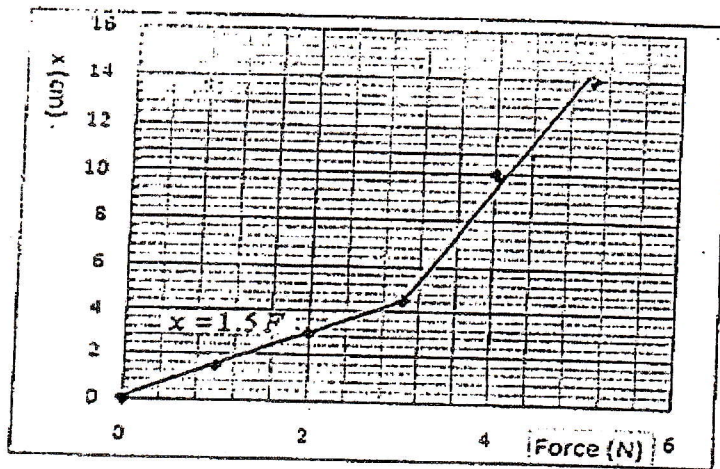


Explanation:

The line P1P2 corresponds to the incident ray and P3P4 corresponding to the reflected ray. Angle of reflection is equal to angle of incidence. This is the first law of reflection.

The second law of reflection states that: The incident ray, the reflected ray and the normal to the surface at the point of incidence all lie in the same plane.

23. a) Graph



- b) The maximum force that is losing its normal elasticity to the spring is between 4N and 5N.
- c) Linear function whose equation is $F = 1.5x$ where $K = 1.5\text{N/cm}$ constant of elasticity.
- d) The rate of increase in length before the spring loses its elasticity is the slope: $k = 1.5\text{N/cm}$

END