PHYSICS
PAPER 1

No. 1.State what mechanics as a branch of physics deals with. (1 mark)

- *Study of motion of bodies under the influence of forces or motion and forces*

No. 2.Figure 1 shows the change in volume of water in a measuring cylinder when an irregular solid is immersed in it.

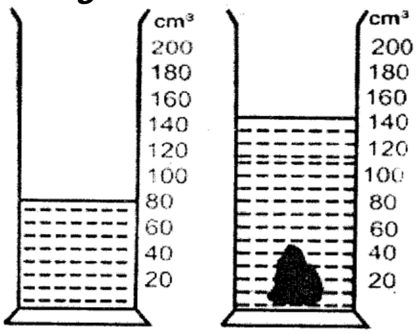


Fig 1.

Given that the mass of the solid is 567 g, determine the density of the solid in gcm^{-3} (Give your answer correct to 2 decimal places) (3 marks)

Volume = 68cm^3

Mass = 567g

Density = $\frac{m}{V} = \frac{567}{68}$

= *8.34 g/cm^3*

No. 3.When a drop of oleic acid of known volume is dropped on the surface of water in a large trough, it spreads out to form a large circular patch. State one assumption made when the size of the molecule of oleic acid is estimated by determining the area of the patch. (1 mark)

- Drop spreads out until the patch is one molecule thick

No. 4].Figure 2(a) and 2(b) shows capillary tubes inserted in water and mercury respectively.

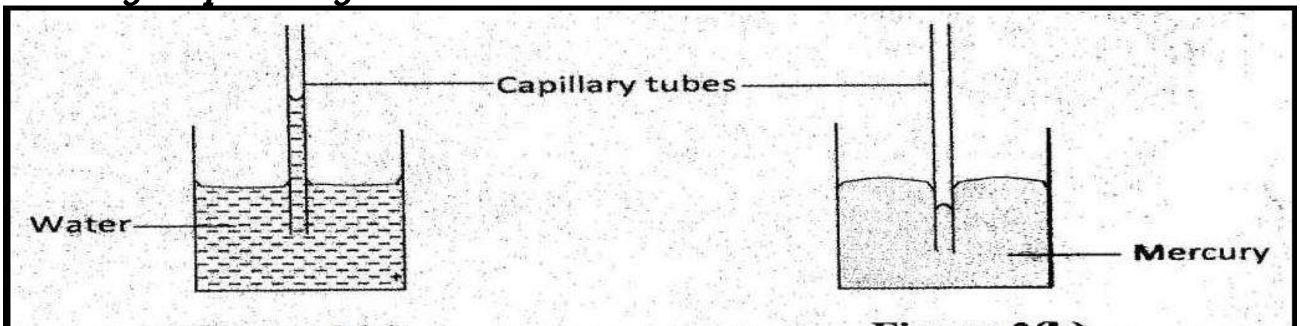


Figure 2 (a) **Figure 2 (b)**

It is observed that in water the meniscus in the capillary tube is higher than the meniscus in the beaker, while in the mercury the meniscus in the capillary tube is lower than the meniscus in the beaker. Explain this observation (2mks)

- *In (a), the adhesive force between water and capillary tube is stronger than the cohesive force between the water molecules while in (b) the cohesive forces between mercury and the tube is higher than the adhesive force between mercury and the tube.*

No. 5.Fig. 3 shows a hot water bath with metal rods inserted t... of its sides. Some wax is fixed at the end of each rod. Use this information to answer question 12.

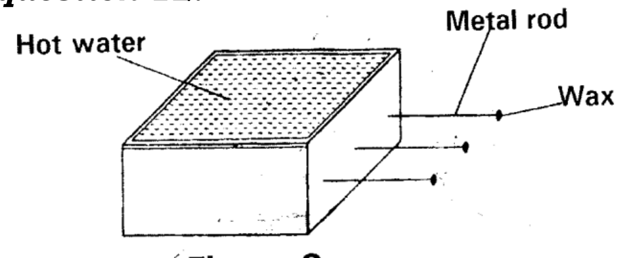


Figure 3

What property of metals could be tested using this set-up? (1mk)

- *Thermal conductivity*

No.6.Figure 2 shows a uniform light bar resting horizontally on corks floating on water in two beakers A and B.

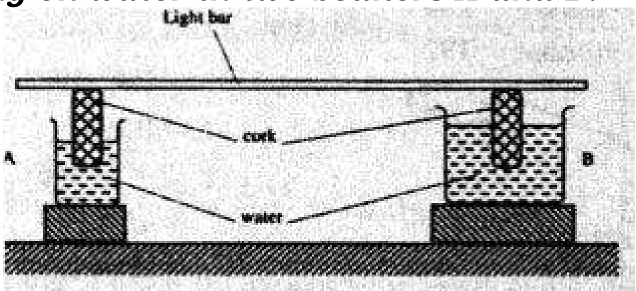


Figure 2

Explain why the bar tilts towards side A when equal amount of heat is supplied to each beaker (2 marks)

- *Since the quantity of water A is smaller, the heat supplied produces a greater change of temperature in A. This causes a greater expansion of water in A, causing the cork to sink further*

No. 7.Figure 5 shows an aluminium tube tightly stuck in a steel tube.

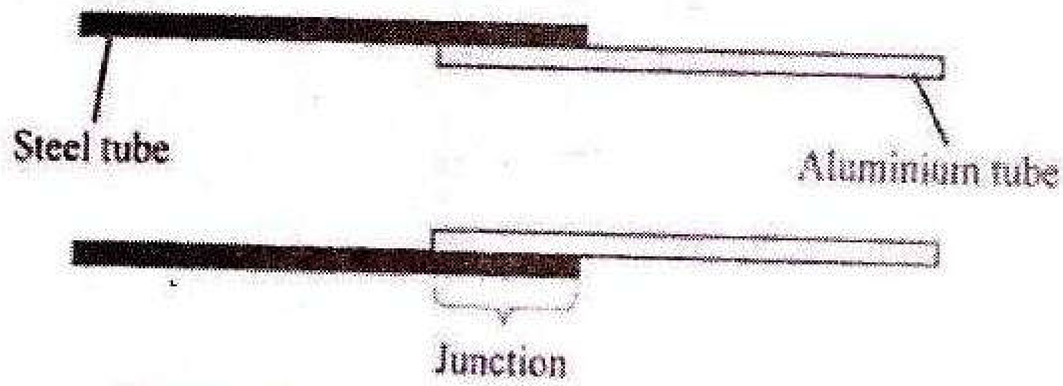


Figure 5

Explain how the two tubes can be separated by applying a temperature change at the same junction given that aluminum expands more than steel for the same temperature rise. (2 marks)

- *By cooling*
- *Aluminium contracts more than steel for the same temperature range*

No.8.(a)An aeroplane is moving horizontally through still air a speed. It is observed that when the speed of the plane is increased, its height above the ground increases. State the reason for this observation. (1 mark)

- *Increase in the speed of the plane decreases the pressure of air above it while the pressure below it remains high. This leads to a resultant upward force*

(b)Figure 6 shows parts A, B and C of a glass tube.

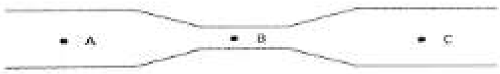


Figure 6

State with a reason the part of the tube in which the pressure will be lowest when air is blown through the tube from A towards C. (2 marks)

- Point B
- The velocity is high at this point hence pressure decreases

No. 9.The three springs shown in figure 5 are identical and have negligible weight. The extension produced on the system of springs is 20 cm.

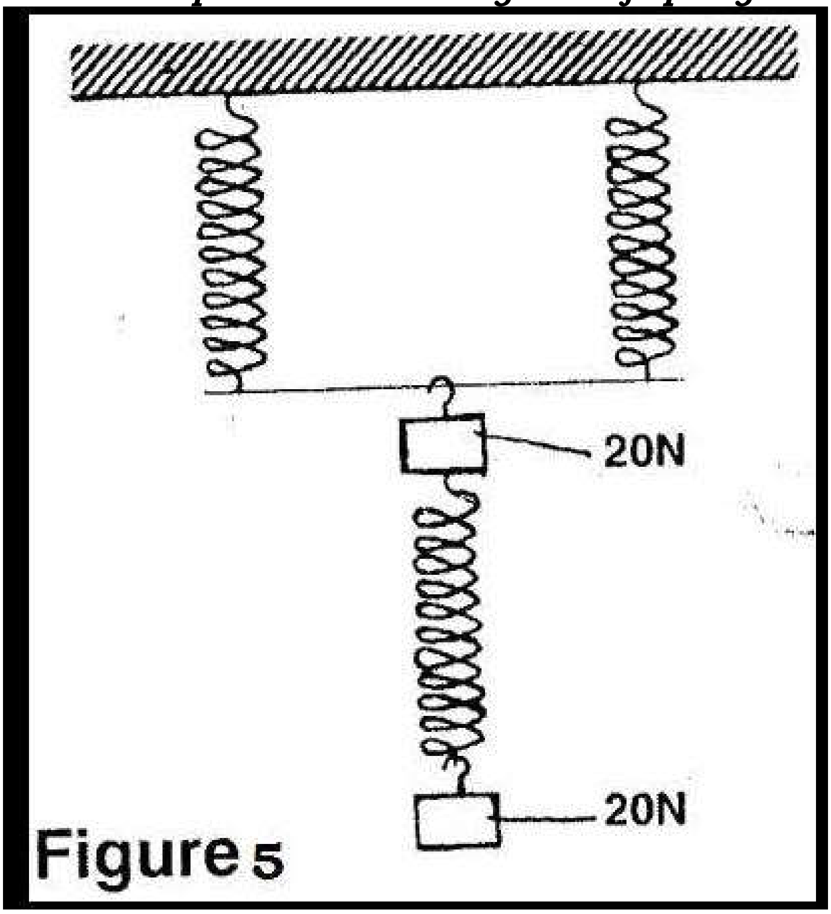


Figure 5

Determine the constant of each spring (2 mks)

Parallel

$F = 2\,ke$

$40 = 2 \times ke$

$E_1 = {}^{40}/_{2k} = {}^{20}/_{k}$

Single $= f = ke_2$

$20 = ke_2$

$E_2 = 20/k$

$E_T = e_1 + e_2$

$20 = 20/k + 20/k$

20 k = 40
K= $^{40}/_{20}$ = 2N/cm
OR Extension of each spring = 10
K = 20N/ 10 cm
- 2N/ cm

Or
Extension of each spring =10,k= $\frac{20N}{10cm} = 2N/cm$

No.10. Figure 8 shows two cylinders of different cross-sectional areas connected with a tube. The cylinders contain an incompressible fluid and are fitted with pistons of cross-sectional areas 4 cm² and 24 cm².

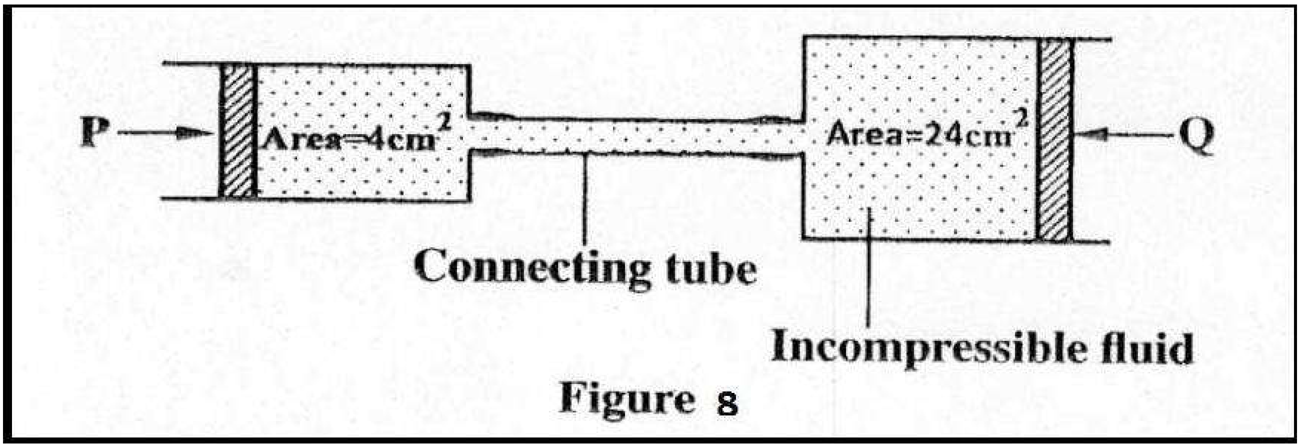
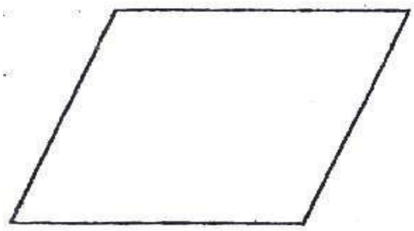


Figure 8

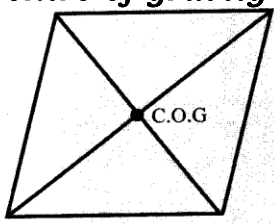
Opposing forces P and Q are applied to the pistons such that the pistons do not move. If the pressure on the smaller piston is 5 N cm2, Determine force Q. (2 marks)

- Pressure at P = Pressure at Q
- But force = P x A
- At Q, force = 24 cm^2 x 5 Ncm^{-2} = 120N

No. 11.Figure 9 shows a uniform cardboard in the shape of parallelogram



Locate the centre of gravity of the cardboard (1 mks)

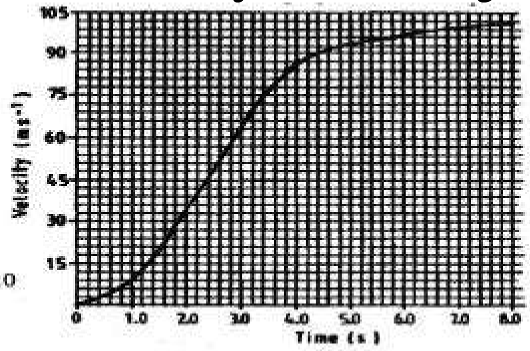


No. 12.State why it is easier to separate water into drops than a solid into smaller pieces(1 mark)

- *There are weaker intermolecular forces in liquids than in solids*

No.13.The graph in figure 10 shows the velocity of a car in the first 8 seconds as it accelerates from rest along a straight line.

Figure 10



Determine the distance traveled 3.0 seconds after the start

- *Distance = area under curve between 0 and 3. 0 second;*
- *= 120 x 3 x 0.2 = 72M: Trapezium Rule (3 trapezia)*
- *Mid – ordinate = 70.5*

No.14.a) Explain why it is advisable to use a pressure cooker for cooking at high altitudes (2 mks)

- *At high altitudes pressure is low so boiling point is low*
- *A pressure cooker increases pressure inside it which raises the boiling point hence faster cooking*

b) Water of mass 3.0kg initially at 20^{0}C is heated in an electric kettle rated 3.0KW. The water is heated until it boils at 100^{0}C. (Take specific heat capacity of water 4200jkg1K-1. Heat capacity of the kettle = 450JK^{-1}, Specific latent heat of vaporization of water = 2.3mjkg-1)

Determine

(i) The heat absorbed by the water. (1 mk)

Q = McΔθ or Mcθ or McΔT

= 3 x 4200 x 80 = 1008000J

ii)Heat absorbed by the electric kettle (2 mks)

Q = cθ / cΔθ / cΔT = 450 x 80

= 36000J

iii) The time taken for the water to boil (2 mks)

PL = McΔθ / cΔθ

3000t = 1008000 + 36000

3000t = 1044000

t = 348 seconds

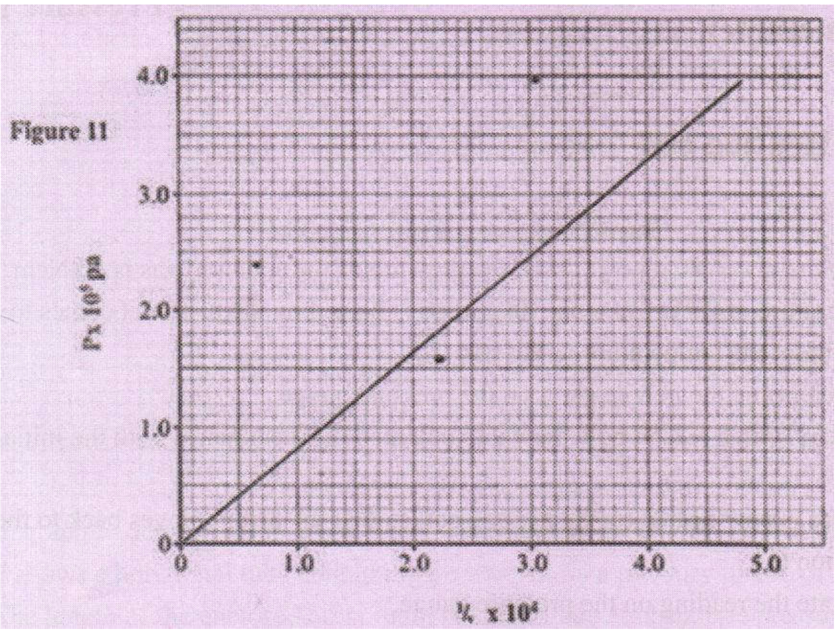
iv) How much longer it will take to boil away all the water.(2 mk)

Mlv = Pt	**OR**	*Mlv = Pt*
3 x 2.3 x 10^6 = 3000t		*3 x 2.3 x 10-3 = 3000t*
t = 2300s		*t = 2.3 x 10^{-6}s*
(38.3 minutes)		

No.15.(a) State what is meant by an ideal gas ***(1 mark)***

- *A gas that obeys the gas laws perfectly*

(b) The pressure acting on a gas in a container was changed steadily while the temperature of the gas maintained constant. The value of volume V of the gas was measured for various values of pressure. The graph in figure 11 shows the relation between the pressure, p and the reciprocal of volume $\frac{1}{v}$



(i) Suggest how the temperature of the gas could be kept constant

- *By changing pressure very slowly or by allowing gas to go to original temperature after each change*

(ii) Given that the relation between the pressure P_1 and the volume, V_1 of the gas is given by PV = k, where k is a constant, use the graph to determine the value of k.

k is slope of graph

$$K = \frac{(2.9 - 0) \times 10^5}{(3.5 - 0) \times 10^6}$$

K = 0.083 Nm

(iii) What physical quantity does k represent? ***(4 mark)***

- *Work done on the gas*

(iv)State one precaution you would take when performing such an experiment(1 mark)

- *Use dry gas*
- *Make very small changes in pressure*

(c) A gas occupies a volume of 4000 litres at a temperature of … normal atmospheric pressure. Determine the new volume of the gas if it is heated at constant pressure to a temperature of 67^{0}C (normal atmospheric pressure P= 1.01 x 105 pa)

Since pressure is constant

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$T_1 = 273 + 37 = 310k$

$T_2 = 273 + 67 = 340k$

$$\frac{4000}{310} = \frac{V_2}{340}$$

$V_2 = 4387$ *litres*

No.16.(a)Define the term velocity ratio of a machine. (1mk)

- *It is the ratio of distance moved by effort to distance moved by load*

(b) Fig. 12 shows part of a hydraulic press. The plunger is the position where effort is applied while the Ram piston is the position where load is applied. The plunger has cross-section area, a m^2 while the Ram piston has cross-section area, A m^2.

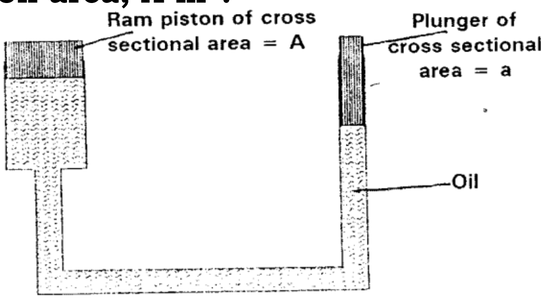


Figure 12

When the plunger moves down a distance d the Ram piston moves up a distance D.

Derive an impression for the velocity ratio (V.R) in terms of A and a(4 marks)

P x A x d = P x a x d or vol of oil at plunger = at RAM

$A \times D = a \times d$	$a \times d = A \times D$
$\frac{d}{D} = \frac{A}{a}$	$\frac{d}{D} = \frac{A}{a}$
$VR = \frac{A}{a}$	$VR = \frac{A}{a}$

c) A machine of velocity ratio 45, overcomes a load of 4.5 x 10^{3}N when an effort of 135N is applied. Determine:

(i)The mechanical advantage of the machine; (2mks)

$$MA = \frac{load}{Effort}$$

$$= \frac{4.5 \times 10^3}{135} = 33.\ 3\ (33\ ^1/_3)$$

(ii) Efficiency of the machine; (2mks)

Efficiency $= \frac{MA}{VR} \times 100\%$ *OR efficiency* $= \frac{MA}{VR} = 33.3$

$$= \frac{33.3}{45} \times 100\%$$

$$= 74\%$$

(iii) The percentage of the work that goes to waste. (

% work wasted = 100% - 74%

= 26%

No.17.(a) When a bus goes round a bend on a flat road, it experiences a centripetal force.
State what provides the centripetal force. (1 mark)

- *Frictional force*

(b) State the purpose of banking roads at bends. (1 mark)

- *Increases the centripetal force acting on the bus*
- *Provide more centripetal force*
- *Prevent skidding force, overturning or rolling*
- *Enable high speed or critical yield*

(c)A student whirls a stone of mass 0.2 kg tied to a string of length 0.4 m in a vertical plane at a constant speed of 2 revolutions per second. (Take acceleration due to gravity g as 10 ms^{-2})

(i) State two forces acting on the stone when it is at the highest point.(2 marks)

- *The weight/ force of gravity*
- *The tension on the string*

(ii) Determine the:
(I)Angular velocity of the stone (3 marks)

$w = 2\pi f = 2 \times 3.142 \times 2$

$= 12.568$ rad/s

(II)Tension in the string when the stone is at the highest point; (3 marks)

$T = mw^2r - mg$

$= 0.2 \times 12.568^2 \times 0.4 - 0.2 \times 10$

$= 12.6364 - 2$

$= 10.636$N

No.18.(a) State Newton's first law of motion (1 mark)

- *A body at rest or motion at uniform velocity tends to stay in that state unless acted on by an unbalanced force/ compelled by some external force to act otherwise.*

(b)A wooden block resting on a horizontal bench is given an initial velocity, u, so that it slides on the bench surface for a distance d, before coming to a stop. The values of d were measured and recorded for various values of initial velocity. Figure 10 shows the graph of u^2 against d.

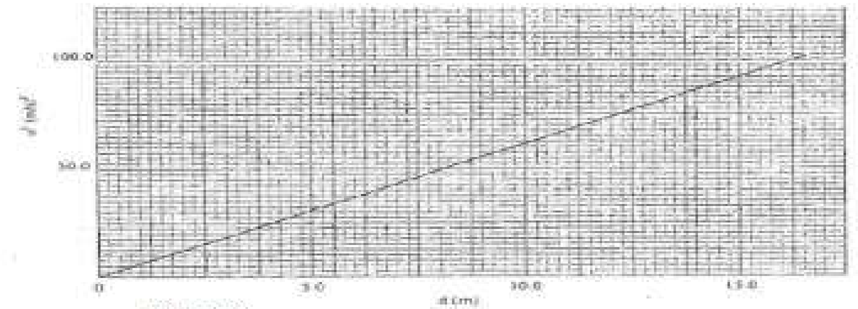


Figure 13

(i)Determine the slope, S of the graph ***(3 marks)***

S = $\frac{\Delta u}{\Delta d}$ or

$\frac{98.\ 75 - 0}{16 - 0}$ $(m/s)^2$

= $6.17ms^{-2}$

(ii)Given that u^2 = 20 kd, where k is a constant for the bench surface, determine the value of k from the graph ***(2 marks)***

20k = s = 6.09 depend on (i)

K = $\frac{6.172}{20}$ = 0. 3086

(iii)State how the value of k would be affected by a change in the roughness of the bench surface (1 mark)

- *Increase in roughness increases k and vice versa*
- *Uniform speed in a straight line – uniform velocity*

(c) A car of mass 800 kg starts from rest and accelerates at 1.2 ms-2. Determine its momentum after it has moved 400 m from the starting point (4 marks)

Applying equation

$V^2 - u^2 = 2as$

$V^2 - 0 = 2 \times 1.2 \times 400$

Momentum p = mv

$P = \sqrt{800 \times \ 2 \times 1.2 \times 400}$

= 24787.07 = $24790Kgms^{-1}$