TERM 2 - 2023

PHYSICS – PAPER ONE (232/1)

FORM FOUR (4)

MARKING SCHEME

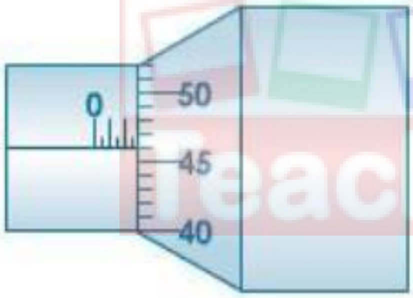
SECTION A (25 MARKS)

1. Explain the meaning of 'geometrical optics' as a branch of physics (1 mark)

   The study of the behavior of light as it traverses through various media ;

2. The figure below shows a section of a micrometer screw gauge with a thimble scale of 50 divisions. When the spindle is in contact with the anvil, the device reads 0.25mm. The screw gauge is used to measure the diameter of a spherical ball and the scale reading is as shown below. State the actual diameter of the ball. (2 marks)

   $\boldsymbol{Reading = 2.5 + 0.46 = 2.96mm}$ **;**



Actual diameter $= \boldsymbol{2.96 - 0.25 = 2.71mm}$ **;**

Figure 1

3. Alcohol in glass thermometer cannot be used when boiling water is used in an experiment. Explain. (1mark)

   Alcohol has a lower boiling temperature (point) than temperature of boiling water ;

4. Explain briefly how the temperature in a green house is kept higher than outside. (2 marks)

   Objects in the green house absorb heat energy of the incident radiation; hence emitted radiation has lower energy which cannot penetrate through the glass roof so the temperature within the green house is increased ;

5. A wooden bench feels neither warm nor cold when touched by bare hands. Explain this observation. (2 marks)

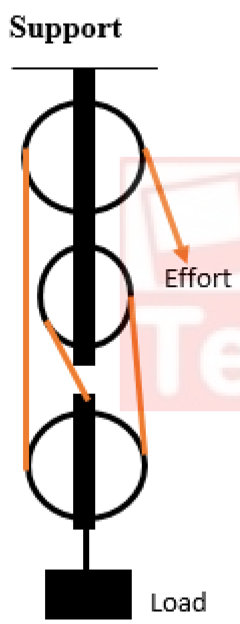
   Wood is a poor conductor of heat; hence cannot conduct heat into or away the body ;

6. The reading on a mercury barometer at Mombasa is 760mm. Calculate the pressure at Mombasa in N/m^2 (density of mercury = 1.36 x 10^4 Kg/m^3) (2 marks)

$$pressure = h\rho g \quad ;$$

$$therefore, P = 0.76 \times 13600 \times 10 = 103,360Nm^{-2} \quad ;$$

7. The diagram shown in figure 2 below is an arrangement of three pulley wheels used to help in lifting loads. The system has a velocity ratio of 3. Complete the diagram to show the threading of the rope and the position of effort, load (3 marks)



Threading ;

Labelling load and effort ;

Figure 2

8. State the meaning of the term ‘radian’ as a unit of measurement (1 mark)

The angle subtended at the centre of a circle by an arc length equal to the radius of the circle ;

9. A stone of volume 800 cm^3 experiences an upthrust force of 6.5 N when fully immersed in a liquid. Determine the density of the liquid. (2 marks)

$$upthrust = V\rho g$$

$$6.5 = 800 \times 10^{-6} \times \rho \times 10 \qquad ;$$

$$\text{Hence: } \rho = \frac{6.5}{800 \times 10^{-6} \times 10} = 812.5 kgm^{-3} \qquad ;$$

10. Figure 3 shows air flowing through a pipe of different cross-sectional areas. Two pipes A and B are dipped into water.

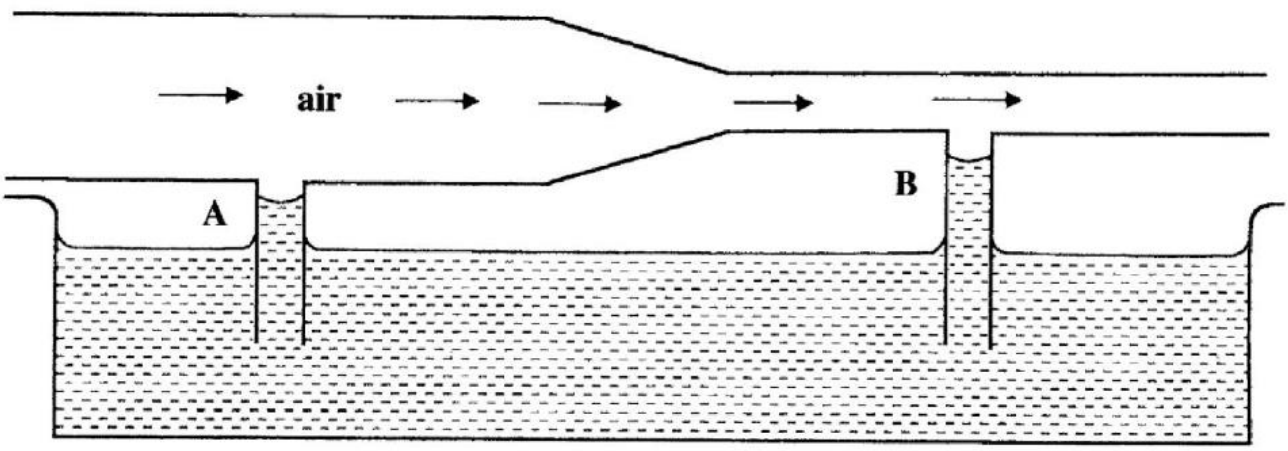


Figure 3

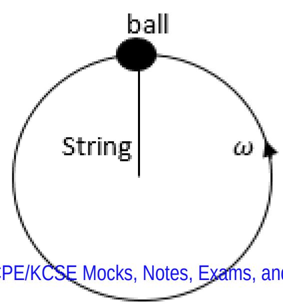
Explain the cause of the difference in the levels of water in the pipes A and B. (2 marks)

Air moves faster above tube B than above tube A casing lower pressure above tube B; the higher atmospheric pressure therefore makes level of water to rise higher in B than in A;

11. A balloon is filled with hydrogen gas and then released into the air. The balloon is observed to expand as the balloon rises. Explain why it expands. (2 marks)

Atmospheric pressure decreases with increase in height; volume must therefore increase (expansion) since pressure is inversely proportional to volume according to Boyle's law;

12. The figure 4 below shows a ball being whirled in a vertical plane. Mark on the same figure, as A, the position where the string is likely to snap if the angular velocity of the ball is increased. Explain your answer. (2 marks)



A ;

Figure 4

13. A uniform metre-rule balances at the 30cm mark when a mass of 500g is placed at the 25cm mark as shown in the figure 5 below. (not drawn to scale).

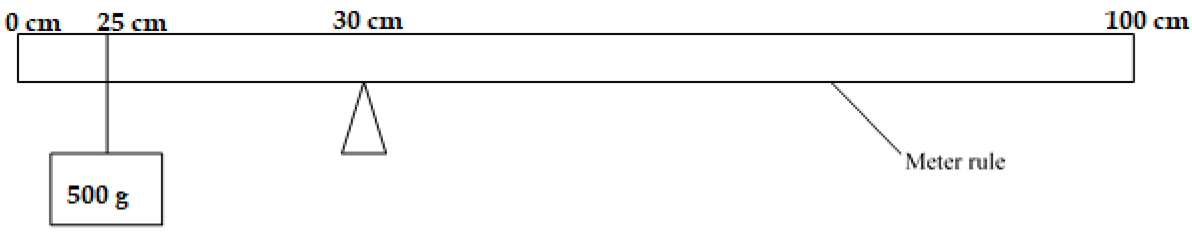


Figure 5

Determine the mass of the meter-rule (3 marks)

$upthrust = V\rho g$;

$6.5 = 800 \times 10^{-6} \times \rho \times 10$;

$hence, \rho = \frac{6.5}{800 \times 10^{-6} \times 10} = 812.5 kgm^{-3}$;

SECTION B (55 MARKS)

14. The diagram below shows a spring balance tied to an object of mass 500g and rotated in a circular path of radius 50 cm.

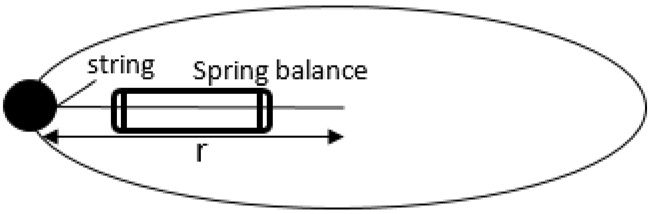


Figure 6

a) State the source of force that keeps the object moving in a circular path. (1mark)

Tension in the string ;

b) The speed of the object is constant but the body is accelerating on the circular path. Explain (1 mark)

The change in direction of the velocity with time constitutes the acceleration of the body ;

c)

i. If the object is whirled faster, what would happen to the spring balance reading? (1 mark)

The reading increases ;

ii. Give a reason for your answer in, c (i) above (2 marks)

Centripetal force increases with increase in angular velocity according to the relation:

$F_c = mr\omega^2$, **hence more tension would be required to keep the object in circular**

d) If the spring balance reads 81N. Determine:

i. the linear velocity, v of the body (3 marks)

$F_c = \frac{mV^2}{r}$; $\rightarrow 81 = \frac{0.5 \times V^2}{0.5}$;

Therefore, V = 9m/s ;

ii. centripetal acceleration of the body (3 marks)

$angular\ velocity, \omega = \frac{v}{r} = \frac{9}{0.5} = 18rads^{-1}$;

$a_c = r\omega^2$; $= 0.5 \times 18^2$ $= 162rads^{-2}$;

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

Banking increases the centripetal force so that vehicles can negotiate bends at relatively higher speed ;

15.

a) State the law of flotation (1 mark)

A floating body displaces its own weight of the fluid in which it floats;

b) Figure 7 below shows a test-tube whose cross-sectional area is $2cm^2$ partially filled with lead shot floating vertically in water.

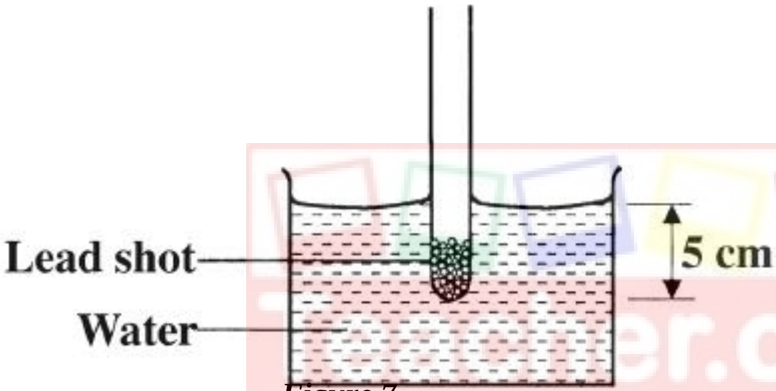


Figure 7

Determine the:

i. Volume of water displaced (2 marks)

$V = Ah \rightarrow 2 \times 5 =; 10cm^3;$

ii. Weight of displaced water (3 marks)

$W = v\rho g;$ $= 10 \times 10^{-6} \times 1000 \times 10;$
$= 0.1N;$

c) State the combined weight of the test-tube and the lead-shot (1 mark)

0.1 N ;

d) Determine the length of the test-tube that would be submerged if a liquid of density $0.8g/cm^3$ is used. (3 marks)

$$U = v\rho g$$

$$\rightarrow 0.1 = 2 \times 10^{-4} \times l \times 800 \times 10 \;;;$$

$$l = \frac{0.1}{2\times10^{-4}\times8000} = 0.0625m \qquad ;$$

e) The set-up in figure 7 may be used as a hydrometer. Suggest any one change that can be made so that it measures small differences in densities of liquids (1 mark)

Using a narrower test-tube ;

16.

a) Define the following terms as used in machines:

i. Efficiency (1 mark)

The ratio of work out put to work in put (expressed as a percentage);

ii. Velocity ratio (1 mark)

The ratio of distance moved by effort to distance moved by the load ;

b) The figure below shows a 200g mass placed on a frictionless surface and attached to a spring.

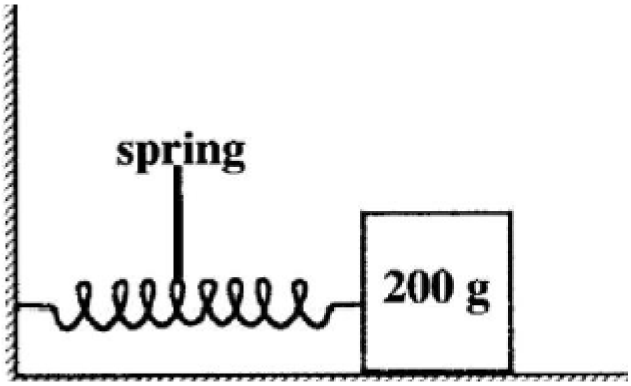


Figure 8

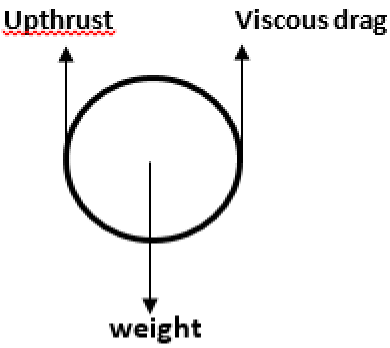
The spring is compressed then released. If the elastic potential energy of the compressed spring is 2.7×10^{-2}J, determine the maximum speed with which the block moves after it is released. (3 marks)

Potential energy of spring = kinetic energy gained by the body ;

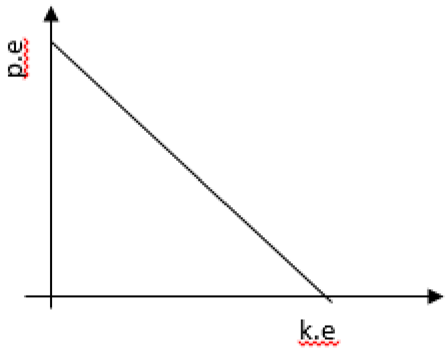
$0.027 = \frac{1}{2} \times 0.2 \times v^2$;

Therefore, $v = \sqrt{\frac{2\times0.027}{0.2}}$ **=0.5196 m/s ;**

c) A spherical ball is released vertically from a height, h. Sketch on a diagram to show the forces acting on the ball just after it is released. (3 marks)



d) Sketch a graph of potential energy against kinetic energy as the ball falls to the ground (2 marks)



e) State two ways in which an inclined plane can be made to reduce the applied effort when pulling a load along the plane (2 marks)

- **Smaller angle of inclination ;**
- **Greasing the surface ;**

17.

a) State what is meant by an ideal gas (1 mark)

A gas that obeys all the gas laws ;

b) The pressure acting in a gas in a container was changed steadily while the temperature of the gas was maintained constant. The value of volume V of the gas measured various values of pressure. The graph in the figure 9 shows the relation between the pressure P and the reciprocal of volume, V^{-1}.

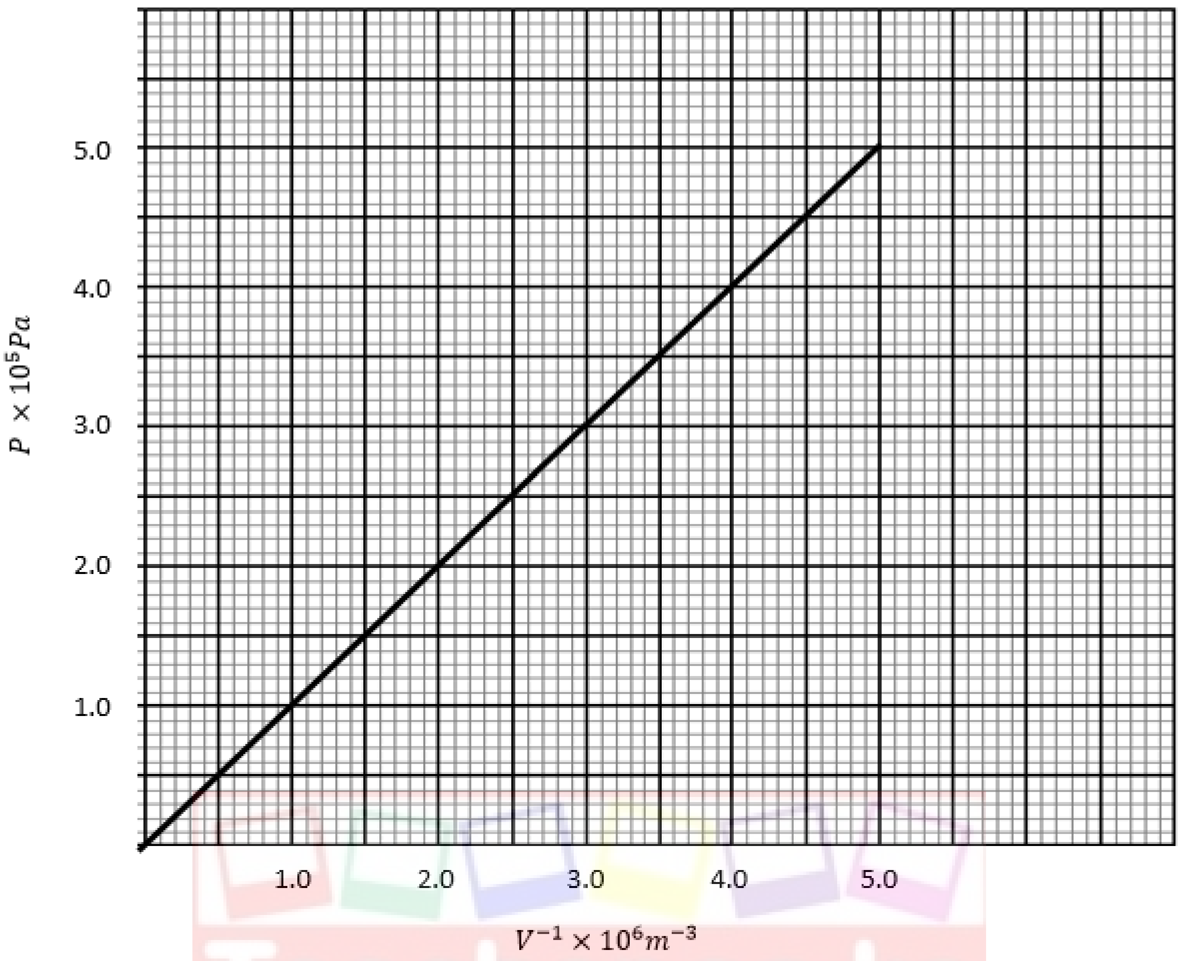


Figure 9

i. Identify the gas law being verified by the above graph (1 mark)

Boyle's law ;

ii. Given that the relation between the pressure P and the value, V of the gas is given by the equation: PV = k, where k is a constant, use the graph to determine the value of k (3 marks)

K is the gradient of the graph ;

$$gradient = \frac{(4-2)\times10^5}{(4-2)\times10^6} = 0.1 \quad \text{Pa.m}^3 \;;;$$

c) A gas occupies a volume of 4000 litres at a temperature of 37°C and normal atmosphere pressure. Determine the new volume of the gas if it is heated at constant pressure to a temperature of 67°C (normal atmosphere pressure P = 1.01 x 105pa) (3 marks)

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

$$\frac{4000}{310} = \frac{V_2}{340}\ ; \qquad \rightarrow V_2 = \frac{4000 \times 340}{310} = 4387.09 \text{ litres;}$$

d) State two limitations of gas laws (2 marks)

- **Size of molecules and intermolecular forces are negligible ;**
- **Real gas is liquefied before zero volume is reached ;**

18.

a) State the principle of transmission of pressure (1 mark)

Pressure applied at one point of an enclosed liquid is transmitted equally to other parts of the enclosed liquid. ;

b) The diagram below shows a U-tube filled with two liquids X and Y.

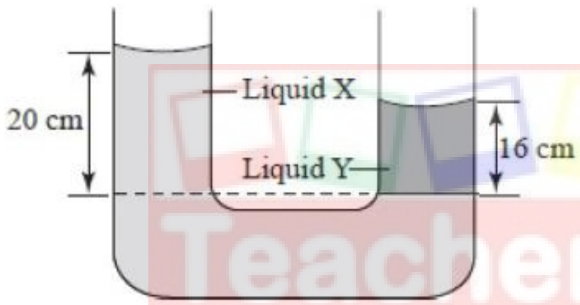


Figure 10

If the density of liquid Y is 1.26 g cm^{-3}, determine the density of liquid X. (3 marks)

$$0.2 \times \rho \times 10 = 0.16 \times 1260 \times 10 \qquad ;;$$

$$\rho = \frac{0.16 \times 1260 \times 10}{0.2 \times 10} = 1008kgm^{-3} \qquad ;$$

c) The figure 11 below shows water getting in and out of a pipe.

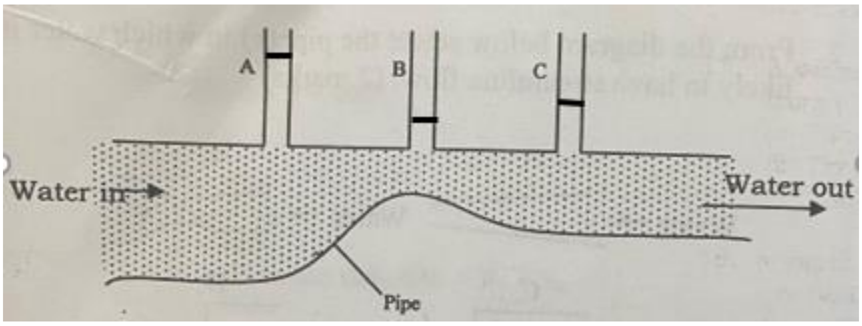


Figure 11

If the water in the pipe is flowing continuously and has a streamline flow:

i. Show on the diagram the relative level of water in tubes A, B and C (1 mark)

ii. Explain your answer above (1 mark)

Speed of the water is highest below the tube, B followed by C and lastly below tube, A hence pressure will inversely vary accordingly ;

d) A strong wind lifted off the roof of a classroom. Explain how this could happen (2 marks)

Fast moving wind above the roof reduces pressure there; higher pressure from below the roof creates a force which lifts the roof;

e) The speed of air at the upper part of an airplane wing is 120m/s and the lower side is 100m/s. The area of the airplane wing is $12m^2$. Calculate the pressure difference on the wings (2 marks)

$$pressure\ difference, P = \frac{1}{2}\rho(V_1{}^2 - V_2{}^2) \quad ; \quad \text{or substitution}$$

$$P = \frac{1}{2} \times 1.25(14400 - 10000) = 2750Pa \quad ;$$

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