TERM 2 - 2023

PHYSICS – PAPER 1 (232/1)

FORM THREE (3)

Time - 2 Hours

MARKING SCHEME

INSTRUCTIONS TO THE TEACHER

- **This marking scheme is just a guide for the teacher (it is NOT the final word on the responses). The teacher is therefore expected to adapt this marking scheme and ensure ALL relevant answers are captured before beginning the marking exercise.**
- **We have used the symbol ';' to guide where marks should be awarded.**

1. A stop watch reads 06:30:94 and 09:10: 20 at the start and end of an experiment respectively. Determine:

a) The accuracy of the stop watch used (1 mark)

$\frac{1}{100} = 0.01\ second$;

b) The duration of the experiment in SI units. (2 marks)

$550.20 - 390.94$; conversion of time to seconds
$= 159.26\ s$; correct answer with units

2. In an experiment to demonstrate Brownian motion, smoke was placed in an air cell and observed under a microscope, Smoke particles were observed to move randomly in the cell.

i. Explain the observation (1 mark)

Smoke particles are hit by invisible air particles in random motion ;

ii. Give a reason for use of smoke in this experiment (1 mark)

Smoke particles are light; hence can float in air and easily pushed by air particles to show the Brownian motion

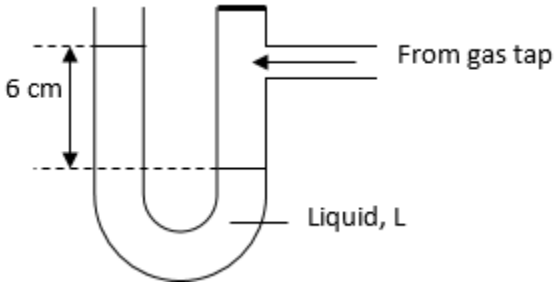
3. The reading on a mercury barometer at Mombasa is 760mm. Express this pressure in SI units. (density of mercury = 1.36 x 10^4 Kg/m^3) (2 marks)

$P = h\rho g$;
$P = 0.76 \times 13600 \times 10 = 103,360Pa$;

4. When a mercury thermometer is used to measure the temperature of hot water, it is observed that the mercury level first drops before beginning to rise. Explain. (2 marks)

Bulb expands first causing level of mercury to fall; heat reaches mercury and it expands faster than the glass capillary tube so its level rises ;

5. Figure below shows a u-tube manometer containing a liquid L. One end of the tube is connected to a gas tap. Given that the atmosphere pressure is 1.0×10^5pa, determine the pressure of the gas (density of liquid L is 900kg/m^3, g=10N/kg) (2 marks)



$$P_g = h\rho g + P_a$$

$$= (0.06 \times 900 \times 10) + 100,000 \quad ;$$

$$= 100{,}540 \text{ Pa} \quad ;$$

Figure 1

6. For a fluid flowing at a velocity, V in a tube of cross-sectional area, A, VA= constant. State two assumptions made in deriving this equation. (2 marks)

- **Flow is streamline ;**
- **Fluid is incompressible ;**

7. The figure 2 shows the graph of extension against force for a certain spring.

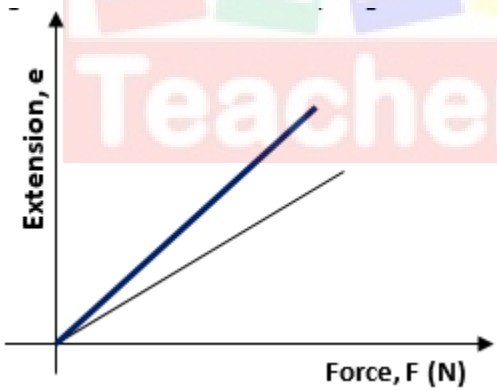


Figure 2

On the same diagram, sketch the graph of extension against force for a spring with a lower value of spring constant. (1 mark)

8. An object is thrown vertically upwards at an initial velocity of 30m/s. Determine its maximum height. (2 marks)

$V^2 = U^2 - 2gS$; **formula or substitution**

$0^2 = 30^2 - (2 \times 10 \times S)$

$S = 45m$; **correct answer with units**

9. A solid marble is resting in a bowl as shown below.

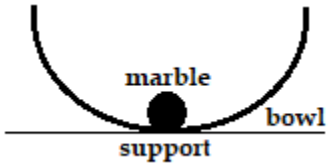


Figure 3

Suggest its state of equilibrium. Explain your answer (2 marks)

- **Stable ;**
- **When slightly displaced, it returns to original position ;**

10. The diagram below (not drawn to scale) shows part of the motion of a tennis ball, which is projected vertically upwards from the ground and allowed to bounce on the ground.

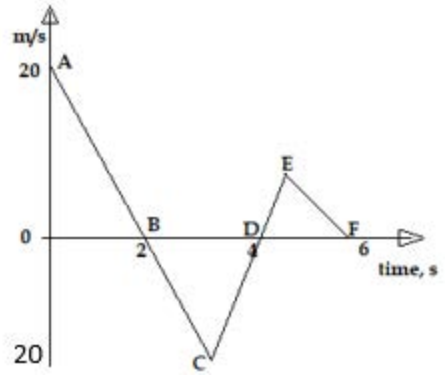


Figure 4

Calculate the height of the ball above the ground at the end of the 3rd second (3 marks)

$maximum\ height = \frac{1}{2} \times 2 \times 20 = 20m$;

Displacement from maximum height $= \frac{1}{2} \times 20 \times (3-2) = 10m$;

Height above ground = (20-10) = 10 m ; must show subtraction

11. The figure below shows a uniform metal rod balanced at its centre by various forces.

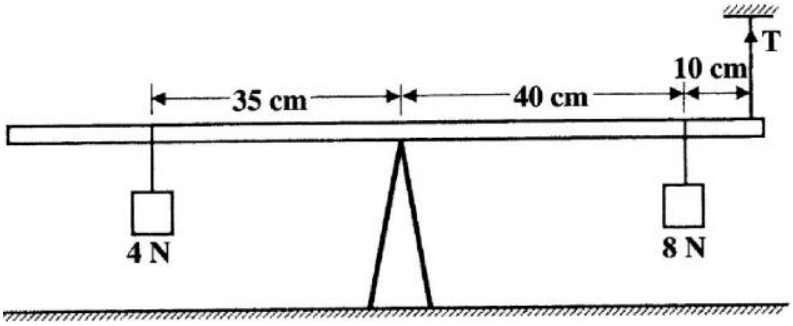


Figure 5

Determine the tension, T. (3 marks)

At equilibrium; the sum of clockwise moment = sum of anti-clockwise moment ;

Taking moments about pivot:

$(T \times 0.5) + (4 \times 0.35) = (8 \times 0.4)$;

$0.5T + 1.4 = 3.2$

Therefore; $T = \frac{3.2-1.4}{0.5} = 3.6N$;

12. A high jumper lands on saw dust. Explain how the saw dust helps in reducing the force of impact. (1 mark)

Saw dust increases the duration of impact because it is soft which allows the impulsive force to reduce;

SECTION B (55 MARKS)

13.

a) Define 'Centre of gravity' of a body (1 mark)

Point where the weight of a body appears to act from ;

b) Explain why a lorry loaded with bags of maize packed high up is likely to topple when negotiating a corner. (2 marks)

The loaded lorry has a raised position of the center of gravity; while negotiating a corner, the line of action of its weight may fall outside the base causing it to topple ;

c) The figure below is an aluminium metal sheet used for manufacturing bodies of motor vehicles.

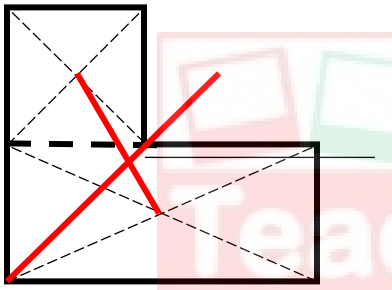


Figure 6

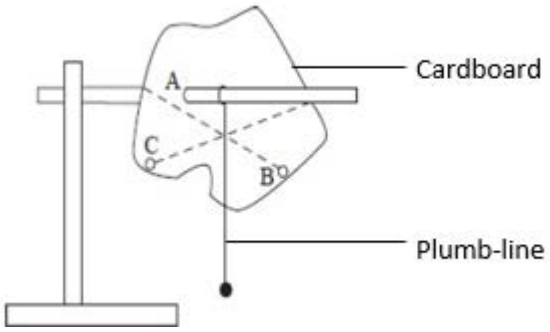
Determine its Centre of gravity (2 marks)

COG of the two rectangles ;

Joining the two centers and bisecting the lower angle to intersect the line joining the Centres to get the COG ;

d) You are provided with the following apparatus: Plumb-line, thread, stand, irregular cardboard. Using a suitable set-up diagram, describe how you would determine the Centre of gravity of the irregular cardboard. (6 marks)

Set-up



Correct set-up with labelling – 2 marks

Procedure - 2 marks

Observation -1 mark

Conclusion stating the exact location of the Centre of gravity -1 mark

Procedure

- **Make three holes at the margin of the irregular cardboard.**
- **Suspend the cardboard through a hole and draw a line along the cardboard as trace-out by the plumb-line.**
- **Repeat above for the other two holes.**

Observation and conclusion:

- **The cardboard balances at the point where the lines intersect. This is the position of the Centre of gravity.**

14.

a) State Bernoulli's principle (1 mark)

For a fluid which is: incompressible, non-viscous and has a streamline flow, the sum of pressure, kinetic energy per unit volume and potential energy per unit volume is a constant.

b) It is dangerous to stand close to a railway line on which a fast moving train is passing. (2 marks)

pressure between the person and the train is lower than pressure behind the person; the pressure difference causes a force which pulls the person toward the train;

c) The diagram below shows the mercury levels when no air is blown into the tube.

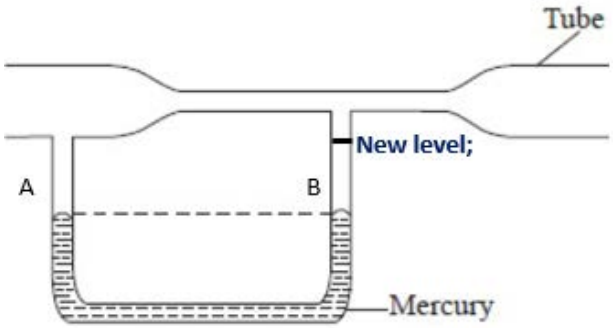


Figure 7

On the same diagram, indicate the new level of mercury when air is continuously moving fast through the tube. Explain your answer. (3 marks)

Fast moving air in the middle constriction reduces pressure there; higher atmospheric pressure forces mercury to rise in limb B but lower in limb A ;

d) A pipe has a cross-sectional area of 40cm^2. The speed of water is 9 m/s at this end. if the speed increases to 15m/s in a constriction in the pipe, find the area of the narrow part of the pipe. (3 marks)

$A_1V_1 = A_2V_2$;

$0.004 \times 9 = A_2 \times 15$;

$A_2 = 0.0024\ m^2$;

e)

i. Other than density, state any other factor which affect pressure in fluid (1 mark)

- **Depth ; accept height of the liquid column**

ii. State the assumption on which Pascal's principle is based (1 mark)

The liquid must be enclosed ;

15.

a) Define the term 'velocity ratio' of a machine (1 mark)

The ratio of effort distance to the load distance ;

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

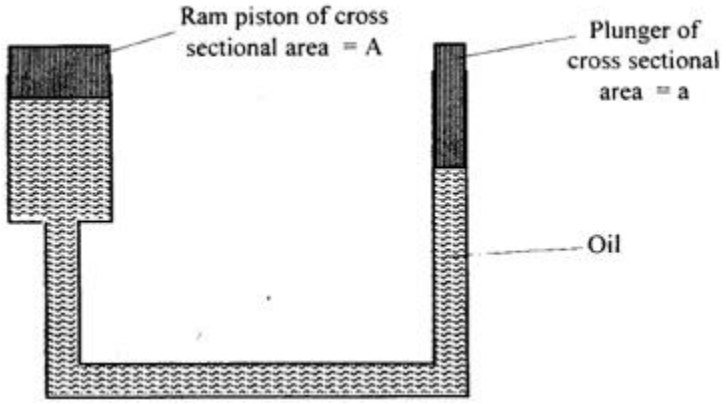


Figure 8

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

i. State one property of the oil used in the hydraulic press (2 marks)

- **Oil is incompressible ;**

c) Determine the velocity ratio of the press in terms of A and a (4 marks)

Volume of liquid that leaves plunger section is equal volume of liquid that enters Ram section;

$$a \times d = A \times D \quad ;$$

$$\textbf{Velocity ratio} = \frac{distance\ moved\ by\ effort}{distance\ moved\ by\ Load} \quad ;$$

Rearranging the above equation:

$\frac{d}{D} = \frac{A}{a}$ **hence, V.R** $= \frac{A}{a}$;

d) A machine of velocity ratio 45 overcomes a load of 4500N when an effort of 135N is applied. Determine:

i. the mechanical advantage of the machine (2 marks)

$$M.A = \frac{Load}{Effort}$$

$$= \frac{4500}{135}; \quad = 33.33N \;;$$

ii. the efficiency of the machine (3 marks)

$$efficiency = \frac{MA}{VR} \times 100 \quad ;$$

$$\frac{33.33}{45} \times 100; = 74.07\% \quad ;$$

iii. percentage of work that goes to waste (2 mark)

(100-74.06) ;= 25.94% ;

16. Figure 9 shows a threaded bolt.

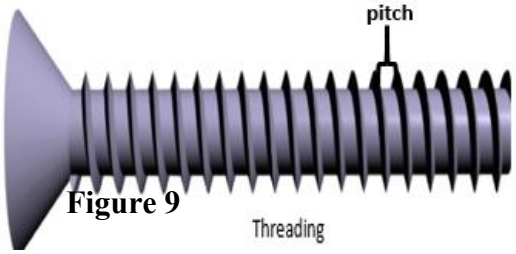


Figure 9

a) Explain how a metre-rule can be used to measure the pitch (distance between adjacent peaks) of the threading (2 marks)

Measure the length, L of 'n' peaks ;

Divide the length, L by the number of peaks (n-1)

i.e. $pitch = \frac{L}{(n-1)}$ **;**

b) Figure 10 is a screw-jack whose pitch is 1mm and has a handle of 25 cm long. Determine the velocity ratio of the jack
(3 marks)

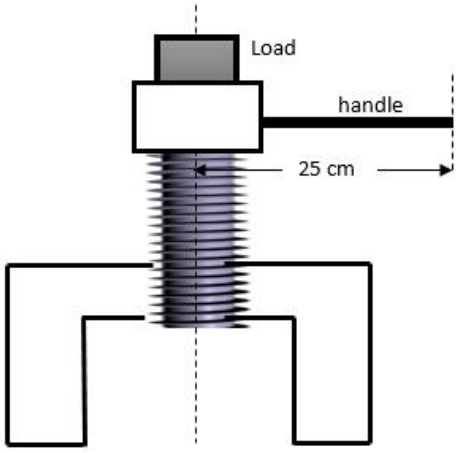


Figure 10

$$VR = \frac{2\pi r}{Pitch} \quad ;$$

$$\rightarrow VR = \frac{2\times 3.142\times 0.25}{0.001} \; ; = 1571;$$

c) A bullet of mass 60g is travelling at 800m/s hits a tree and penetrates a depth of 15 cm before coming to rest.

i. Describe the energy changes of the bullet as it penetrates the tree (2 marks)

Kinetic energy of the bullet in motion is converted to heat and sound ;;

ii. Determine the average retarding force of the bullet (3 marks)

$$kinetic\ energy = work\ done\ against\ friction \;;$$

$$\frac{1}{2}\times 0.06 \times 800^2 = F \times 0.15 \quad ;$$

$$\text{Therefore, } F = 128,000N \quad ;$$

17.

a) Define 'atmospheric pressure' and state it's SI unit (1 mark)

Force per unit area

SI unit is newton per square metre ;

(also accept pascal)

b) In an experiment to demonstrate the existence of atmospheric pressure, a plastic bottle is partially filled with hot water and the bottle is then tightly corked. After sometime the bottle starts to get deformed.

i. State the purpose of the hot water (1 mark)

It provides vapor ;

ii. Explain why the bottle gets deformed (2 marks)

The vapor condenses reducing pressure inside the bottle; greater atmospheric pressure provides the force which deforms the bottle ;

c) A trolley is pulled a long a smooth horizontal surface by a constant force as shown below:

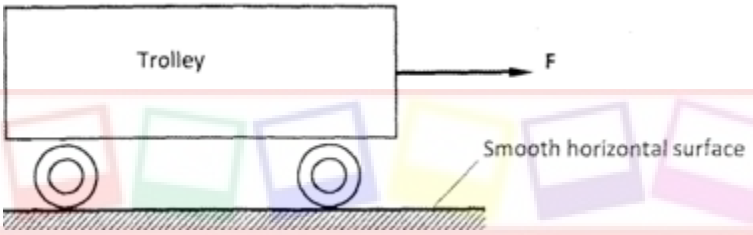
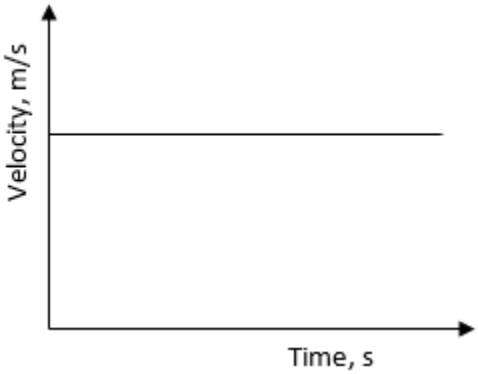


Figure 11

i. On the axes provided, sketch the velocity-time graph for the motion (1 mark)



ii. State the assumption made in part (i) above (1 mark)

The surface is frictionless ;

iii. A parachute falling through air soon attains terminal velocity. Explain the meaning of the term terminal velocity (2 marks)

This is constant velocity attained by a body falling through a fluid when the sum of forces downward is equal to the sum of forces upward ;;

d) State the equation showing the relationship among the various forces acting on the parachute soon after it attains the terminal velocity. (1 mark)

$$\boldsymbol{Weight = viscous\ drag + Upthrust}$$;

This is the last printed page.