

TEACHER.CO.KE

Kenya Certificate of Secondary Education

KCSE 2021

— PHYSICS —

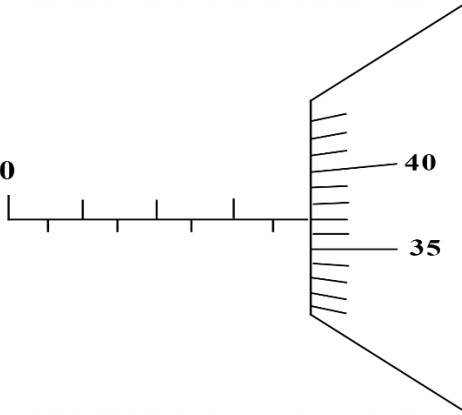
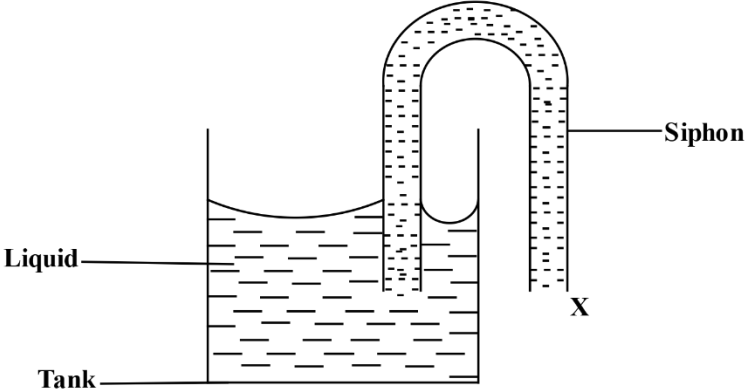
Paper 1

March. 2022 - 2hours

**MARKING
SCHEME**



SECTION A (25 MARKS)

No.	CONTENT	NOTES
1	<p>Figure 1 shows part of the thimble scale of a screw gauge with 50 divisions. On the diagram, draw the sleeve scale to show a reading of 3.87mm (1 mark)</p> <p><i>Expected response</i></p>  <p style="text-align: center;">Figure 1</p>	
2	<p>Figure 2 shows a siphon used to empty a tank.</p>  <p style="text-align: center;">Figure 2</p> <p>In order to start the siphon, state why:</p> <p>(a) it must be full of liquid (1 mark)</p> <p><i>Expected response</i></p> <ul style="list-style-type: none"> ➤ To overcome atmospheric pressure inside the siphon by expelling trapped air inside the siphon. 	

(b) end X must be below the level of the liquid in the tank (1 mark)

Expected response

➤ To create pressure difference.

3 **Figure 3(a)** shows a horizontal tube containing air trapped by a mercury thread of length 5cm. The length of the enclosed air column is 7.5cm. The atmospheric pressure is **76cmHg**.

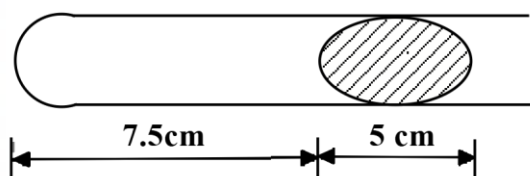


Figure 3(a)

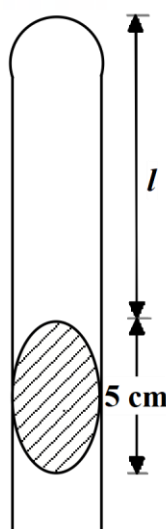


Figure 3(b)

The tube is then turned vertically with its mouth facing down as shown in **Figure 3(b)**.

(a) Determine the length l of the air column. (3 marks)

Expected response

$$P_1V_1 = P_2V_2$$

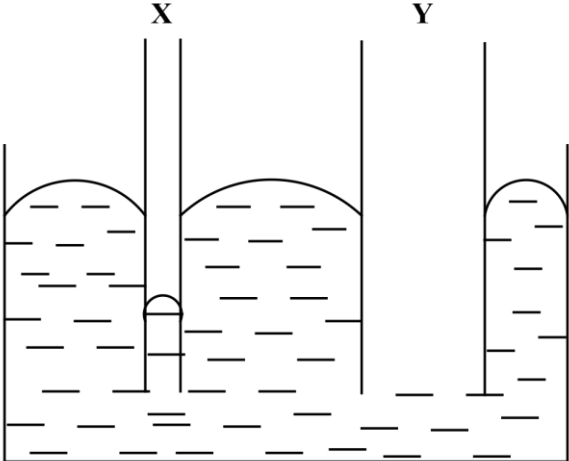
$$76 \times 7.5 = (76 - 5)l$$

$$l = 8.03 \text{ cm (2d.p)}$$

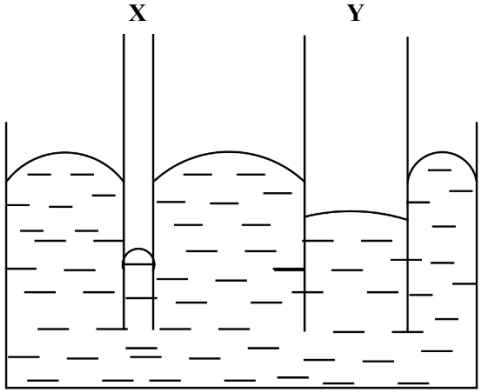
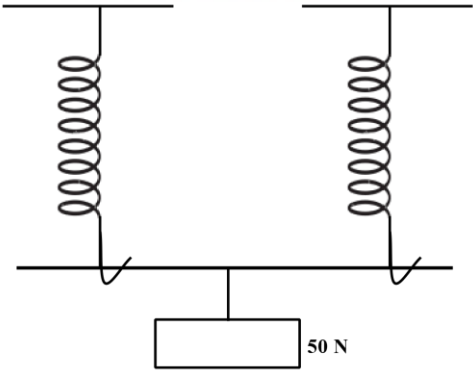
(b) State the reason why the mercury thread did **not** fall out in **Figure 3(b)**.

Expected response

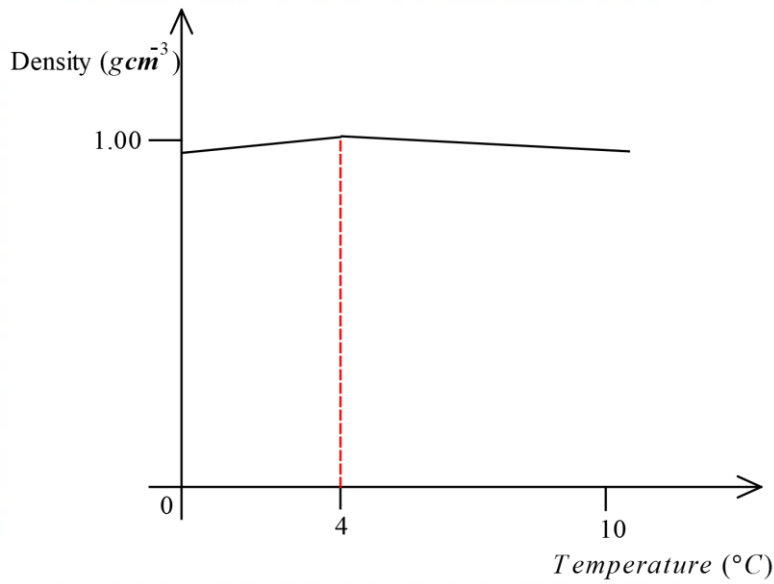
➤ The pressure acting upward on the mercury thread is greater than the downward pressure due to air column.

<p>4</p>	<p>In a Physics experiment, a student filled a burette with water up to a level of 15ml. The student ran out 3 drops of water each of volume 2cm^3 from the burette into a beaker. Determine the final reading of the burette. (3 marks)</p> <p><i>Expected response</i></p> <p style="text-align: center;"><i>Initial burette reading = 15ml</i></p> <p style="text-align: center;"><i>Volume of water dropped out = 3drop \times 2cm^3</i></p> <p style="text-align: center;"><i>= 6cm^3</i></p> <p style="text-align: center;"><i>New burette reading = $15\text{cm}^3 + 6\text{cm}^3$</i></p> <p style="text-align: center;"><i>= 21cm^3</i></p>	<p>1ml $= 1\text{cm}^3$</p>
<p>5</p>	<p>State two factors that affect the angular velocity of a body moving in a circular path. (2 marks)</p> <p><i>Expected response</i></p> <ul style="list-style-type: none"> ➤ The instantaneous linear velocity of the moving body ➤ The radius of the circular path 	
<p>6</p>	<p>Figure 4 shows two capillary tubes X and Y of different diameters dipped in mercury.</p> <div style="text-align: center;">  </div> <p style="text-align: center;">Figure 4</p> <p>Complete the diagram to show the meniscus in Y</p> <p><i>Expected response</i></p>	

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7	<p>In an experiment, a drop of black ink is introduced at the bottom of a container filled with water. It is observed that the water gradually turns black. State the effect on the observation when the experiment is carried out using water at a lower temperature. (1 mark)</p> <p>Expected response</p> <p>➤ The rate of water gradually turning black will reduce.</p>	
8	<p>Figure 5 shows two identical springs arranged side by side and supporting a weight of 50 N.</p>  <p>Figure 5</p> <p>When the same weight is supported by one of the springs above, it produces an extension of 1 cm. Determine the effective spring constant of the arrangement in Figure 5. (3 marks)</p> <p>Expected response</p> $K = F/e \rightarrow \frac{50N}{1cm}$ $= 50N/cm$ $K_T = 2 \times 50N/cm$ $= 100N/cm \text{ or } 10000N/m$	

9 On the axes provided, sketch a graph of density against temperature for water between 0°C and 10°C



10 State the reason why a student climbing a hill tends to bend forward. (1 mark)

Expected response

- To shift the position of the centre of gravity to the front part to maintain equilibrium.

11 Figure 6 shows a graph of temperature against time for a pure molten substance undergoing cooling.

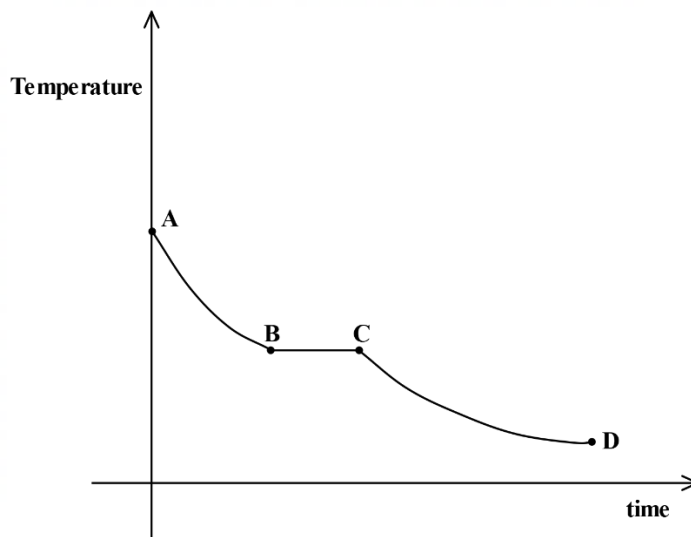
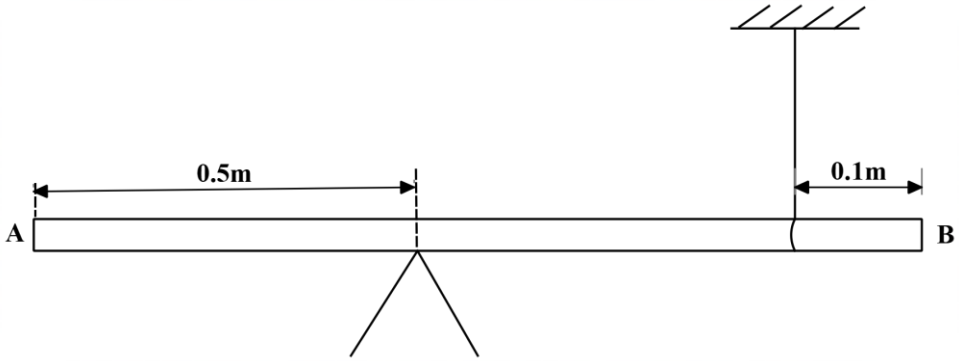
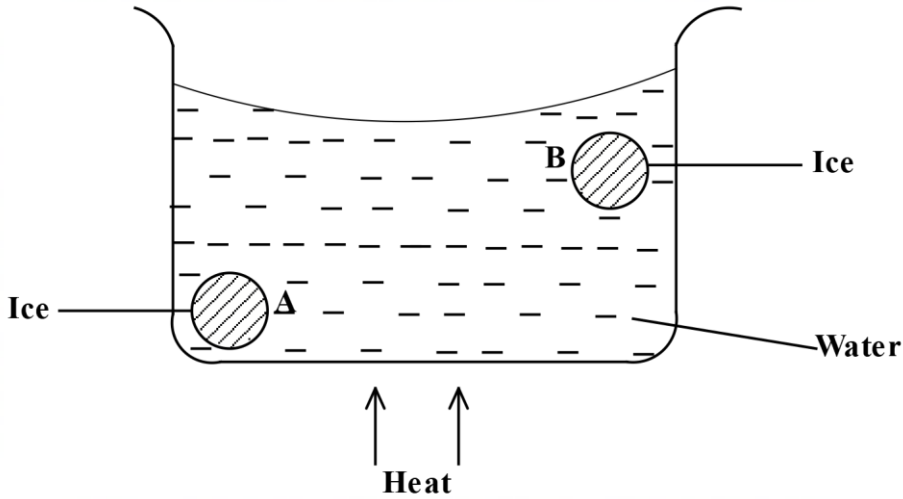
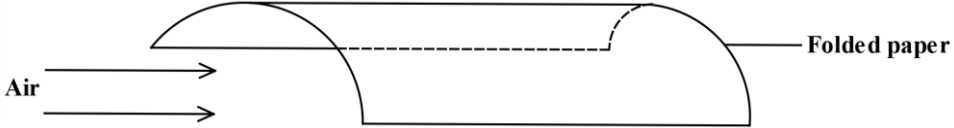
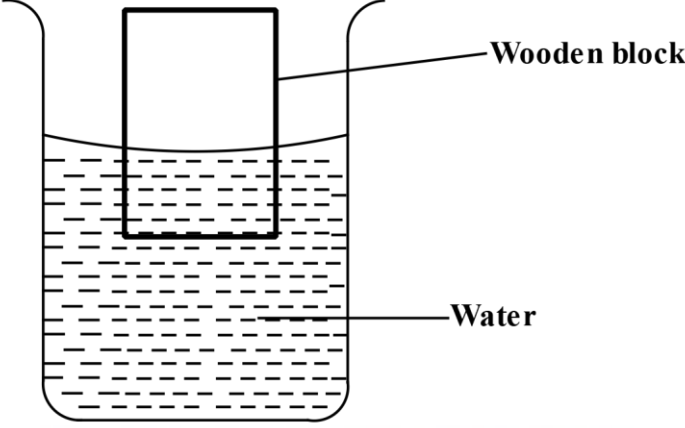


Figure 6

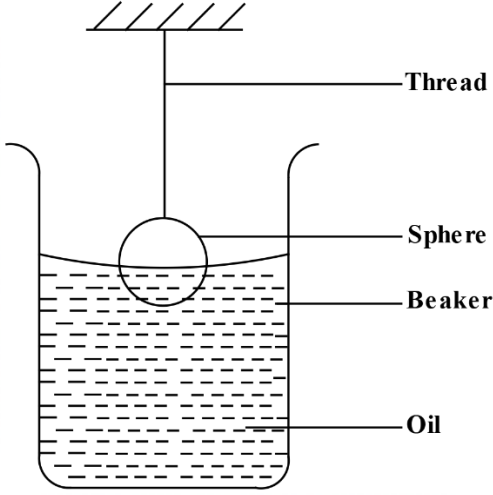
	<p>Explain what happens to the substance in region BC (2 marks)</p> <p>Expected response</p> <ul style="list-style-type: none"> ➤ The substance undergoes change of state from molten to solid without change in temperature. 	
<p>12</p>	<p>Figure 7 shows a uniform rod AB 2m long and of mass 1 kg. It is pivoted 0.5m from end A and balanced horizontally by a string attached 0.1m from end B.</p>  <p style="text-align: center;">Figure 7</p> <p>Determine the tension in the string. (take $g = 10\text{Nkg}^{-1}$) (2 marks)</p> <p>Expected response</p> <p><i>Sum of clockwise moments = sum of anti – clockwise moments</i></p> $10\text{N} \times 0.5\text{m} = 1.4\text{m} \times T$ $T = 3.57\text{N}$	
<p>13</p>	<p>Figure 8 shows two pieces of ice A and B trapped using wire gauze in a larger beaker containing water.</p>  <p style="text-align: center;">Figure 8</p>	

	<p>Heat is supplied at the center of the base of the beaker as shown. State the reason why B melted earlier than A. (1 mark)</p> <p>Expected response</p> <ul style="list-style-type: none">➤ Heated water at the bottom becomes less dense which rises to the top. Hence ice B melts earlier than A.	
<p>14</p>	<p>Figure 9 shows a folded piece of paper. A stream of air is blown underneath the paper.</p>  <p style="text-align: center;">Figure 9</p> <p>Explain why the paper collapsed. (2 marks)</p> <p>Expected response</p> <ul style="list-style-type: none">➤ Air blown underneath the paper reduces pressure acting on the paper. Atmospheric pressure acting from top becomes higher. Hence the paper collapses.	

SECTION B (55 MARKS)

No.	CONTENT	NOTES
15	<p>a) Figure 10 shows a wooden block of volume 90cm^3 floating with $\frac{1}{3}$ of its body submerged in water of density 1gcm^{-3}. ($g = 10\text{Nkg}^{-1}$)</p> <div style="text-align: center;">  <p>Figure 10</p> </div> <p>Determine: (i) the weight of the block</p> <p><i>Expected response</i></p> $\text{weight of the block} = v\rho g$ $\frac{1}{3} \times \frac{90}{100000} \times 1000 \times 10$ $= 0.3\text{N}$ <p><i>Alternatively</i></p> $W = mg$ $m = \frac{1}{3} \times 90 \times 1$ $= 30\text{g}$ $W = \frac{30}{1000} \times 10$ $= 0.3\text{N}$ <p>(ii) the weight of a metal block that can be placed onto the block so that its top surface is on the same level as the water surface. (3marks)</p> <p><i>Expected response</i></p> $\text{Volume of remaining part} = 90 - 30$ $= 60\text{cm}^3$ $U \rightarrow W = v\rho g$ $= \frac{60}{100000} \times 1000 \times 10$ $= 0.6\text{N}$ $w = mg$ $\text{but } m = v \times \rho$	

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	$60 \times 1 = 60g$ $\therefore w = \frac{60}{1000} \times 10$ $= 0.6N$ <p>b) Figure 11 shows a solid metal suspended in oil using a thread.</p>  <p>(i) Other than upthrust, list two other forces acting on the sphere. (2 marks).</p> <p>Expected response</p> <ul style="list-style-type: none"> ➤ Tension force ➤ Weight, mg <p>(ii) The oil is carefully and gradually drawn from the beaker. State the effect on each of the two forces in 15(b)(i). (2 marks)</p> <p>Expected response</p> <ul style="list-style-type: none"> ➤ Tension force will increase ➤ Weight, mg, will remain constant 	
16	<p>a) Define the term “specific latent heat of fusion” (1 mark)</p> <p>Expected responses</p> <ul style="list-style-type: none"> ➤ Quantity of heat required to change a unit mass of the material from solid state to liquid without change in temperature. <p>b) Ice of mass 5g at a temperature of -10°C is immersed into 10.5g of hot water at 100°C in a container of negligible heat capacity. All the ice melts and the final temperature of the mixture is 40°C. Assuming there are no heat losses to the surrounding and taking specific latent heat of fusion for ice as L_f. ($C_{\text{water}} = 4200 \text{ Jkg}^{-1}\text{K}^{-1}$ and $C_{\text{ice}} = 2100 \text{ Jkg}^{-1}\text{K}^{-1}$)</p> <p>Determine the:</p>	

(i) heat lost by the water. (3 marks)

Expected response

$$\begin{aligned} \text{Heat lost by the water} &= m_w c_w \Delta\theta \\ 0.0105 \times 4200 \times (100 - 40) \\ &= 2646J \end{aligned}$$

(ii) heat gained by ice from -10°C to 0°C

Expected response

$$\begin{aligned} \text{Heat gained by ice upto } 0^\circ\text{C} &= m_{ice} c_{ice} \Delta\theta \\ 0.005 \times 2100 \times 10 \\ &= 105J \end{aligned}$$

(iii) heat required to melt the ice in terms of L_f (1 mark)

Expected response

$$\begin{aligned} mL_f \\ 0.005L_f \end{aligned}$$

(iv) heat gained by the melted ice. (2 marks)

Expected response

$$\begin{aligned} \text{Heat gained by melted ice} &= m_{ice} c_{ice} \Delta\theta \\ 0.005 \times 4200 \times 40 \\ &= 840J \end{aligned}$$

(v) specific latent heat of fusion. (3 marks)

Expected response

heat lost by hot water

$$\begin{aligned} &= \text{heat gained by ice}(-10^\circ\text{C to } 0^\circ\text{C}) + \text{melting ice} \\ &+ \text{melted ice upto } 40^\circ\text{C} \\ 2646J &= 105J + 0.05L_f + 840J \\ L_f &= 340,200J \end{aligned}$$

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- 17 **Figure 12** shows hydraulic lift system. The radius of the small piston is 5.64cm while that of the larger piston is 14.24cm. The small piston is operated using a lever. A force of 100N is applied to the lever.

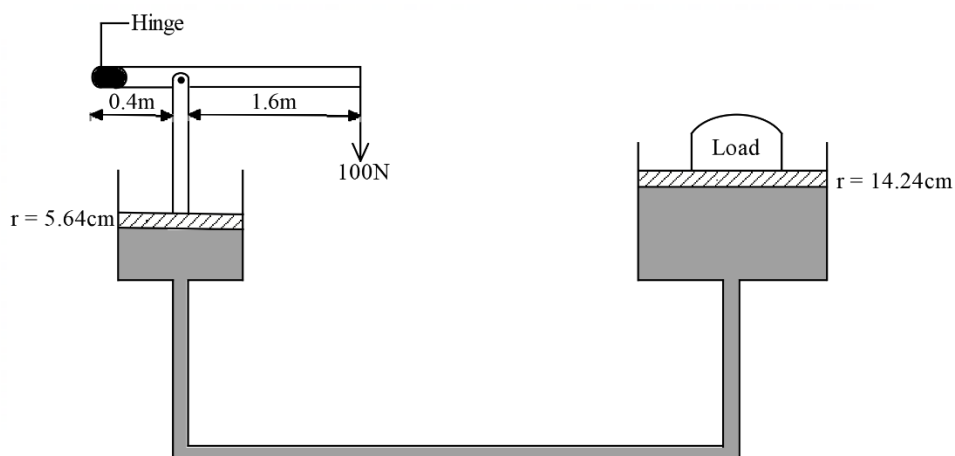


Figure 12

Determine the:

- (a) pressure exerted by the smaller piston. (5 marks)

Expected response

$$w \times 0.4 = 100N \times 2.0m$$

$$w = 500N$$

$$P = F/A, \text{ but } A = \pi r^2$$

$$= \frac{22}{7} \times 5.64^2$$

$$= 99.97cm^2 \equiv 99.97 \times 10^{-4}m^2$$

$$\therefore P = \frac{500N}{99.97 \times 10^{-4}m^2}$$

$$= 5.0015 \times 10^4 Pa$$

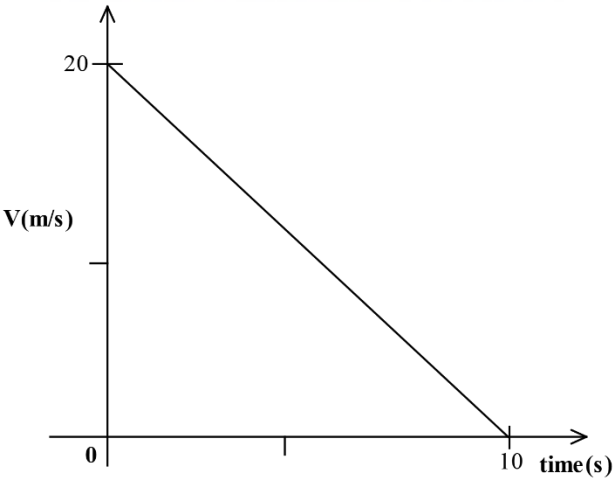
- (b) load that can be lifted. (3 marks)

Expected response

$$L = P \times A_{\text{larger piston}}$$

$$5.0015 \times 10^4 \times \frac{22}{7} \times 14.24^2 \times 10^{-4}m^2$$

$$= 3187.46N$$

	<p>(c) mechanical advantage of the system. (3 marks)</p> <p><i>Expected response</i></p> $M.A = \frac{\text{Load}}{\text{Effort}}$ $\frac{3185.22N}{500N}$ $= 6.37$	
<p>18</p>	<p>a) A bus moving initially at a velocity of $20ms^{-1}$ decelerates uniformly at $2ms^{-2}$.</p> <p>(i) Determine the time taken for the bus to come to a stop. (3 marks)</p> <p><i>Expected response</i></p> $t = \frac{v - u}{a}$ $= \frac{0 - 20}{2}$ $= 10sec$ <p>(ii) Sketch the velocity-time graph for the motion of the bus up to the time it stopped. (2 marks)</p> <p><i>Expected response</i></p>  <p>(iii) Use the graph to determine the distance moved by the bus before stopping. (1 mark)</p> <p><i>Expected response</i></p> $\text{Distance} = \text{Area under the curve}$ $\frac{1}{2} \times 20 \times 10$ $= 100m$	

b) A car of mass 1000kg travelling at a constant velocity of 40ms^{-1} collides with a stationary metal block of mass 800kg. This impact takes 3 seconds before the two move together. Determine the impulsive force. (4 marks)

Expected response

$$m_1v_1 + m_2v_2 = v(m_1 + m_2)$$

$$(1000 \times 40) + (800 \times 0) = v(1000 + 800)$$

$$= 22.22 \text{ m/s}$$

$$v = u + at$$

$$22.22 = 40 + 3a$$

$$a = -5.93 \text{ m/s}^2 \text{ (decelerating)}$$

$$F = ma$$

$$1800 \times -5.93$$

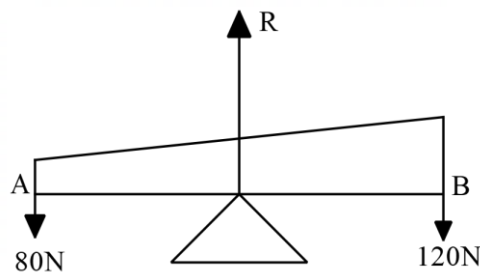
$$= 10674\text{N}$$

19 a) State **two** conditions necessary for a body to be in equilibrium. (2 marks)

Expected response

- Sum of clockwise moments about a point must be equal to the sum of anti-clockwise moments about the same point.
- For a system of parallel forces in equilibrium, sum of forces in either direction is equal.

b) **Figure 13** shows a non-uniform log of wood AB of length 4m. The log is held horizontally by applying forces of 80N at end A and 120N at end B.



Determine:

(i) the value of R. (1 mark)

Expected response

$$R = 80 + 120 \\ = 200N$$

(ii) the position of the centre of gravity of the log from end B. (3 marks)

Expected response

Let x be the distance from the pivot to point B

$$80(4 - x) = 120x \\ 320 = 200x \\ x = 1.6m$$

c) You are provided with the metre rule, a knife edge and a mass m_1 .

(i) Describe how the position of the centre of gravity of the metre rule can be determined using the knife edge. (2 marks)

Expected response

- Place the metre rule horizontally on knife edge. The position where it balances on the knife edge is the centre of gravity.

(ii) Using the position of centre of gravity determined in 19(c)(i) and the mass m_1 , describe how the mass M of the metre rule can be determined. (4 marks)

Expected response

- Move the knife edge away from the centre of gravity to a new position. Note the distance from the knife edge and the centre of gravity as d_1 .
- Place the mass m_1 on one side of the metre rule and adjust it until the rule balances as in 19 c (i). Note the distance from the knife edge and the mass m_1 as d_2 .
- Using principle of moment;

$$Md_1 = m_1d_2 \\ M = \frac{m_1d_2}{d_1}$$

Where M is the mass of the metre rule

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