TEACHER.CO.KE

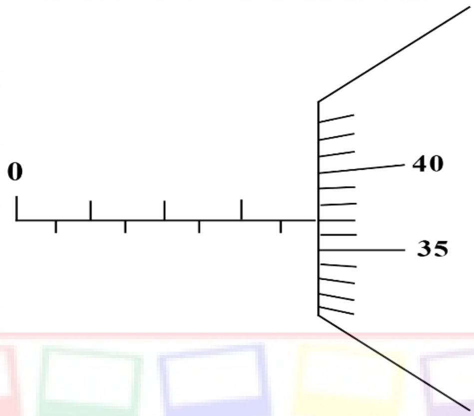
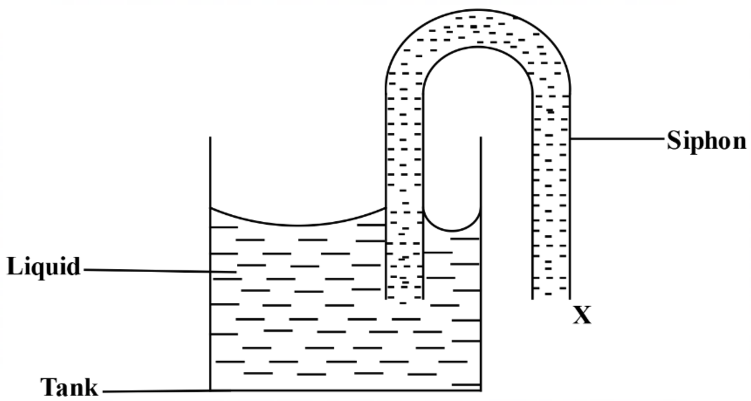
Kenya Certificate of Secondary Education

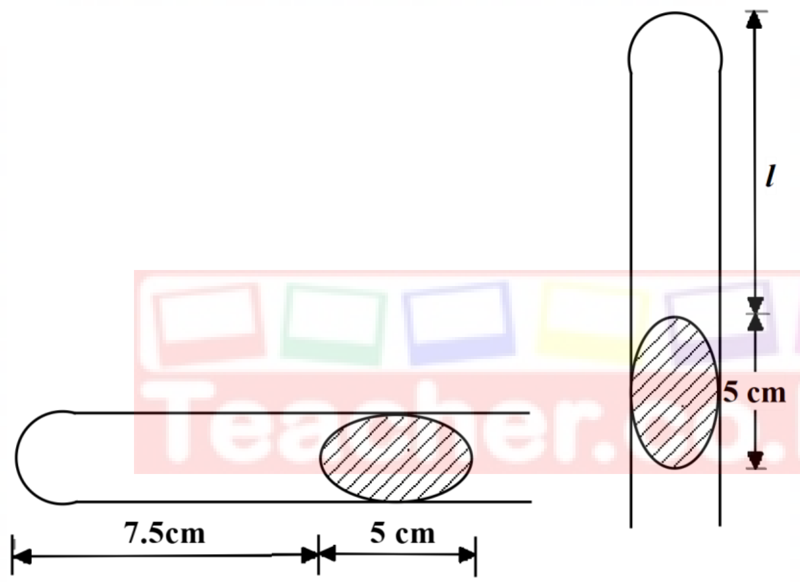
KCSE 2021 – PHYSICS – Paper 1

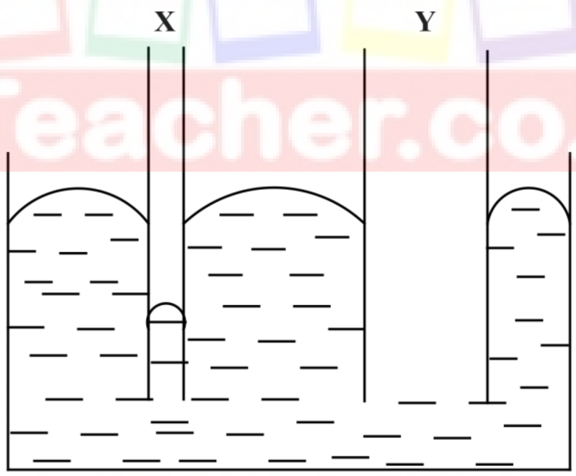
March. 2022 - 2hours

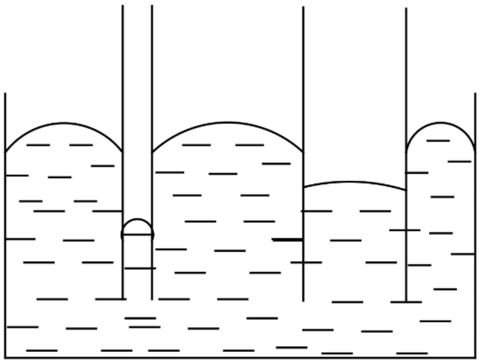
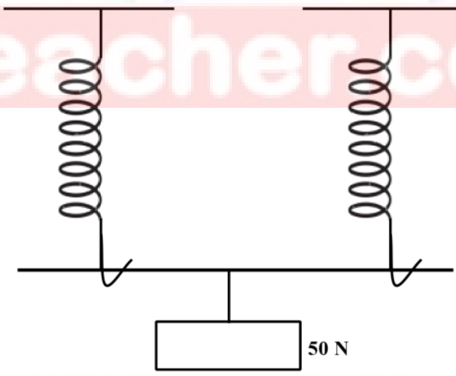
MARKING SCHEME

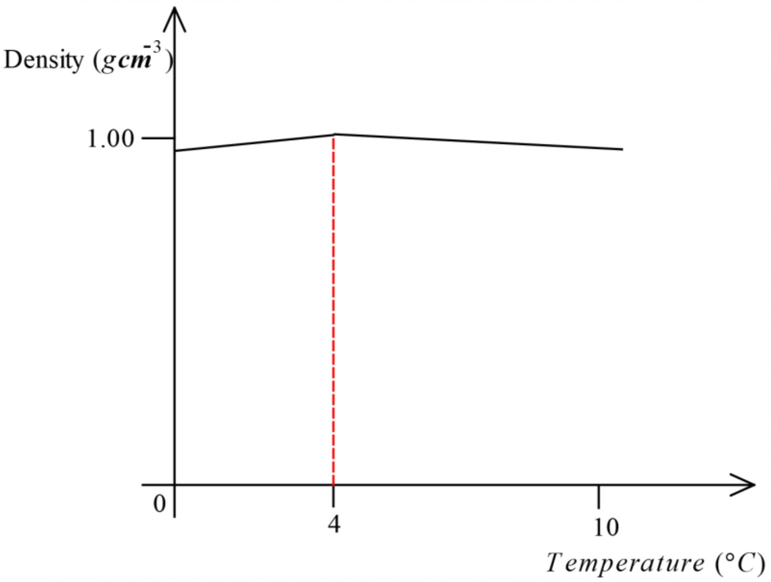
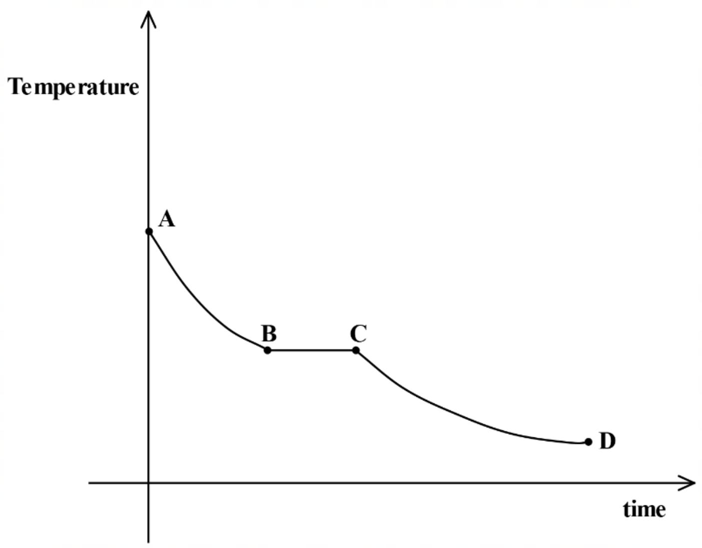
SECTION A (25 MARKS)

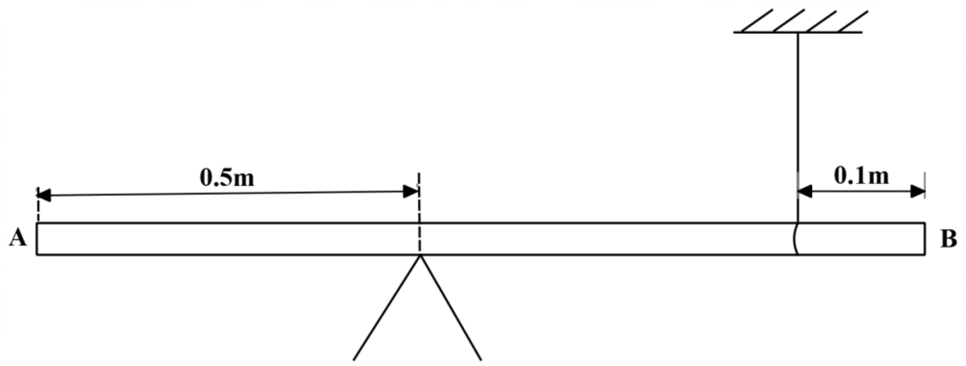
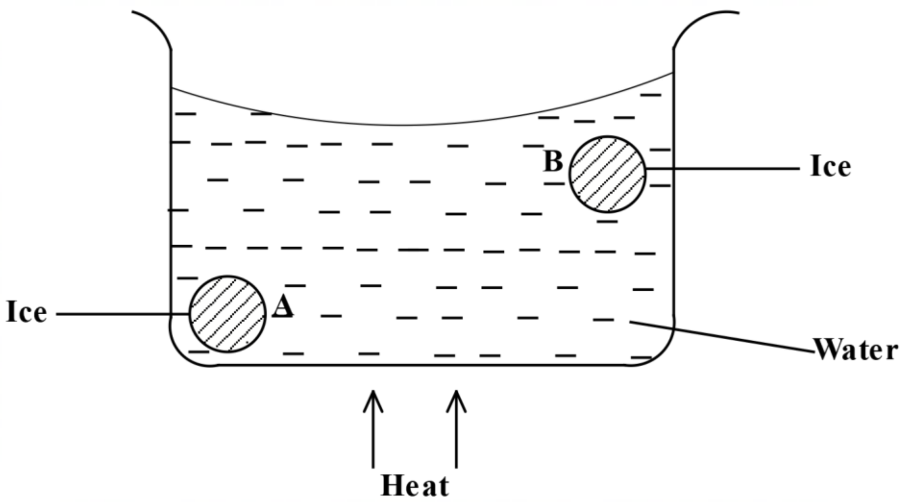
No.	CONTENT	NOTES
1	**Figure 1** shows part of the thimble scale of a screw gauge with 50 divisions. On the diagram, draw the sleeve scale to show a reading of 3.87mm **(1 mark)** ***Expected response***  **Figure 1**	
2	**Figure 2** shows a siphon used to empty a tank.  **Figure 2** In order to start the siphon, state why: **(a)** it must be full of liquid **(1 mark)** ***Expected response*** ➢ **To overcome atmospheric pressure inside the siphon by expelling trapped air inside the siphon.**	

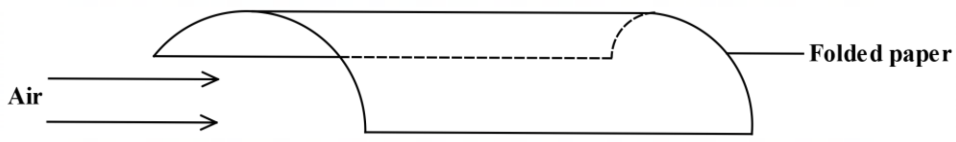
	(b) end **X** must be below the level of the liquid in the tank **(1 mark)** *Expected response* ➢ **To create pressure difference.**	
3	**Figure 3(a)** shows a horizontal tube containing air trapped by a mercury thread of length 5cm. The length of the enclosed air column is 7.5cm. The atmospheric pressure 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* $P_1V_1 = P_2V_2$ $76 \times 7.5 = (76 - 5)l$ $l = 8.03\ cm\ (2d.p$ **(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.**	

4	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)** *Expected response* $$\boldsymbol{Initial\ burette\ reading = 15ml}$$ $$\boldsymbol{Volume\ of\ water\ dropped\ out = 3drop \times 2cm^3}$$ $$\boldsymbol{= 6cm^3}$$ $$\boldsymbol{New\ burette\ reading = 15cm^3 + 6cm^3}$$ $$\boldsymbol{= 21cm^3}$$	$\boldsymbol{1ml = 1cm^3}$
5	State **two** factors that affect the angular velocity of a body moving in a circular path. **(2 marks)** *Expected response* ➢ **The instantaneous linear velocity of the moving body** ➢ **The radius of the circular path**	
6	**Figure 4** shows two capillary tubes **X** and **Y** of different diameters dipped in mercury.  **Figure 4** Complete the diagram to show the meniscus in **Y** *Expected response*	

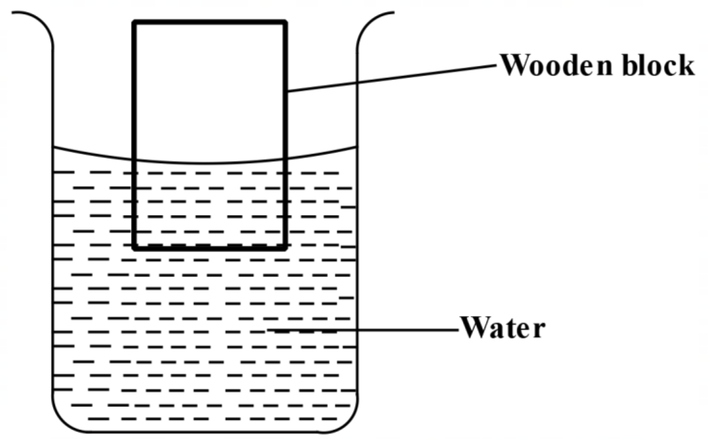
		
7	In an experiment, a drop of black ink is introduced at the bottom of a container filled with water. It is observed that the water gradually turns black. State the effect on the observation when the experiment is carried out using water at a lower temperature. **(1 mark)** ***Expected response*** ➢ **The rate of water gradually turning black will reduce.**	
8	**Figure 5** shows two identical springs arranged side by side and supporting a weight of 50 N.  **Figure 5** 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)** ***Expected response*** $K = {}^{F}/_{e} \rightarrow \frac{50N}{1cm}$ $= 50N/cm$ $K_T = 2 \times 50N/cm$ $= 100N/cm \ \ or\ 10000N/m$	

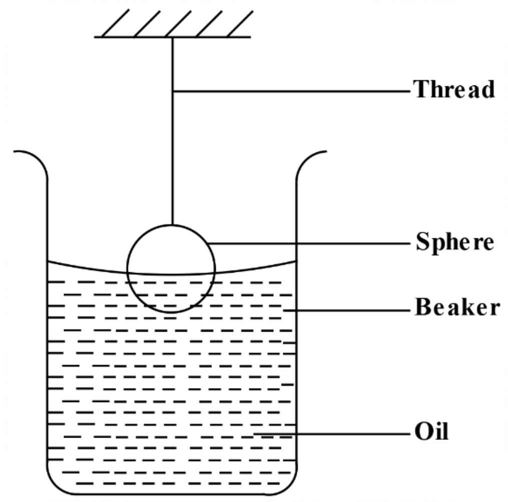
9	On the axes provided, sketch a graph of density against temperature for water between 0°C and 10°C 	
10	State the reason why a student climbing a hill tends to bend forward. **(1 mark)** ***Expected response*** ➢ **To shift the position of the centre of gravity to the front part to maintain equilibrium.**	
11	**Figure 6** shows a graph of temperature against time for a pure molten substance undergoing cooling.  **Figure 6**	

	Explain what happens to the substance in region **BC (2 marks)** *Expected response* ➢ **The substance undergoes change of state from molten to solid without change in temperature.**	
12	**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.  **Figure 7** Determine the tension in the string. ($take\ g = 10Nkg^{-1}$) **(2 marks)** *Expected response* $Sum\ of\ clockwise\ moments = sum\ of\ anti-clockwise\ moments$ $10N \times 0.5m = 1.4m \times T$ $T = 3.57N$	
13	**Figure 8** shows two pieces of ice A and B trapped using wire gauze in a larger beaker containing water.  **Figure 8**	

	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)** *Expected response* ➢ **Heated water at the bottom becomes less dense which rises to the top. Hence ice B melts earlier than A.**	
14	**Figure 9** shows a folded piece of paper. A stream of air is blown underneath the paper.  **Figure 9** Explain why the paper collapsed. **(2 marks)** *Expected response* ➢ **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	**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}. ($g = 10Nkg^{-1}$)  **Figure 10** Determine: (i) the weight of the block ***Expected response*** $weight\ of\ the\ block = v\rho g$ $^1/_3 \times \frac{90}{100000} \times 1000 \times 10$ $= 0.3N$ ***Alternatively*** $W = mg$ $m = {^1/_3} \times 90 \times 1$ $= 30g$ $W = \frac{30}{1000} \times 10$ $= 0.3N$ (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)** ***Expected response*** $Volume\ of\ remaining\ part = 90 - 30$ $= 60cm^3$ $U \to W = v\rho g$ $= \frac{60}{1000000} \times 1000 \times 10$ $= 0.6N$ $w = mg$ $but\ m = v \times \rho$	

	$60 \times 1 = 60g$ $\therefore w = \frac{60}{1000} \times 10$ $= 0.6N$ **b) Figure 11** shows a solid metal suspended in oil using a thread.  **(i)** Other than upthrust, list **two** other forces acting on the sphere. **(2 marks).** *Expected response* ➢ **Tension force** ➢ **Weight, *mg*** **(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)** *Expected response* ➢ **Tension force will increase** ➢ **Weight, *mg*, will remain constant**	
16	**a)** Define the term "*specific latent heat of fusion*" **(1 mark)** *Expected responses* ➢ **Quantity of heat required to change a unit mass of the material from solid state to liquid without change in temperature.** **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. ($C_{water} = 4200\, Jkg^{-1}K^{-1}$ and $C_{ice} = 2100 Jkg^{-1}K^{-1}$) Determine the:	

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

Expected response

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

(ii) heat gained by ice from −10℃ to 0℃

Expected response

$$\textbf{Heat gained by ice upto } 0℃ = m_{ice} c_{ice} \Delta\theta$$
$$0.005 \times 2100 \times 10$$
$$= 105J$$

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

Expected response

$$mL_f$$
$$0.005L_f$$

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

Expected response

$$\textbf{Heat gained by melted ice} = m_{ice} c_{ice} \Delta\theta$$
$$0.005 \times 4200 \times 40$$
$$= 840J$$

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

Expected response

$$\textbf{heat lost by hot water} = \textbf{heat gained by ice}(-10℃ \textbf{ to } 0℃) + \textbf{melting ice} + \textbf{mealted ice upto } 40℃$$
$$2646J = 105J + 0.05L_f + 840J$$
$$L_f = 340,200J$$

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.	

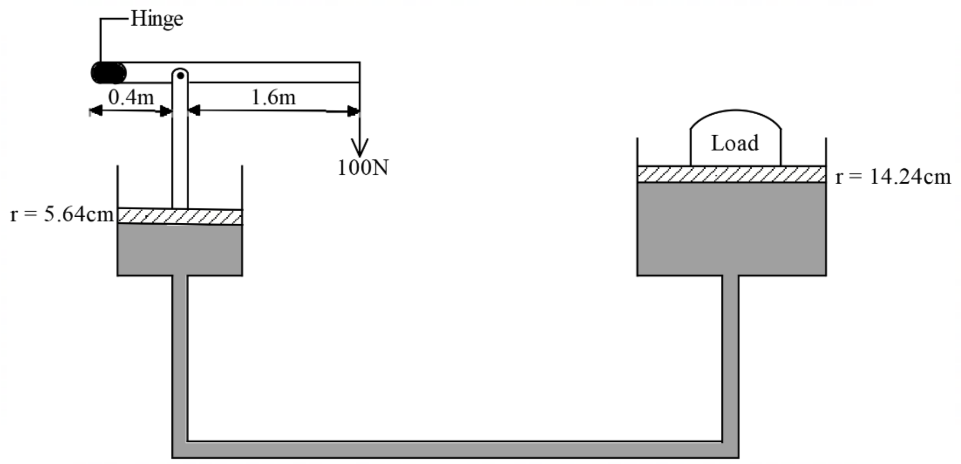


Figure 12

Determine the:

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

Expected response

$$w \times 0.4 = 100N \times 2.0m$$
$$w = 500N$$

$$P = {}^{F}\!/_{A}\ , but\ A = \pi r^2$$
$${}^{22}\!/_{7} \times 5.64^2$$
$$= 99.97cm^2 \equiv 99.97 \times 10^{-4}m^2$$

$$\therefore P = \frac{500N}{99.97 \times 10^{-4}m^2}$$
$$= 5.0015 \times 10^4 Pa$$

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

Expected response

$$L = P \times A_{larger\ piston}$$
$$5.0015 \times 10^4 \times {}^{22}\!/_{7} \times 14.24^2 \times 10^{-4}m^2$$
$$= 3187.46N$$

(c) mechanical advantage of the system. **(3 marks)**

Expected response

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

$$\frac{3185.22N}{500N}$$

$$= 6.37$$

18

a) A bus moving initially at a velocity of $20ms^{-1}$decelerates uniformly at $2ms^{-2}$.

(i) Determine the time taken for the bus to come to a stop. **(3 marks)**

Expected response

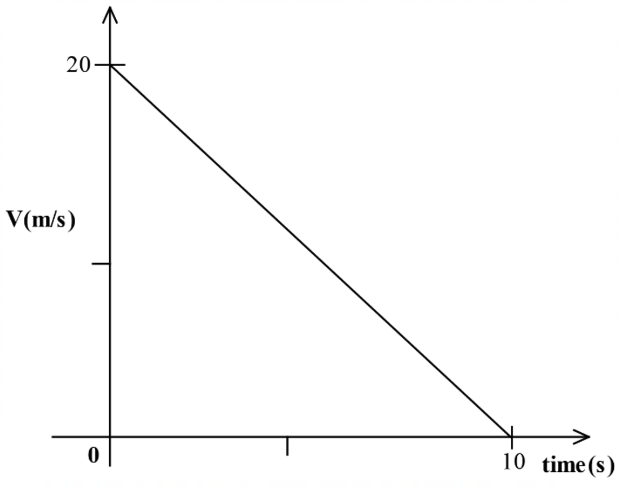
$$t = \frac{v - u}{a}$$

$$= \frac{0 - 20}{2}$$

$$= 10sec$$

(ii) Sketch the velocity-time graph for the motion of the bus up to the time it stopped. **(2 marks)**

Expected response



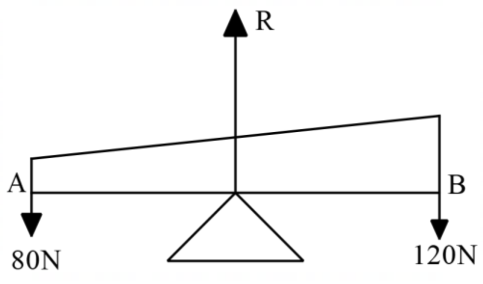
(iii) Use the graph to determine the distance moved by the bus before stopping. **(1 mark)**

Expected response

$$Distance = Area\ under\ the\ curve$$

$$\frac{1}{2} \times 20 \times 10$$

$$= 100m$$

	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* $m_1v_1 + m_2v_2 = v(m_1 + m_2)$ $(1000 \times 40) + (800 \times 0) = v(1000 + 800)$ $= 22.22\, m/s$ $v = u + at$ $22.22 = 40 + 3a$ $a = -5.93\, m/s^2\ (decelerating)$ $F = ma$ 1800×-5.93 $= 10674N$	
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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