

SECTION A: (25 marks)

Answer ALL questions in this Section in the spaces provided

1. The figure 1 shows picture of a metre rule and a tree on a sunny day and their respective shadows. The shadow of the metre rule is 75cm long and that of the tree is 840cm long.

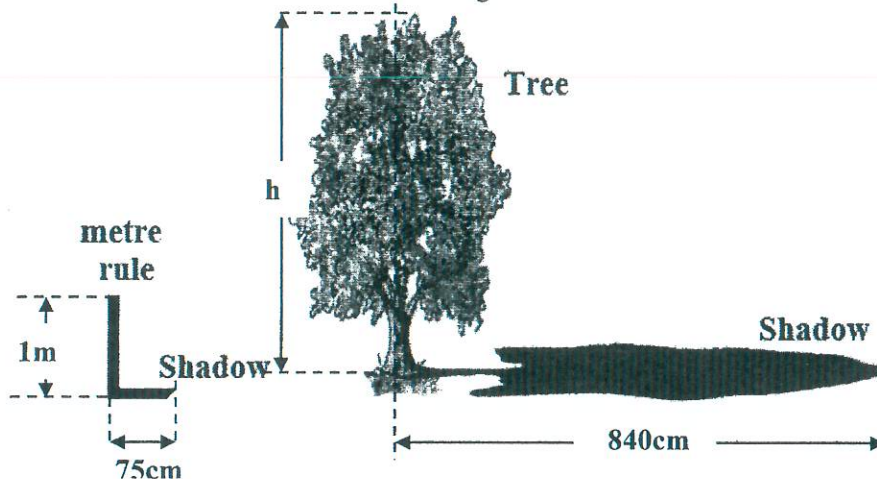


Figure 1

Determine the height, h of the tree in metres.

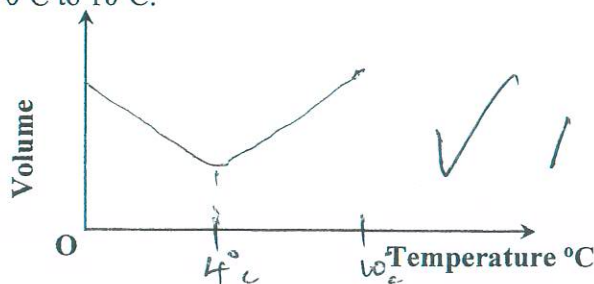
(3marks)

$$\frac{h}{h_{\text{rule}}} = \frac{\text{length of shadow of tree}}{\text{length of shadow of rule}}$$

$$\frac{h}{100} = \frac{840}{75}$$

$$h = \frac{84000}{75} = 1120 \text{ cm}$$

2. In an experiment to investigate the unusual expansion of water, a fixed mass of water at 0°C was heated until its temperature reached 10°C . On the axes provided, sketch a graph of mass against temperature of water from 0°C to 10°C . (1 marks)



3. **Figure 2** shows a circular disc of diameter 2m and weight 300N. The disc is pulled by a horizontal force, F acting through its centre of gravity, G , the force acting against a step 0.4m high.

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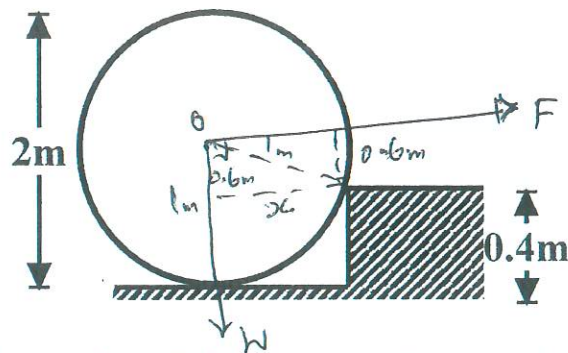


Figure 2

Determine the initial horizontal force, F just sufficient to turn the disc so that it will rise over the step.

(3 marks)

$$x = \sqrt{1^2 - 0.6^2}$$

$$= \sqrt{0.64}$$

$$= 0.8 \text{ m}$$

$$2 \text{ m} \times 1 \text{ m} = 8 \text{ m} \times 1 \text{ m}$$

$$300 \times 0.8 = F \times 0.6$$

$$F = \frac{300 \times 0.8}{0.6}$$

$$= 400 \text{ N}$$

3.

4. Figure 3 shows a paper tape with marks made by a ticker-tape. A is the initial mark. The frequency of the ticker timer is 50Hz. The average acceleration of the tape is 1.5 ms^{-2} .

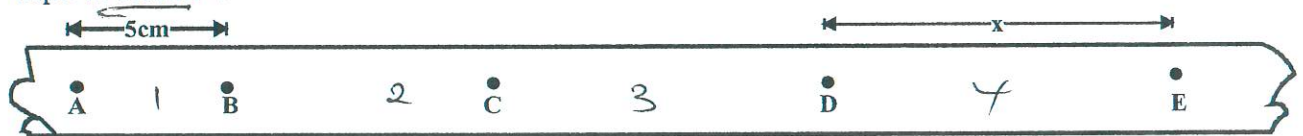


Figure 3

Determine the Length x .

(3 marks)

$$T = \frac{1}{f} = 0.02 \text{ s}$$

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

$$u = \frac{s}{t} = 2.5 \text{ cm/s}$$

$$v = \frac{x}{0.02} = 50x \text{ cm/s}$$

$$t = 3 \times 0.02 = 0.06 \text{ s}$$

$$1.5 = \frac{50x - 2.5}{0.06}$$

$$19 = 50x - 2.5$$

$$21.5 = 50x$$

$$x = 0.43 \text{ cm}$$

5. A barometer has reading of 675mmHg at a certain place. The average density of air is 1.25 kgm^{-3} . Determine the altitude of the place. Take the atmosphere pressure at sea level to be 760mmHg.

(3 marks)

$$P_a h_a \rho = P_m h_m \rho$$

$$1.25 h_a = 13600 \times \frac{760 - 675}{1000}$$

$$\frac{1.25 h_a}{1.25} = \frac{1156}{1.25}$$

$$h_a = 924.8 \text{ m}$$

6. Figure 4 show a fire hose *straight-stream* nozzle. The nozzle has a diameter of 4.76cm where it is connected to the hose and a diameter of 2.54cm at the open end.

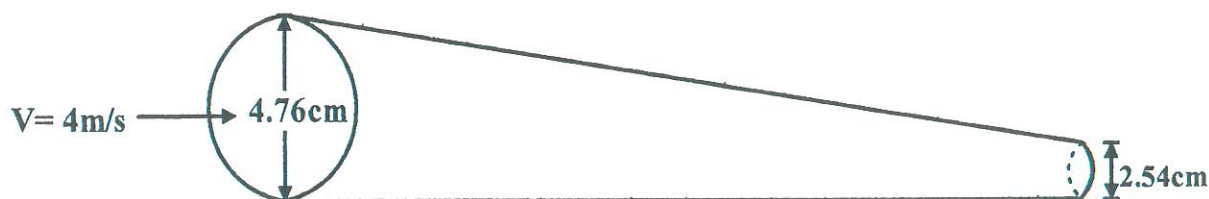


Figure 4

Water enters the nozzle at a speed of 4 m/s. Determine the speed with which it leaves the nozzle.

$$A_1 V_1 = A_2 V_2 \quad \checkmark$$

$$(u \times 2.38^2) \times 400 = (u \times 1.27^2) \times V_2$$

$$V_2 = \frac{u \times 2.38^2 \times 400}{u \times 1.27^2} \quad \checkmark$$

$$= \frac{2,265.76}{1.6129}$$

$$V_2 = 1404.78 \text{ cm/s}$$

$$\checkmark$$

$$V_1 = 14.64 \text{ m/s}$$

(3 marks)

7. Figure 5 shows a funnel dipped into a liquid soap solution.

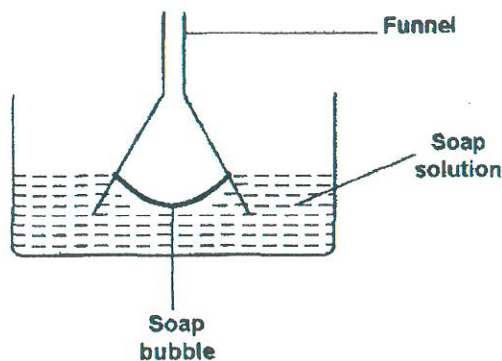


Figure 5

State and explain what happens as the funnel is lifted up from solution

(2 marks)

- The bubble flattens to a film and the film slowly rises up the funnel. \checkmark
- The soap bubble behaves as if its surface is tightly stretched. As it tries to make its surface as small as possible, it rises up the funnel. \checkmark

8. You are provided with two identical pieces of wires. How can you make two springs of different spring constants? (1 mark)

- One wire should have a wider diameter with fewer turns than the other. \checkmark

OS

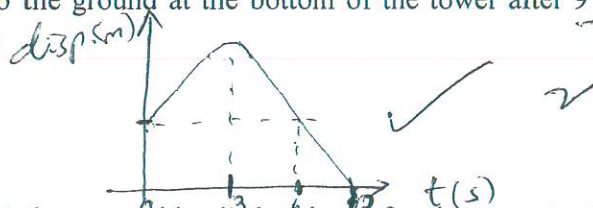
9. A mass of 100g is hung at the 20cm marks and a 50g mass at the 70cm marks of a uniform metre rule

balanced at the 40cm marks. Determine the weight of the rule. (3mks)

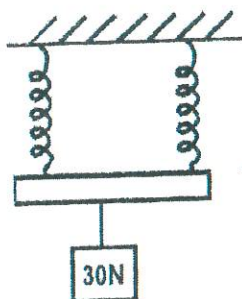
20cm 40cm 50cm 70cm 100cm

 1N W 0.5N
Sum of clockwise moments = Sum of anticlockwise moments
 $1 \times 0.20 = W \times 0.10 + 0.5 \times 0.30$
 $0.20 = 0.10W + 0.15$
 $0.10W = 0.05$
 $W = 0.5\text{N}$

10. An object is thrown vertically upwards from the top of a tower takes 3 seconds to attain maximum height. It drops to the ground at the bottom of the tower after 9 seconds. Sketch a displacement time graph for the motion. (2 marks)



11. Figure 4 shows two identical springs of springs constant 3N/cm supporting a load of 30N.



Determine the extension of each spring. (3mks)

$e = \frac{F}{2k} = \frac{30}{2 \times 3} = \frac{30}{6} = 5\text{cm}$

14. a) An oil drop, of volume $7.0 \times 10^{-5} \text{ cm}^3$, introduced on a clean surface of water spread to form a circular patch of diameter 200mm.

- (i) Determine the diameter of a molecule of the oil. Give your answer to 3 significant figures. (1 marks)

$$d = \frac{V}{A}; A = \pi r^2 = \pi \times 20^2 = 1256 \text{ cm}^2$$

$$= \frac{7 \times 10^{-5}}{1256} = 5.5733 \times 10^{-8} \text{ cm}$$

- (ii) State **one** assumption you made in obtain your answer in (i) above. (1 mark)

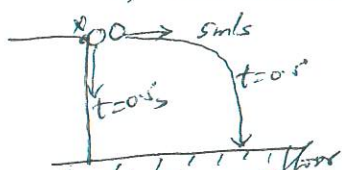
The oil patch is one molecule thick.
(Any correct (x1))

- (iii) State **one** source of error in performing this experiment. (1 mark)

Measurement of diameter of oil patch is an estimate.
(Any one correct (x1))

15. A ball bearing X is dropped vertically downwards from the edge of the table and it takes 0.5s to hit the floor below. Another ball bearing Y leaves the edge of the table horizontally with a velocity of 5 ms^{-1} find :

- a) The horizontal distance travelled by Y before hitting the floor. (3mks)



$$R = at = 0.5 \times 5 = 2.5 \text{ m}$$

- b) The vertical distance of the table top above the floor level. (3mks)

$$h = \frac{1}{2}gt^2$$

$$= \frac{1}{2} \times 10 \times 0.5^2 = 1.25 \text{ m}$$

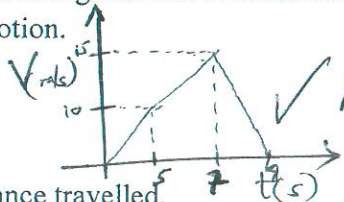
- c) A car starts from rest and accelerates uniformly at 2 m/s^2 for 5 seconds before accelerating again at 2.5 m/s^2 for 2 more seconds. The car is then brought to rest in another 2 seconds.

- ii) Sketch a velocity time graph for this motion. (3mks)

$$v = at + u$$

$$= 2 \times 5 + 0 = 10 \text{ m/s}$$

$$v = 2.5 \times 2 + 10 = 15 \text{ m/s}$$



- iii) From the graph, calculate the total distance travelled. (3mks)

$$\text{Total distance} = \text{Area under graph.}$$

$$= \frac{1}{2} \times 5 \times 10 = 25 \text{ m}$$

$$= \frac{1}{2} \times \frac{1}{2} (10 + 15) \times 2 = 25 \text{ m}$$

$$= \frac{1}{2} \times 2 \times 15 = 15 \text{ m}$$

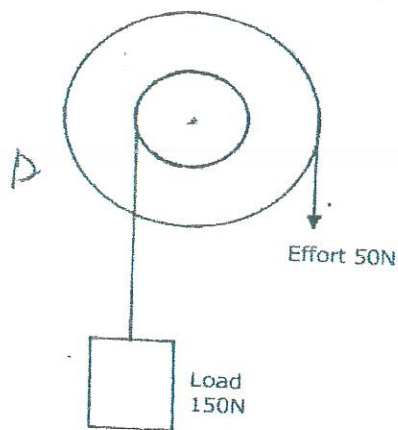
$$= 25 + 25 + 15 = 65 \text{ m}$$

16. a) Define the term efficiency as used in machines.

(1mk)

- Ratio of work output to work input expressed as a percentage ✓ 1

b) Figure 10 shows the cross-section of a wheel and axle of radius 6.5cm and 1.5 cm respectively used to lift a load. Use it to answer the questions that follow.



Determine the

i) mechanical advantages (MA) of the system

(2mks)

$$M.A = \frac{Load}{Effort} = \frac{150}{50} = 3 \quad \checkmark 1 \quad 2$$

ii) velocity ratio (V.R) of the system

(2mks)

$$V.R = \frac{R}{r} = \frac{6.5}{1.5} = 4.333 \quad \checkmark 1 \quad (4.5.f) \quad 2$$

iii) efficiency of the machine

(2mks)

$$\eta = \frac{M.A}{V.R} \times 100 \quad \checkmark 1 \quad 2$$

$$= \frac{3}{4.333} \times 100 = 69.2\% \quad \checkmark 1$$

iv) give two reasons why the above machine is not 100% efficient

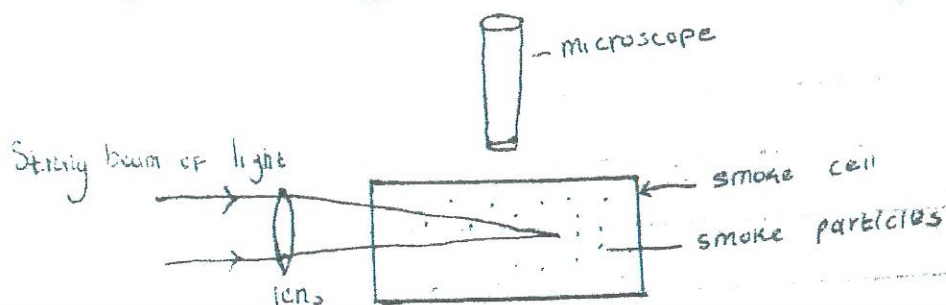
(2mks)

- ✓ The work done in overcoming friction of movable parts is a wastage. ✓ 1
- ✓ The work done in lifting lower parts of machine is a wastage. ✓ 1

47
24
61

09

- c) The figure below shows apparatus used to observe behavior of smoke particles in a smoke cell.



- i) State a reason why smoke particles are used in the experiment. (1mk)

They are visible.
(motion is visible). ✓

- ii) State the observation made. (1mk)

The bright specks of smoke are in a constant random motion. ✓

- iii) What would happen if temperature was lowered? (1mk)

The speed at which the particles move will be slower. ✓

- d) A) i) Alcohol is sometimes very advantageous as thermometric liquid over mercury. Give a possible reason. (1mk)

Can measure even very low temperatures ✓

- ii) State the function of a constriction in a clinical thermometer. (1mk)

Prevent backflow of mercury before readings are made. ✓

- B) The water from a gardener hose pipe fills a bucket in 3.0s. The volume of the bucket is $8.00 \times 10^{-3} \text{ m}^3$. Find the speed of the water that leaves the hose pipe at a cross section area of $2.85 \times 10^{-4} \text{ m}^2$. (3mks)

$$R = AV \quad \checkmark$$

$$\frac{8 \times 10^{-3}}{3.0} = 2.85 \times 10^{-4} \times V$$

$$V = \frac{2.667 \times 10^{-4}}{2.85 \times 10^{-4}} \quad \checkmark$$

$$= 0.9358 \text{ m/s.}$$

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