

NAME:.....INDEX NO:.....

SCHOOL:

Candidate's Signature:

Date:

INSTRUCTIONS TO CANDIDATES

- ❖ Write your name and index number in the spaces provided above
 - ❖ Sign and write the date of the examination in the spaces provided
 - ❖ This paper consists of two sections, A and B.
 - ❖ Answer **all** the questions in the spaces provided
 - ❖ All working must be clearly shown
 - ❖ Non programmable silent electronic calculators and KNEC Mathematical tables **may** be used except where stated otherwise.
- Take acceleration due to gravity $g\ 10ms^{-2}$

1. Figure 1 below shows a burette that was initially filled to 10ml.

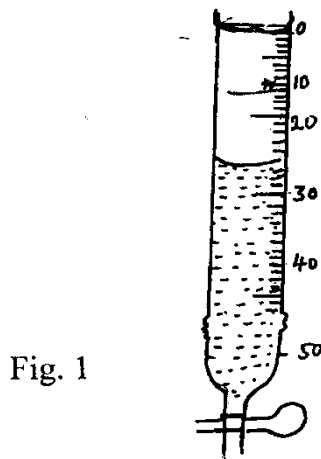


Fig. 1

If the volume of liquid removed from the burette has a mass of 11g, determine the density in gcm^{-3} . (Leave your answer in 2 decimal places.) (2 mks)

Answer

Initial burette volume = 10ml

Final burette volume= 26 ml

Volume of liquid run off = $(26 - 10)\ ml = 16ml$

Mass of liquid = 11g.

Density of liquid = mass of liquid

Volume of liquid.

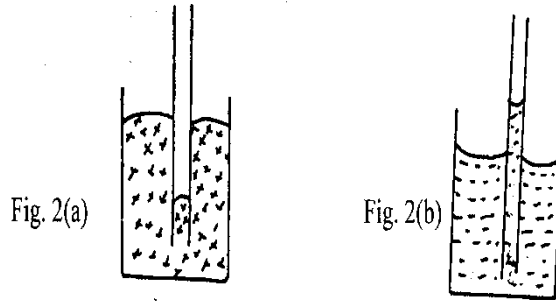
$= 11/16 = 0.6875\ g/cm^3 = 0.69\ g/cm^3\ (2dp)$

2. An object is placed 16 cm from a converging lens of focal length 12 cm. Find the image distance (3 marks)

Answer

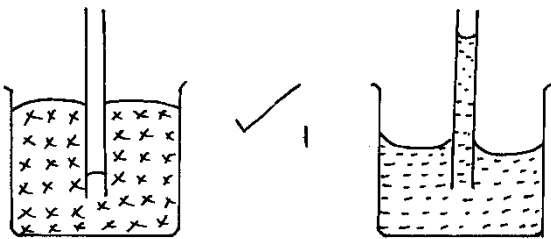
Answer: 48cm

3. Figure 2, a & b below shows narrow tubes dipped in mercury and water respectively.



The temperature of the two liquids in the containers is raised slightly. Indicate the new levels of mercury and water in the tubes respectively and explain your answer. (3 mark)

answer



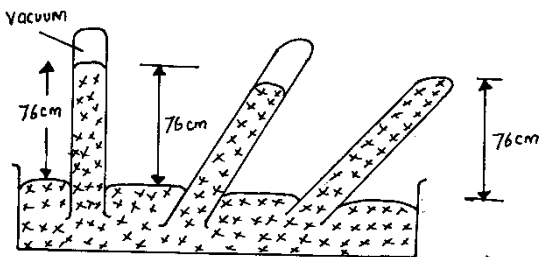
Increase in temperature lower the density of the liquids. The level of water in the tube rises up. Increase in temperature also lowers the cohesive forces between molecules hence the mercury level sinks further.

4. Figure 3 shows Three identical tubes containing mercury were inverted as shown.

Use fig. 3 below to answer part a and b.

(a).Indicate on the diagram above the levels of mercury in tube B and C. (1 mk)

answer



b).Explain the effect on the level of mercury in tube A if region X is filled with some air.(2 marks)

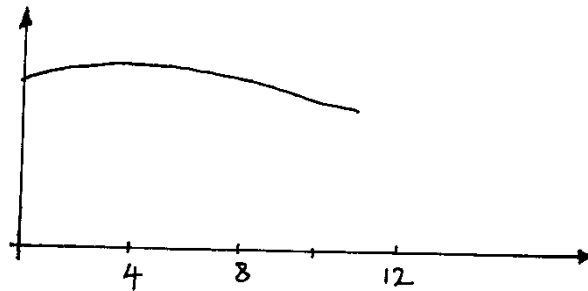
The vertical height of mercury would be less than 76 cm.

The trapped air would exert pressure on the column of mercury.

5. On the axis below, sketch the variation of density of water with temperature if it is heated from 0°C to 10°C.

(2 mks)

Answer



6. **Figure 3** below shows a laclanche cell.

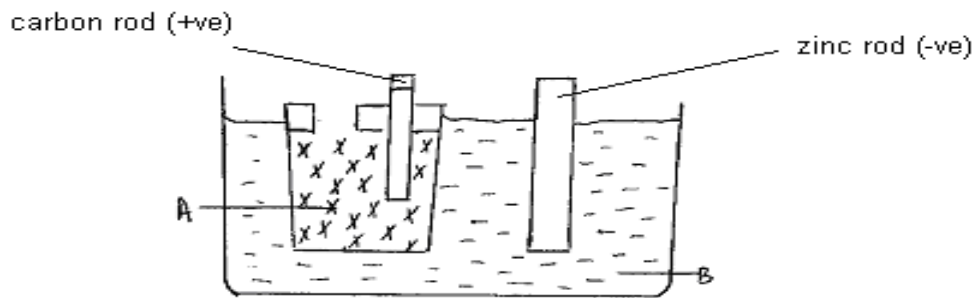


Fig.3

Name the chemical substances in the parts labeled.

A

B..... (2 marks)

Answer

A: Manganese IV Oxide mixed with carbon;

B: Ammonium chloride solution;

7. An electric kettle is rated 3KW, 250V. Determine the resistance of the coil. (3mks)

Answer:

$$P = \frac{V^2}{R} ; \quad R = \frac{V^2}{P} = R = \frac{250 \times 250}{3000} = 20.83 \Omega ;$$

8. The force on a conductor carrying an electric current in a magnetic field can be varied by changing the magnetic field strength and the magnitude of the current. Name two other factors that can affect the force.

(2mks)

Answer

- Angle of inclination to the field;
- Length of conductor;

9. Study the circuit shown in fig. 6 below.

Determine the ammeter reading when both switches are closed. (2 mks)

Answer

Parallel resistors

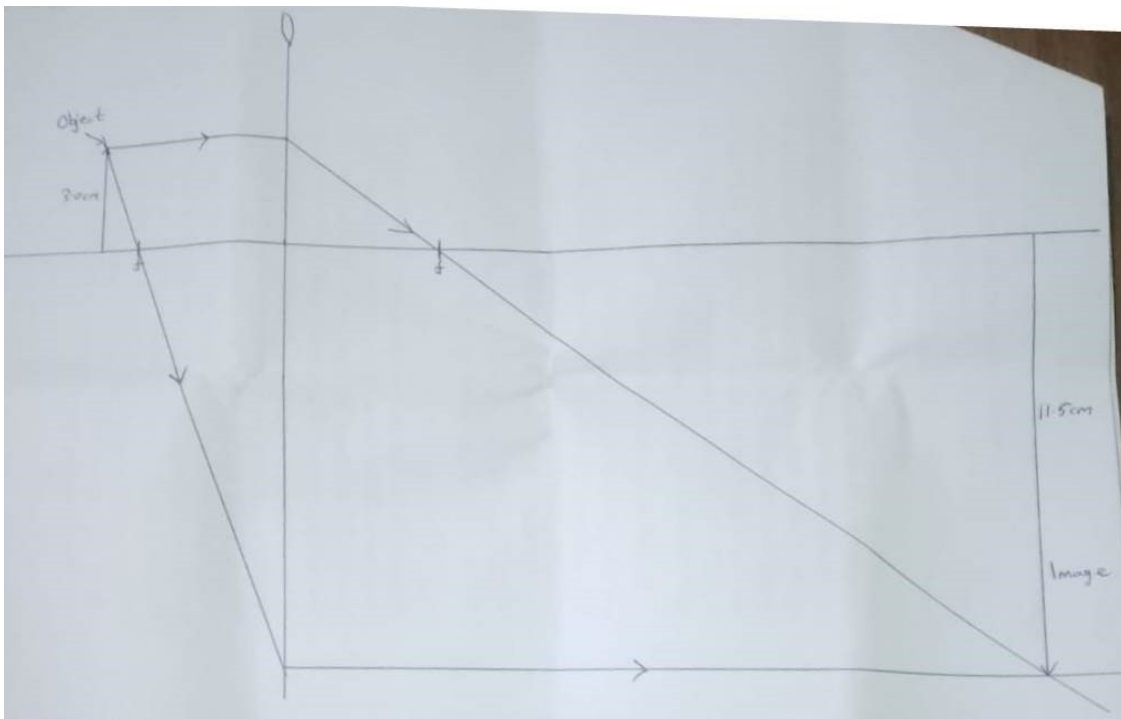
$$1/R = 1/2 + 1/3 + 1/6 \quad R1 = 1$$

$$1/R2 = 1/3 + 1/6 = 2$$

$$\text{Series resistor } R_1 + R_2 = 3$$

$$\text{Current} = V/R = 6V/3 = 2A;$$

10. (a) An object of height 15cm is placed 25 cm in front of a convex lens of focal length 20cm. using a scale diagram of 1cm =5cm, draw the ray diagram. (4 marks)



(b) Use the diagram to determine magnification of the image obtained (2 marks)

the image height as measured from diagram is 11.5 cm

the actual image height is therefore $11.5 \text{ cm} \times 5 = 57.5 \text{ cm}$

from the normal definition of magnification; Magnification $M = \frac{\text{image height}}{\text{object height}}$

$$M = \frac{57.5 \text{ cm}}{15.0 \text{ cm}} = 3.83$$

SECTION 11

11. (a) State Hooke's Law (1mk)

Answer:

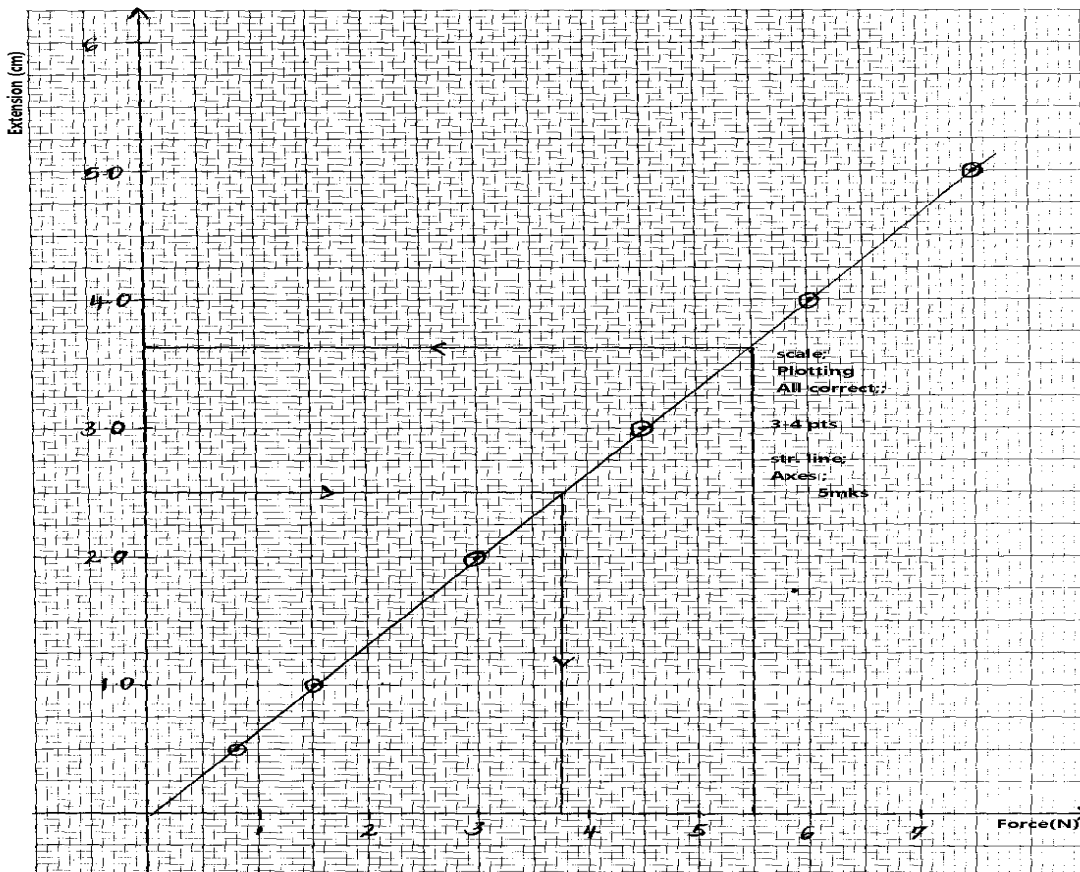
Extension of a spring is proportional to the force applied provided the elastic limit is not exceeded

(b) A student carried out an experiment to investigate the relationship between the force applied and extension produced on a spiral spring. He tabulated his results as shown in the table below.

| | | | | | | | |
|---------------|---|-----|-----|-----|-----|-----|-----|
| Force (N) | 0 | 0.8 | 1.5 | 3.0 | 4.5 | 6.0 | 7.5 |
| Extension(cm) | 0 | 0.5 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 |

(i) Plot a graph of extension in cm on the Y-axis against force in N (5mks)

Answer



From the graph

(ii) Determine the spring constant (3mks)

Answer:

$$\text{Spring constant} = \frac{1}{\text{gradient}}$$

$$\begin{aligned} \text{Gradient} &= \frac{(4 - 1)\text{cm}}{(6 - 1.5)\text{N}} \\ &= \frac{3 \times 10^{-2} \text{ m}}{4.5 \text{ N}}; \\ &= 0.67 \times 15^{-2} \\ &= 1.49 \times 10^2 \text{ N / m}; \end{aligned}$$

(iii) **What force would be required to produce an extension of 2.5 cm?** (1mk)

Answer:

(ii) **Force producing extension of 2.5cm is 3.75N,**
(Indicated on graph) (1mk)

(iv) **What extension is produced by a force of 5.5N?** (1mk)

Answer

Force of 5.5 N extensions is 3.65cm, (indicating on graph) (1mk)

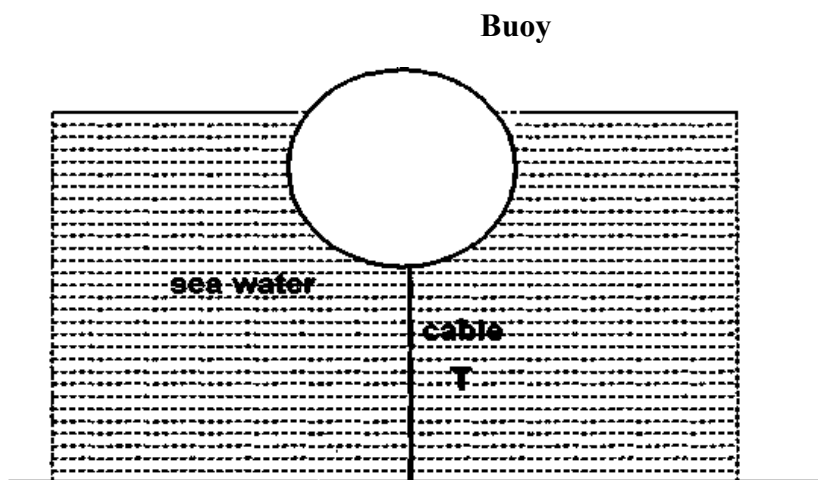
12. (a) **State Archimedes principle** (1mark)

it states that when a body is partially or wholly immersed in a fluid, it experiences an upward force equal to the weight of the fluid it displaces.

(b) **Define the law of floatation** (1mk)

The law of floatation states that a floating body displaces its own weight of the fluid in which it floats. This means the total weight of the object is equal to the upward buoyant force (weight of the liquid displaced) exerted by the fluid.

(c) **Figure 13 shows a buoy, B, of volume 40 litres and mass 10 kg. It is held in position in sea water of density 1.04 g cm⁻³ by a light cable fixed to the bottom so that 3/4 of the volume of the buoy is below the surface of the sea water . Determine the tension T in the cable. (4 marks)**



Answer

iv) **Volume of water displaced = 3/4 x 40 = 30 l = 0.03 m³**
Weight of buoy = mg = 10 x 10 = 100N
Weight of sea water displaced = density x gravity x volume
= 1.04 x 10³ x 10 x 0.03 N = 312N
Weight of sea water displaced = Up thrust
Tension T = Up thrust - Weight of buoy = 312 - 100 ; T = 212N

(b) **A sphere suspended from a spring balance in air has its weight recorded as 6N when submerged half-way in water, the spring balance reads 4.2 N. Calculate the volume of the sphere. Take density of water as 1000kgm⁻³ (4 marks)**

upthrust = weight in air – weight in water

$$u = 6.0 - 4.2 = 1.80\text{N}$$

mass of water displaced = 0.18kg

$$\text{volume} = \frac{\text{mass}}{\text{density}} = \frac{0.18\text{kg}}{1000\text{kgm}^{-3}}$$

$$\text{volume} = 1.8 \times 10^{-4} \text{m}^3 = 1.8 \times 10^{-4} \text{m}^3 \times 10^6 \text{cm}^3/\text{m}^3$$

$$\text{volume} = 1.8 \times 10^2 \text{cm}^3$$

13. (a) state 2 applications of convex lenses (2 marks)

Magnifying glass – A convex lens is used to enlarge the appearance of small objects.

Camera lenses – Convex lenses focus light onto the film or sensor to form clear images.

Microscopes – used to view very tiny objects by magnifying them.

Telescopes – used to observe distant objects like stars and planets.

Spectacles (glasses) – used to correct vision problems such as long-sightedness.

(b) A form 4 student did an experiment on thin lenses by varying the object distance and recording the corresponding image distance for the formed by the lense in an attempt to determine the focal length.

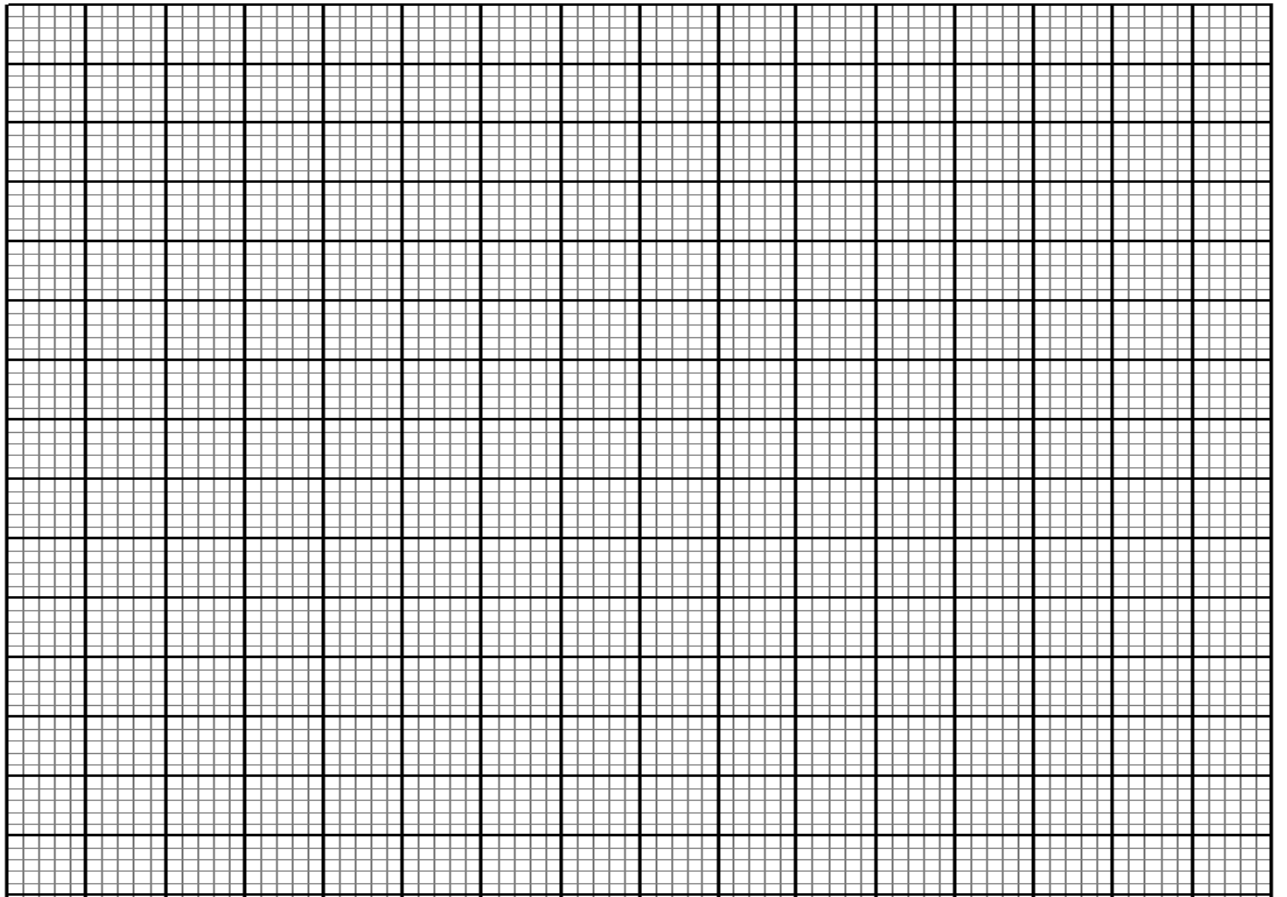
| Object distance u (cm) | Image distance V (cm) | UV (cm ²) | (U+V) cm |
|-------------------------------|------------------------------|------------------------------|-----------------|
| 15 | 30 | | |
| 20 | 20 | | |
| 25 | 16.7 | | |
| 30 | 15 | | |
| 40 | 13.3 | | |
| 60 | 12 | | |

(i) Fill in the columns of uv and (u+v) (2 marks)

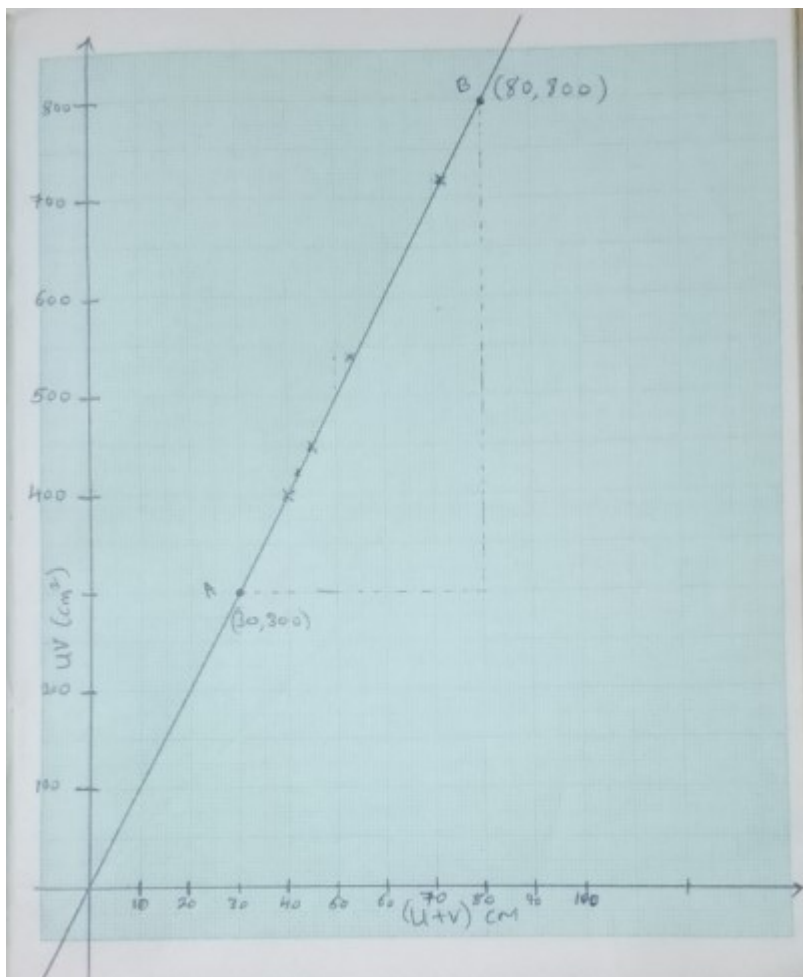
Solution

| u (cm) | v (cm) | UV (cm ²) | (u + v) (cm) |
|---------------|---------------|------------------------------|---------------------|
| 15 | 30 | 450 | 45 |
| 20 | 20 | 400 | 40 |
| 25 | 16.7 | 417.5 | 41.7 |
| 30 | 15 | 450 | 45 |
| 40 | 13.3 | 532 | 53.3 |
| 60 | 12 | 720 | 72 |

(ii) On the grid provided, plot the graph of uv against u+v (5 marks)



Solution



(iii) Use the graph to determine the focal length of the lens (3 marks)

- Find two points on the graph where the line is clearly defined. The two points are A and B from the graph shown. (30,300) and (80,800)

The slope of the line in the UV vs $(U + V)$ graph gives us the value of the focal length (f). This is because:

$$\text{slope of the graph} = \frac{\Delta UV}{\Delta(U+V)} = f = \frac{(800-300)cm^2}{(80-30)cm} = \frac{(500)cm^2}{(50)cm} = 10cm$$

so from the graph, the focal length = 10 cm

14. (a) What is meant by the term the velocity ratio of a machine? (1mk)

Answer:

Velocity ratio is the ratio of distance moved by the effort to the distance moved by the load;

(b) Figure 7 shows a pulley system used to lift a load.

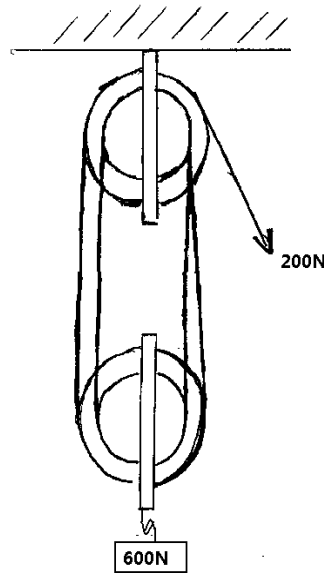


Figure 1

(i) Determine the velocity ratio of this machine. (1mk)

Answer

VR = 4 (No of string supporting the load)

(ii) Calculate the work done by the effort in lifting the load through 1 metre. (3mks)

Answer

Distance moved by effort = 4m (1mk)

Work done by effort = 200×4 ; (1mk)

= 800J; (1mk)

(iii) Calculate the percentage (%) efficiency of the machine. (3mks)

Answer

(iii) $\lambda = \frac{MA}{VR} \times 100$; (1mk)

$$MA = \frac{\text{Load}}{\text{Effort}} = \frac{600}{200} = 3$$

$$VR = 4$$

$$\text{Therefore } \lambda = \frac{3}{4} \times 100 = 75\% \quad (2 \text{ marks})$$

(c) The machine wheel and axle has a lot of application in real life. Name any two practical

examples of such machine.

(2mks)

Answer:

- The car steering wheel; (1mk)
- A water tap etc; (1mk)
- Bicycle pedals

16. (a) A watchman uses a bow to fire an arrow of mass 0.2kg vertically upwards into the air.

- (i) The watchman stretches the bow by 0.15m with a maximum force of 100N. **Calculate** the energy transferred to the arrow. (3mks)

Answer

to calculate the **energy transferred to the arrow**, we need to find the **elastic potential energy** stored in the bow when it is stretched. The energy transferred to the arrow is equal to the work done by the bow, which is given by the formula for elastic potential energy:

$$E = \frac{1}{2}ke^2$$

$$W = \frac{1}{2}F_{\max} \times e$$

Fmax=100N is the maximum force exerted by the bow,

x = 0.15m is the distance the bow is stretched.

$$W = \frac{1}{2} \times 100 \text{ N} \times 0.15 = 7.5\text{J}$$

- (ii) **Calculate** the speed with which the arrow leaves the bow assuming all energy is transferred to the arrow. (2mks)

Assuming all the energy stored in the bow is transferred to the arrow, the kinetic energy of the arrow will be equal to the elastic potential energy stored in the bow:

$$\text{Kinetic Energy(K.E)} = \frac{1}{2}mv^2$$

$$\frac{1}{2}mv^2 = 7.5\text{J}$$

$$M = 0.2\text{kg}$$

$$\frac{1}{2} \times 0.2 \times v^2 = 7.5\text{J}$$

$$V^2 = 75$$

$$V = \sqrt{75} \approx 8.667 \text{ ms}^{-1}$$

- (iii) **Determine** the greatest height reached by the arrow before it begins to fall. (3mks)

From the principle of conservation of energy, As the arrow rises, kinetic energy is converted into **gravitational potential energy**.

Greatest height is the height at which velocity will be zero. At the maximum height, all kinetic energy is converted into potential energy:

$$\frac{1}{2}mv^2 = mgh \text{ and cancelling } m \text{ from both sides of the equation;}$$

$$\frac{1}{2}v^2 = gh$$

$$h = \frac{v^2}{2g} = \frac{8.667^2}{2 \times 10.0} = 3.82\text{m}$$

(iv) **Determine** the time the arrow will remain in the air. (3mks)

We can use the following kinematic equation to find the time taken to reach the maximum height:

$$v = u + at$$

Substitute the known values into the equation: $0 = 8.667 + (10.0)t$

$$10t = 8.667$$

$$t = \frac{8.667}{10} = 0.8667 \text{ sec}$$

Since the time to go up is the same as the time to come down; Total time = $2 \times t = 2 \times 0.8667 = 1.7334 \text{ sec}$

17. (a) **State** what is meant by absolute zero temperature. (1mk)

Absolute zero is the lowest possible temperature, defined as **0 K (Kelvin)** or **-273.15°C**. It is the temperature at which the **particles** (atoms and molecules) of a substance have **minimal vibrational motion** and theoretically no kinetic energy.

(b) **What** are the molecular differences between a real gas and ideal gas? (2mks)

Intermolecular Forces:

Ideal gas: Molecules are assumed to have no intermolecular forces (attraction or repulsion) between them.

Real gas: Molecules experience attractive or repulsive forces (Van der Waals forces), which affect their behavior, especially at high pressures or low temperatures.

Volume of Molecules:

Ideal gas: The volume of individual gas molecules is assumed to be negligible compared to the total volume of the gas.

Real gas: Molecules have a finite volume, which becomes significant at high pressures, causing deviations from ideal behavior.

(c) In an experiment to find the relationship between volume and temperature of a given mass of air at constant pressure the following results were obtained

| | | | | | | |
|---------------------------|----|----|----|----|----|-----|
| Volume (cm ³) | 31 | 33 | 35 | 38 | 40 | 43 |
| Temperature(°c) | 0 | 20 | 40 | 60 | 80 | 100 |

(i) Plot an appropriate graph to show the relationship between volume and temperature.

Answer

Since the ideal gas law assumes temperature in **Kelvin**, we need to convert the temperatures from Celsius to Kelvin: $T(\text{K}) = T(^{\circ}\text{C}) + 273(\text{K})$

| | | | | | | |
|---------------------------|-----|-----|-----|-----|-----|-----|
| Volume (cm ³) | 31 | 33 | 35 | 38 | 40 | 43 |
| Temperature(°c) | 0 | 20 | 40 | 60 | 80 | 100 |
| Temperature (K) | 273 | 293 | 313 | 333 | 353 | 373 |

The graph

