PREFACE

This book provides a varied selection of questions and answers. The questions, which include some MANEB past paper questions, have been carefully selected to cover all the Physics topics at MSCE level.

The questions cover the fundamentals which appear most frequent in MANEB questions in line with the current Physical Science Syllabus.

This book serves as a quick revision aid and a self-assessment resource for students as they prepare for examinations. It is also an illustration of how Physics questions should be answered to get the best grades.

The questions selected are expected to familiarise students with the type of questions set for MSCE examinations.

In some cases, the method or solution to a problem given is not the only one. It would prove a useful experience for the student to find alternative method or solution to such problems.

I hope you find this book a very useful resource as you prepare for your examinations.

Wishing you all the best.

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PRODUCTION

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I also wish to thank St John's Secondary school management, teaching staff, support staff and the entire student body for their support and encouragement which helped me work positively while writing this book.

CHAPTER 1

PROPERTIES OF MATTER, KINETIC THEORY & THE GAS LAWS

63 QUESTIONS WITH ANSWERS

To the student.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

After reading the chapter, test your understanding by answering the 63 questions in this chapter. Cross check your answers with the answers provided.

The following list of books is not exhaustive.

1. Keith Wallis, Chanco Physical Science for Malawi, Book 2 (3rd edition), pages 95-114.

2. Samuel Kalea, MSCE Physical Science (New edition) pages 1-19.

3. Tom Duncane, GCSE Physics(4th edition), pages 77-79, 101-104, 155-162.

4. Mukabi Murigi etal, KCSE Golden Tips Physics, pages 44-47, 68-73, 80-85.

5. Keith Johnson, Physics for You: Revised edition for GCSE, pages 14-17, 21-36, 57-61.

KAY. BOSS

CONTENTS

Q1. State the following laws:

a. Charles law.

b. Boyles law.

c. Pressure law.

Answers

a. Boyle's law states that for a fixed mass of gas at constant temperature, volume is inversely proportional to pressure.

b. Charles' law states that for a fixed mass of gas at constant pressure, volume is directly proportional to the absolute temperature.

c. Pressure law states that for a fixed mass of gas at constant volume, pressure is directly proportional to the absolute temperature.

Q2. State the kinetic theory of matter.

Answer

The kinetic theory states that matter is made up of tiny particles which are in continuous motion

Q3. Why are gases easily compressible while liquids and solids are almost incompressible?

Answer

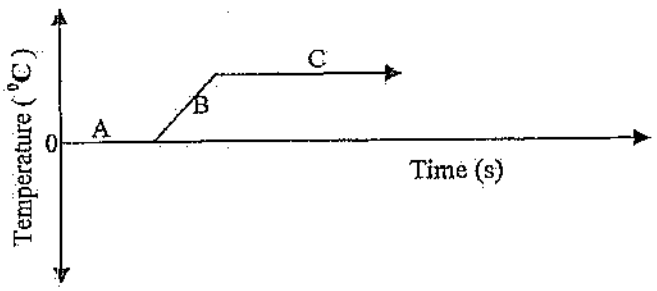
Gases have large spaces between their molecules while liquids and solids have very tiny spaces between their molecules.

Q4. Explain why liquids expand more than solids for the same amount of heat applied.

Answer

The intermolecular forces are stronger in solids than in liquids. For that reason, the molecules in a liquid move apart much further than the molecules in a solid for the same amount of heat applied.

Q5. The diagram below shows the variation of temperature (^{0}C) with time (s) when frozen water is heated for some time.



a. Explain what happens at parts A, B and C.

b. When the temperature starts to rise, the volume initially decreases and then increases. State the reason for this observation.

Answers

a. *At A, the heat supplied is used to break the molecules free from their fixed positions so there is no increase in temperature. Melting is taking place and the molecules move further apart however they are still held together by the intermolecular forces. At B, the water is in liquid form. The heat supplied increases the kinetic energy of the molecules. The molecules move faster, the temperature increases. At C, the molecules have enough energy to break free from the intermolecular forces holding them together. The temperature remains constant because the heat supplied is used to break the molecules from each other, boiling is taking place and the water changes to gas state.*

b. *This is because water contract when heated from 0^0C to 4^0C instead of expanding.*

Q6. A bubble of volume 2 cm^3 is at the bottom of the lake where the pressure is 3.0 atmospheres. What will be its volume just before the surface of water where the pressure is 1.0 atmosphere?

Answer

Let the volume just before the surface be (V_2)
Volume at the bottom of the lake (V_1) = 2 cm^3
Pressure at the bottom of the lake (p_1)= 3.0 atmospheres
Pressure just before the water surface (p_2) = 1.0 atmosphere.
Using Boyle's law, $p_1 \times V_1 = p_2 \times V_2$

$$V_2 = \frac{p_1 \times V_1}{p_2} = \frac{3.0 \times 2.0}{1.0} = 6\ cm^3$$

The gas bubble has a volume of 6 cm^3 just before the surface.

Q7. Mention any three applications of gas pressure in every day life.

Answers

a. *The drinking straw uses gas pressure.*
b. *Tyres of cars use gas pressure.*
c. *Water pumps use gas pressure to function.*

Q8. Use the kinetic theory to explain why if perfume is sprayed in front of a classroom, everybody in the room smells the perfume after a few seconds.

Answer

Perfume molecules are continuously moving at high speeds in different directions colliding with air molecules. They spread out from the region where the perfume is sprayed to the rest of the room in a process called diffusion

Q9. Ice melts when it is heated. Explain clearly what happens to the water molecules as the ice melts.

Answer

The heat increases the kinetic energy of the water molecules. The water molecules vibrate faster and more vigorously. Eventually they break free from their fixed positions and begin to slide over each other.

Q10. A gas syringe contains 25 cm^3 of oxygen at 10^0C. If the temperature was increased to 25^0C, what would be the volume occupied by this gas assuming constant pressure.

Answer
Let the final volume occupied by the gas be V_2
Initial volume (V_1) = 25 cm^3
Initial temperature (T_1) = 10^0C = 283 K
Final temperature (T_2) = 25^0C = 298 K

Using Charles' law, $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$V_2 = \frac{V_1 \times T_2}{T_1} = \frac{25 \times 298}{283} = 26.3\ cm^3$$

The gas will occupy a volume of 26.3 cm^3.

Q11. Explain the difference between melting and sublimation.

Answer
Melting is change of state from solid to liquid while sublimation is change of state from solid direct to gas.

Q12. Mention the difference between heat and temperature.

Answer
Heat is a form of energy while temperature is a measure of the degree of hotness or coldness of a substance.

Q13. Mention two uses of contraction and expansion of solids in everyday life.

Answers
Used in shrink fitting.
Used in making thermostats.

Q14. State any two main points of the kinetic theory.

Answer
It states that:
- *Matter is made up of tiny particles called molecules.*
- *The tiny particles which make up matter are in constant motion.*

Q15. Mention two applications of liquid pressure in our everyday life.

Answers
The walls of a dam are built thicker at the bottom than the top to withstand high pressure at the bottom.

Divers wear special suits to withstand liquid pressure.

Q16. What is meant by the term "absolute temperature?"

Answer
Is the lowest temperature at which a substance has minimum internal energy.

Q17. The height of a column of water in a reservoir is 500m. If the density of water is 100kg/m^3 and force due to gravity is 10N/kg. Calculate the pressure exerted by the column of water at the base of the reservoir.

Answer
Pressure = density x gravity x height.
= 100kg/m^3 x 10N/kg x 500 m
= 500000 N/m^2
The column exerts a pressure of 500000 N/m^2

Q18. Explain why liquids are used in car hydraulic brake system and not gases.

Answer
Liquids are almost incompressible and transmit the pressure applied at one point to all parts of the container in which the liquid is kept. Gases absorb the pressure applied because of their compressibility.

Q19. Mention any two properties of liquid pressure.

Answers
Liquid pressure increases with depth.
Liquid pressure acts in all directions.

Q20. Mention any two devices which use liquid pressure.

Answers.
The hydraulic car jack
Hydraulic brakes

Q21. Explain why sugar melts when it is heated.

Answer
Heat increases the kinetic energy of the sugar molecules. The molecules vibrate faster and more vigorously, eventually a point is reached when they break free from their fixed positions and slide over each other. Melting takes place.

Q22. Use the kinetic theory of matter to explain the cause of gas pressure in a closed container.

Answer
Gas pressure is caused by the random motion of gas particles. The gas particles move in all directions hitting the inside surface of the container in which the gas is kept. The particles exert a force on the walls of the container which creates pressure.

Q23. A bubble of volume 2 cm^3 is at the bottom of the lake where the pressure is 3.0 atmospheres. What will be its volume just before the surface of water where the pressure is 1.0 atmosphere?

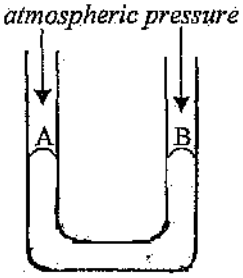
Answer
Let the volume just before the surface be (V_2)
Volume at the bottom of the lake (V_1) = 2 cm^3
Pressure at the bottom of the lake (p_1)= 3.0 atmospheres
Pressure just before the water surface (p_2) = 1.0 atmosphere.
Using Boyle's law, $p_1 \times V_1 = p_2 \times V_2$

$$V_2 = \frac{p_1 \times V_1}{p_2} = \frac{3.0 \times 2.0}{1.0} = 6\ cm^3$$

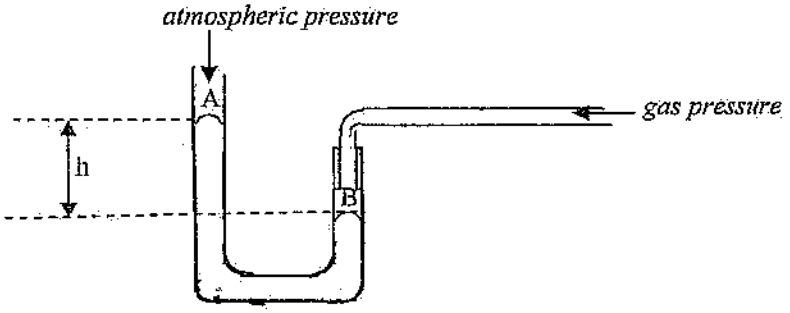
The gas bubble has a volume of 6 cm^3 just before the surface.

Q24. With the aid of a well labelled diagram, explain how a manometer works to measure gas pressure.

Answer
A manometer is a U-shaped transparent glass tube filled with liquid mercury. Equal pressure (atmospheric pressure) acts at points A and B making the mercury to be at the same level.



If one end is connected to a gas supply, the gas pressure pushes the liquid at point B downwards. The liquid rises up along point A. Due to the difference in levels of mercury in the tube, the liquid also exerts a pressure.



When the liquid finally stops moving along the tube, gas pressure equals sum of atmospheric pressure and liquid pressure.
Therefore, Gas pressure = atmospheric pressure + liquid pressure
Liquid pressure = d x g x h where d is the density of the liquid, g is force due to gravity and h is height of liquid column.

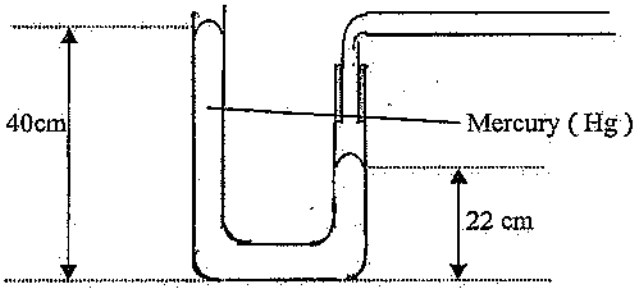
Q25. Using the kinetic theory, explain why clothes dry faster on a sunny day than on a cloudy day.

Answer
On a sunny day, the heat from the sun increases the kinetic energy of the water molecule in the cloth, evaporation takes place at a faster rate than on a cloudy day.

Q26. A biologist named Brown noticed that when he examined tiny particles of pollen floating on water under a microscope, the particles moved around in a haphazard fashion. When the pollen was examined on its own no movement was observed. Explain this observation.

Answer
The haphazard movement of the pollen grains is because of the water molecules. The water molecules are in constant motion. They collide with the grain particles making them move around haphazardly.

Q27. The figure below shows a pressure instrument.



a. Name the instrument.
b. State the reading in mm of mercury.
c. If the pressure of the gas supply is 520mm Hg, what is the value of the atmospheric pressure?

Answers
a. The instrument is a manometer.
b. Reading in millimetres of mercury = 400 mm - 220 mm = 180 mm Hg
c. Gas pressure = atmospheric pressure + liquid pressure
Atmospheric pressure = gas pressure - liquid pressure.
Atmospheric pressure = 520 mm Hg - 180 mm hg = 340 mm Hg.

Q28. a. Define the term 'diffusion'.
b. Explain why gases diffuse more than liquids.

Answers
a. Diffusion is the movement of particles from a region of high pressure to a region of low pressure.
b. Gases have very weak intermolecular forces compared to liquids therefore gas particles move freely while liquid particles are loosely held by intermolecular forces.

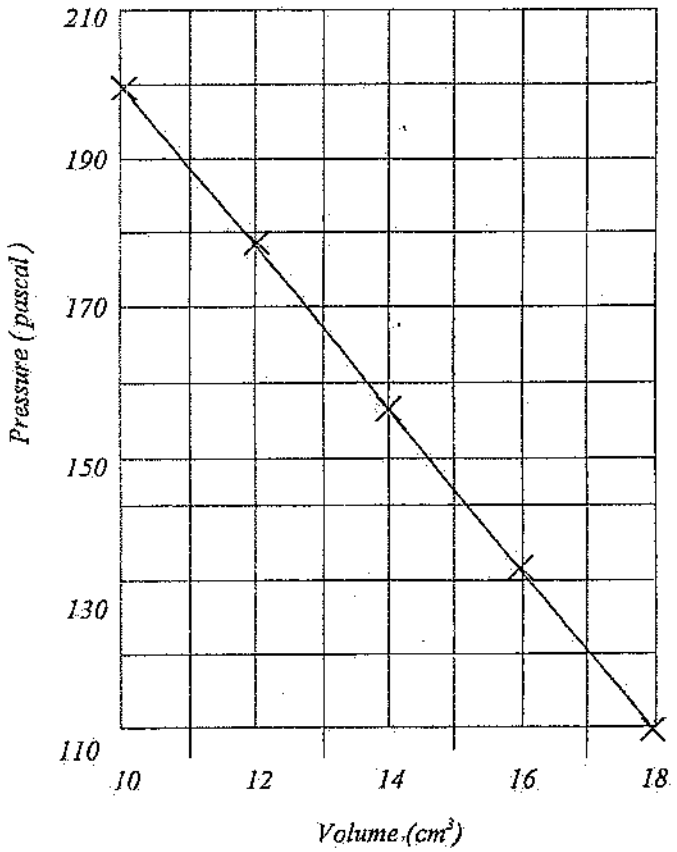
Q29. The table below shows results of an experiment to verify a gas law.

Volume (cm^3)	10	12	14	16	18
Pressure (Pascal)	200	179	156	135	114

a. Plot a graph of pressure against volume.
b. What is the relationship between pressure and volume?
c. What quantities would be kept constant in this experiment?
d. Suggest one source of error in this investigation.

Answers

a. *Graph of pressure against volume.*

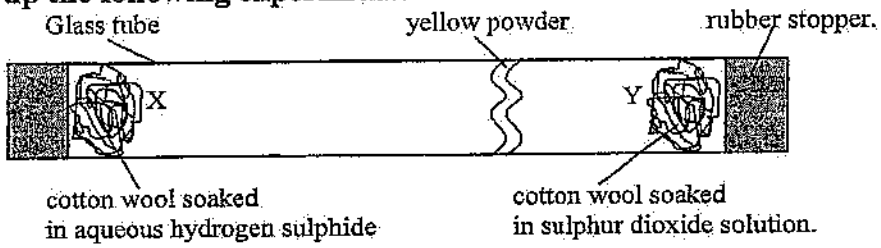


b. *The pressure is inversely proportional to volume.*
c. *Mass and temperature of the gas.*
d. *There is likely to be a slight variation in temperature.*

Q30. Explain why roads made from concrete slabs are designed in such a way that there are gaps between the slabs and these gaps are filled with a soft substance which can be easily squeezed.

Answer
To allow room for expansion of the slabs when the temperatures are high so that the slabs do not push against each other and crack.

Q31. A student set up the following experiment:



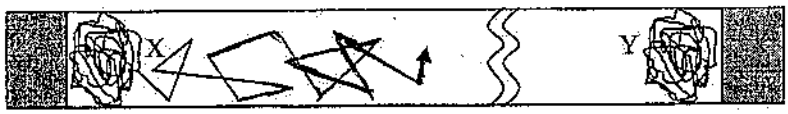
At X, hydrogen sulphide gas is released.
At Y, sulphur dioxide gas is released.

a. Which particles travel faster. Explain.
b. Draw the path you would expect a hydrogen sulphide particle to follow down the tube.
c. What would happen if the experiment was repeated at a higher temperature?
d. What scientific principle does the experiment demonstrate?

Answers

a. Hydrogen sulphide travels faster because the yellow powder is formed closer to the cotton wool soaked in sulphur dioxide.

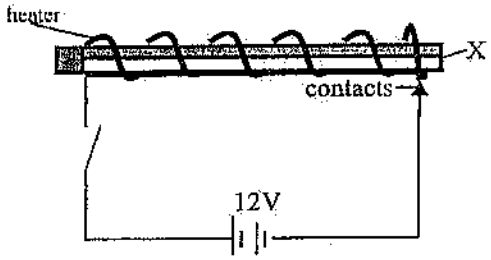
b.



c. The yellow powder would form much faster.

d. Smaller particles diffuse faster than bigger particles.

*** Q32. In the following circuit diagram, X is made up of two different metals welded together.**



a. Explain how X works to maintain the temperature of the heater.
b. What name is given to X.

Answers

a. When the switch is closed, current flows through the heater. The heater gets hot and heats metal X. Metal X expands as it is heated. As metal X expands, it bends because it is a bimetallic strip and cuts the circuit. The heater is temporarily switched off. As metal X cools, it straightens and comes back to its original position thereby switching on the heater. The process repeats itself over and over.

b. X is a bimetallic strip.

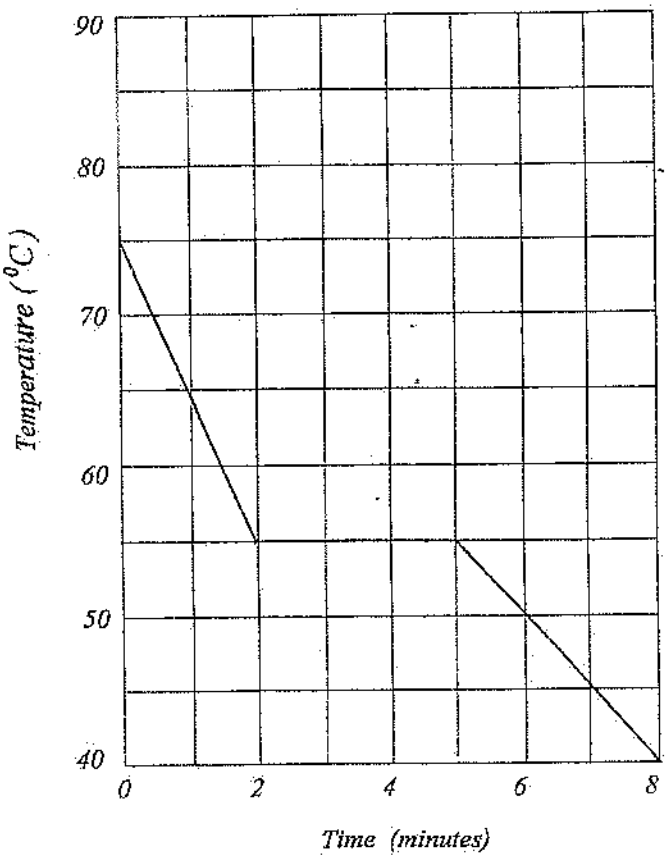
Q33. A pure substance was melted and then allowed to cool. The temperature of the substance was measured every minute as it cooled down. The results are given in the table below.

Time (min)	0	1	2	3	4	5	6	7	8
Temperature (^{0}C)	75	64	55	55	55	55	50	45	40

a. Plot a graph of temperature against time.
b. Determine the melting point of the substance.

Answers

a. *Graph of temperature against time.*



b. *The melting point is 55 ^{0}C*

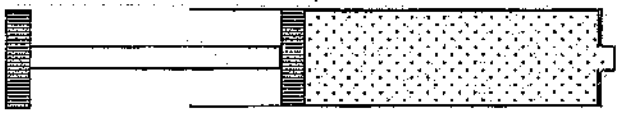
Q34. a. Explain two advantages of using alcohol in a thermometer over mercury.
b. Explain two advantages of using mercury in a thermometer over alcohol.

Answers

a. *Alcohol can be used at very low temperatures without freezing.*
Alcohol has a greater expansion rate than mercury therefore responds quickly to temperature changes.

b. *Mercury expands evenly as the temperature rises.*
Mercury can be used at high temperatures without evaporating.

Q35. The following diagram shows a syringe containing air. The end of the syringe is sealed. The volume of air is 150 cm^3 at a pressure of 100 kN/m^2 (100 kPa).



a. Explain, in terms of movement of the particles, how the air exerts pressure on the inside surface of the syringe.

b. A force is applied to the piston which compresses the air to 120cm^3 . The temperature remains constant. Calculate the pressure of the air.

Answers

a. Pressure is caused by the random motion of gas particles which make up the air. The gas particles move in all directions hitting the inside surface of the container in which the gas is kept. The particles therefore exert a force on the walls of the container which creates pressure.

b. Let the final pressure be p_2
Initial pressure (p_1) = 100 kN/m^2
Initial volume (V_1) = 150 cm^3
Final volume (V_2) = 120 cm^3
Using Boyle's law, $p_1 \times V_1 = p_2 \times V_2$

$$p_2 = \frac{p_1 \times V_1}{V_2} = \frac{100 kN/m^2 \times 150\ cm^3}{120\ cm^3} = 125\ kN/m^2$$

The pressure of the air is 125 kN/m^2.

Q36. Convert the following: a. 10°C to Kelvin
b. 300 K to °C

Answers

a. Temperature in Kelvin = T + 273, T is the temperature on the Celsius scale.
= 10 + 273
= 283 K

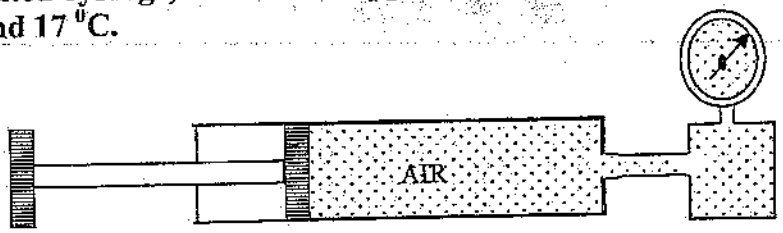
b. Temperature (^0C) = K - 273, K is the temperature on the Kelvin scale.
= 300 - 273
= 27 ^0C

Q37. a. Define 'liquid pressure'.
b. Apart from depth of the liquid, what other factor affects liquid pressure.

Answers

a. Liquid pressure is the force a liquid exerts per unit area of a surface.
b. Density of the liquid.

Q38. The diagram below shows apparatus in which a fixed mass of air was compressed in a calibrated syringe, which was approximately half full of air at atmospheric pressure and 17 ^{0}C.



Corresponding values of volume and pressure of the trapped air are shown in the table below.

Pressure (kPa)	50	60	75	90	105	120
Volume (m^3)	0.00048	0.00040	0.00032	0.00027	0.00023	0.00020
$\frac{1}{\text{volume}}$ (m^{-3})		2500		3704		5000

a. Copy and complete the table.

b. Plot a graph of pressure against $\frac{1}{\text{volume}}$

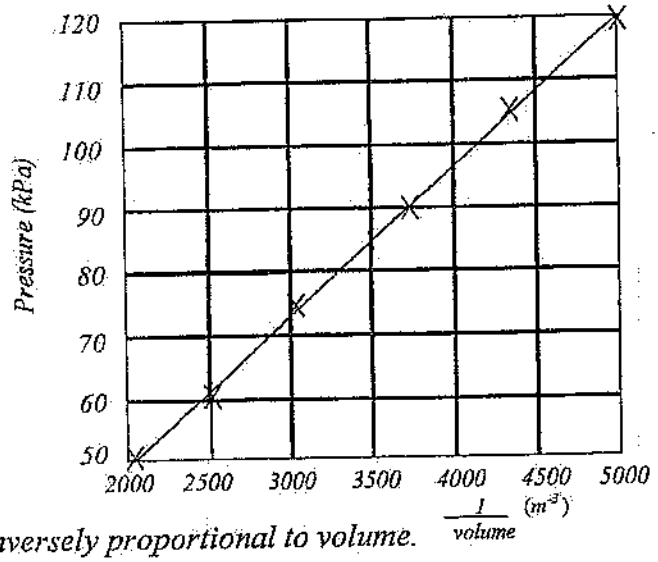
c. Deduce the relationship between pressure and volume from your graph.

Answers

a.

Pressure (kPa)	*50*	*60*	*75*	*90*	*105*	*120*
Volume (m^3)	*0.00048*	*0.00040*	*0.00032*	*0.00027*	*0.00023*	*0.00020*
$\frac{1}{volume}$ (m^{-3})	*2083*	*2500*	*3125*	*3704*	*4348*	*5000*

b. Graph of pressure against $\frac{1}{volume}$



c. Pressure is inversely proportional to volume.

Q39. a. **A deep sea diver is working at a depth where the pressure is 6.0 atmosphere. He is breathing out air bubbles . The volume of each air bubble 4cm^3. At the surface, the pressure is 2.0 atmosphere. What is the volume of each bubble when it reaches the surface?**

b. **What is the assumption made in your calculation in part (a) above?**

Answers

a. *Let the volume of each air bubble at the surface be V_2*
Pressure at the bottom (p_1) = 6.0 atmosphere.
Pressure at the surface (p_2) = 2.0 atmosphere.
Volume at the bottom (V_1) = 4.0 cm^3
Using Boyle's law, $p_1 \times V_1 = p_2 \times V_2$

$$V_2 = \frac{p_1 \times V_1}{p_2} = \frac{6 \times 4}{2} = 12\ cm^3$$

The volume of each air bubble is 12 cm^3

b. *The assumption made is that the temperature remains constant.*

Q40. A rectangular block measures 8cm by 5cm by 4cm and has a mass of 1.2 kg.

a. **If the gravitational field strength is 10N/kg, what is the weight of the block?**

b. **What is the area of the smallest face?**

c. **What pressure (in N/cm^2) will the block exert when it is resting on a table on its smallest face?**

d. **What is the volume of the block?**

e. **Calculate the density (in g/cm^3) of the material from which the block is made.**

Answers

a. *Weight = mass x gravity.*
= 1.2 kg x 10 N/kg
= 12 N.

b. *Area of smallest face = 5 cm x 4 cm = 20 cm^2.*

c. $Pressure = \frac{force}{area} = \frac{12\ N}{20cm^2} = 0.6\ N/cm^2.$

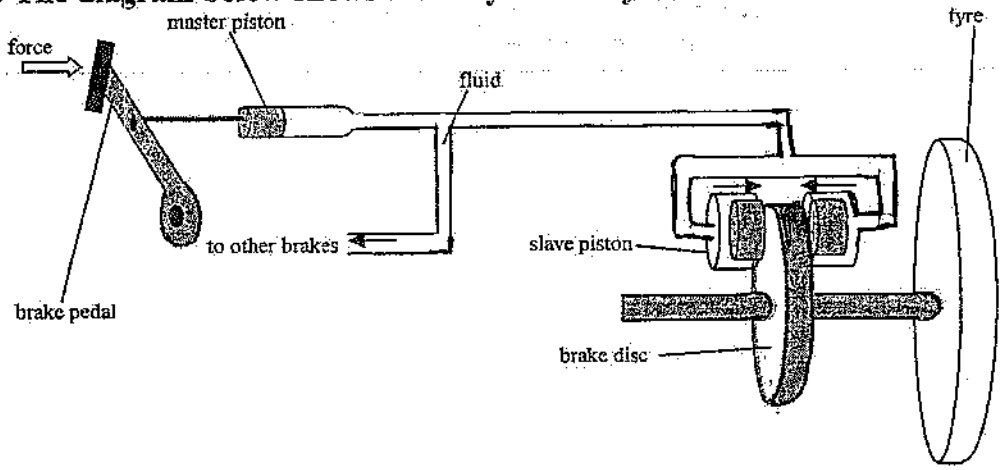
d. *Volume = 20 cm^2 x 8 cm = 160 cm^3*

e. $Density = \frac{mass}{volume} = \frac{1200\ kg}{160cm^3} = 7.5\ g/cm^3$

Q41. Explain why the pressure inside the tyre is higher at the end of a journey.

Answer
As the car moves, there is friction between the tyre and the ground. Friction causes the tyre to heat up. The heat is transferred to the air inside as a result the air particles move faster and collide more frequently with the inside of the tyre increasing the pressure.

Q42. The diagram below shows a car hydraulic system.



a. The area of the master piston is 0.5 cm^2. The brake pedal applies a force of 600N to this piston. Calculate the pressure exerted on the fluid by the master piston.

b. Calculate the force exerted on one slave piston if its surface area is 1.5 cm^2.

c. Calculate the force exerted on the brake disc by the two identical slave pistons.

d. Why does having air trapped in a hydraulic system make it less efficient?

Answers

a. $Pressure = \frac{force}{area} = \frac{600\ N}{0.5cm^2} = 1200\ N/cm^2.$

b. *Pressure applied to the slave piston* $= 1200\ N/cm^2$.
Area of the slave piston $= 1.5\ cm^2$
Force = pressure x area $= 1200\ N/cm^2 \times 1.5\ cm^2 = 1800\ N$

c. *Total force exerted* $= 1800\ N \times 2 = 3600\ N.$

d. *Air is compressible and reduces the pressure which is transmitted through the liquid.*

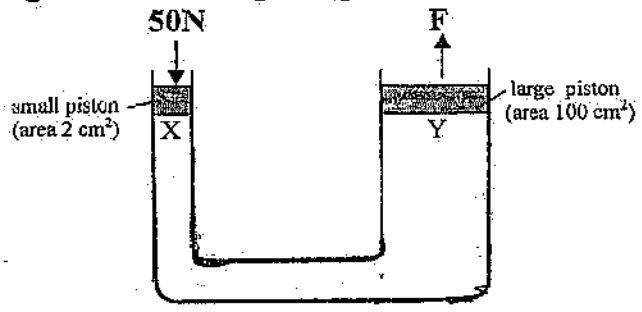
Q43. A bicycle tyre contains 70 cm^3 of air at a pressure of 1.0 atmosphere and temperature of 7 °C . When the air is compressed to 30cm^3 at a temperature of 27°C, what is the pressure?

Answer
Initial volume $(V_1) = 70\ cm^3$
Initial pressure $(p_1) = 1.0$ *atmosphere.*
Initial temperature $(T_1) = 7^0C = 280\ K$
Let the final pressure be p_2
Final volume $(V_2) = 30\ cm^3$
Final temperature $(T_2) = 27^0C = 300\ K$

Using the ideal gas equation; $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$

$p_2 = \frac{p_1V_1T_2}{T_1V_2} = \frac{1.0 \times 70 \times 300}{280 \times 30} = 2.5$ *atmosphere.*

Q44. The following diagram shows the principle of a hydraulic car jack.



a. If a force of 50N is applied to the small piston, calculate the pressure produced in the oil at X.
b. What is the pressure exerted by the oil at Y? Explain your answer.
c. Calculate the magnitude of force F.

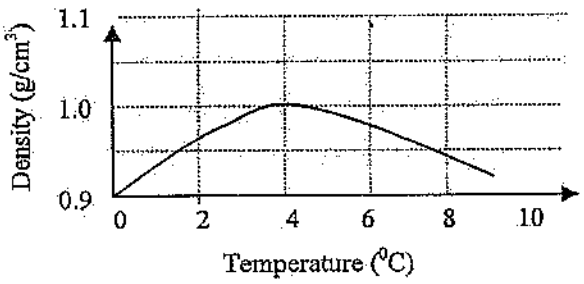
Answer

a. $Pressure = \frac{force}{area} = \frac{50\ N}{2\ cm^2} = 25\ N/cm^2.$

b. At Y, the pressure is 25 N/cm² because in liquids pressure applied at one point is transmitted equally throughout the liquid.

c. Force = pressure x area = 25 N/cm² x 100 cm² = 2500 N

Q45. The following diagram is a sketch showing changes in the density of water as its temperature rises.

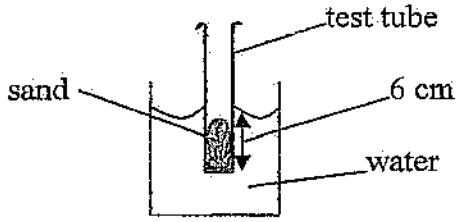


a. Describe how the density of water changes from 0°C to 8°C.
b. What would be the effect on the density of water if salt is added to it?
c. Explain why in general, the density of an object decreases as the temperature increases.

Answer

a. The density increases from 0 °C to 4 °C . From 4 °C to 8 °C it decreases.
b. The density would increase.
c. As the temperature increases, the volume of the liquid increases. Increase in volume decreases the density of the liquid for a constant mass.

Q46. A flat bottomed test tube of length 12 cm and uniform cross-sectional area of 4 cm^2 has a mass of 8g when empty. When the test tube is partly filled with sand, it floats upright in the water with 6 cm of its length submerged as shown in the following diagram.



a. Calculate the volume of water displaced.
b. What is the mass of water displaced?
c. Calculate the length of the test tube that would be submerged if the test tube is to be placed in alcohol of density 0.8g/ cm^3.
d. The densities of glass and sand are greater than the density of water. Why does the test tube partly filled with sand float in water?

Answer

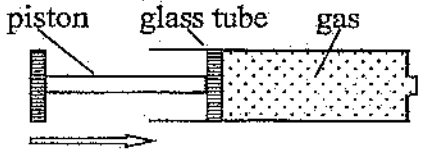
a. Volume of water displaced = 4 cm^2 x 6 cm = 24 cm^3.

b. Mass of water = 24 cm^3 x 1 g/cm^3 = 24 g.

c. Let the length of the test tube submerged in alcohol be h cm.
Volume of test tube submerged = 4h cm^3
The test tube will displace alcohol of mass 24 g.
Mass = density x volume
Therefore, 24 = 0.8 x 4h
h = 7.5 cm
7.5 cm of the test tube will be submerged in alcohol.

d. The partially filled test tube floats because the average density of the test tube, sand and air is less than that of the water.

Q47. The following diagram shows a gas in a glass tube fitted with a piston.



What will happen to the volume and pressure of the gas when the piston is pressed in the direction shown on the diagram. Explain your answer.

Answer

The volume decreases while the pressure increases. Volume decreases because the gas is compressed into a smaller space. Pressure increases because by compressing the gas into a smaller space the collisions per second with the inside surface of the glass tube increases.

Q48. Explain why gas pressure in a closed container increases when the temperature increases.

Answer

When the temperature increases , particles of the gas move faster and collide with the walls of the container more frequent.

Q49. A container with a cross-sectional area of $3cm^2$ is filled with $9cm^3$ of water. Calculate the pressure at the bottom of the container. Density of water is $1g/cm^3$.

Answer

Cross-sectional area $= 3cm^2 = 3 \times 10^{-4} m^2$ *(10,000* $cm^2 = 1m^2$ *)*

Mass of the water = density x volume

$= 1\ g/cm^3 \times 9\ cm^3$

$= 9\ g = 0.009\ kg$

Weight = mass x gravity $= 0.009\ kg \times 10\ N/kg = 0.09\ N$

$$Pressure = \frac{force}{area} = \frac{0.09\ N}{3 \times 10^{-4}\ m^2} = 300\ N/m^2$$

The pressure at the bottom of the container is $300\ N/m^2$

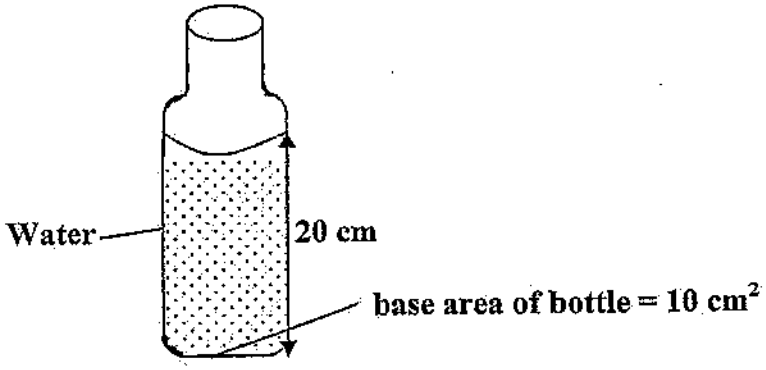
Q50. A pressure of $50000\ N/m^2$ is exerted by a column of water at the base of a container. Calculate the height of the water column. (density of water $=1000kg/m^3$, g $=10N/kg$).

Answer

$$Height = \frac{pressure}{density \times gravity} = \frac{50000\ N/m^2}{1000kg/m^3 \times 10N/kg} = 5\ m.$$

The height of the water column is 5 m.

Q51. The following diagram shows a bottle containing water.



a. Calculate the pressure of the water at the bottom of the bottle. (density of water = 1 g/cm^3)

Answer

Density $= 1\ g/cm^3 = 1000\ kg/m^3$

Height of the water = 20 cm = 0.2 m.

Acceleration due to gravity $= 10\ m/s^2$

Pressure $= 1000\ kg/m^3 \times 10\ m/s^2 \times 0.2\ m = 2000\ N/m^2$

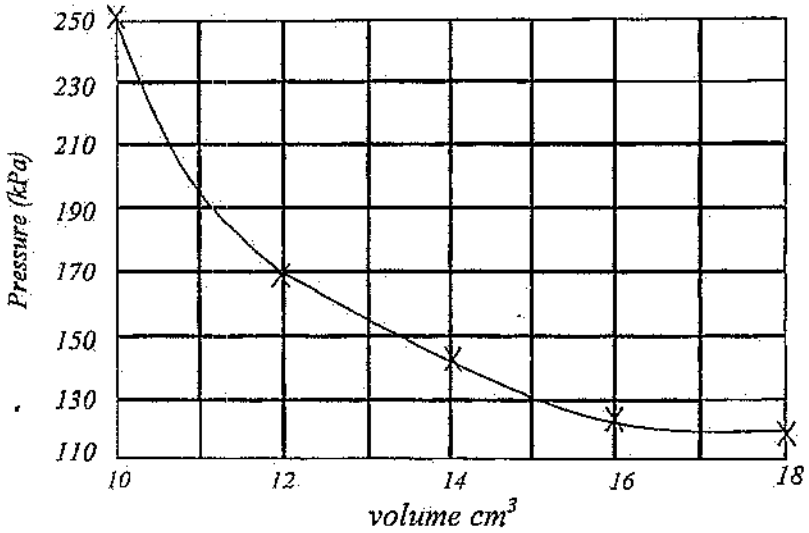
Q52. The following table shows results of an experiment to verify a gas law.

Volume (cm^3)	10	12	14	16	18
Pressure (kpa)	200	169	144	127	114

a. Plot a suitable graph to show the relationship between pressure and volume.
b. What relationship is being demonstrated by this graph?
c. Which variables would be kept constant in this investigation?

Answer

a. *Graph of pressure against volume.*



b. *As the volume increases, pressure decreases.*
c. *Temperature and mass of the gas.*

Q53. Atmospheric pressure of a mercury barometer reads 0.76m. If one atmosphere is equal to 101 000 Pa, calculate the density of mercury.

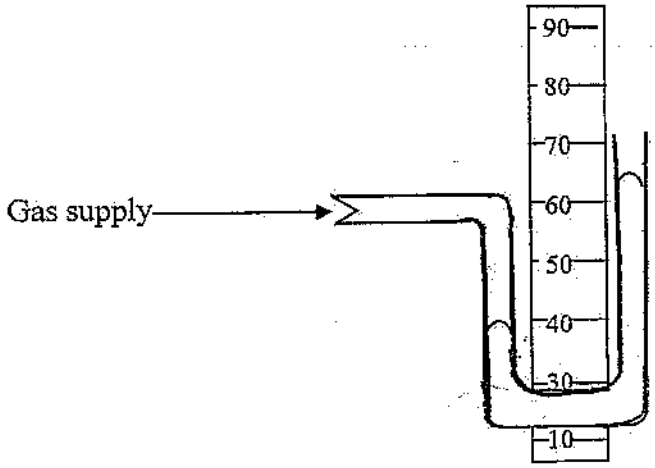
Answer
Pressure = 101 000 Pa,
Height of liquid column = 0.76 m = 760 mm
Acceleration due to gravity = 10 m/s²

$$Density = \frac{pressure}{gravity \times height} = \frac{101\,000\ Pa}{10\ m/s^2 \times 0.76\ m} = 13,289\ kg/m^3. = 13.3\ g/cm^3$$

Q54. Two identical gas jars were filled with liquid mercury (density = 13.6 g/cm^3) and water (density = 1.0 g/cm^3). Explain the difference in pressure exerted at the base of the jars by the two liquids.

Answer
Mercury exerts more pressure than water because it has a higher density. The higher the density of a liquid, the more the pressure it exerts.

Q55. The following diagram shows an instrument used to measure gas pressure.



a. Name the instrument.
b. Read the pressure difference in mm Hg.
c. What is the pressure of the gas supply if the atmospheric pressure is 755mm Hg and the pressure difference is 30 mm Hg.
d. Mention two reasons why mercury is used in the above instrument.

Answer
a. The instrument is a manometer.
b. The reading is 25 mm Hg.
c. pressure of gas supply = atmospheric pressure + liquid pressure
= 755 mm Hg + 30 mm Hg.
= 785 mm Hg.
d. Does not stick to the walls of the glass tube.
Has high expansion rate.

Q56. A rectangular container whose base is 9 cm^2 is filled with 27 g of water. Calculate the pressure exerted by the water at the bottom of the container in N/m^2. (acceleration due to gravity = 10 ms^{-2}).

Answer
Mass of water = 27 g = 0.27 kg
Weight of water = 0.27 x 10 N = 2.7 N
Area of the base = 9 cm^2 = 9.0×10^{-4} m^2 (10,000 cm^2 = 1m^2)

$$Pressure = \frac{force}{area} = \frac{2.7\ N}{9.0 \times 10^{-4}\ m^2} = 3000\ N/m^2$$

Q57. State any two factors that affect gas pressure.

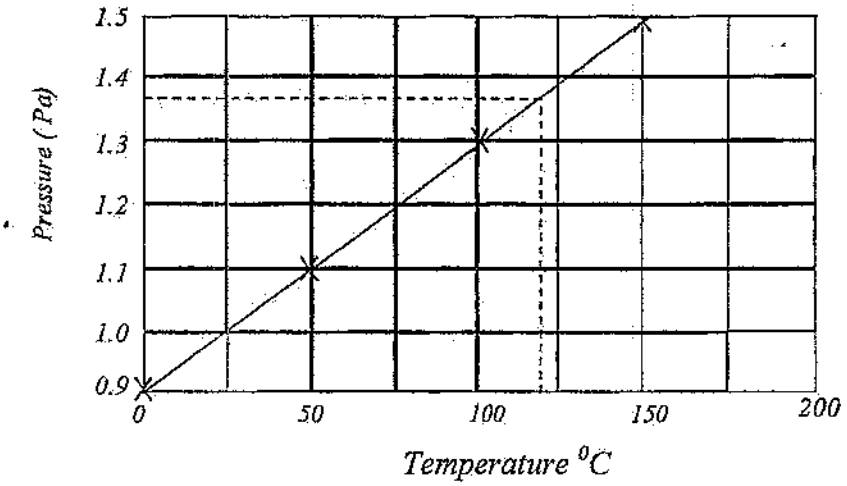
Answer
Temperature
Volume

Q58. The following table shows results of an experiment to demonstrate a gas law.

Pressure (pa)	0.9	1.1	1.3	1.5
Temperature (^{0}C)	0	50	100	150

a. What was the aim of the experiment
b. What variables would be kept constant in this experiment?
c. Plot a graph of pressure against temperature.
d. What is the relationship between temperature and pressure?
e. Use your graph to find the pressure of the gas when the temperature was 120 ^{0}C.
f. Mention any one source of error in this experiment.

Answer
a. To determine the relationship between pressure and temperature.
b. Volume and mass.
c. Graph of pressure against temperature

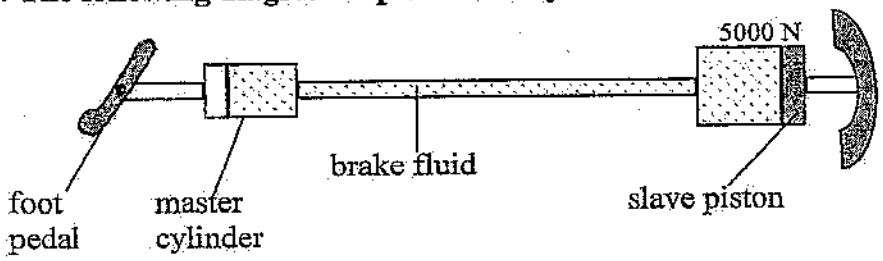


d. As temperature increases pressure also increases proportionally.
e. The pressure is 1.36 Pa.
f. Variations in the volume of the gas.

Q59. The height of mercury in a mercury barometer is 64 cm. Calculate the pressure of the place in Pascals. Density of mercury = 13000 kg/m^3

Answer
Height of mercury = 64 cm = 0.64 m
Density of mercury = 13000 kg/m^3.
Acceleration due to gravity = 10 m/s^2
Pressure = density x gravity x height.
= 13 000 kg/m^3 x 10 m/s^2 x 0.64 m
= 83 200 Pa
The pressure of the place is 83 200 Pa

Q60. The following diagram represents a hydraulic brake.



A force of 20 N is applied at the foot pedal connected to the piston of area 0.0005 m^2 and this causes a stopping force of 5000 N. Calculate:

a. The pressure in the master cylinder
b. The area of the slave piston.

Answer

a. Force applied to the master piston = 50 N
Area of the master piston = 0.0005 m^2

$$Pressure = \frac{force}{area} = \frac{50\ N}{0.0005\ m^2} = 100{,}000\ \ N/m^2$$

b. Force = 5000N
Pressure applied = 100,000 N

$$Area = \frac{force}{pressure} = \frac{5000\ N}{100{,}000\ N} = 0.05\ m^2$$

Q61. What is an ideal gas?

Answer
Is a gas that obeys the gas laws exactly.

Q62. a. What are Van der Waals forces?
b. Explain giving examples, how the strength of Van der Waals forces depend on the molecular size and the kind of atoms in a molecule.

Answers

a. They are forces of attraction which hold molecules of a substance together.
b. The bigger the size of the molecule, the stronger the Van der Waals forces. For example, ethanol is liquid at room temperature because its Van der Waals forces are stronger than methanol which is gas at room temperature.

Compounds which contain group 6 or group 7 elements in their molecules tend to be polar and have stronger Van der Waals forces than non-polar compounds. Water is liquid at room temperature because it is polar. Methane is gas at room temperature because it is non-polar.

Q63. Why is carbon dioxide a gas at room temperature?

Answer
Carbon dioxide molecules are held together by weak intermolecular forces.

CHAPTER 2.

FORCES & MOTION.

46 QUESTIONS WITH ANSWERS

To the student.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

After reading the chapter, test your understanding by answering the 46 questions in this chapter. Cross check your answers with the answers provided.

The following list of books is not exhaustive.

1. Keith Wallis, Chanco Physical Science for Malawi, Book 2 (3rd edition), pages 29-36, 51-61, 69-87.

2. Samuel Kalea, MSCE Physical Science (New edition), pages

3. Tom Duncane, GCSE Physics(4th edition), pages 93-95, 118-137.

4. Mukabi Murigi etal, KCSE Golden Tips Physics, pages 21-27, 30-33

5. Keith Johnson, Physics for You: Revised edition for GCSE, pages 73-77, 92-96, 130-138, 144-146.

6. Stephen Pople, Complete Physics, pages 18-43.

Q1. What is meant by the following terms:

a. Free fall.
b. Acceleration
c. Velocity.
d. Displacement
e. Speed.

Answers

a. Is the motion of a falling body under the force of gravity alone with negligible air resistance.
b. Acceleration is the rate of change of velocity.
c. Is the rate of change of displacement.
d. Is the distance between two points in a specific direction.
e. Is the distance covered per unit time irrespective of direction

Q2. State the following laws of motion.

a. Newton's first law of motion.
b. Newton's second law of motion.
c. Newton's third law of motion.

Answers

a. A body at rest or moving with uniform velocity continues to do so unless acted upon by some external force.
b. For a fixed mass, acceleration is directly proportional to the applied force.
c. For every force of action, there is an equal and opposite force of reaction.

Q3. Define the following terms:

a. Momentum.
b. Impulse.
c. inertia
d. Friction
e. Terminal velocity.

Answers

a. Is the product of mass of a body and its velocity.
b. Is the change in momentum.
c. Is the tendency of an object at rest to remain at rest or a body in motion to keep on moving with uniform velocity.
d. Is the force which opposes motion of a body.
e. Constant velocity reached by a falling body due to balanced forces acting on the body.

Q4. What is meant by the following terms:

a. Vector quantity.
b. Scalar quantity.
c. Resultant force.

Answers

a. A quantity with both magnitude and direction.
b. A quantity with magnitude only.
c. Is a single force which has exactly the same effect as different forces acting on an object.

Q5. Give an example of each of the following :

a. Vector quantity.

b. Scalar quantity.

Answers: a. Velocity, displacement, force. *b. Mass, speed, time.*

Q6. State the S.I units of the following:

a. Speed. **b. Acceleration** **c. Displacement.**

Answers

a. metres per second (m/s)

b. metres per second squared. (m/s^2)

c. metres (m)

Q7. State the S.I units of the following:

a. Momentum **b. Impulse** **c. Force**

Answers

a. Kilogram metre per second (Kgm/s).

b. Kilogram metre per second (Kgm/s).

c. Newtons (N)

Q8. A car weighing 500 kg moves from rest and reaches a speed of 15 m/s in 5 seconds. Calculate:

a. Acceleration of the car.

b. Force exerted by the car's engine.

Answers

a. Starting speed (u) = 0 m/s

Final speed (v) = 15 m/s

Time taken (t) = 5 seconds

$$Acceleration = \frac{v - u}{t} = \frac{(15 - 0)\ m/s}{5\ s} = 3\ m/s^2$$

b. Force = mass x acceleration.

= 500 kg x 3 m/s^2

= 1500 N

Q9. A bullet of mass 10g is fired at 400m/s from a riffle of mass 4 kg. What is the recoil velocity of the riffle?

Answer

Let the recoil velocity of the riffle be - V_2. (negative sign shows that it moves in the opposite direction to the direction of the bullet)

Mass of the bullet (m_1)= 10 g = 0.01 kg.

Velocity of the bullet (V_1) = 400 m/s

Mass of the riffle (m_2) = 4 kg.

Total momentum before explosion = total momentum after explosion

$0 = (m_1 \times V_1) + (m_2 \times V_2)$

$0 = (0.01 \times 400\ kgm/s) + (-V_2 \times 4\ kg)$

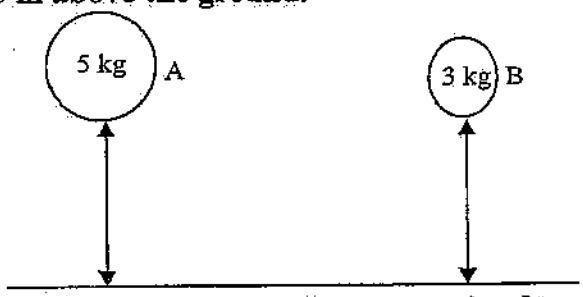
$0 = (0.01 \times 400\ kgm/s) - (V_2 \times 4\ kg)$

$V_2 \times 4\ kg = 0.01 \times 400\ kgm/s.$

$$V_2 = \frac{0.01 \text{ x } 400 \text{ kgm/s}}{4 \text{ kg}} = 1.0 \text{ m/s}$$

The recoil velocity of the riffle is 1.0 m/s

Q10. The following diagram shows two metals spheres A of mass 5 kg, and B of mass 3 kg at rest 5 m above the ground.



a. When the spheres are released from rest simultaneously, they strike the ground at the same time. Why is this so?

b. Describe the motion of sphere B from the time it is released to the time it hits the ground.

c. Find the force with which sphere A hits the ground.

d. Suppose metal sphere A was released from a height 3m above the ground, what effect if any would this have on the force with which it hits the ground?

Answers

a. The two objects fall under constant acceleration due to gravity and the effect of air resistance is negligible.

b. The velocity of sphere B increases at a constant rate of 10 m/s till it hits the ground.

c. Force = mass x acceleration
= 5 x 10 N
= 50 N.

d. It will have no any effect.

Q11. The speed of a runner dropped from 80m/s to 60 m/s in 4 seconds.

a. Calculate the average deceleration of the runner.

b. If the runner maintained the deceleration in part (a) above, after how long did the speed reach zero.

Answers

a. Initial speed (u) = 80 m/s
Final speed (v) = 60 m/s
Time taken (t) = 4 seconds

$$\text{Deceleration} = \frac{v - u}{t} = \frac{(60 - 80) \text{ m/s}}{4 \text{ s}} = -5 \text{ m/s}^2$$ *Therefore, deceleration = 5ms^{-2}*

b. Initial speed (u) = 80 m/s *Final speed (v) = 0 m/s*

$$\text{Deceleration} = \frac{v - u}{t} \quad \text{So, } -5 = \frac{0 - 80}{t} \quad \text{Therefore, } t = \frac{0 - 80}{-5} = 16 \text{ s.}$$

Q12. A car accelerates uniformly for 10 seconds from a velocity of 0 m per second to a velocity of 25 m per second, continues at the velocity of 25 m per second for a further 40 seconds and then decelerates uniformly for 20 seconds so that it stops.

a. Calculate the total time for the journey.

b. Draw a velocity time graph to represent the motion of the car.

c. From the graph, calculate:

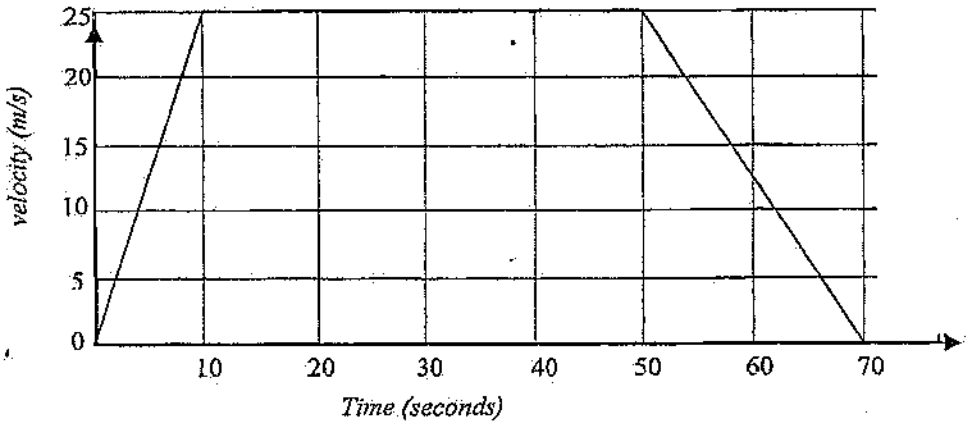
i. acceleration during the first 10 seconds.

ii. deceleration during the last 20 seconds of the journey.

Answers

a. Total time = (10 + 40 + 20) seconds
= 70 seconds.

b. *Velocity-time graph.*



c. i. $Acceleration = \frac{change\ in\ velocity}{time} = \frac{25\ m/s}{10\ s} = 2.5\ m/s^2.$

ii. $Deceleration = \frac{change\ in\ velocity}{time} = \frac{-25\ m/s}{20\ s} = -1.25\ m/s^2.$

Q13. Explain the following.

a. Seat belts are designed to stretch.

b. Safety helmets are padded.

c. A hammer is designed from hard metal.

d. Why is the front of a car designed to crumple?

Answers

a. To increase time of impact thereby reducing the force if there is an accident.

b. To increase time of impact thereby reducing the force if there is an accident.

c. To minimise time of impact thereby increasing the force.

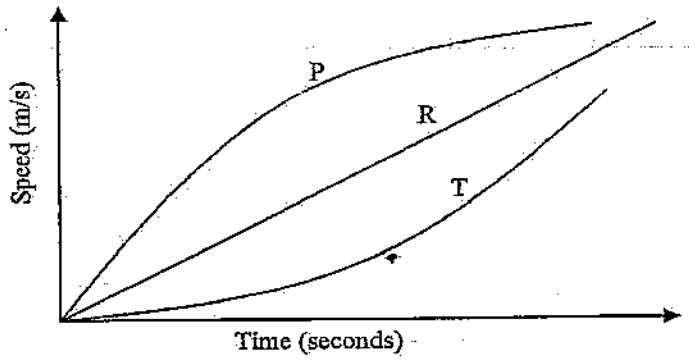
d. To increase time of impact thereby reducing the force if there is an accident.

Q14. Explain why force is a vector quantity.

Answer

A force has both magnitude and direction in which it acts.

Q15. The following diagram shows a sketch of three speed-time graphs labelled P, R and T.



a. What type of acceleration is represented by the graphs P, R and T?

b. Presenting numerical data graphically is widely used by scientist. Give two reasons why this is so.

Answers

a. *P represents decreasing acceleration*
R represents constant acceleration.
T represents increasing acceleration.

b. *Easy to establish relationships between two or more variables.*
Can provide information beyond recorded data through extrapolation or interpolation.

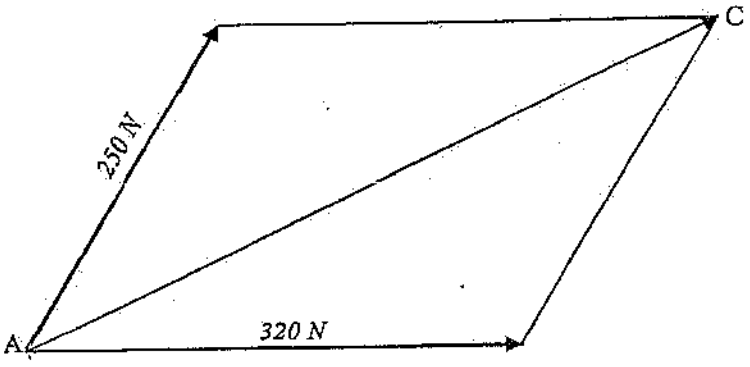
Q16. An object is pulled by two forces whose magnitudes are 250 N and 320 N. the angle between the two forces is 60^0.

a. Draw a scale diagram to show the size of the resultant force .

b. Find the magnitude of the resultant force.

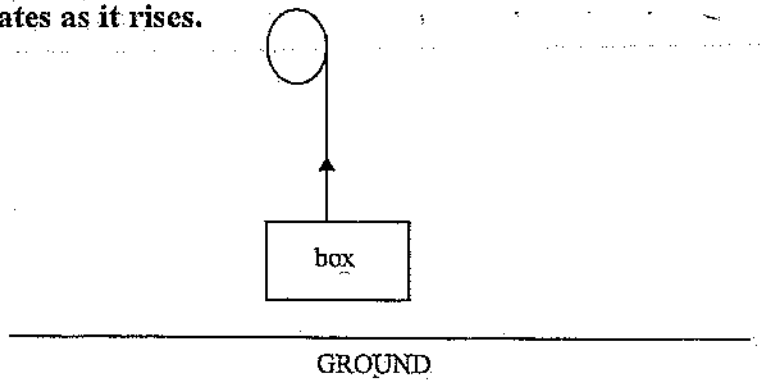
Answers

a. *Scale: let 1 cm represent 50 N*
250 N = 5 cm
320 N = 6.4 cm
Using parallelogram law, line AC represents the resultant force.



b. *Length of line AC = 9.8 cm*
Magnitude = 9.8 x 50 N = 490 N
Therefore, resultant force = 490 N.

Q17. The following diagram shows a box being raised by a rope from the ground. The box accelerates as it rises.



a. **What are the forces acting on the box assuming air resistance is negligible?**
b. **Which of the forces is greater?**
c. **How would the forces compare if the box was moving upwards at constant speed?**
d. **How would the forces compare if the box stopped moving?**

Answers

a. The forces are weight and pulling force
b. The pulling force is greater.
c. Pulling force will be equal to weight.
d. Pulling force will be equal to weight.

Q18. A car travels from point A due north to a point B 40 km away in 30 minutes. It then travels 30 km due east to appoint C in another 30 minutes.

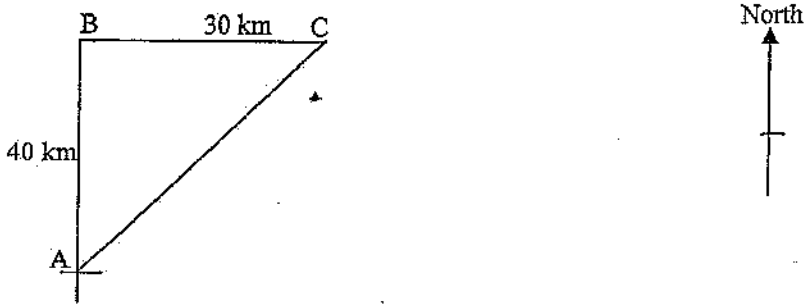
a. **Find the average speed in kilometres per hour for the whole journey.**
b. **If the car travelled from point A to point C using the most direct route, what distance would it cover?**

Answers

a. Total distance covered = 40 km + 30 km = 70 km.
Total time taken = 2 x 30 minutes = 60 minutes.
60 minutes = 1 hour.

$$\text{Average speed} = \frac{\text{distance}}{\text{time}} = \frac{70\ km}{1\ hour} = 70\ km/h$$

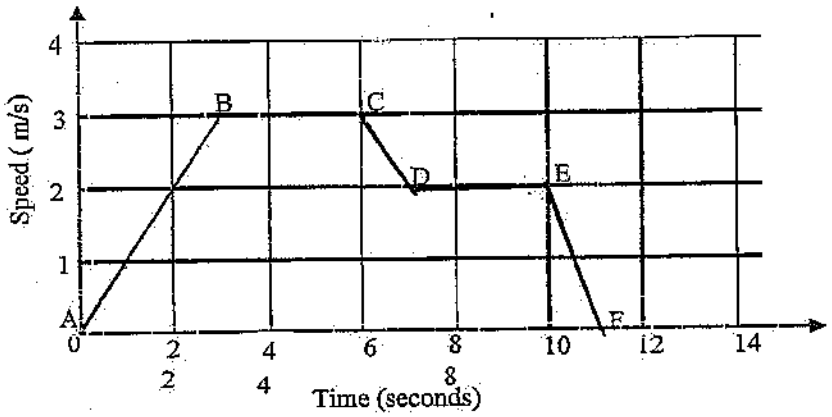
b. The following diagram shows a sketch of the car's journey not drawn to scale.



Line AC gives the most direct route.

$$AC = \sqrt{40^2 + 30^2} = \sqrt{1600 + 900} = \sqrt{2500} = 50\ km.$$

Q19. Study the speed-time graph of a bus below and answer the questions that follow.



a. Describe the motion of the bus between A and D.
b. Calculate the acceleration of the bus between A and B.
c. Calculate the total distance travelled between A and C.

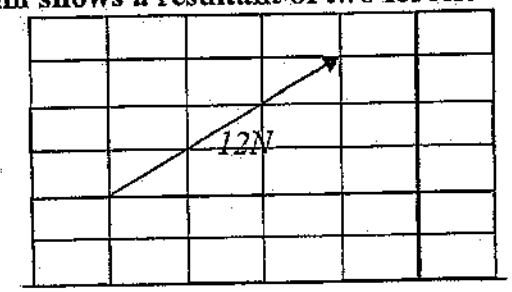
Answers

a. Between AB, the bus moves with constant acceleration, Between BC the buy moves at constant speed and between CD the bus decelerates uniformly.

b. $Acceleration = \frac{change\ in\ velocity}{time} = \frac{30\ m/s}{3\ s} = 10\ m/s^2.$

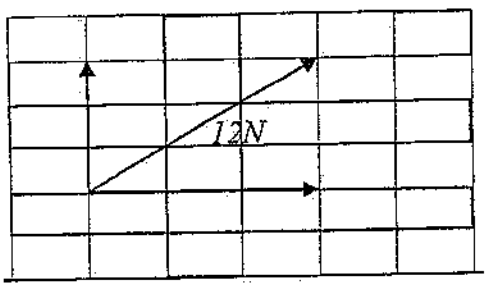
c. Total distance travelled = Area under the graph line from A to C.
= ½ (sum of parallel sides) h
= ½ (3 + 6) 30 m.
= 9 x 15 m
= 135 m.
The bus covers a distance of 135 m between A and C.

Q20. The following diagram shows a resultant of two forces.



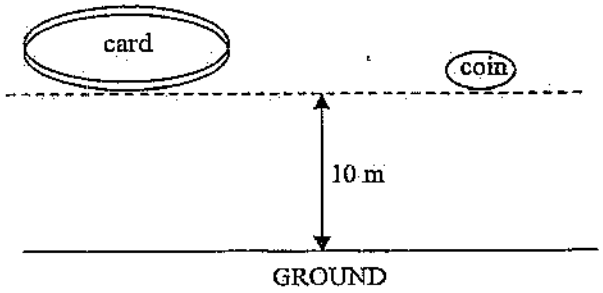
a. Complete the diagram to show the vertical and horizontal components.
b. Calculate the magnitude of the horizontal component.

Answers.
a.



b. Length of the resultant force (12 N) = 3.5 cm
Therefore, 1 cm = 3.4 N.
Length of the horizontal component = 3 cm.
Magnitude of the horizontal component = 3 x 3.4 N = 10.2 N

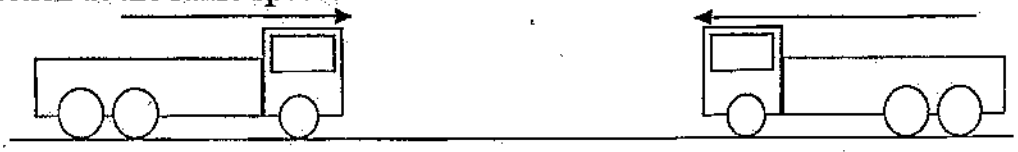
Q21. A piece of card and a coin of the same mass are released at the same time from a height of 10m as shown in the following diagram.



a. Which of the two would reach the ground first. Give reason for your answer.
b. State the three forces that act on each object as it falls.
c. Which forces remain constant as the object falls?

Answers
a. The coin will reach the ground first because it experiences less air resistance.
b. The three forces are air resistance, weight and upthrust.
c. Weight and upthrust remain constant.

Q22. The following figure shows two cars of the same mass travelling in opposite direction at the same speed.



What would happen to the velocities of both cars if they collide head on. Give reason for your answer.

Answer
The velocities would reduce to zero because both cars have the same momentum but in opposite direction.

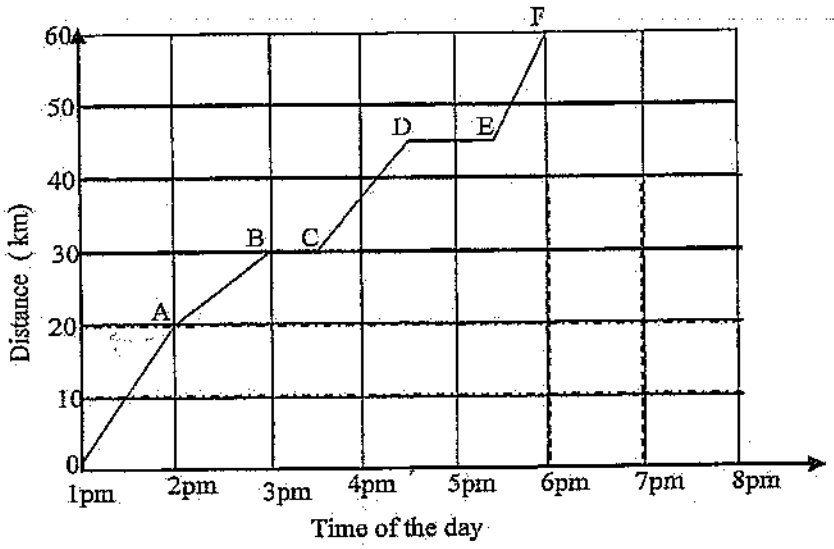
Q23. What is the average speed in km/hr of a car which travels 400m in 20 seconds?

Answer
400 m = 0.4 km.
20 seconds = 0.0056 hours.

$$\text{Average speed in km/h} = \frac{0.4\ km}{0.0056\ h} = 71.43\ km/h$$

The average speed is 71.43 km/h

Q24. The figure below shows a distance-time graph for a cyclist. Use it to answer the questions that follow.



a. What is the total distance travelled by the cyclist?
b. How long did it take the cyclist to cover the distance?
c. Describe the motion of the cyclist from 2pm to 4:30 pm.
d. Calculate the average speed of the cyclist during the first 2 hours of the journey.
e. State whether distance is a vector quantity or scalar quantity. Give a reason for your answer.

Answers

a. 60 km.

b. 5 hours

c. The cyclist moved with constant speed of 10 km/hr from 2 pm to 3 pm. From 3pm to 3:30 pm, the cyclist stopped moving. From 3:30pm to 4pm, the cyclist moved with a constant speed of 15 km/h.

d. $\text{Average speed} = \frac{\text{distance covered in 2 hours}}{\text{time taken}} = \frac{30\ km}{2\ h} = 15\ km/h.$

e. Distance is a scalar quantity because it has magnitude only.

Q25. Forces of 40N and 50N are acting at right angles to each other. Draw a scale diagram to find the resultant force. (use a scale of 1 cm to represent 10N).

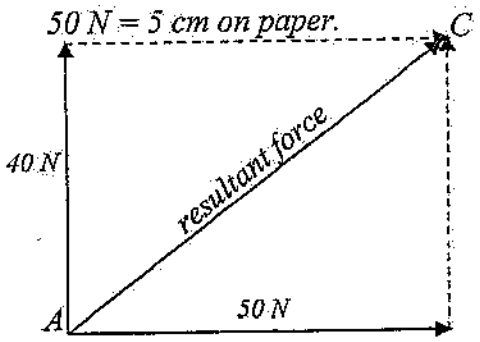
Answer

40 N = 4 cm on paper,

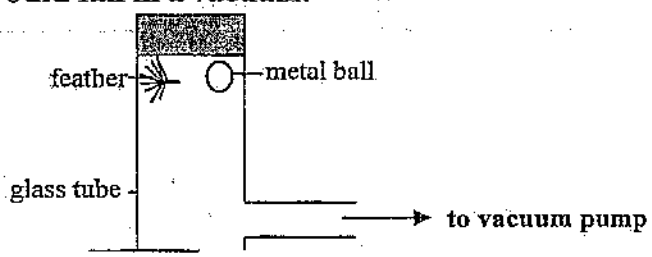
AC = 6.4 cm

Resultant force = 6.4 x 10 N

= 64 N



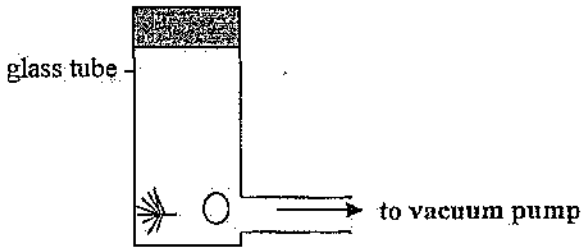
Q26. The following diagram shows a set up used in an experiment to investigate how a feather and a metal would fall in a vacuum.



a. Name the resultant force acting on the ball.
b. State the direction of the resultant force in part b.
c. If the feather and the metal ball were allowed to fall at the same time, draw in the diagram to show the positions of both the feather and the metal ball before they reach the bottom of the tube. Explain your answer.

Answers
a. It is weight.
b. Acts downwards toward the ground.

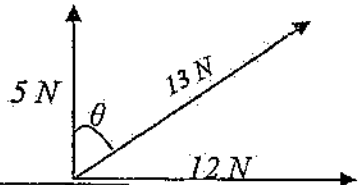
c.



They would be at the same height above the bottom of the tube because both the feather and the ball are falling at a constant acceleration due to gravity and air resistant is zero. They move at the same velocity down the tube.

Q27. Find the size of the resultant of two forces of 5N and 12N acting.
a. In opposite directions to each other.
b. In the same direction.
c. At 90^0 to each other.

Answers
a. Resultant force = 12 N - 5 N = 7N in the direction of the 12N force.
b. Resultant force = 12 N + 5 N = 17 N in the same direction of the two forces.
c.

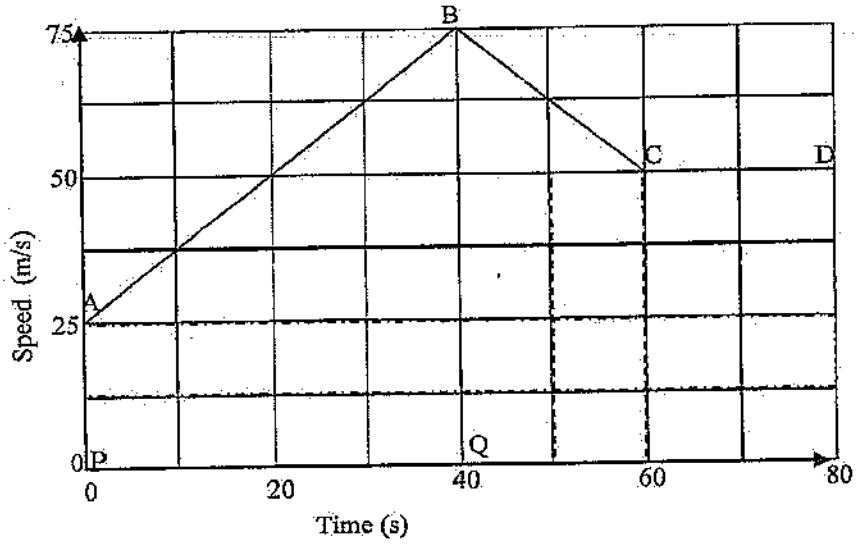


Resultant force $= \sqrt{12^2 + 5^2} = 13$ *N.*

$\theta = \cos^{-1}\left[\frac{5}{13}\right] = 67^0$

The resultant force is 13 N, 67^0 from the direction of the 5N force.

Q28. Use the following graph to answer the questions that follow.



a. Describe the motion of the car from point A to D.
b. Calculate the distance covered when the car moves from point A to B.

Answers

a. From point A to B, the car moves with constant acceleration. From point B to point C, the car moves with constant deceleration. From point C to point D, the car moves at a constant speed of 50 m/s.

b. Distance covered = area under the graph line (trapezium PABQ).
= ½ (75 + 25)40 m
= 2000 m.

Q29. What is the average speed in km/hr of an athlete who runs 1500m in 4 minutes?

Answer
1500 m = 1.5 km
4 minutes = 0.067 hours.

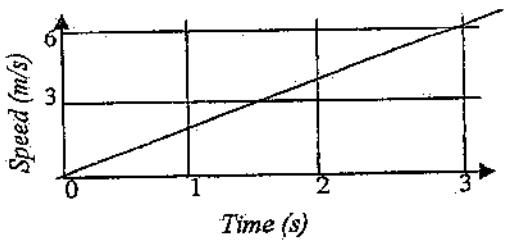
$$Speed\ in\ km/h = \frac{1.5\ km}{0.067\ h} = 22.39\ km/h.$$

Q30. A motor cyclist starts from rest and reaches a speed of 6m/s after travelling with uniform acceleration for 3 seconds.
a. What is his acceleration?
b. Draw the speed-time graph for the cyclist.

answers

a. Acceleration $= \frac{change\ in\ velocity}{time} = \frac{(6 - 0)\ m/s}{3\ s} = 2\ m/s^2.$

b.



Q31. a. **State any two factors that affect the terminal velocity of a free falling object in air.**

b. **The following diagram shows an object falling at terminal velocity. F_1 and F_2 are forces acting on the object.**

i. **Name the forces F_1 and F_2**

ii. **What would be the relationship between F_1 and F_2 at terminal velocity?**

Answers

a. *The factors are mass and shape.*

b. *i.* *F_1 is air resistance and F_2 is weight.*

ii. *F_1 is equal in magnitude to F_2.*

Q32. A train increases its speed steadily from 10m/s to 20m/s in 1 minute.

a. **What is the average speed of the train during this time in m/s?**

b. **How far does the train travel?**

Answers

a. $\text{Average speed} = \dfrac{\text{initial speed} + \text{final speed}}{2} = \dfrac{(10 + 20)\ m/s}{2}$

$= 15\ m/s$

b. *1 minute = 60 s*

Distance travelled = average speed x time = 15 x 60 m = 900m.

Q33. When a force of 6N is applied to a block of mass 2kg, it moves along a table at constant velocity.

a. **What is the force of friction?**

b. **When the force is increased to 10 N, what is:**

i. **The resultant force?**

ii. **The acceleration?**

Answers

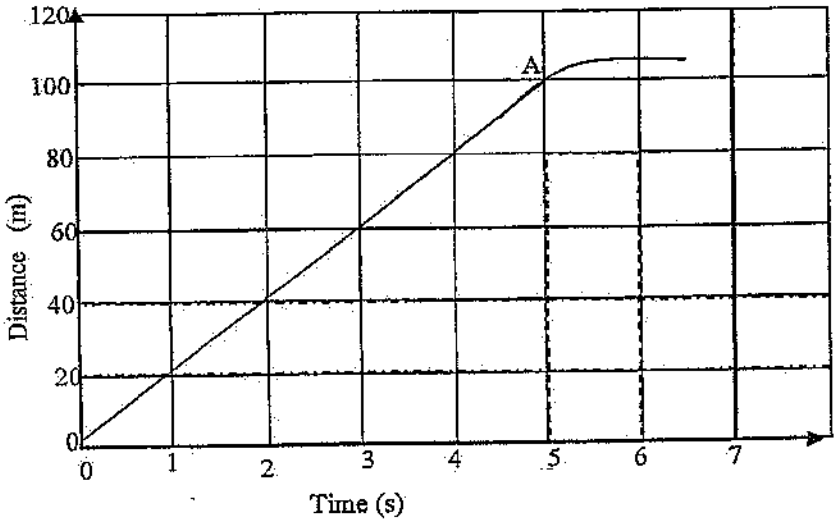
a. *Force of friction is equal to 6N in the opposite direction to the applied force.*

b. *i.* *Resultant force = 10 N - 6 N = 4 N in the direction of the 10 N force.*

ii. *Resultant force = mass x acceleration*

$\text{Acceleration} = \dfrac{\text{Resultant force}}{\text{mass}} = \dfrac{4\ m/s^2}{2} = 2\ m/s^2.$

Q34. The following graph represents the distance travelled by a car plotted against time. Use the graph to answer the questions that follow.



a. How far has the car travelled at the end of the 5 seconds?
b. What is the speed of the car during the first 5 seconds?
c. What has happened to the car after point A.
d. Draw a graph showing the speed of the car plotted against time during the first 5 seconds.

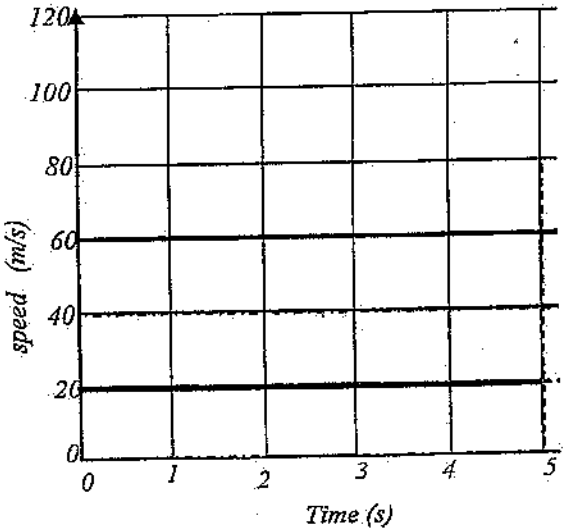
Answers

a. The car has travelled 100m

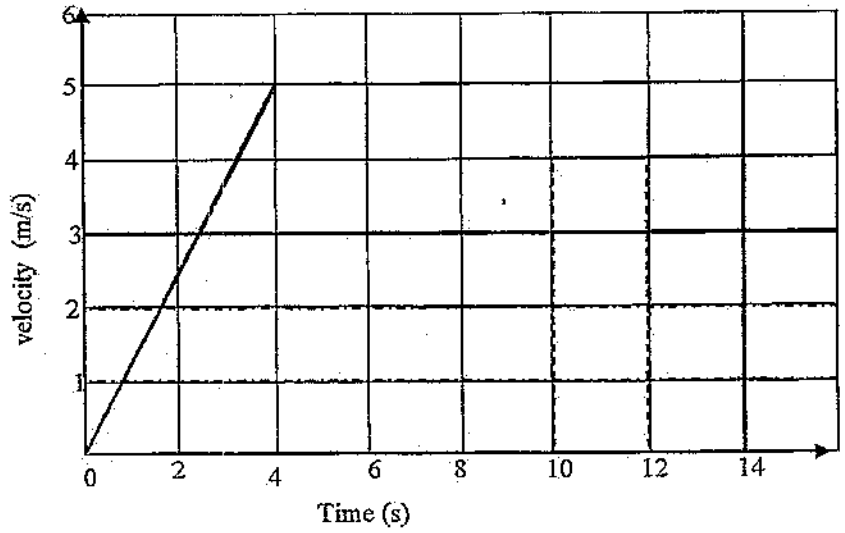
b. $Speed = \frac{Distance}{time} = \frac{100\ m}{5\ s} = 20\ m/s.$

c. The car decelerates and eventually stops moving.

d. The graph of speed against time.



Q35. The following diagram shows an incomplete velocity-time graph of a boy running a distance of 100m.



a. What is his acceleration during the first 4 seconds?
b. How far does the boy travel during the first 4 seconds?
c. Copy and complete the graph showing clearly at what time he has covered the distance of 100m. Assume his speed remains constant.

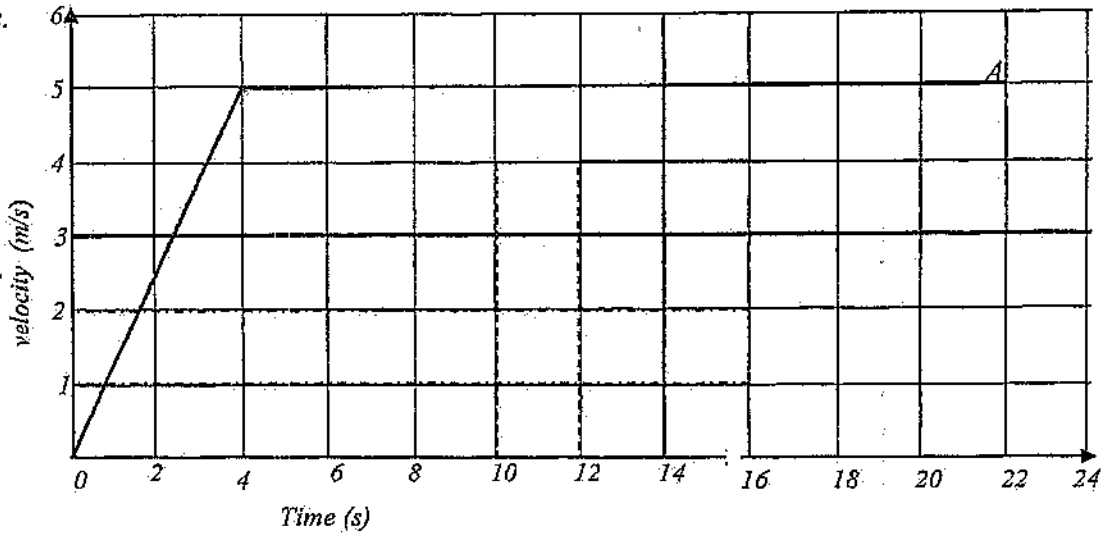
Answers

a. Initial velocity (u) = 0 m/s
Final velocity (v) = 5 m/s

$$Acceleration = \frac{change\ in\ velocity}{time} = \frac{v - u}{4\ s} = \frac{(5 - 0)\ m/s}{4\ s} = 1.25\ m/s^2.$$

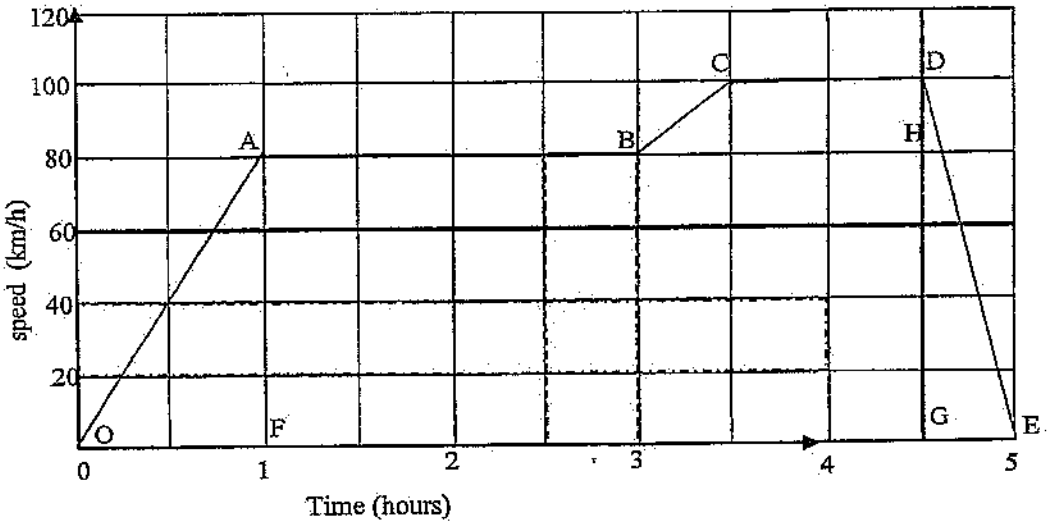
b. Distance travelled = area under the graph line.
= ½ x 4 x 5 m
= 10 m

c.



The boy covered 100 m after running for 22 seconds in total (point A).

Q36. The velocity-time graph of a car on a 5-hour journey is shown below. (There is a very quick driver change midway to prevent driving fatigue).



a. State in which of the regions OA, AB, BC, CD, DE is the car :
- **i. accelerating iii. decelerating**
- **ii. travelling with uniform velocity.**

c. What is the total distance travelled?

d. Calculate the average velocity for the whole journey.

Answers

a. *i. Regions OA and BC.*
ii. Region DE.
iii. Regions AB and CD.

b. *Distance travelled = area under the graph line.*
$= ½(1 \times 80)+(3.5 \times 80)+½ (0.5 \times 100) + ½(1.5 + 1) 20$ km.
$= (40 + 280 + 25 + 25)$ km
$= 370$ km.
The total distance travelled is 370 km.

c. $\text{Average velocity} = \frac{\text{total distance travelled}}{\text{total time}} = \frac{370 \text{ km}}{5 \text{ h}} = 74 \text{ km/h}.$

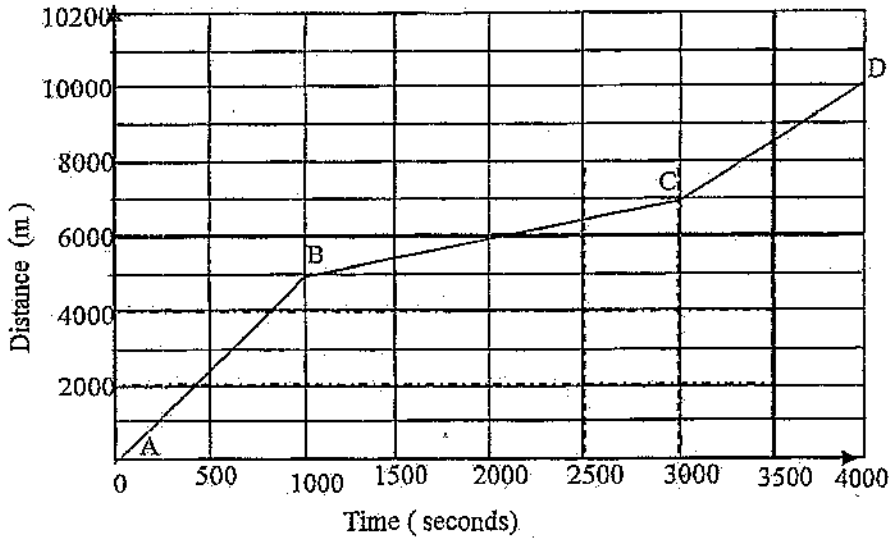
Q37. A vehicle is uniformly retarded and brought to rest from a speed of 120km/h in 15 seconds. Find the deceleration.

Answer
Initial speed (u) = 120 km/h = 33 m/s
Final speed (v) = 0 m/s

$\text{Deceleration} = \frac{v - u}{t} = \frac{0 - 33}{15} = -2.2 \text{ m/s}^2.$

The deceleration is 2.2m/s²

Q38. Two students, Anna and Graham took part in a sponsored run. The distance-time graph for Graham's run is shown. Four points have been labelled A, B, C and D.



a. Between which pair of points was Graham running the slowest?

b. Anna did not start the run until 500 seconds after Graham. She completed the whole run at a constant speed of 4 m/s.

i. Calculate how long, in seconds, it took Anna to complete the journey.

ii. Copy the graph and draw a line to show Anna's run.

iii. How far had Graham run when he was overtaken by Anna?

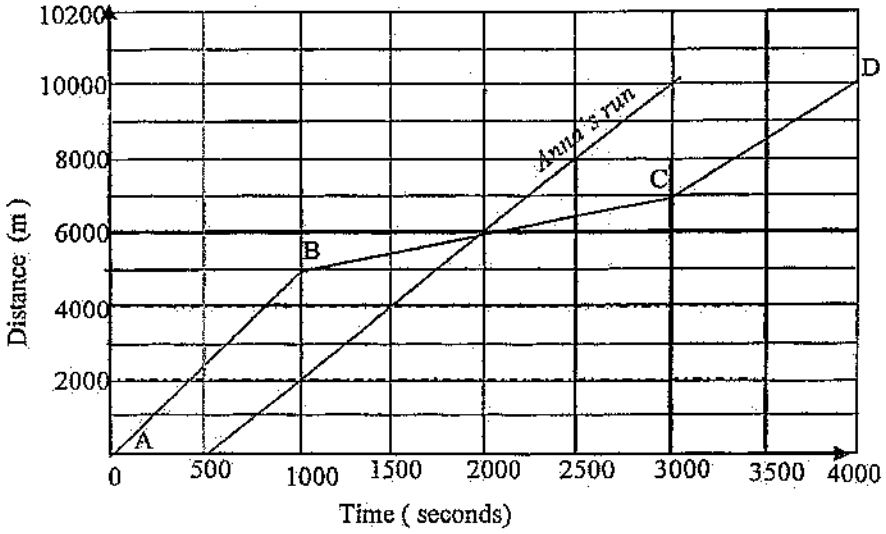
Answers

a. Points BC.

b. i. Speed = 4m/s, Distance to covered = 10000 m.

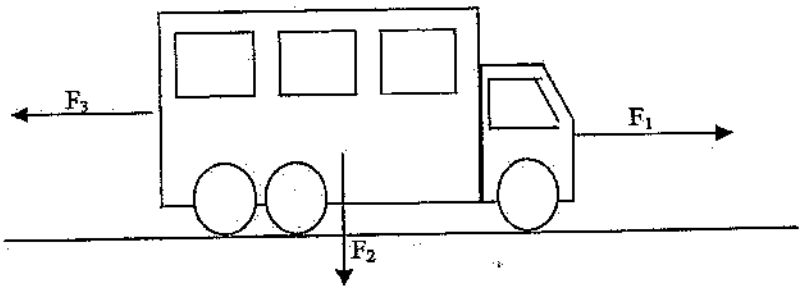
$$\text{Time taken} = \frac{\text{distance}}{\text{speed}} = \frac{10000\ m}{4\ m/s} = 2500\ s.$$

ii.



iii. Graham had run 6000 m.

Q39. The following diagram shows three forces acting on a van in motion.



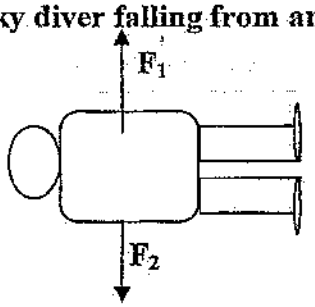
a. Name the three forces shown.
b. When is F_3 equal to zero.
c If the van is moving with constant velocity, what can be said about F_3 andF_1?
d. How does the size of F_3 compare with F_1 if the van is:
i. Decelerating?
ii. Accelerating?

Answers
a. F_1 is pulling force from the engine.
F_2 is weight.
F_3 is frictional force.
b. F_3 is equal to zero when the car stops moving.
c. F_1 and F_3 are equal.
d. i. F_3 is greater than F_1.
ii. F_1 is greater than F_3.

Q40. a. State the principle of conservation of momentum.
b. A toy truck of mass 2 kg travels at 8m/s towards a stationary toy truck of mass 6kg. After colliding, the two toy trucks link and move off together. What is their common velocity?
c. What is meant by the term *elastic collision*?

Answers
a. When two or more bodies act upon one another, their total momentum remains constant provided no external forces are acting OR When two or more bodies act upon one another, their total momentum before collision is equal to total momentum after collision provided no external forces are acting.
b. Let the common velocity after the collision be v.
Total momentum before collision = (2kg x 8 m/s) + (6 kg x 0 m/s)
= 16 kgm/s
Total momentum after collision = v (6 kg + 2 kg)
= 8v kg
Total momentum before collision = Total momentum after collision
16 kgm/s = 8v kg
Therefore, v = 2 m/s.
The common velocity is 2 m/s.
c. Elastic collision means the total momentum and kinetic energy are conserved after the collision.

Q41. The diagram below shows a sky diver falling from an aeroplane.

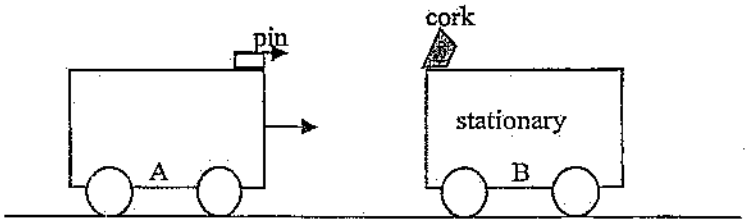


a. Name the forces F_1 and F_2
b. State how each force changes as the sky diver speeds up.
c. Why does the sky diver reach a steady speed?
d. Describe what happens when the sky diver opens the parachute.

Answers

a. F_1 is air resistance
F_2 is weight.
b. As the sky diver speeds up, F_2 remains the same but F_1 increases.
c. A steady speed is reached because at some point F_1 is equal to F_2 and the resultant force acting on the diver is zero.
d. Opening the parachute increases F_1. F_1 becomes greater than F_2, so the diver decelerates.

Q42. The diagram below shows two laboratory trolleys which collide and stick together.

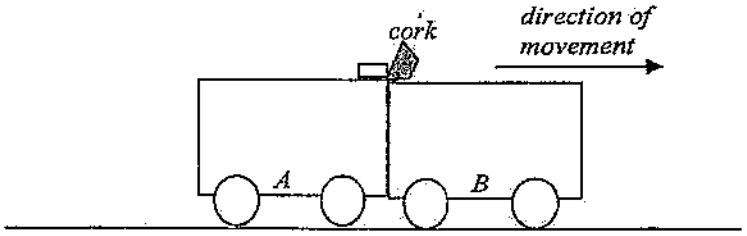


a. What is the momentum of trolley B before the collision. Explain your answer.
b. Draw the diagram of the two trolleys after collision and show the direction of their movement.

Answers

a. It has zero momentum because it is stationary.

b.



Q43. Friction is the type of force which opposes motion.

a. Mention two useful applications of frictional force.

b. Mention two dangers of frictional force.

Answers

a. Landing of sky divers using a parachute is an application of frictional force.
Car breaking system makes use of frictional force.

b. Frictional force slows down movement of an object in motion.
Frictional force can cause fires.

Q44. A sky-diver jumps out of a helicopter. He uses a parachute to land safely on the ground.

a. Describe his motion from the time he jumps out of the parachute to the time he lands on the ground.

b. Sketch a well labelled speed-time graph for the sky diver.

Answers

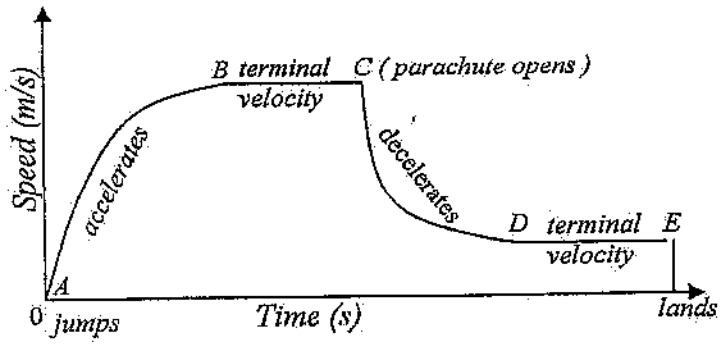
a. When the sky-diver jumps out of the helicopter, he falls towards the ground because of weight. The unbalanced force (weight) makes the sky diver accelerate as he moves towards the ground.

As the speed of the sky diver increases, the air resistance acting in the opposite direction to weight increases while weight remains constant. A point is reached when the air resistance is equal to weight. At this point, the resultant force acting on the sky diver is zero and he moves with uniform speed called terminal velocity.

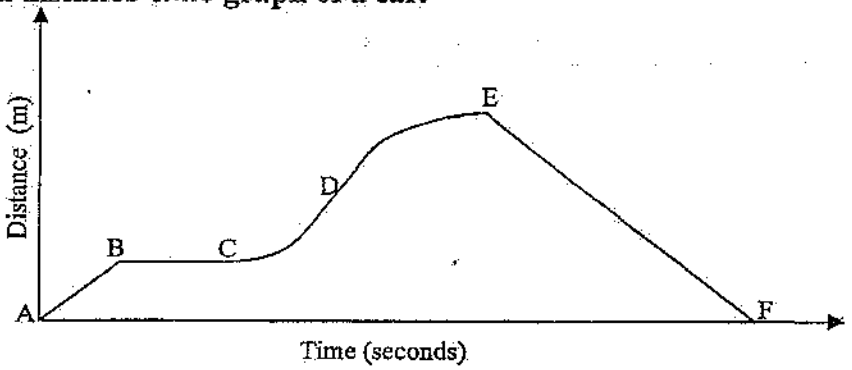
When the sky-diver reaches terminal velocity, he opens the parachute.

The parachute increases air resistance making it greater than weight. The sky-diver decelerates. As the sky diver decelerates, air resistance decreases while weight remains the same. A point is reached when the air resistance is equal to weight and the resultant force acting on the sky-diver is zero. The sky-diver moves with uniform speed with which he lands on the ground.

b. Speed-time graph of the sky-diver.



Q45. Below is a distance-time graph of a car.



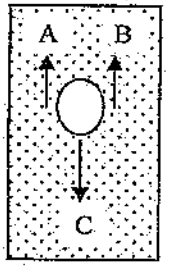
Describe what happens to the car between the following points:

a. AB b. BC. c. CD d. DE e. EF.

Answers

a. The car moves with constant speed.
b. The car is stationary.
c. The car moves with non-uniform increasing speed.
d. The car moves with non-uniform decreasing speed.
e. The car moves with uniform speed in the opposite direction.

Q46. a. The following diagram shows forces A, B and C acting on a ball which is falling through a liquid. Name the forces A, B and C.



b. With the aid of a well labelled diagram, describe an experiment that could be done to demonstrate that resistance of a media affects the speed of an object falling through the media. Your description should use: two identical ball bearings, water, oil and two transparent jars of the same size.

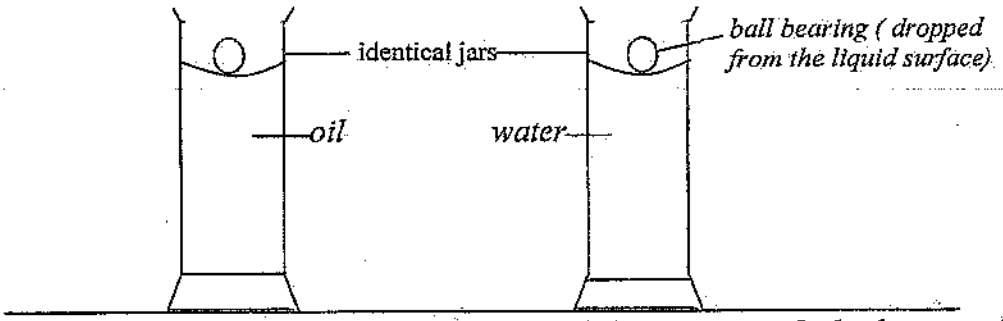
Answers

a. A is upthrust
B is frictional force.
C is weight.

b. ***Materials:*** *Two identical ball bearings, water, oil and two transparent jars.*

Procedure: *(i) Fill one jar with the oil and the other jar with an equal volume of water.*

(ii) At the same time, drop one ball bearing into the oil and another ball bearing into the water just from the surface of the liquids as shown in the following diagram.



(iii) *observe if the two ball bearings reach the bottom of the jar in which they are falling at the same time.*

Results: *The two ball bearings reach the bottom of the jar in which they are falling at different times.*

Conclusion: *The two ball bearings reached the bottom of the jars at different times because they were moving at different speeds. The two liquids have different viscosities. Viscosity affects the resistance of a liquid, so the resistance of the two liquids is different. Therefore, it can be concluded that the speed of the falling ball bearings is different because of the difference in resistance of the two liquids.*

CHAPTER 3.

OSCILLATIONS, WAVES AND LENSES.

69 QUESTIONS WITH ANSWERS

To the student.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

After reading the chapter, test your understanding by answering the 69 questions in this chapter. Cross check your answers with the answers provided.

The following list of books is not exhaustive.

1. Keith Wallis, Chanco Physical Science for Malawi, Book 2 (3rd edition), pages 135-163,
2. Samuel Kalea, MSCE Physical Science (New edition), pages 43-60.
3. Tom Duncane, GCSE Physics(4th edition), pages 2-16, 20-26, 30-31, 33-34, 40-48.
4. Mukabi Murigi etal, KCSE Golden Tips Physics, pages 87-95, 97-101, 102-107, 113-121.
5. Stephen Pople, Complete Physics, pages 124-133, 156-163.
6. Keith Johnson, Physics for You: Revised edition for GCSE, pages 174-190, 192-193, 202-214.

Q1. a. Explain the difference between transverse waves and longitudinal waves.
b. Give one example of each of the following types of waves:
(i) transverse waves. (ii) longitudinal waves.

Answers

a. In a transverse wave the particles of the medium are displaced in a direction perpendicular (at right angles) to the direction in which the wave travels while in a longitudinal wave the particles of the medium move in a direction parallel (in the same direction) to the direction in which the wave travels.

b. (i) Water wave is a transverse wave
(ii) Sound wave is a longitudinal wave.

Q2. What is an oscillation?

Answer
An oscillation is a repetitive forward and backward movement or upward and downward movement of an object or particle from its rest position.

Q3. Mention three characteristics of an oscillating system.

Answer
The three characteristics are: frequency, periodic time and amplitude.

Q4. Mention two characteristics of a wave.

Answer
The two characteristics are: frequency and velocity.

Q5. Briefly, describe the following wave properties:
a. Diffraction. b. Interference

Answers

a. Diffraction is the bending or spreading of waves as they emerge from an opening or as they pass through the edge of an obstacle.

b. Interference refers to the superposition of waves travelling along the same medium.

Q6. A straight vibrator produces water waves with a distance of 4cm between successive crests. The waves travel a distance of 30cm in 1.5 seconds. Calculate the: a. Velocity of the waves. b. Frequency of the vibrator.

Answers.

a. $velocity = \frac{distance\ travelled}{time} = \frac{30\ cm}{1.5\ s} = \mathbf{20\ cm/s}$

b. *wavelength* (λ) = 4 cm, *velocity* (v) = 20 cm/s, *frequency* (f) = ?.

$v = \lambda f$ Therefore, $f = \frac{v}{\lambda} = \frac{20\ cm/s}{4\ cm} = \mathbf{5\ Hz}$

The vibrator has a frequency of 5 Hz.

Q7. Find by calculation the nature and magnification of an image of an object that is placed 30cm from convex lens of focal length 10cm.

Answer

Object distance (u) = 30cm, focal length (f) = 10cm, image distance (v) = ?

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	$\frac{1}{v} = \frac{1}{10} - \frac{1}{30}$	$\frac{1}{v} = \frac{2}{30}$	*Therefore, v = 15cm.*
$\frac{1}{30} + \frac{1}{v} = \frac{1}{10}$	$\frac{1}{v} = \frac{3 - 1}{30}$	$v = \frac{30}{2}$	

$$\text{Magnification} = \frac{\text{image distance}}{\text{object distance}}$$

$$= \frac{15\ cm}{30\ cm}$$

$$= \mathbf{0.5}$$

Therefore, the image is real, inverted and diminished.

Q8. A cantilever makes 20 vibrations in 8 seconds. Calculate
a. the frequency. b. the period.

Answers

a. $\text{frequency} = \frac{\text{number of vibrations}}{\text{total time}} = \frac{20}{8} = \mathbf{2.5\ Hz}$

b. $\text{Periodic time (T)} = \frac{1}{f} = \frac{1}{2.5Hz} = \mathbf{0.4s}$

Q9. If you pull the mass of a pendulum to one end and let it vibrate freely, it soon comes to rest. Give two reasons why this is the case.

Answers

The two reasons are: i. *friction with the air*
ii. *friction with points of contact.*

Q10. Explain the energy changes which take place in a vibrating cantilever.

Answer

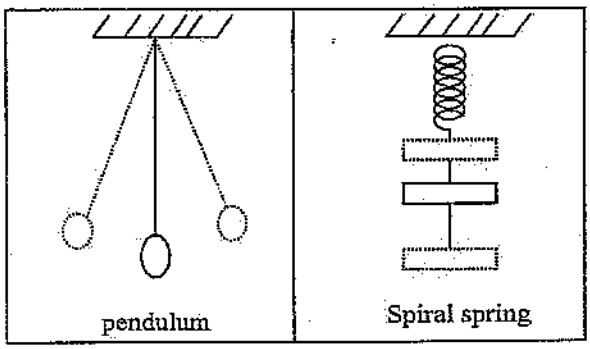
Potential energy changes to kinetic energy and vice versa.

Q11. Explain the difference between an ideal oscillation and a real oscillation.

Answer

In an ideal oscillation, the total potential and kinetic energy remains constant. In other words, there is no loss of energy from the system to the surrounding. In a real oscillation, there is energy loss to the surrounding resulting into damped oscillation.

Q12. The diagram below shows a vibrating pendulum and vibrating spiral spring.



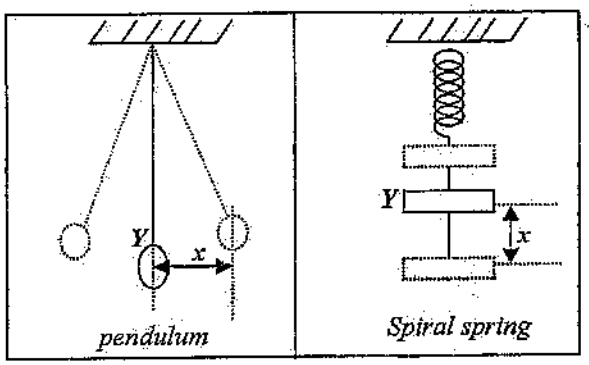
a. In each of the diagrams, indicate the following:
(i) amplitude
(ii) equilibrium position

b. Sketch the graph of the oscillating systems showing the following on your graph (assume an ideal situation).
(i) periodic time
(ii) amplitude
(iii) one complete cycle

c. Give an example of another oscillating system which can produce a similar graph to the one you have sketched in part b above.

Answers

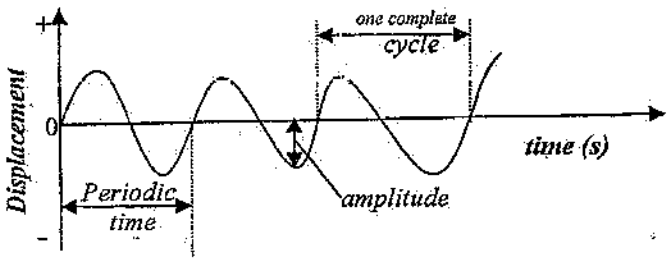
a.



Distance x represents the amplitude

Y is the equilibrium position.

b. Graph of the oscillating systems



c. A vibrating cantilever

Q13. Explain why it is possible to hear round corners.

Answer: This is because waves diffract as they pass through the edge of obstacles.

Q14. a. Define the following characteristics of an oscillation.

i. Amplitude. ii. Period. iii. Frequency

b. Mention two factors which affect the frequency of a vibrating cantilever.

Answers

a. i. Amplitude is the maximum displacement of a vibrating material from the rest position.

ii. Period is the time taken for a vibrating system to complete one cycle.

iii. Frequency is the number of cycles completed in a unit time.

b. The two factors are: length of the vibrating cantilever

Mass attached at the end of the cantilever

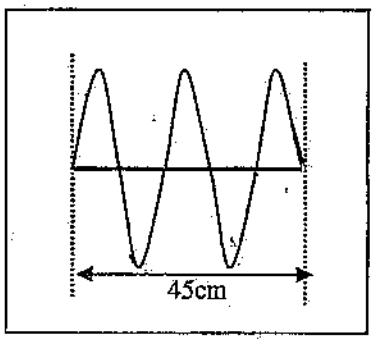
Q15. An earthquake caused houses to vibrate 7 times in 2 seconds. What was the period of the wave?

Answer.

$$Frequency = \frac{7 \text{ vibrations}}{2 \text{ seconds}} = 3.5 \text{ Hz}$$

$$Period = \frac{1}{frequency} = \frac{1}{3.5 \text{ Hz}} = 0.29 \text{ seconds.}$$

Q16. The diagram below shows waves on a rope.



a. Calculate the wavelength.

b. If the rope is swung 18 times in 3 seconds, calculate the average speed of the wave.

Answers.

a. Number of cycles = 2.5 cycles

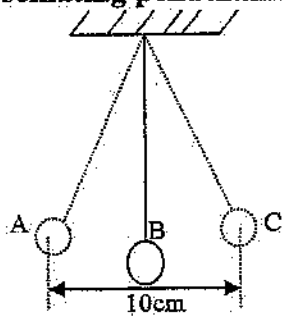
$$Wavelength = \frac{45 \text{ cm}}{2.5} = 18 \text{ cm}$$

b. $$frequency = \frac{18 \text{ vibrations}}{3 \text{ seconds}} = 6\text{Hz}$$

$$Velocity = wavelength \times frequency$$
$$= 18 \text{ cm} \times 6\text{Hz}$$
$$= 108 \text{ cm/s}$$

The waves have a speed of 108 m/s

Q17. The figure below shows an oscillating pendulum.



pendulum

a. Calculate the amplitude of the vibration.
b. At which point does the oscillating mass have the highest kinetic energy?
c. Describe how the kinetic energy and potential energy change as the mass moves from point A to C.

Answers.

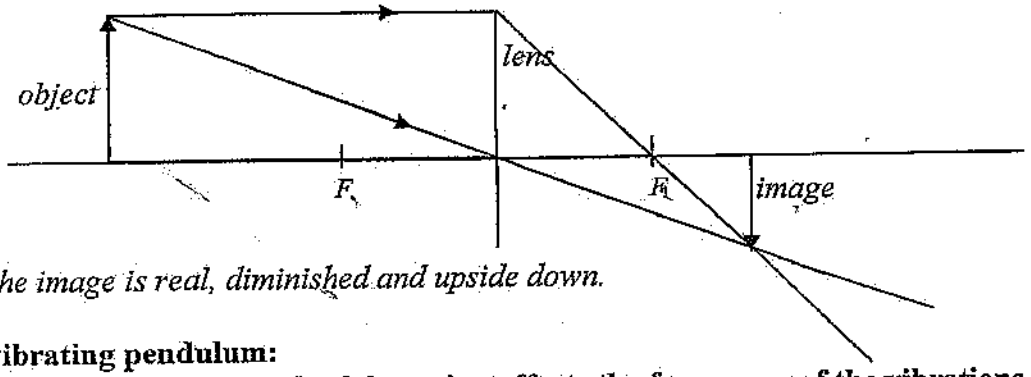
a. *Amplitude* $= \frac{10\ cm}{2} = 5\ cm.$ *b. Point B.*

c. At point A, the mass has highest potential energy and zero kinetic energy. As the mass moves from point A, potential energy decreases while kinetic energy increases until it reaches point B where kinetic energy is highest and potential energy in zero. As the mass moves from point B towards point C, kinetic energy decreases while potential energy increases till it reaches point C where potential energy is highest and kinetic energy is zero.

Q18. a. An object 4cm high is placed 10cm from the centre of a convex lens of focal length 4cm. Draw a ray diagram to show the position of the image formed Use a scale of 1cm on paper to represent 2cm.
b. Describe the nature of the image formed.

Answers.

a.



b. The image is real, diminished and upside down.

Q19. For a vibrating pendulum:
a. Explain how the length of the string affects the frequency of the vibrations.
a. Explain how the length of the string affects the period of vibrating string.

Answers.
a. Frequency decreases with increasing length of the string.
b. Period increases with increasing length of the string.

Q20. An object 2cm high is placed 7.5cm in front of a converging lens of focal length 5cm.

a. Calculate the image distance.

b. Calculate the magnification of the image.

c. Describe the nature of the image formed.

Answers.

a. Object distance (u) = 7.5 cm, focal length (f) = 5 cm, image distance (v) = ?

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ | $\frac{1}{v} = \frac{1}{5} - \frac{1}{7.5}$ | $\frac{1}{v} = \frac{1}{15}$ | ***Therefore, v = 15 cm.***

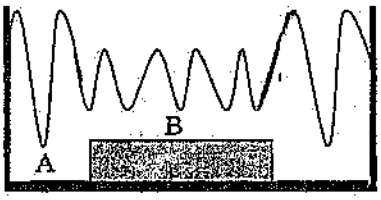
$\frac{1}{7.5} + \frac{1}{v} = \frac{1}{5}$ | $\frac{1}{v} = \frac{3 - 2}{15}$ | $v = \frac{15}{1}$

b. $Magnification = \frac{image\ distance}{object\ distance}$

$= \frac{15\ cm}{7.5cm} = 2$

c. Therefore, the image is real, inverted and magnified.

Q21. The following figure shows a cross section of a ripple tank. A block of metal in the centre makes the water shallower.



a. What wave property is being demonstrated in the diagram.

b. In region A, the frequency is 15Hz and the wavelength is 1.5cm. What is the velocity of the waves?

c. In region B, the velocity is 12cm/s. what is the new wavelength?

d. What assumptions have you made about the frequency in regions A and B?

Answers.

a. Refraction.

b. $Velocity = wavelength \times frequency = 15\ Hz \times 1.5\ cm = 22.5\ cm/s$

c. $Wavelength = \frac{velocity}{frequency} = \frac{12\ cm/s}{15\ Hz} = 0.8\ cm.$

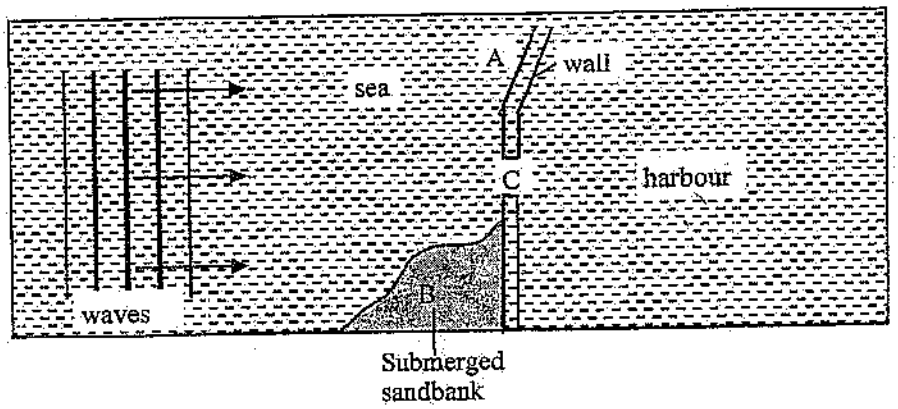
d. The frequency in regions A and B remains the same.

Q22. What is the difference between constructive interference and destructive interference?

Answer

Constructive interference occurs if waves which are in phase superpose and reinforce each other making larger amplitude while destructive interference occurs if waves which are out of phase superpose and cancel each other making zero amplitude.

Q23. The following diagram shows water waves moving towards a harbour.



a. Name the type of waves
b. What will happen to the waves striking the harbour wall at A?
c. What will happen to the waves slowed by the submerged sand bank at B?
d. What will happen to the waves passing through the harbour entrance at C?
e. If the harbour entrance were wider, what difference would this make?

Answers.
a. Transverse waves.
b. The waves will be reflected by the wall.
c. The waves will be refracted.
d. The waves will be diffracted.
e. There will be less diffraction of waves.

Q24. a. A convex lens of focal length 6cm has an object placed at 12cm from the lens. The object is 5 cm tall. Using lens formula, calculate image distance, magnification and image height.
b. Describe the nature of the image formed.

Answers.
a. Object distance (u) = 12 cm, focal length (f) = 6 cm, image distance (v) = ?

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ | $\frac{1}{v} = \frac{1}{6} - \frac{1}{12}$ | $\frac{1}{v} = \frac{1}{12}$ | ***Therefore, v = 12 cm.***

$\frac{1}{12} + \frac{1}{v} = \frac{1}{6}$ | $\frac{1}{v} = \frac{2-1}{12}$ | $v = \frac{12}{1}$

$$\text{Magnification} = \frac{\text{image distance}}{\text{object distance}}$$

$$= \frac{12\ cm}{12\ cm} = 1$$

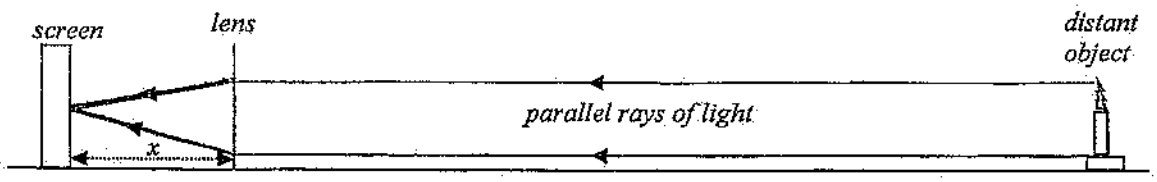
Since the magnification is 1, object height is equal to image height. The image is 5 cm tall.

b. The image is real, inverted and same size as the object.

Q25. With the aid of a diagram, briefly describe how you can find an approximate value for the focal length of a convex lens.

Answer
Approximate value of the focal length of a lens can be found by focussing a distant object on to a screen using the lens. Light rays from a distant object travel almost parallel to each other. Parallel light rays always converge on the focal point of a convex lens.

The following diagram shows the experimental set up.



The distance between the lens and the image formed gives an approximate value of the focal length of the lens. This distance is shown as x in the diagram.

Q26. a. If a convex lens picks up rays from a very distant object, where is the image formed?
b. If the object is moved towards the lens, what happens to the position and size of the image?

Answers.
a. It is formed on the focal plane.
b. The image gets bigger and moves away from the lens.

Q27. Where should the object be placed if the image formed by a convex lens is to be:
a. virtual and larger than the object?
b. real and the same size as the object?
c. real and larger than the object?

Answers.
a. Object should be placed at a distance less than focal length of the lens.
b. Object should be placed at a distance which is exactly twice the focal length of the lens.
c. Object should be placed at any distance greater than the focal length and less than twice the focal length.

Q28. What happens to the wavelength of a wave when it moves from a deeper area to a shallow area of a ripple tank.

Answer: The wavelength decreases.

Q29. A short-sighted person can not see distant objects clearly. Explain.

Answer.
For a short-sighted person, the image of a distant image is formed in front of the retina because the eyeball is too long or because the eye lens is too thick.

Q30. The following diagram shows two lenses A and B.

a. Which of the lenses is a convex lens?
b. What is meant by the principal focus of a convex lens?
c. What is meant by the focal length of a convex lens?

Answers.
a. Lens marked A.
b. Principal focus is a point where parallel rays converge after passing through the lens.
c. Focal length is the distance between the optical centre of the lens and the principal focus.

Q31. If an object moves closer to the eye, the lens has to adjust to refocus image.
a. What is this process called?
b. How does the lens make focusing adjustments?

Answers.
a. Accommodation of the eye.
b. Lenses achieve focusing adjustments with the help of ciliary muscles which change shape thereby making the lens thick or thin. Nearby objects require a strong lens to focus images onto the retina so the lens become thick. Distant objects require a relatively weak lens to focus images onto the retina so the lens become thin.

Q32. Which part of the eye
a. Is the screen on which images are formed?
b. Converges light rays entering the eye?
c. controls the amount of light entering the eye?

Answers: a. Retina. b. Cornea, aqueous/vitreous humour and lens.
c. Iris.

Q33. Why must the film or transparency be put into the projector upside down?

Answer.
This is because the image formed is inverted so if the film is upside down, the image is upright.

Q34. If an object moves closer to a camera, which way must the lens be moved to keep the image in focus?

Answer: The lens should be moved away from the film (outwards).

Q35. In a projector, what job is done by:

a. The condenser lens? **b. The projection lens?**

Answers

a. The condenser lens concentrates light rays onto the object (film) so that it is well illuminated.

b. Projection lens refracts light rays from the object (film) onto the screen to produce an image.

Q36. Mention two ways in which the amount of light entering the camera can be controlled.

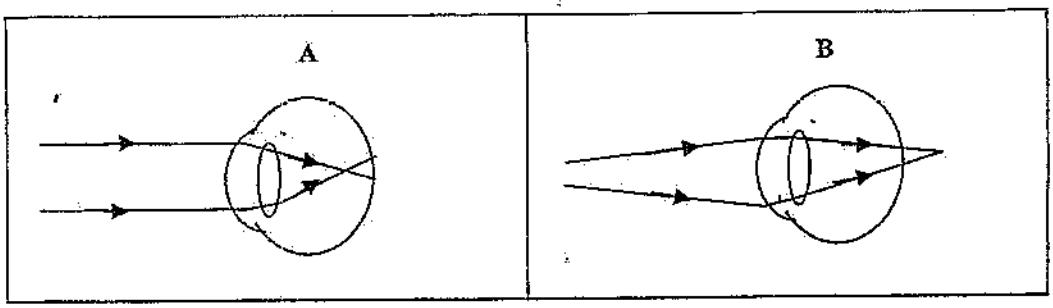
Answers:

a. Adjusting the size of the aperture. b. Adjusting the exposure time.

Q37. Suppose the original lens of a camera is removed and replaced by another one with shorter focal length. How is the size of the image formed affected?

Answer: The image formed is smaller.

Q38. The following diagrams show eye defects.



a. Identify the eye defects A and B.

b. How can each of the eye defects be corrected?

c. Mention any two possible causes of each eye defect.

Answers.

a. A is short-sightedness (myopia) and B is long-sightedness (hypermetropia)

b. A can be corrected by using diverging lens while B can be corrected by using converging (convex) lens.

c. A can be caused by: (i). Eyeball too long
(ii). Lens too strong for distant objects.

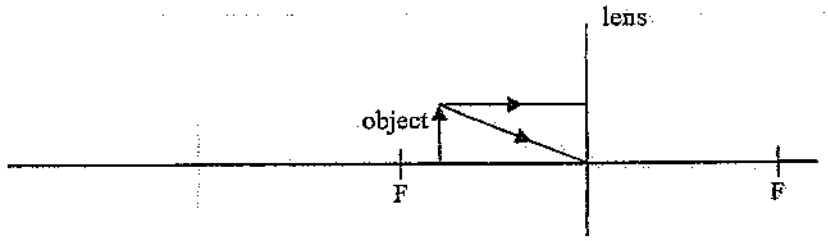
B can be caused by: (i). Eyeball too short
(ii). Lens too weak for nearby objects.

Q39. What is the difference between a real and a virtual image?

Answer

Real images can be focussed onto a screen while virtual images can not be focused onto a screen.

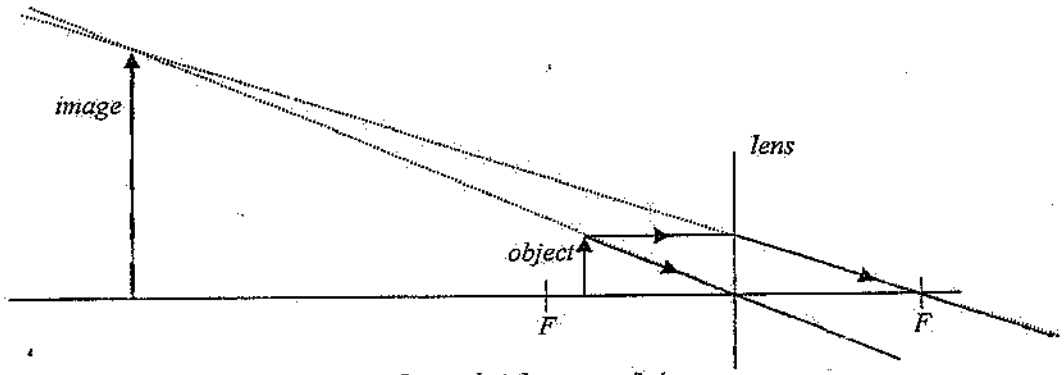
Q40. An object is placed closer to a convex lens than its principal focus. The diagram below shows an incomplete ray diagram for the formation of its image.



a. Copy and complete the ray diagram and show the position of the image.
b. Calculate the linear magnification produced by the lens.
c. Use your ray diagram to describe three properties of the image formed.

Answers.

a.



b. $\textit{Linear magnification} = \frac{\textit{Image height}}{\textit{Object height}} = \frac{3.4\ cm}{0.8\ cm} = 4.25$

c. The image formed is virtual, upright and magnified.

Q41. Copy and complete the diagram below about the images formed by some optical devices.

Optical device	Nature of image	Size of image	Position of image
eye	real		
projector		magnified	
magnifying glass			further from lens than the object

Answers.

Optical device	*Nature of image*	*Size of image*	*Position of image*
eye	*real*	***diminished***	***Retina (closer to the lens than the object)***
projector	***real***	*magnified*	***Screen (further from lens than the object)***
magnifying glass	***virtual***	***magnified***	*further from lens than the object*

Q42. Water waves are made by a dipper moving up and down 5 times every second. If the velocity of the wave is 10 m/s, determine the wavelength of the waves.

Answer.
Frequency = 5 Hz, velocity = 10 m/s

$$Wavelength = \frac{velocity}{frequency} = \frac{10\ m/s}{5\ Hz} = 2\ m.$$

The waves have a wavelength of 2m.

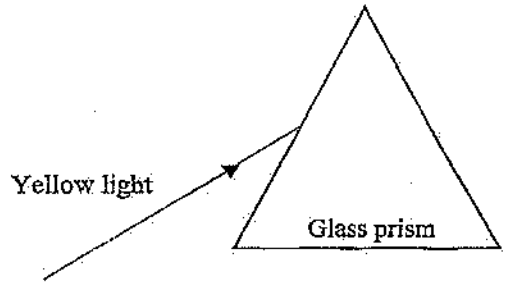
Q43. A source generates 40 waves in a second. If the wavelength is 8.5 m, calculate the time the wave takes to reach a wall 102 m from the source.

Answer.
Distance = 102 m, frequency = 40 Hz, wavelength = 8.5 m.

$$Velocity = frequency \times wavelength$$
$$= 40\ Hz \times 8.5\ m$$
$$= 340\ m/s$$

$$Time = \frac{distance\ travelled}{velocity} = \frac{102\ m}{340\ m/s} = 0.3\ seconds.$$

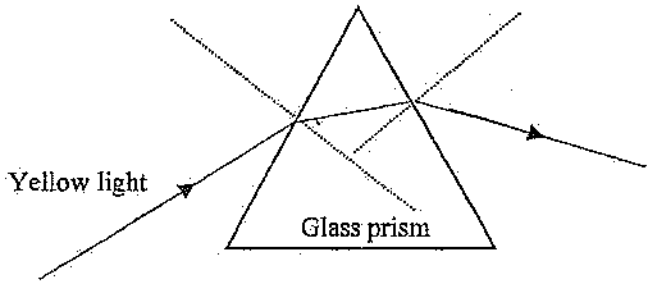
Q44. The diagram below shows yellow light passing through a glass prism.



a. Draw the path taken by the ray of yellow light as it passes through the glass prism.
b. What property of light is shown in the diagram?
c. Explain why light changes direction as it enters the glass prism?

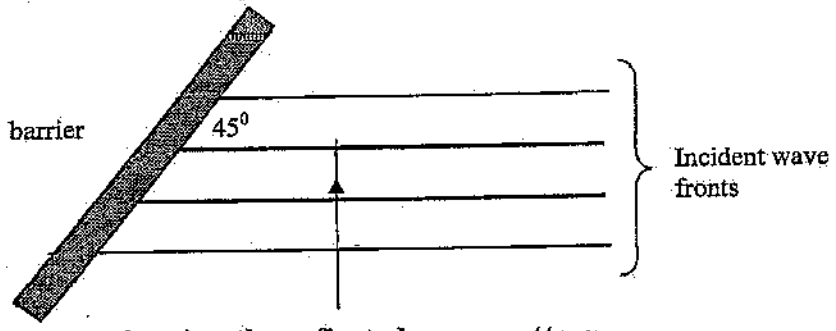
Answers.

a.



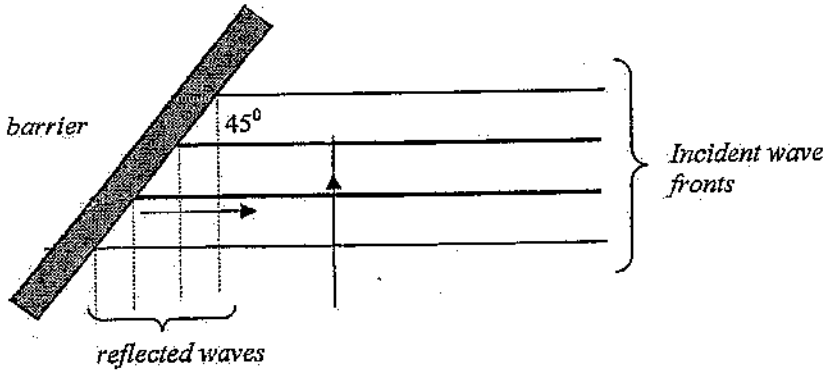
b. Refraction.
c. This is because its velocity changes as it changes medium through which it travels.

Q45. The following figure shows water waves incident on a barrier in a ripple tank. The barrier is inclined at an angle of 45^0 to the incident wave fronts.



Complete the diagram showing the reflected wave pattern.

Answer.



Q46. A vibrating string makes 30 complete oscillations in 2 seconds. Calculate the period of the sound wave produced.

Answer

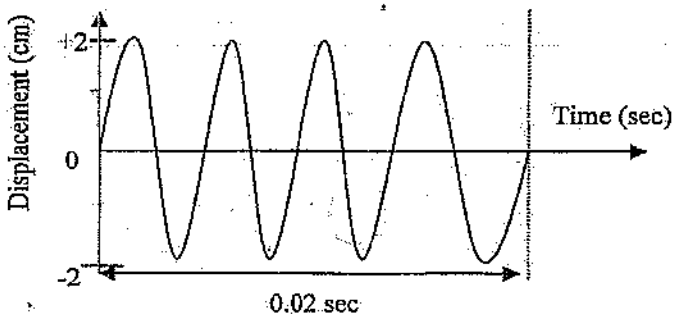
Number of complete oscillations = 30, time = 2 seconds.

$$Frequency = \frac{Number\ of\ oscillations}{time} = \frac{30}{2\ sec} = 15\ Hz$$

$$Period = \frac{1}{frequency} = \frac{1}{15\ Hz} = 0.07\ seconds.$$

The sound wave produced has a period of 0.07 seconds.

Q47 The figure below shows a wave form.

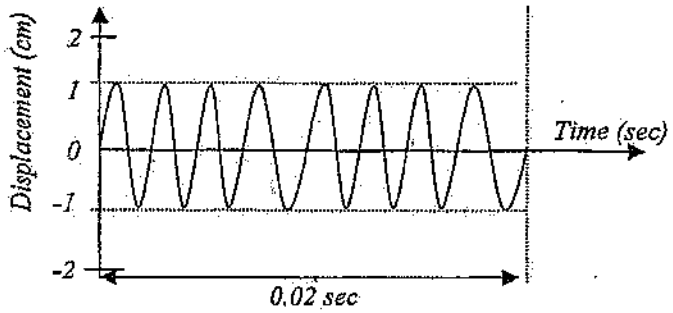


a. How many complete cycles are shown?
b. What is the frequency of the wave form shown?
c. Draw a diagram to show a wave of twice the frequency and half the amplitude of the one shown in the diagram.

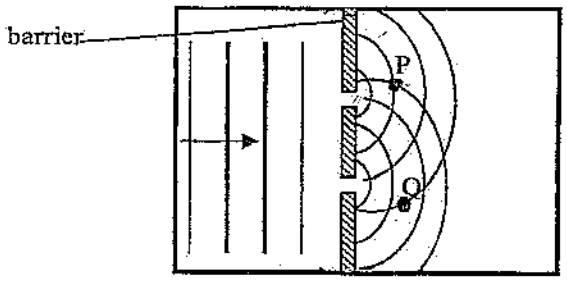
Answers.
a. 4 complete cycles.
b. Number of cycles = 4, time = 0.02 seconds.

$$Frequency = \frac{Number\ of\ cycles}{time} = \frac{4}{0.02\ sec} = 200\ Hz$$

c.



Q48. In the following figure, water waves are made to move towards a barrier with two slits.



a. State what happens at point P and point Q. Explain your answer
b. What property of waves is being demonstrated?

Answers.
a. At point P, there is constructive interference because a crest is superposed on another crest.
At point Q,, there is destructive interference because a trough is superposed on a crest.
b. Interference of waves

Q49. Mention two factors which affect the frequency of the following;

a. Vibrating mass at the end of a spring.

b. vibrating pendulum.

Answers.

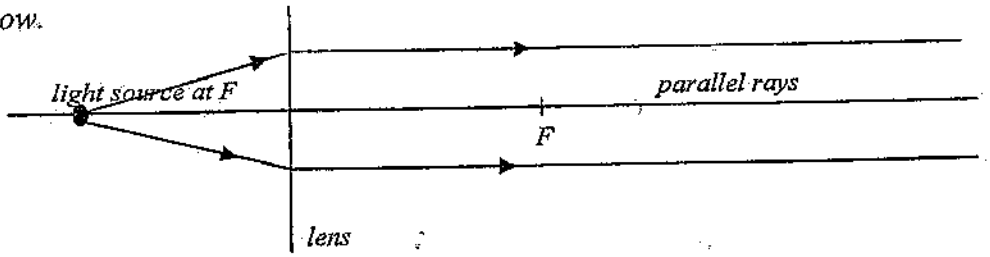
a. (i) Size of the mass (ii) force constant of the spring.

b. (i) length of the string (ii) type of material used to hold the mass.

Q50. With the aid of a diagram, show how a convex lens can be used to provide a parallel beam of light from a small source of light.

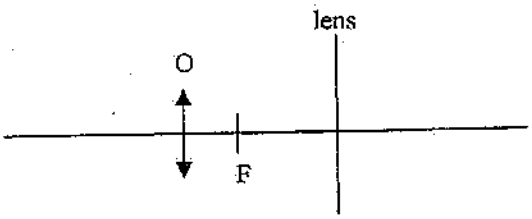
Answer.

Place the small source of light at the focal point of the convex lens as shown in the diagram below.



The refracted light rays are parallel to each other.

Q51. The diagram in the following figure shows an object O placed in front of a converging lens.

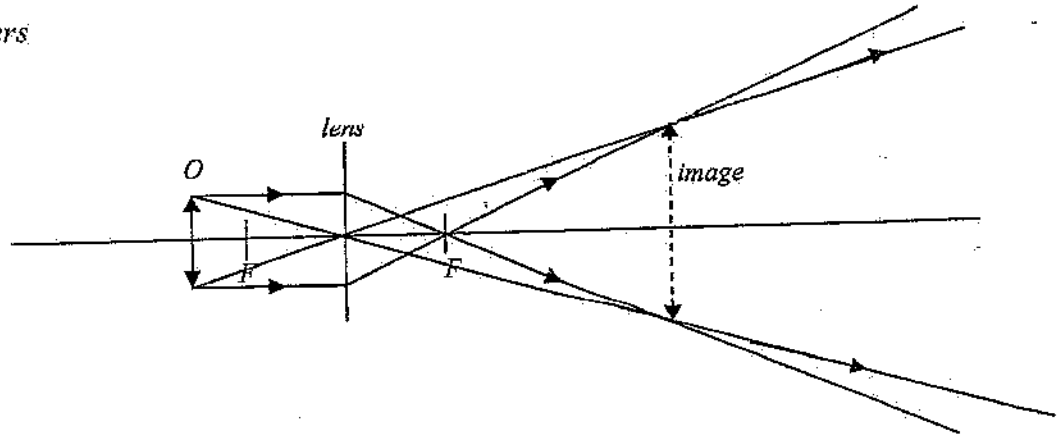


a. Draw rays on the diagram to show formation of the image.

b. Describe the nature of the image formed.

Answers

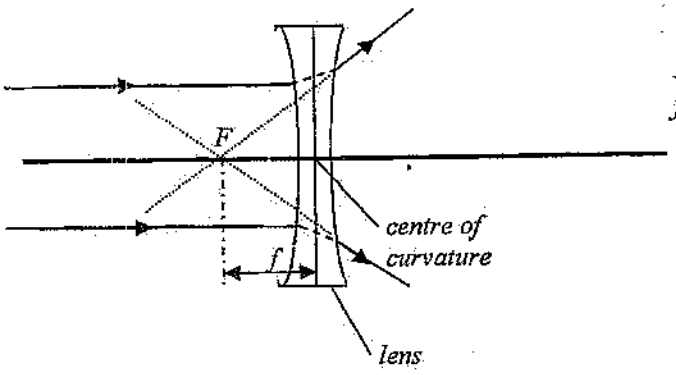
a.



b. The image is real, upside down and magnified.

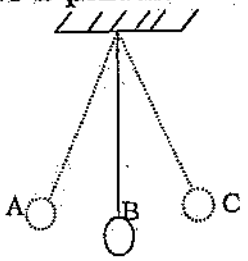
Q52. Show on a diagram the centre of curvature, principal focus, and the focal length of a concave mirror.

Answer.

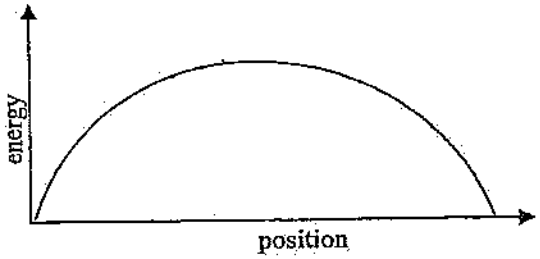


F is the principal focus
f is the focal length.

Q53. The following diagram shows a pendulum swinging freely between positions A and C.



A graph of energy against position is shown in the figure below.

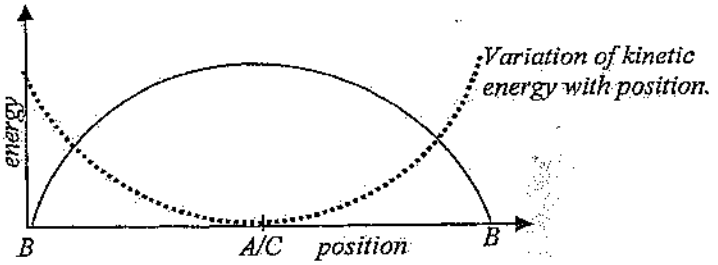


a. Indicate on the x-axis the positions A, B and C given that the curve represents the variation of potential energy with position.

b. Using the same axes, show how the kinetic energy changes with position.

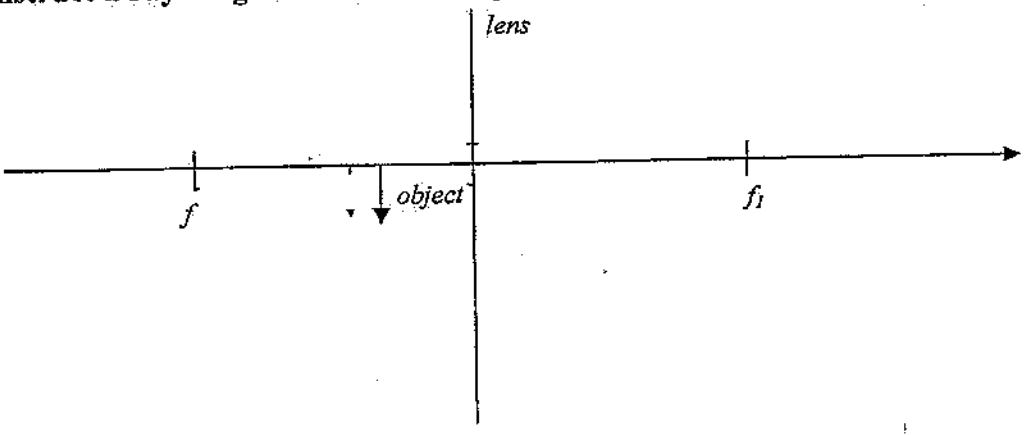
Answers.

a.

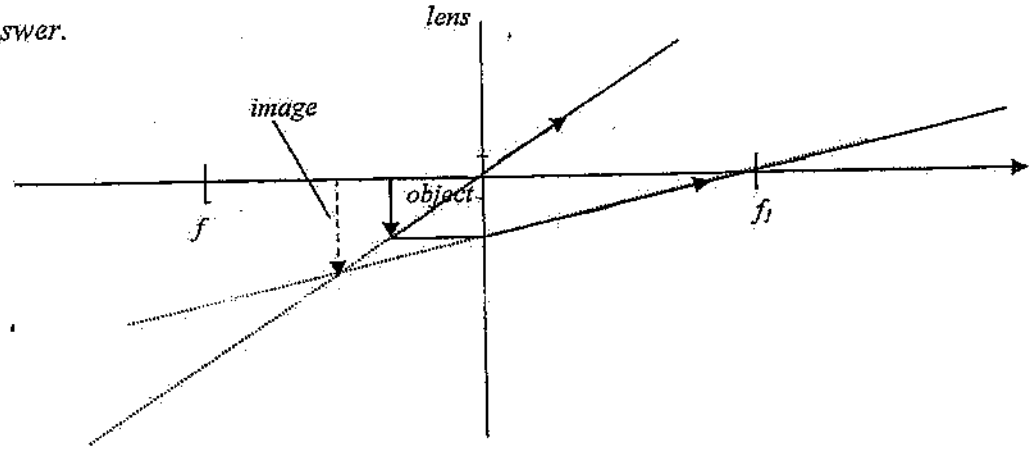


b. see graph in part (a) above.

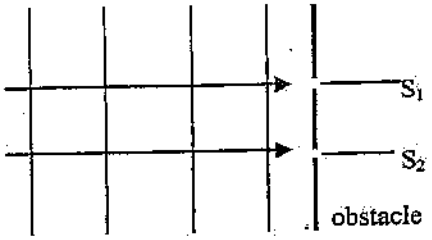
Q54. Below is an object placed in front of a concave lens of principal foci f and f_1. Construct a ray diagram to locate the position of the image.



Answer.



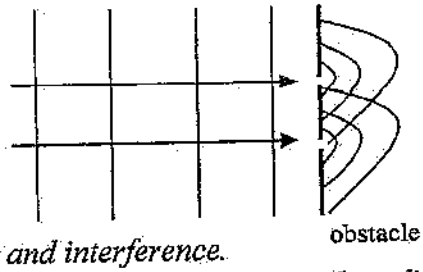
Q55. The following diagram shows water waves approaching two slits S_1 and S_2 on an obstacle.



a. Complete the diagram to show waves emerging on the other side of the obstacle.
b. State two properties that are demonstrated in the completed diagram.
c. What would happen to the waves emerging on the other side of the obstacle if the width of S_1 and S_2 were increased.

Answers.

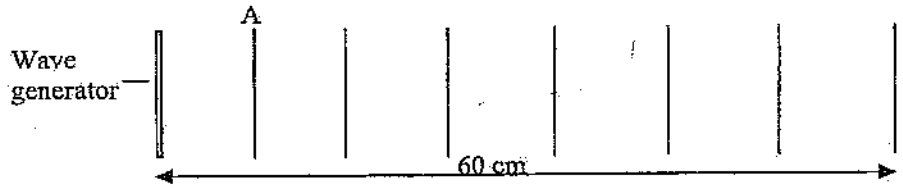
a.



b. Diffraction and interference.

c. The emerging waves will experience less diffraction.

Q56. The following diagram shows crests of straight ripples on water surface produced in a ripple tank by a wave generator.



a. What type of waves are represented by the crests?
b. What is the wavelength of the ripples if there are 5 complete waves in a distance of 60 cm?
c. What is the frequency of the ripples if four crests pass through point A in one second?
d. Calculate the speed of the waves.
e. What would happen to the wavelength if the waves moved from deep water to shallow water? Explain your answer.
f. Describe constructive interference in water waves.
g. What type of waves are radio waves?

Answers.

a. Transverse waves

b. $Wavelength = \frac{Distance}{Number\ of\ complete\ waves} = \frac{60\ cm}{5\ waves} = 12\ cm.$

c. $Frequency = \frac{number\ of\ cycles}{time} = \frac{4\ cycles}{1s} = 4\ Hz.$

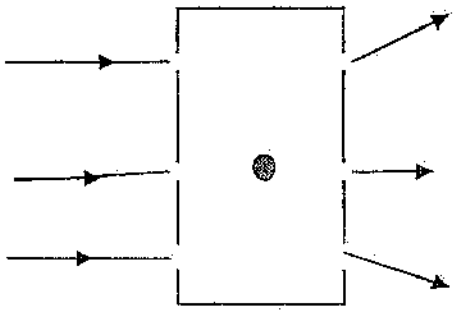
d. $Speed = wavelength \times frequency.$
$= 0.12\ m \times 4\ Hz$
$= 0.48\ m/s$

e. The wavelength decreases because the wave speed decreases as waves move to shallow waters.

f. Constructive interference occurs when two troughs or crests which are in phase meet producing a bigger wave.

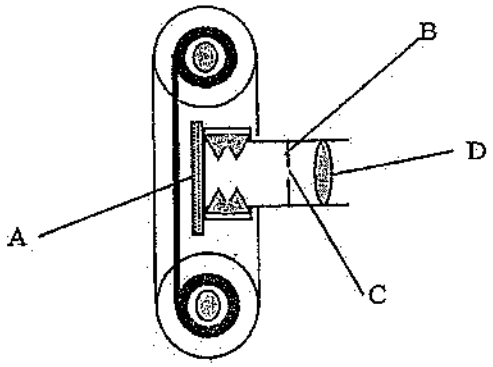
g. They are transverse waves.

Q57. The figure below shows a set of parallel light rays incident on a lens. The lens is placed inside a black box with narrow openings. Name the type of lens in the box. Explain your answer.



Answer: Concave lens because the rays coming out of the box are diverging.

Q58. The diagram below shows an outline of a camera.



a. **Name the parts labelled A, B, C and D.**
b. **What is the function of each of these parts?**
c. **The camera has a lens of focal length 150mm and produces a sharp image of an object which 2.0m away from the lens. Calculate the distance between the lens and the film.**
d. **If the object was moved further away from the camera so that it is a distant object, by how much should the lens be moved to get a sharp image on the film? Explain.**
e. **Explain two differences and two similarities between the camera and the eye.**

Answers.

a. A is shutter B is diaphragm C is aperture D is lens.

b. A blocks light and allows it to enter only during exposure time.
B controls the size of the aperture
C is a hole through which light enters the camera.
D refracts light rays from an object and focuses them onto the film to produce an image.

c. Distance between lens and film is equal to image distance, v.
Object distance (u) = 2 m (200 cm), focal length (f) = 150 mm (15 cm).

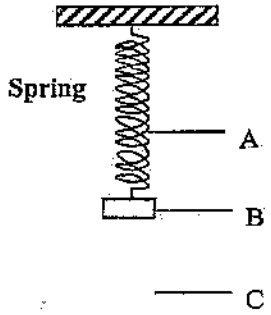
$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ | $\frac{1}{v} = \frac{1}{15} - \frac{1}{200}$ | $\frac{1}{v} = \frac{185}{3000}$ | $v = 16.22$ cm.

$\frac{1}{200} + \frac{1}{v} = \frac{1}{15}$ | $\frac{1}{v} = \frac{200 - 15}{3000}$ | $v = \frac{3000}{185}$ | ***Therefore, v = 162 mm***

d. For a distant object, image distance is equal to focal length of the lens therefore the lens has to be moved towards the film by 12 mm.

e. ***Similarities***
Both the eye and the camera use convex lens to focus images.
Both the eye and the camera form images which are real, diminished and upside down.
Differences
The focal length of lens in camera is fixed while the focal length of lens in the eye varies.
The eye is always open allowing light onto the retina while the camera opens only during exposure time.

Q59. The following diagram shows a mass moving up and down on the end of a spring between points A and C.



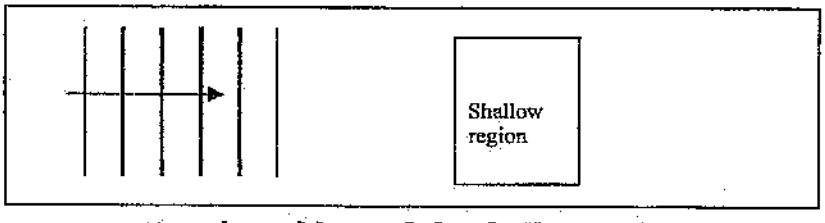
a. Complete each of the following statements using one word selected from the following list (maximum, minimum, zero and same).

When the mass is at position A:
Acceleration of the mass is.....
Weight of the mass is .....
Strain in the spring is.....
When the mass is at point B
Speed of the mass is.....
Kinetic energy of the mass is.....

b. Measure in cm the amplitude of vibration of the mass.
c. Measure the distance in cm which represents one complete oscillation of the mass.
d. What effect, if any, would there be on the up and down movement of the mass if the distance A to C were reduced.
e. As the mass moves up and down, the distance A to C gradually decreases. Explain.

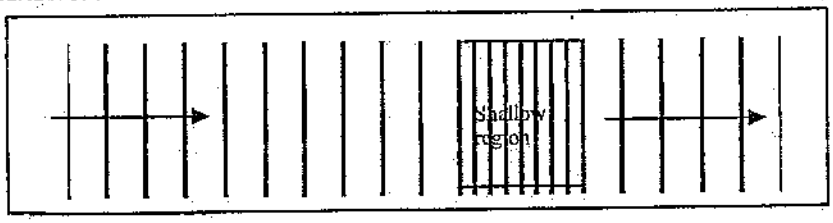
Answers.
a. When the mass is at position A:
Acceleration of the mass is zero
Weight of the mass is the same
Strain in the spring is ***minimum***
When the mass is at point B
Speed of the mass is ***maximum***
Kinetic energy of the mass is ***maximum***
b. Amplitude is 1.1 cm.0
c. One complete oscillation is 4.4 cm
d. No effect
e. The distance decreases because of friction between the air and the mass.

Q60. The following diagram shows water waves in a pond incident on a shallow region represented with dotted lines.



Sketch the wave pattern in and beyond the shallow region.

Answer.



Q61. In an experiment to determine the focal length of a convex lens the following results were obtained.

u (cm)	30.0	35.0	40.0	45.0	50.0
v (cm)	44.0	37.0	32.0	31.0	28.0
$M = \frac{v}{u}$					

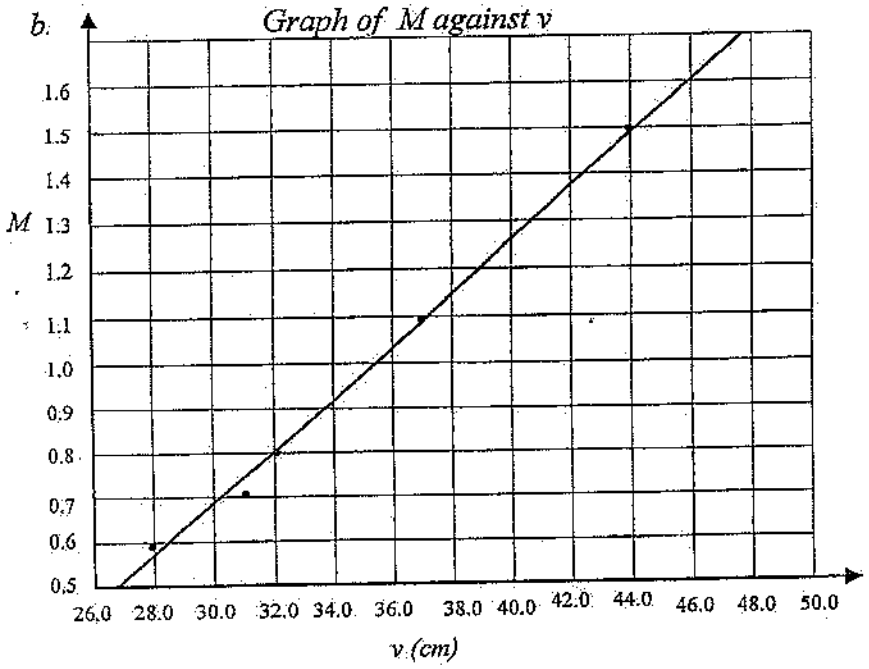
a. Complete the table shown.
b. Plot a graph of M against v.
c. Determine the slope of the graph.
d. If the equation of the graph is given by $M = \frac{v}{f} - 1$, use your graph to determine the value of the focal length of the lens.

Answers

a.

u (cm)	30.0	35.0	40.0	45.0	50.0
v (cm)	44.0	37.0	32.0	31.0	28.0
$M = \frac{V}{u}$	1.5	1.1	0.8	0.7	0.6

b.



c. Slope $= \frac{0.8}{14.0}$

$= 0.06/cm$

d. From the graph,
If M=0.8, v=32cm

$M = \frac{V}{f} - 1$

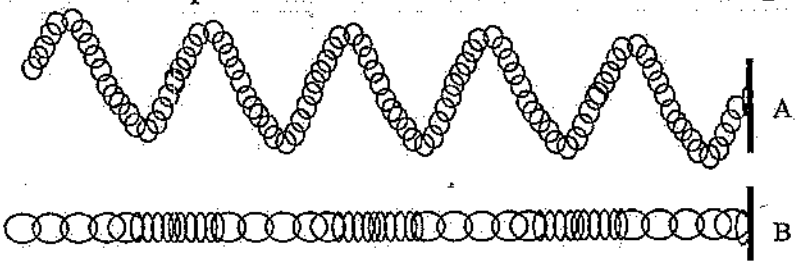
$0.8 = \frac{32cm}{1.8} - 1$

$1.8 = \frac{32cm}{1.8}$

$f = \frac{32cm}{1.8}$

Therefore, f = 18 cm

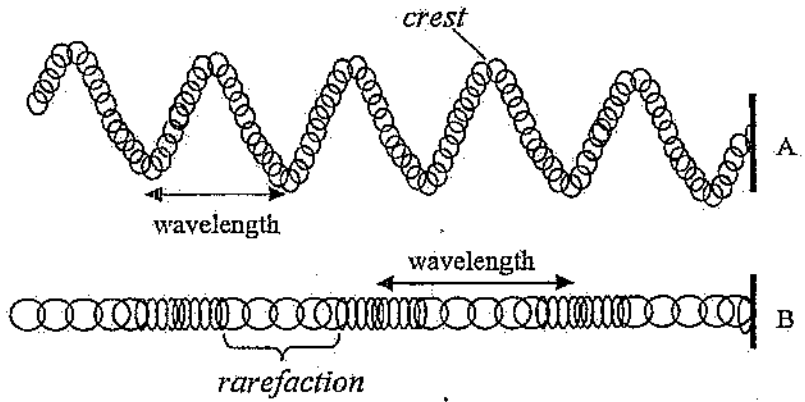
Q62. Diagrams A and B represents two kinds of waves on a slinky spring.



a. Label the positions of crest and rarefaction in the figure.
b. State how each kind of wave is produced on the spring.
c. Explain the difference in which the two types of waves are transmitted.
d. Give the name of each wave
e. Mark the distance which represents one wavelength in A and B.

Answers.

a.



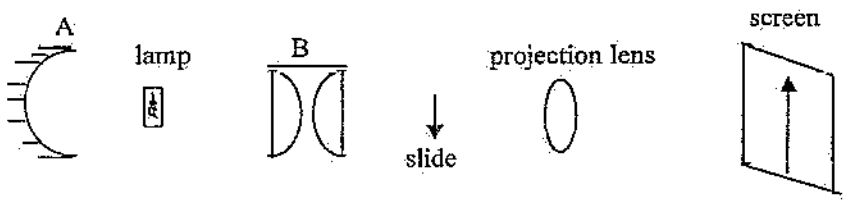
b. Wave A is produced by moving one end of the spring up and down repeatedly. Wave B is produced by moving the spring forward and backwards in the direction in which the wave travels..

c. In A, the particles vibrate at right angles to the direction in which the wave travels while in B, the particles vibrate parallel to the direction in which the wave travels.

d. A is a transverse wave and B is a longitudinal wave.

e. See diagram above.

Q63. The following diagram is a simple slide projector.



a. Name the parts labelled A and B.
b. Explain the function of all the parts shown in the diagram.
c. If the screen is placed 200 cm away from the projection lens, how far away from the projection lens should the slide be placed to give a focused image if whole magnification is 10.

Answers.

a. *A is concave mirror .* *B is condenser lens*

b. *The concave mirror reflects stray light rays towards the condenser.*
The lamp produces light for illuminating the object (film)
Condenser lens bends and directs more light onto the film
The slide contains tiny pictures that act as objects.
Projection lens focuses light rays from the object onto the screed thereby producing real images on the screen.
The screen provides a surface where real images are produced.

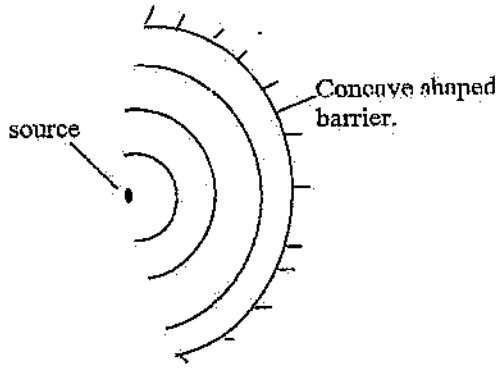
c. $Magnification = \frac{Image\ distance\ (v)}{Object\ distance\ (u)}$ $u = = 20\ cm$

$$10 = \frac{200\ cm}{u}$$

$$u = \frac{200\ cm}{10} = 20\ cm.$$

Therefore, slide should be 20 cm away from the projection lens.

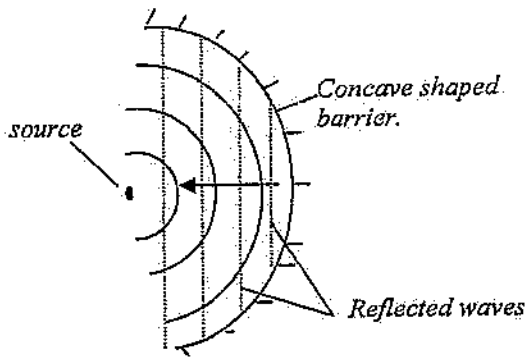
Q64 a. Complete the following diagram to show what happens to the waves after reflection on the mirror.



b. State the condition under which a converging lens is used as a magnifying glass.

Answers.

a.



b. *The object distance should be less than the focal length of the lens.*

Q65. In a class experiment on thin lenses the following data was collected.

Object distance , u (cm)	30	40	60	75	90
Image distance, v (cm)	30	24	20	18.75	18
vu (cm^2)					
v + u (cm)					

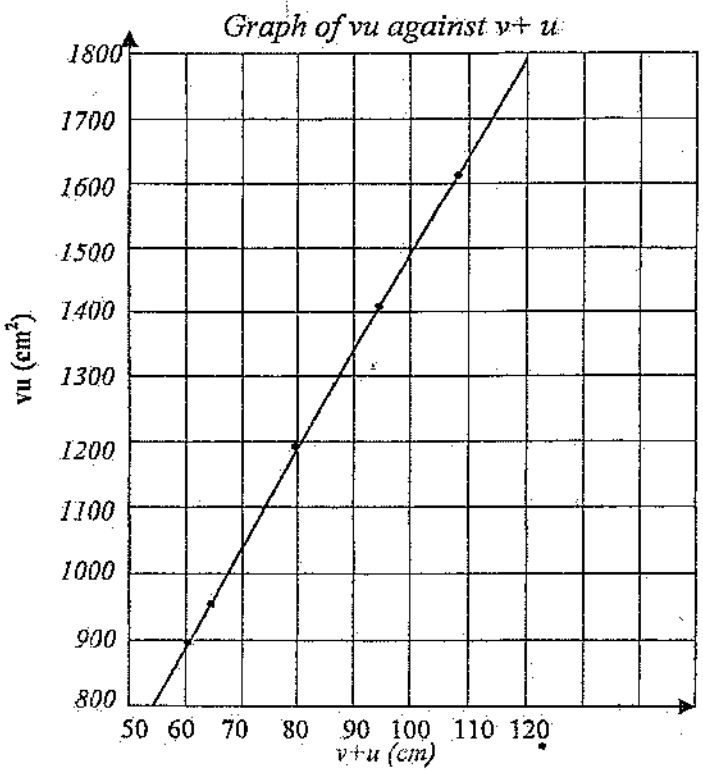
a. Complete the table.
b. Plot a graph of vu against v + u.
c. Determine the gradient of your graph.
d. Given that the focal length of the lens is given by $f = \frac{vu}{v+u}$ find the focal length.

Answers.

a.

Object distance , u (cm)	*30*	*40*	*60*	*75*	*90*
Image distance, v (cm)	*30*	*24*	*20*	*18.75*	*18*
vu (cm^2)	*900*	*960*	*1200*	*1406*	*1620*
v + u (cm)	*60*	*64*	*80*	*93.75*	*108*

b.

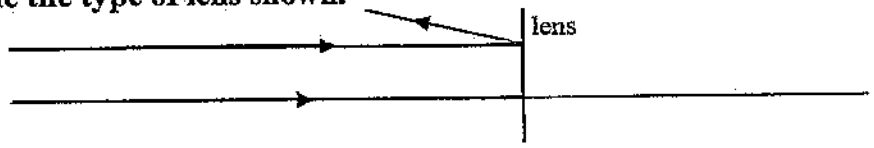


c. $Gradient = \frac{change\ in\ vu}{change\ in\ v+u} = \frac{300\ cm^2}{20\ cm} = 15\ cm.$

d. *The focal length is 15 cm.*

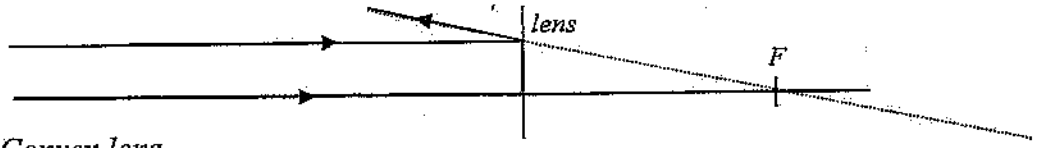
Q66. a. Complete the following diagram to show the position of the principal focus of the lens.

b. Name the type of lens shown.



Answers.

a.



b. Convex lens.

Q67. a. State one application of a concave mirror and one application of a convex mirror.

b. The table below shows the object distance, u and corresponding image distance, v of an object placed in front of a convex lens.

u (cm)	5	10	15	20	25	30	35
v (cm)	4.0	6.6	8.6	10.0	11.1	12.0	12.7
$\frac{1}{u}$ (cm^{-1})							
$\frac{1}{v}$ (cm^{-1})							

i. Complete the table for values for and

ii. Plot the graph of $\frac{1}{u}$ against $\frac{1}{v}$

iii. Use your graph to determine the focal length of the lens.

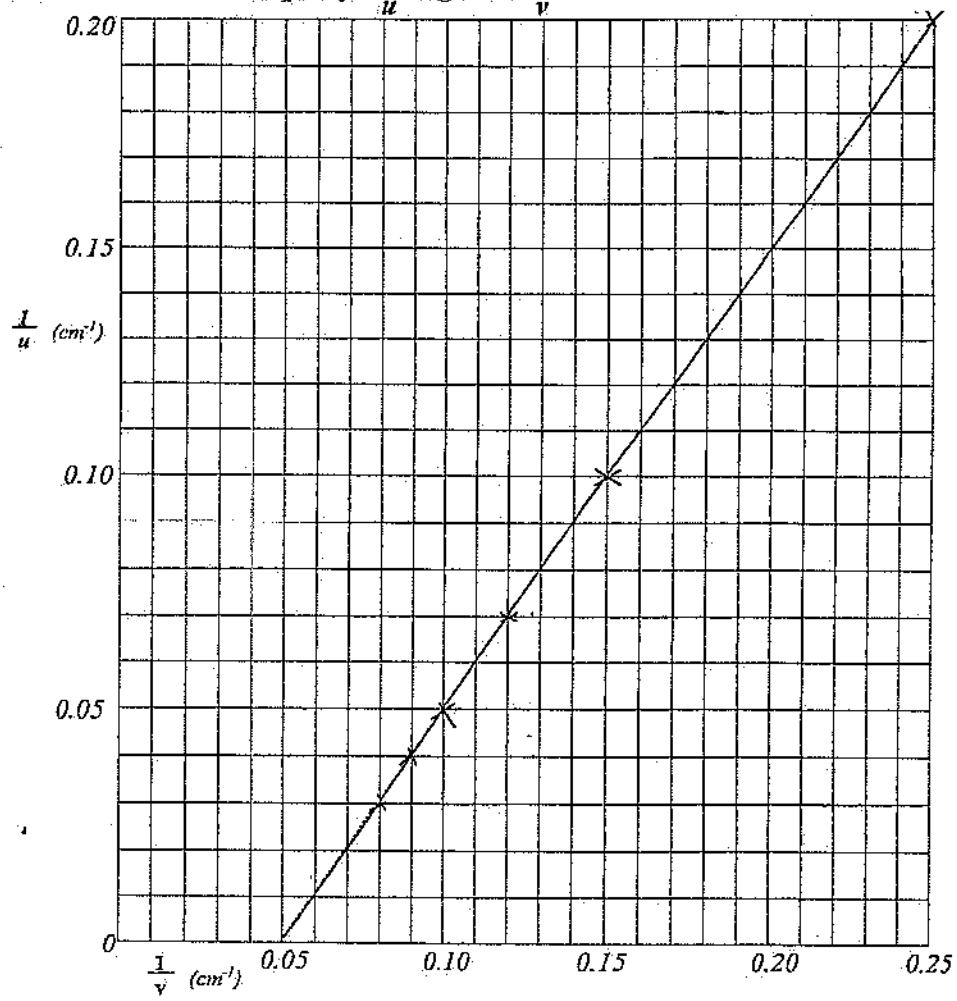
Answers.

a. Concave mirror is used in projectors to reflect stray light towards the slide
Convex mirror is used in vehicles as rear view mirror giving the driver a wider field of view.

b i.

u (cm)	*5*	*10*	*15*	*20*	*25*	*30*	*35*
v (cm)	*4.0*	*6.6*	*8.6*	*10.0*	*11.1*	*12.0*	*12.7*
$\frac{1}{u}$ (cm^{-1})	*0.2*	*0.10*	*0.07*	*0.05*	*0.04*	*0.03*	*0.03*
$\frac{1}{v}$ (cm^{-1})	*0.25*	*0.15*	*0.12*	*0.10*	*0.09*	*0.08*	*0.08*

ii. Graph of $\frac{1}{u}$ against $\frac{1}{v}$



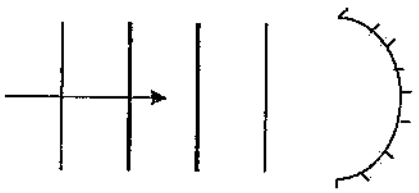
iii. *From the graph, when* $\frac{1}{u} = 0$, $\frac{1}{v} = 0.05$

If $\frac{1}{u} = 0$, *then* $u = \infty$, *therefore, the object is a distant object and image distance is equal to focal length of the lens.*

So, $\frac{1}{v} = 0.05$, $v = \frac{1}{0.05} = 20$ *cm.*

The lens has a focal length of 20 cm.

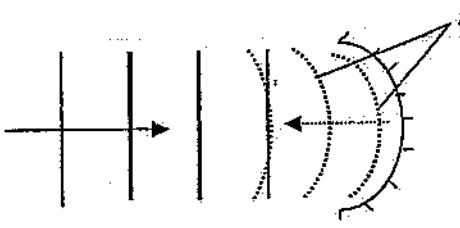
Q68a. Complete the following diagram to show what happens to the wave fronts after reflection on the concave reflector.



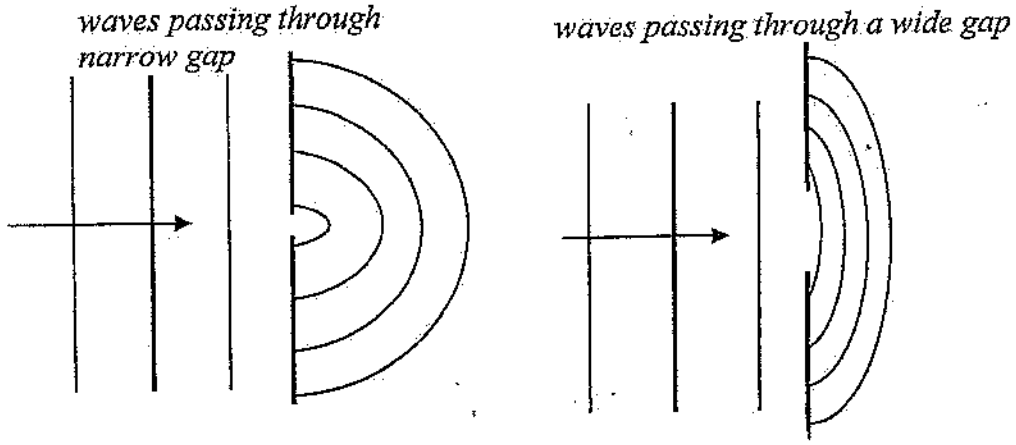
b. With the aid of labelled diagrams, explain the difference between waves passing through narrow and wide gaps

Answers.

a.

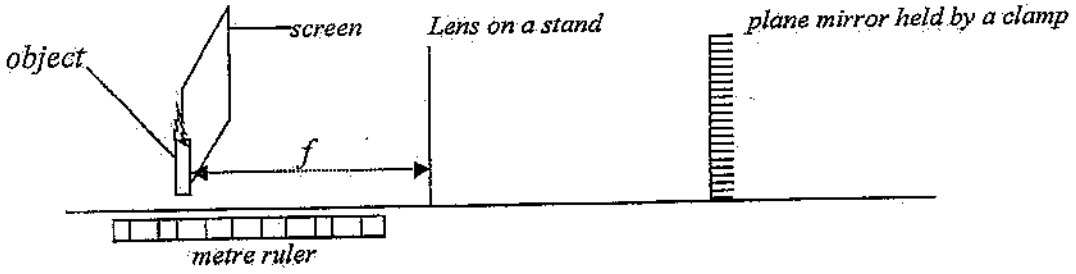


b. Waves passing through narrow gaps bend more than waves passing through wide gaps.



Q69. With the aid of a diagram, explain how the focal length of a convex lens can be determined using the plane mirror method.

Answer
To determine the focal length of a convex lens by the plane mirror method, the apparatus is set up as shown below.



A burning candle is used as the object. The object, the lens and the plane mirror are placed in a straight line. The lens is placed between the object and the mirror. The screen is aligned with the object as shown in the diagram.

The lens is then carefully moved towards or away from the mirror until a clear image is focused on the screen.

Image distance, f, is then carefully measured using the ruler.
The value of the image distance found is equal to the value of the focal length of the lens.

CHAPTER 4.

ELECTROSTATICS

34 QUESTIONS WITH ANSWERS

To the student.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

After reading the chapter, test your understanding by answering the 34 questions in this chapter. Cross check your answers with the answers provided.

The following list of books is not exhaustive.

1. Keith Wallis, Chanco Physical Science for Malawi, Book 2 (3rd edition), pages 169-178.
2. Samuel Kalea, MSCE Physical Science (New edition) pages 135-139
3. Tom Duncane, GCSE Physics(4th edition) pages 192-197.
4. Mukabi Murigi etal, KCSE Golden Tips Physics, pages 133-136.
5. Stephen Pople, Complete Physics, pages 177-181.
6. Keith Johnson, Physics for You: Revised edition for GCSE, pages 247-253.

Q1. Explain why metals are good conductors of electricity while plastics are poor conductors of electricity.

Answer.
Metals have valence electrons which are delocalised (free to move) while plastics have valence electrons which are localised (not free to move).

Q2. Why is it easy to charge polythene by rubbing and not copper?

Answer.
Polythene is a poor conductor of charge therefore the charge gained is not instantly conducted away or neutralised as is the case with copper which is a good conductor of charge.

Q3. If a plastic comb is rubbed against hair, it becomes negatively charged. Explain how the comb becomes negatively charged.

Answer: The comb gains electrons from the hair.

Q4. a. Give one example where electrostatic charge might be hazardous.
b. How can the built up of electrostatic charge be prevented in (a) above.

Answers.
a. When an aeroplane is being refuelled by a tanker lorry, charge may build up due to the friction between the moving liquid and walls of the tank. If enough charge builds up, it can cause a spark igniting the flammable liquid.
b. By connecting the aeroplane to the tanker lorry using copper wire.

Q5. Explain in terms of electron movement what happens when polythene rod becomes charged negatively by being rubbed with woollen cloth.

Answer.
It becomes charged negatively because in the process of rubbing, some electrons jump from the cloth to the polythene rod making it have an excess of electrons.

Q6. Explain why a rubbed balloon will stick to the wall for some time.

Answer. The rubbed balloon gets charged by friction. When the charged balloon is brought close to the wall, the wall gets charged by electrostatic induction such that the wall surface close to the balloon has opposite charges to the balloon. The balloon gets attracted to the wall because unlike charges attract.

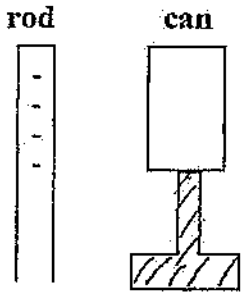
Q7. State the law of electric charges.

Answer: It states that unlike charges attract while like charges repel.

Q8. A brass rod can not be charged by friction without being insulated. Explain.

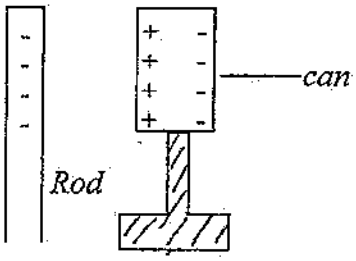
Answer: Brass rod is a good conductor of charge. If not insulated, the charge is instantly neutralised.

Q9. The diagram below shows a charged rod held close to a metal can.



a. Copy the diagram and show the induced charge on the can.
b. Why is the can attracted to the rod even though it is not charged?
c. If you touch the can with your finger, electrons flow through it. In which direction is the flow?
d. What type of charge is left on the can after it has been touched?

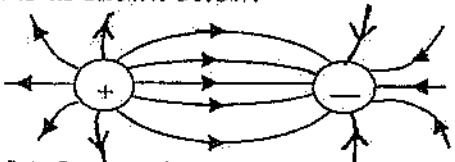
Answers.
a.



b. The can gets charged by electrostatic induction when the charged rod is brought close to it. The surface of the can which is close to the rod is left with positive charges as a result the two objects attracts because opposite charges which are close to each other attract.
c. Electrons move away from the can through the body to the ground.
d. The can is left with a positive charge.

Q10. Show the electric field pattern between the following two unlike charges.

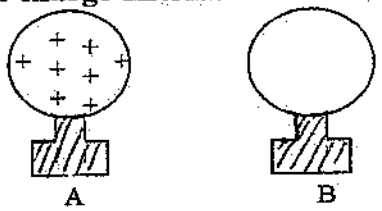
Answer.
The electric field pattern is as shown below.



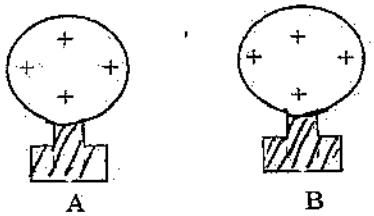
Q11. A charged rod is brought close to the cap of a negatively charged electroscope causing the leaf to fall. Would you consider the rod to be negatively charged or positively charged. Explain your answer.

Answer.
The rod is positively charged. When brought close to the metal cap of the negatively charged electroscope, it attracts the electrons towards the metal cap leaving the metal plate and the leaf less charged, hence the leaf falls.

Q12. The figure below shows two identical conducting spheres on insulating stands. Each cross represents a charge. The spheres are briefly brought into contact and then separated. Show the charge distribution on the two spheres after separation.



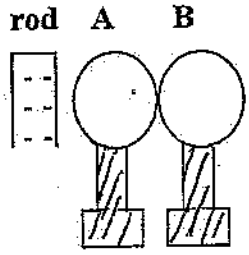
Answer: Charge distribution is as shown below.



Q13. State any three uses of a gold leaf electroscope.

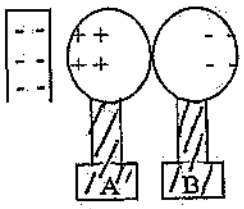
Answers.
Detecting the presence of charge.
Identifying the type of charge on an object.
Estimating the quantity of charge on an object.

Q14. The diagram below shows a charged rod brought close to two uncharged metal spheres, A and B, mounted on insulating supports. The two spheres are positioned so that they touch.



a. Why are the spheres mounted on insulating support?
b. Copy the diagram and show the charges on the two spheres.
c. If the two spheres are separated while the charged rod is still in position, what will be the resulting charge on each sphere after the rod is withdrawn?

Answers.
a. To prevent charge from being conducted away or instantly neutralised.
b.



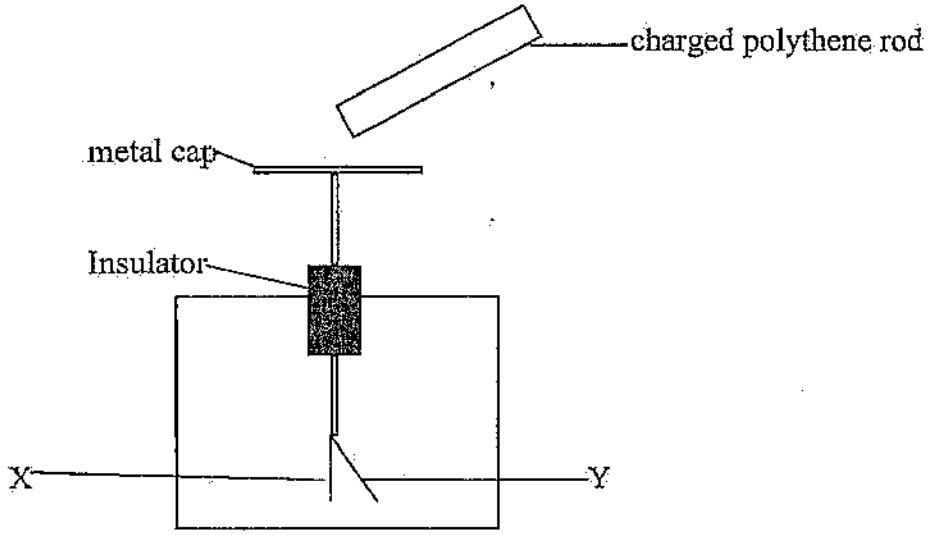
c. Sphere A will be positively charged
Sphere B will be negatively charged.

Q15. Explain why the leaf of uncharged electroscope diverges when a charged object is brought near the cap.

Answer.
If the object is negatively charged, it repels the electrons to the metal plate and the leaf. The metal plate and the leaf both become negatively charged, they repel each other as a result the leaf diverges.

If the object is positively charged, it attracts the electrons towards the metal cap leaving the metal plate and the leaf positively charged. The metal plate and the leaf repel each other as a result the leaf diverges.

Q16. The following diagram shows a charged polythene rod brought close to the metal cap of a neutral electroscope. The polythene rod was charged by rubbing with a piece of dry cloth.



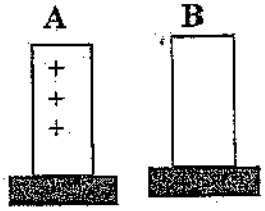
a. Name parts labelled X and Y.
b. Explain what will be observed in this experiment.

Answers.
a. X is metal plate.
Y is gold-leaf.
b. The leaf diverges because the charged polythene rod repels electrons away from the metal cap making the metal plate and leaf negatively charged. As a result they repel each other causing the leaf to diverge.

Q17. Explain in terms of electron movement what happens when a polythene rod is rubbed with a piece of dry cloth.

Answer.
Some electrons move from the cloth to the polythene. The polythene becomes negatively charged due to the excess electrons while the cloth is left positively charged.

Q18. In the following diagram, body B which is not charged is held close to a positively charged body A both in a vacuum. Body B experiences electrostatic force from body A.



State two ways in which this force can be increased.

Answers:
By moving body A closer to body B
By charging body B negatively

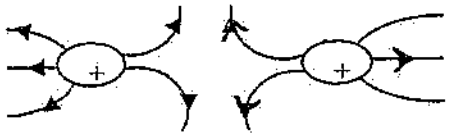
Q19. A Bunsen flame brought close to the cap of a charged electroscope causes the divergence of the leaf to decrease. Explain this observation.

Answer.
The Bunsen flame ionises the surrounding air. The charged electroscope either attracts the electrons or the positive ions which neutralise its charge.

Q20. The following figure shows two charged spheres separated from one another.

Draw the electric field pattern produced by the charges.

Answer.
The electric field pattern is as shown below.



Q21. Explain what happens when a negatively charged polythene rod touches the cap of a positively charged electroscope.

Answer.
Electrons move from the negatively charged polythene rod to the positively charged electroscope thereby neutralising it. Consequently, the leaf falls.

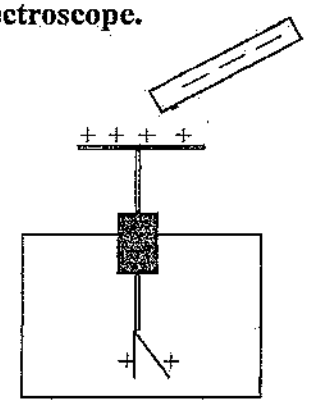
Q22. Explain how air pollution by smoke from a factory chimney can be minimized by placing a charged object in the chimney.

Answer.
The charged object induces charge in the smoke particles as a result the smoke particles are attracted by the object so they do not escape to the environment.

Q23. Explain why a charged conductor will slowly lose its charge when mounted on a good insulator.

Answer: The charged particles in the air neutralise the charge on the conductor.

Q24. The following figure shows a negatively charged rod slowly brought near the cap of a positively charged leaf electroscope.



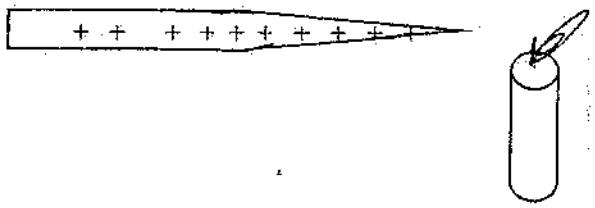
State what is observed and explain your observation.

Answer.
The divergence of the leaf decreases because the negatively charged rod repels electrons towards the metal plate and the leaf. The net effect is making the leaf and metal plate less positively charged thereby decreasing forces of repulsion between the two metal plates. The leaf falls.

Q25. Given a positively charged electroscope, describe how you would distinguish an insulator from a conductor.

Answer.
Hold one material in the hand and bring it in contact with the metal cap of the electro scope.
Observe what happens to the leaf of the charged electroscope. Withdraw the material. Repeat the procedure with the remaining material.
A conductor discharges the electroscope therefore the leaf falls. An insulator does not discharge the electroscope, therefore the leaf remains diverged.

Q26. Explain why a sharp wire with positive charges causes a candle flame to be deflected as shown in the following diagram.



Answer.
The flame ionises the surrounding air. The positively charged sharp wire repels the positive ions surrounding the flame. Movement of these positive ions deflects the flame in the direction shown.

Q27. Explain why television or computer screens often become very dusty compared to their neighbouring surfaces.

Answer.
When the television or the computer is switched on, the screen becomes charged. The charged screen induces charge in the dust particles as a result the dust particles are attracted by the screen.

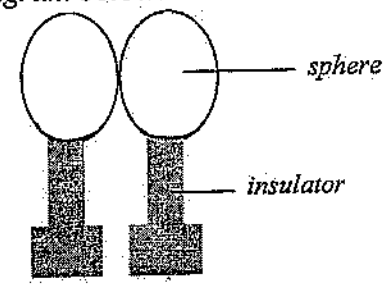
Q28. Explain how a lightning conductor works to protect a building from a lightning discharge.

Answer.
The lightning conductor is made of a metal rod fixed to the ground. In the event of a lightning discharge, the lightning conductor provides an easiest path for the discharge to the ground. The charge passes through the lightning conductor and is safely conducted to the ground.

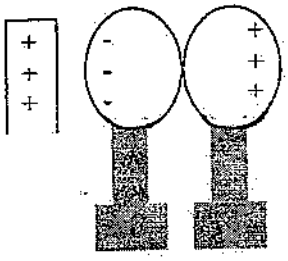
The lightning conductor also conducts away the electrons repelled by the negatively charged cloud as a results the positive ions move into the cloud thereby neutralising it and reducing chances of a discharge.

Q29. Using an ebonite rod which is positively charged, describe a procedure you would use to charge two spheres with identical opposite charge. In your description, use releyant diagrams.

Answer.
Mount each of the two spheres on an insulator and bring them close so that they touch each other as shown in the diagram below.



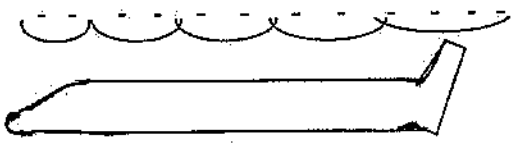
Bring the charged ebonite rod close to the spheres. The charged ebonite rod induces charges in the sphere as shown below.



While still holding the charged ebonite rod close to the spheres, separate the two spheres so that they are no longer in contact then withdraw the ebonite rod.

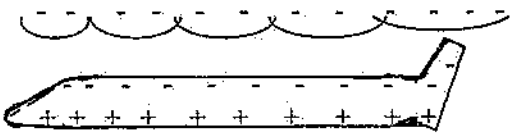
The two spheres have been charged with identical opposite charges.

Q30. An aeroplane flies just below a negatively charged thunder cloud as shown. Electrostatic charges are induced on the aeroplane.



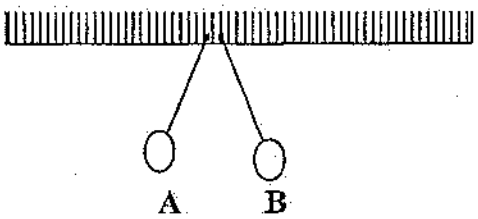
a. Show the distribution of induced charges on the plane.
b. What happens to the induced charge when the plane flies away.

Answers.
a. Distribution of charge is as shown below.



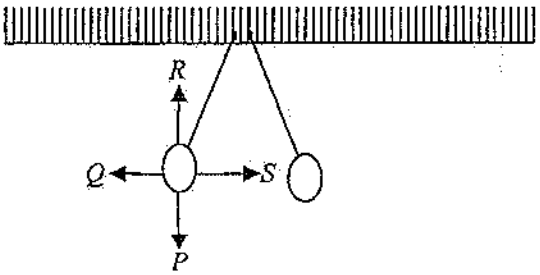
b. The electrons move back to their original positions and the charge separation disappears.

Q31. The following figure is a diagram showing polythene balls A and B suspended on nylon threads. After being charged, the balls come to rest in the position shown.



a. What charge was given to A and B?
b. Using arrows show direction of all the forces acting on ball A and name them.
d. What would be observed if the two balls were momentarily touched. Explain.

Answers.
a. Ball A was given a negative charge.
Ball b was given a negative charge.
b.



P is weight. Q is force of repulsion R is tension force
S is force of attraction.
c. The two balls would move towards each other because touching the balls neutralises the charge as a result there is no force of repulsion between the two

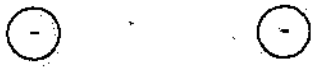
Q32. Mention any two practical uses of static electricity.

Answers.
Used in electrostatic precipitators to prevent pollution of the environment by smoke from factories.
Used to prevent fires. For example, when refuelling an aeroplane by a tanker lorry, they are always connected together by a copper wire.

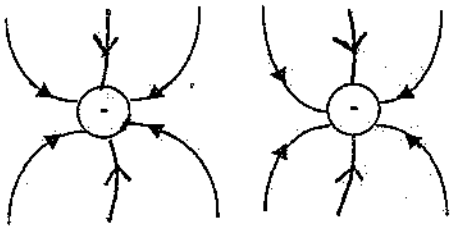
Q33. A balloon after rubbing with a woollen cloth is found to be negatively charged and is attracted to the cloth. Explain:
a. Why the balloon becomes negatively charged.
b. Why the balloon is attracted to the cloth.

Answers.
a. Rubbing causes some electrons to move from the cloth to the balloon.
b. After losing some electrons, the cloth becomes positively charged hence it is attracted to the negatively charged balloon, unlike charges attract.

Q 34.a. What is an electric field?
b. Draw an electric field pattern between the following charges.



Answers.
a. Is a region around a charged object where other charged objects experience an electric force.
b. The electric field pattern is as shown below.



CHAPTER 5.

ELECTRICITY & MAGNETISM

94 QUESTIONS WITH ANSWERS

To the student.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

After reading the chapter, test your understanding by answering the 94 questions in this chapter. Cross check your answers with the answers provided.

The following list of books is not exhaustive.

1. Keith Wallis, Chanco Physical Science for Malawi, Book 2 (3rd edition) pages 189-249

2. Samuel Kalea, MSCE Physical Science (New edition) pages 139-146.

3. Tom Duncane, GCSE Physics(4th edition), pages 198-210, 215-241, 245-253

4. Mukabi Murigi etal, KCSE Golden Tips Physics, pages 140-164.

5. Stephen Pople, Complete Physics, pages 182-238.

6. Keith Johnson, Physics for You: Revised edition for GCSE, pages 254-279, 284-311.

Q1. A current of 1A flows through a lamp for 1 minute. How much charge passes through the lamp?

Answer: *1 minute = 60 seconds*
Charge = current x time
= 1A x 60s
= 60 coulombs.

Q2. A 6V battery passes a current of 1A through a lamp for 1 minute. How much energy is transferred from the battery to the lamp?

Answer: *1 minute = 60 seconds.*
Energy transferred = voltage x current x time
= 6V x 1A x 60s
= 360 joules.

Q3. A p.d of 6V is supplied to two resistors (3 ohms and 6 ohms) connected in parallel.
Calculate: a. The combined resistance.
b. The current flowing in the main circuit.
c. The current in the 3 ohm resistor.

Answers.

a. Total resistance: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R} = \frac{1}{3} + \frac{1}{6} = \frac{2+1}{6} = \frac{1}{2}$$

Therefore, combined resistance = 2 Ω.

b. $V = I \times R$
$6 = I \times 2$
$I = \frac{6}{2}$ *Therefore: I = 3A*

c. $V = I \times R$
$6 = I \times 3$
$I = \frac{6}{3}$ *Therefore: I = 2A.*

Q4. A 2V accumulator is connected to a wire of resistance 20 ohms. What current flows in the circuit?

Answer: $V = I \times R$
$2 = I \times 20$
$I = \frac{2}{20}$ *Therefore: I = 0.1A*

Q5. A p.d of 4V is supplied to two resistors (6 ohms and 2 ohms) connected in series.
Calculate: a. The combined resistance.
b. The current flowing in the circuit.
c. The p.d across the 6 ohm resistor.

Answers.

a. *Total resistance* $= 6\Omega + 2\Omega$
$= 8\Omega$

b. $V = I \times R$
$4 = I \times 8$

$I = \frac{4}{8}$ *Therefore:* $I = 0.5A$

c. $V = I \times R$
$V = 0.5 \times 6$. *Therefore,* $V = 3V$

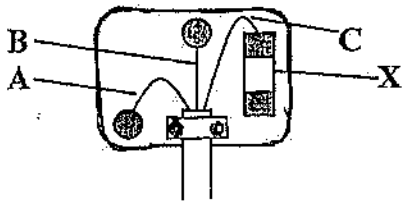
Q6. Mention any three uses of electrolysis.

Answers: *Electrolysis is used in the following:*
Electroplating.
Extraction of metals from their ores.
Purification of metals.

Q7. State two safety features present in modern mains plugs.

Answer: *Safety features are:* *fuse*
earth wire

Q8. The following diagram shows a three pin plug.



a. What is the colour of each of the wires labelled A, B and C.
b. Identify wires labelled A and C.
c. Name the part labelled X.
d. Explain the use of part X.

Answers.

a. *Wire A is blue in colour*
Wire B is green and yellow in colour (green and yellow stripes).
Wire C is brown in colour.

b. *A is neutral wire.* *C is live wire.*

c. *Part X is a fuse.*

d. *Part X acts as a protective device by melting if there is too much current flowing.*

Q9. Mention two ways of increasing the strength of an electric motor.

Answers: *By increasing the number of turns in the coil.*
By using a stronger magnet.

Q10. A vacuum cleaner is labelled 250V, 500W. When connected to 250V mains supply, how much current does it take?

Answer: *Power = voltage x current*
500 W = 250V x current

$$Current = \frac{500}{250} = 2A.$$

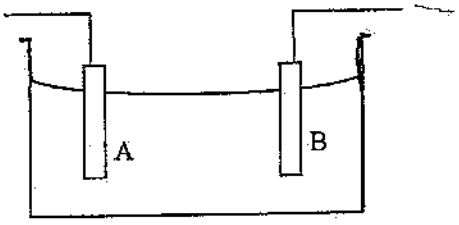
Q11. A 2000 watt electric fire is used for 10 hours. What is the cost at K8 per kWh?

Answer: *2000W = 2kW*
Energy used in kWh = power (in kW) x time (in hours)
= 2kW x 10h
= 20kWh.
Cost at K8 per kWh = 20 x K8
= K160.

Q12. An electric kettle connected to 230V mains supply draws a current of 10A.
Calculate: a. Power of the kettle
b. Energy transferred in 1 minute.

Answers: *a.* *Power = voltage x current*
= 230V x 10A
= 2300 watts or 2.3kW (1000W = 1kW).
b. *Energy = power x time.*
= 2300W x 60s
= 138 000 joules or 138kJ (1000J = 1kJ).

Q13. The following diagram shows an apparatus used to copper-plate an object at B.



a. What is the substance at A.
b. What is liquid C
c. Which part would be connected to the positive part of the battery?

Answers:
a. Copper metal.
b. Copper sulphate.
c. The part with substance A would be connected to the positive part of the battery.

Q14. What must be done to a generator to enable it to produce electricity?

Answer: *The coil must be rotated so that the wire in the coil cuts magnetic lines of force of the magnet.*

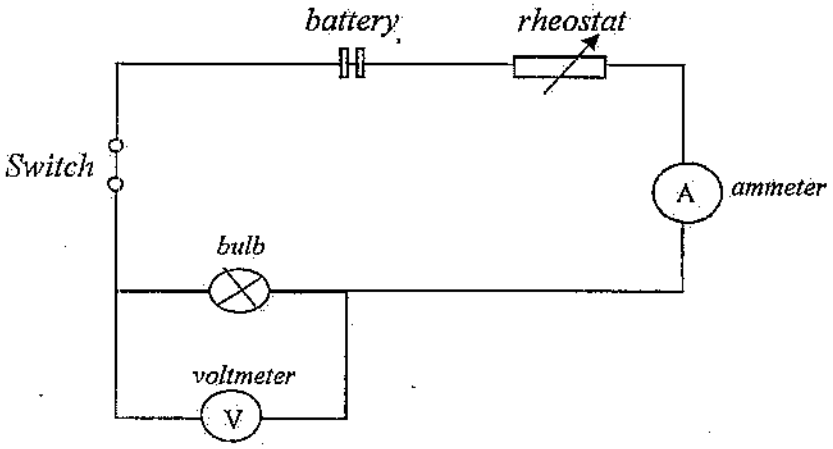
Q15. The table below shows corresponding values of potential difference across a torch bulb and the current flowing through it.

Voltage (volts)	0	0.02	0.1	0.5	1.0	1.65	2.3	3.1	4.0
Current (amps)	0	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32

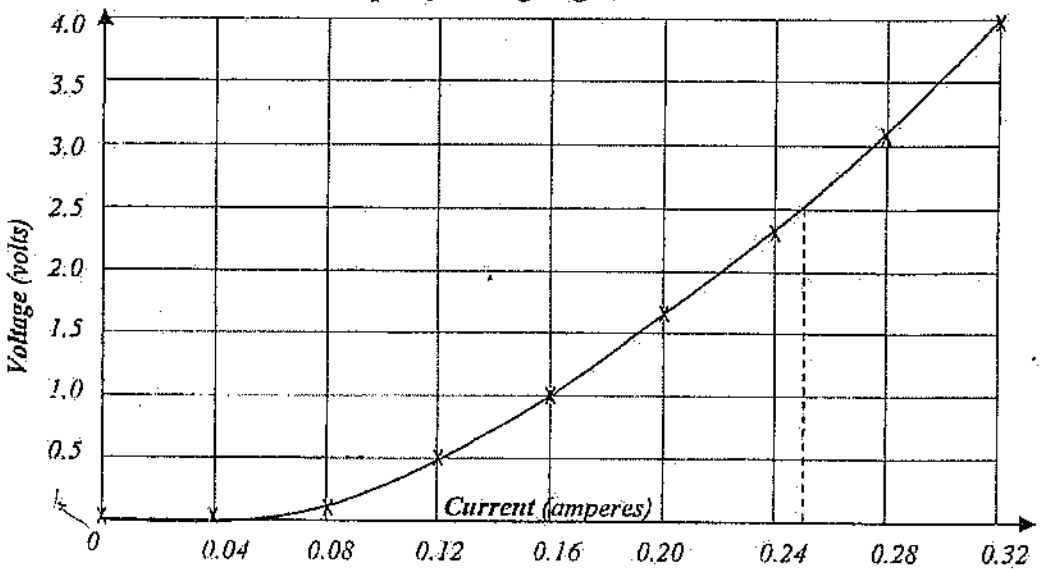
a. Draw a diagram of a circuit which could have been used to obtain the data.
b. Plot a graph of voltage against current.
c. Use the graph to find the voltage when the current through the torch bulb is 0.25A.

Answers.

a.



b. *Graph of voltage against current.*



c. *From the graph, the voltage is 2.5 V.*

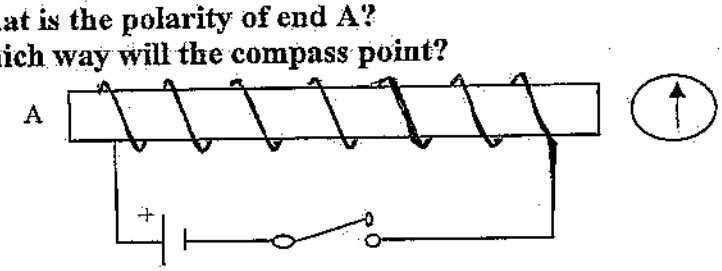
Q16. How would the resistance of a piece of wire change if:
a. The length were doubled?
b. The diameter were doubled?

Answers.
a. *Doubling the length increases the magnitude of resistance by a factor of 2.*
b. *Doubling the diameter reduces the magnitude of resistance by a factor of ½.*

Q17. For the coil in the diagram, when the switch is closed:

a. What is the polarity of end A?

b. Which way will the compass point?



Answers: *a. End A behaves like a south pole.*

b. The compass points to the east.

Q18. When a current of 4A passes through a certain resistor for 10 minutes, 2.88×10^4 J of heat are produced. Calculate:

a. The power of the heater.

b. The voltage across the resistor.

Answers: *a.* $Energy = power \times time$

$2.88 \times 10^4 = power \times 600$

$Power = \frac{2.88 \times 10^4}{600}$

Therefore, power = 48W

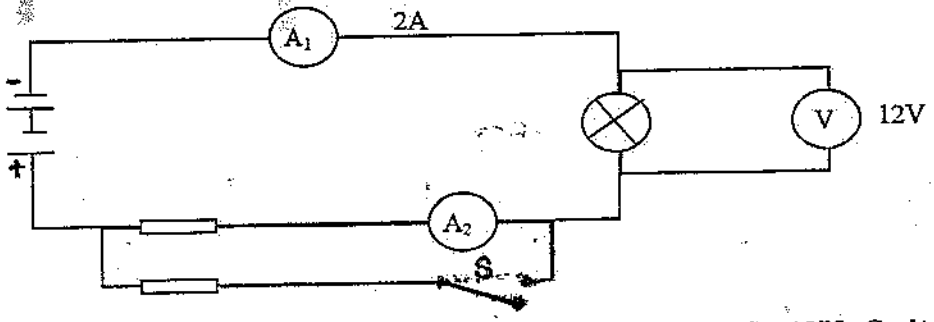
b. $Power = V \times I$

$48 = V \times 4$

$V = \frac{48}{4}$

Therefore, voltage = 12V.

Use the following circuit diagram to answer question 19.



Q19. In the circuit, ammeter A_1 reads 2A and the voltmeter reads 12V. Switch S is open.

a. What is the reading of ammeter A_2?

b. Calculate the resistance of the lamp.

c. Calculate the power of the lamp.

d. If switch S is closed, what happens to the reading of A_1 and A_2. Explain.

Answers.

a. *A_2 reads 2A.* *b.* $V = I \times R,\ 12 = 2 \times R,\ R = \frac{12}{2} = 6\,\Omega.$

c. *Power = voltage x current*

$= 12 \times 2 = 24\ W.$

d. *Reading of A_1 will increase because closing switch 'S' causes current to flow through the two resistors in parallel thereby reducing the total resistance in the circuit. Reading of A_2 decreases because current is split between the two resistors.*

Q20. A step-down transformer is required to transform 240V a.c to 12V a.c for a model railway. If the primary coil has 1000 turns, how many turns should the secondary have?

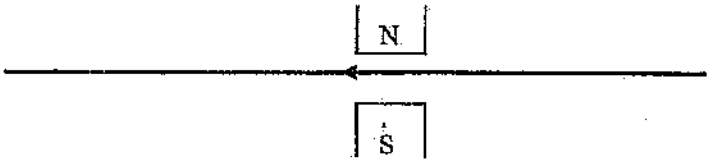
Answer.

$$\frac{Vs}{Vp} = \frac{Ns}{Np} \qquad so, \quad \frac{12}{240} = \frac{Ns}{1000}$$

$$Ns = \frac{12x1000}{240} = 50 \text{ turns.}$$

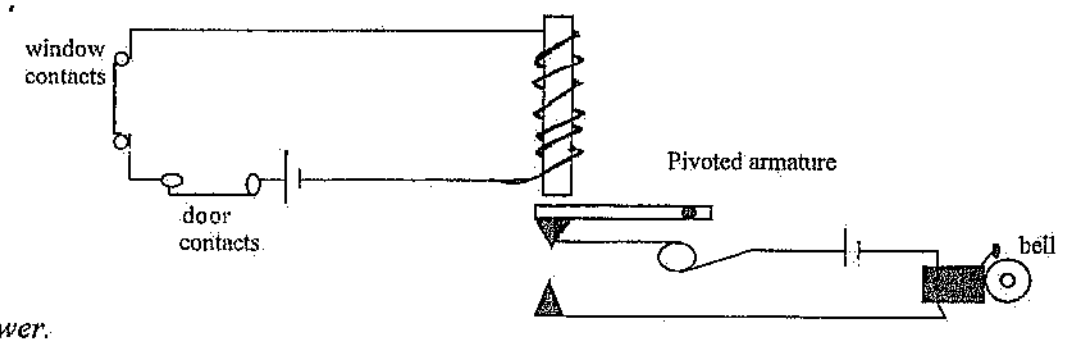
The secondary coil has 50 turns.

Q21. The following diagram shows a wire in a magnetic field. If a current flows in the wire in the direction of the arrow, in which direction will the wire move?



Answer: The wire moves upwards.

Q22. The diagram shows a relay circuit for a burglar alarm. Briefly explain how it works.



Answer.
The window and door circuit is complete, therefore current flows. The electromagnet is magnetised and pulls the pivoted armature. This makes the bell circuit to be incomplete, the bell does not ring.
The pivoted armature sticks to the electromagnet for as long as the door and window circuit is complete. Opening the window or the door cuts the current thereby demagnetising the electromagnet. The pivoted armature moves back completing the bell circuit. The electric bell rings.

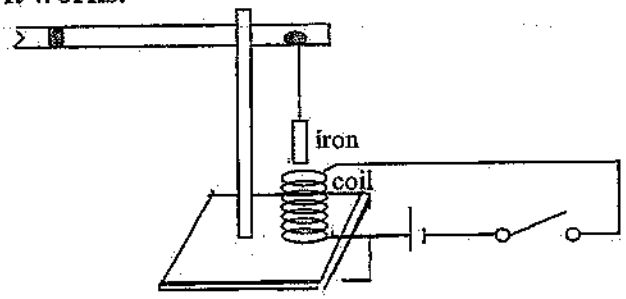
Q23. Explain why electrical energy is transmitted at very high voltage.

Answer: To minimise power losses due to the heating effect of the current during transmission.

Q24. Explain the difference between alternating current and direct current.

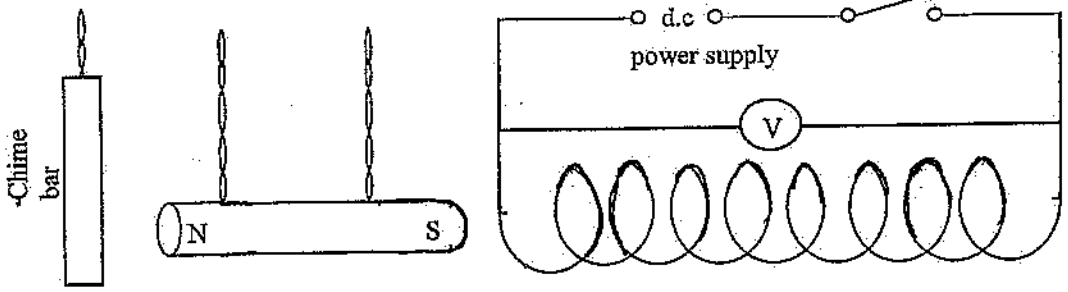
Answer: Direct current flows in one direction while alternating current changes direction every half cycle.

Q25. The diagram shows the design for an electrically operated model railway signal. Briefly explain how it works.



Answer.
When the switch is open, there is no current flowing. The solenoid is not magnetised. The red signal is displayed. When the switch is closed, current flows and the solenoid is magnetised. The magnetised solenoid pull the iron down, as a result the red signal is pulled from its horizontal position and stands vertically.

Q26. A student hung a magnet next to a coil of wire to make a door chime. When the current was switched on, the magnet hit the chime bar which made a noise.



a. Explain this observation.
b. Suggest two ways to make the magnet hit the chime bar harder.

Answers.
a. The current magnetised the solenoid in such a way that the south pole of the magnet was directly facing the south pole of the magnetic field of the solenoid. This created repulsion between the solenoid and the magnet hence the magnet hit the chime bar.
b. By using a stronger magnet.
By increasing the number of turns in the coil.

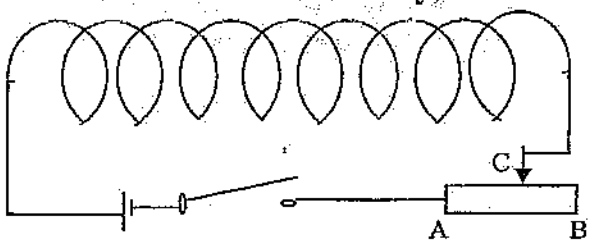
Q27. What is the difference between hard and soft magnetic materials?

Answer.
Hard magnetic materials are difficult to magnetise however once magnetised they do not lose their magnetism easily while soft magnetic materials are easy to magnetise and lose their magnetism easily.

Q28. Explain why a transformer will not work on d.c current.

Answer.
Direct current produces a stationary magnetic field therefore the lines of force are not continuously cut by the secondary coil. No voltage is induced in the secondary coil.

Q29. A coil of wire is connected in series with a battery, a rheostat and a switch.



a. Draw the shape of the magnetic field created by the coil.

b. If the slider ,C, of the rheostat is moved towards B, what is the effect on:

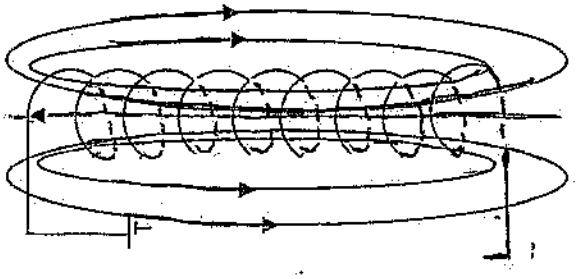
(i). The resistance of the circuit.

(ii). The current through the coil.

(iii). The magnetic field in the coil.

Answers.

a.



b. i. Resistance of the circuit increases.

ii. The current through the coil decreases.

iii. The magnetic field in the coil decreases.

Q30. Suppose you are given three metal rods which have been painted so that they all look identical. One rod is made of magnetised steel, the other rod is made of unmagnetised iron and the third rod is made of copper. Describe an experiment you could use to identify the three rods.

Answer.

Suspend one of the rods freely using some threads and a clamp attached to a stand. Observe the general direction in which the suspended rod points when it has stopped moving about. Bring the other two metal rods close one at a time and observe. Record the observations made.

Repeat the procedure by suspending the remaining rods one after the other and record the observations.

The suspended rod which is not attracted to any of the two rods is copper. The suspended rod which points in a North-South direction is magnetised steel which implies that the remaining rod is iron.

Q31. Explain why a transformer only works with alternating current.

Answer.

Alternating current produces a moving magnetic field in the primary coil whose magnetic lines of force continuously cut the wire in the secondary coil of the transformer. Current is induced in the secondary coil by electromagnetic induction.

Q32. An overhead power line transmits electricity at 400kV. The transmission line carries 200MW of power.

a. Calculate the current in the lines.
b. Calculate the voltage drop if the total resistance of the transmission line is 10 ohms.
c. Calculate the power loss in the lines.
d. What is the advantage of transmitting power using alternating voltage.

Answers.

a. *Power* $= V \times I$

$200 \times 10^6 = 400 \times 10^3 \times I$ *(1000 000W = 1MW, 1000W = 1kW).*

$$I = \frac{200 \times 10^6}{400 \times 10^3}$$

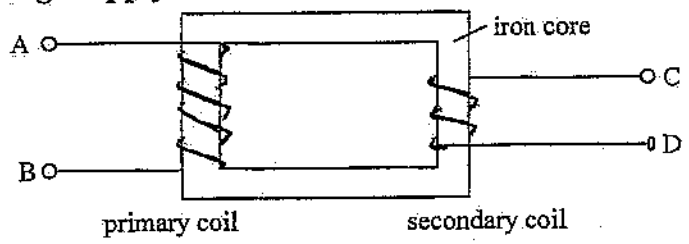
Therefore, I = 500A.

b. *Voltage* $= I \times R$
$= 500 \times 10$
$= 5000V.$

c. *Power* $= V \times I$
$= 5000 \times 500$
$= 2500kW.$

d. *Easy to step-up or step down using transformers.*

Q33. The diagram shows a simple form of a transformer used for stepping down an alternating voltage supply.



a. Explain how the transformer works.
b. If the input voltage to the transformer is 11000V and the transformer changes this to 415V. The power input of the transformer is 800kW.
(i). Calculate the current in the secondary coil of the transformer.
(ii). What assumption have you made in your calculation?

Answers.

a. *The alternating current creates a moving magnetic field in the primary coil which continuously reverses its direction. The magnetic lines of force of this moving magnetic field continuously cut the wire in the secondary coil thereby producing current by electromagnetic induction.*
The secondary coil in a step-down transformer has less turns in its coil therefore, less lines of force cut the wire. This produces less voltage than the input voltage.

b. *i.* *Power input = Power output.*
$800\,000 = Vs \times Is$
$800\,000 = 415 \times Is$

$$Is = \frac{800\,000}{415}$$

Therefore, Is = 1928 A

ii. *The transformer is 100% efficient.*

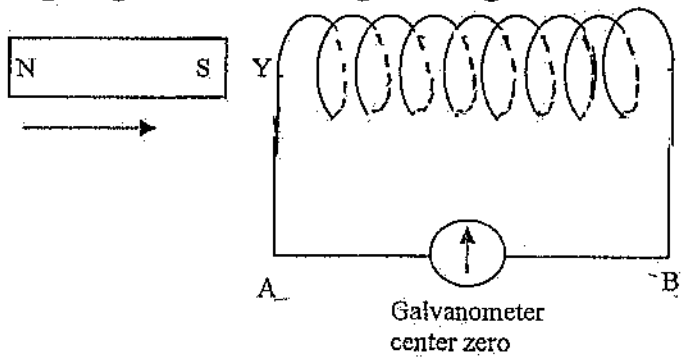
Q34. Explain why the core of a transformer needs to be laminated.

Answer.
To reduce eddy currents in the iron core which decrease the efficiency of the transformer.

Q35. How does a step-up transformer differ from a step-down transformer?

Answer.
A step-up transformer has more turns in the secondary coil than primary coil while a step-down transformer has more turns in the primary coil than secondary coil.

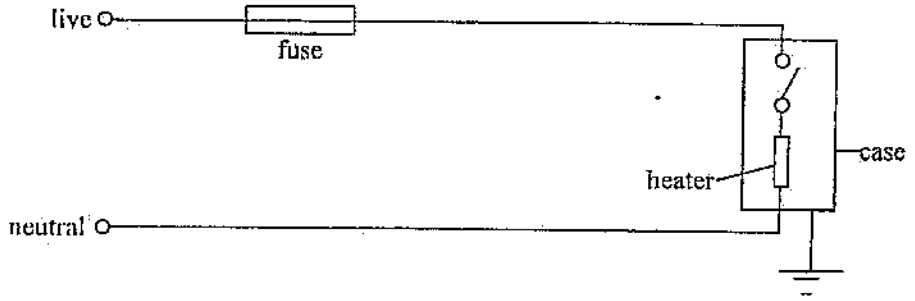
Q36. The following diagram shows a magnet being moved towards a coil.



a. As current is being induced in the coil, what type of pole is formed at end Y of the coil? Give a reason for your answer.
b. In which direction does the conventional current flow through the meter, AB or BA?

Answers.
a. A south pole is formed because according to Lenz's Law, the direction of the induced current is such that it opposes the change producing it.
b. In the direction of AB.

Q37. The diagram shows the mains wiring to an electric heater. The heater shown has an earth wire attached to the case. If the live wire accidentally touches the case of the heater, the earth wire makes the heater electrically safe. Explain.



Answer.
The earth wire safely conducts the electrons to the ground at the same time the fuse melts, so the equipment is protected and there is no danger to a person touching the equipment

Q38. An electromagnet has a core.

a. What is the purpose of the core?

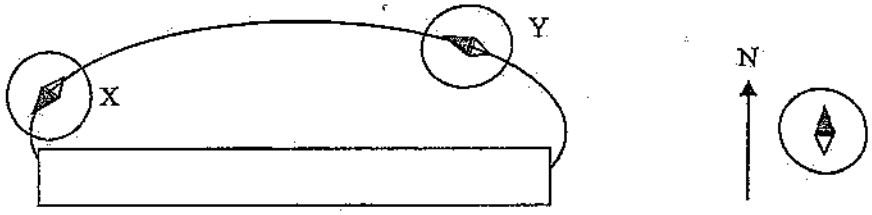
b. Why is iron a better material for the core than steel?

Answers.

a. The core increases the strength of the magnet.

b. By design, an electromagnet is easily magnetised and demagnetised. Iron is a soft magnetic material therefore easy to magnetise and loses its magnetism quickly compared to steel which is a hard magnetic material, difficult to magnetise and once magnetised does not easily lose its magnetism.

Q39. a. Copy the following diagram and mark in the poles of the magnet to show which one is the North pole and which one is the South pole.

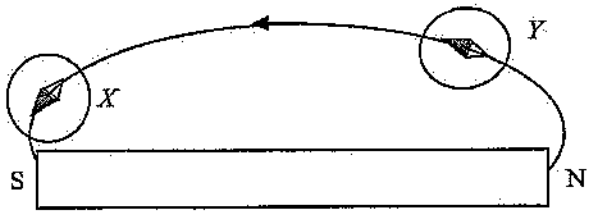


b. Draw an arrowhead on the field line to show its direction.

c. At which position, X or Y, would you expect the magnetic field to be stronger?

Answers.

a/b.



c. Point X.

Q40. A transformer has a turns ratio of $^1/_4$. Its input coil is connected to a 12V a.c supply. Assuming the transformer is 100% efficient,

a. What is the output voltage?

b. What turns ratio will be required for an output voltage of 36V?

Answers.

a. $\frac{Np}{Ns} = \frac{1}{4}$ *therefore,* $\frac{1}{4} = \frac{Vp}{Vs}$

$Vs = Vp \times 4$

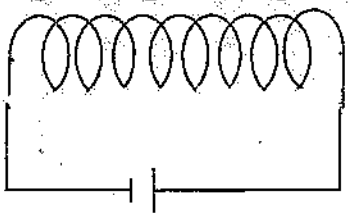
$Vs = 12 \times 4$

$Vs = 48V$

The output voltage is 48 volts.

b. Required turns ratio $= \frac{12}{36} = \frac{1}{3}$

Q41. The coil in the following diagram is producing a magnetic field.

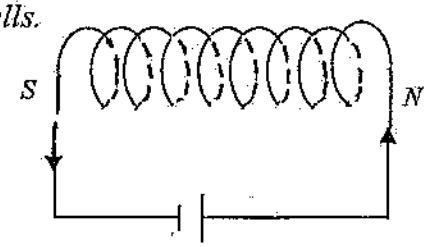


a. Give two ways of increasing the strength of the magnetic field produced.
b. How could the direction of the field be reversed?
c. Copy the diagram. Show the conventional current direction and the North and South pole of the coil.

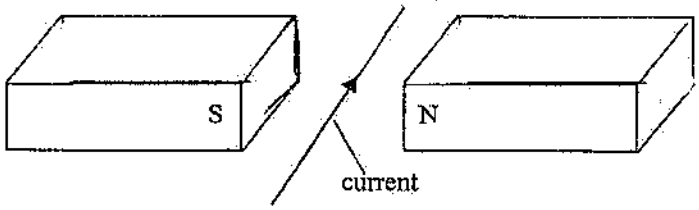
Answers.
a. Increasing the number of turns in the coil.
Increasing the number of cells to produce more current.

b. By reversing the cells.

c.



Q42. There is a force on the wire in the following diagram.



a. Use Fleming's left-hand rule to work out the direction of the force.
b. Give two ways in which the direction of the force could be reversed.

Answers.
a. The force acts upwards.
b. By reversing the poles of the magnet.
By reversing the current which can be achieved by reversing the cells.

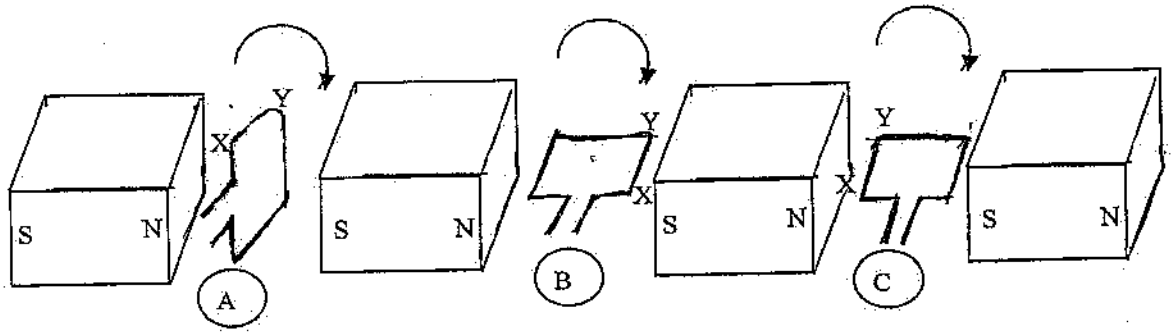
Q43. Which part of a motor changes the current direction every half-turn?

Answer: The commutator.

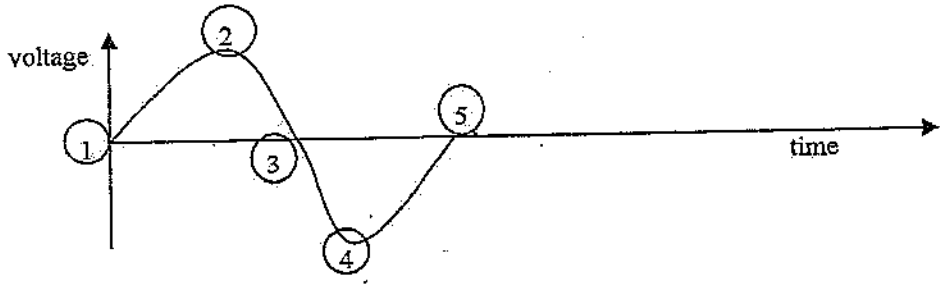
Q44. a. When one of the lights on a Christmas tree breaks , the other lights go out as well. What does this tell you about the way the lights are connected.
b. Give two advantages of connecting bulbs to a battery in parallel.

Answers.
a. It shows that the bulbs are connected in series.
b. The bulbs light with maximum brightness.
When one bulb breaks, the other bulbs still give light.

Q45. The following diagrams, A, B and C show three positions of a coil as it rotates clockwise in a magnetic field produced by two poles.



The diagram below shows how the voltage produced changes as the coil rotates.



a. When the coil is in the position shown by diagram A, the output voltage is zero and is marked as 1 on the voltage time graph. State which point on the voltage-time graph correspond to the coil position shown by:

i. Diagram B

ii. Diagram C.

b. What type of current is induced in the moving coil.

c. Explain how current is induced in the coil.

Answers.

a. i. Position 2.

ii. Position 4.

b. Alternating current.

c. When the coil rotates, it cuts the magnetic field lines of the wire. When a wire cuts through magnetic field lines, current is induced in the wire by electromagnetic induction.

Q46. What type of current is generated by a dynamo? Explain.

Answer.

Alternating current because as the coil rotates, its ends cut the magnetic field lines in two directions. These are upward direction and downward direction. The two opposite directions cause the current to reverse itself every half a cycle. This current is alternating current.

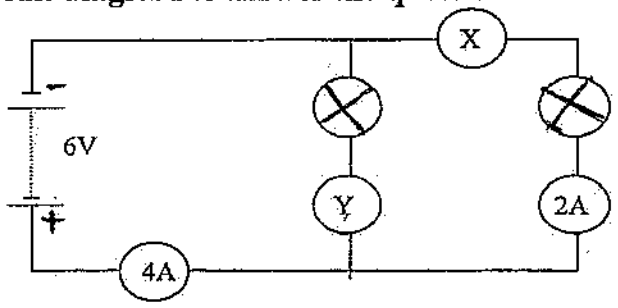
Q47. Calculate the amount of energy supplied to a 60 watts bulb in 1 minute.

Answer: $Energy = Power \times Time = 60\,W \times 60\,s = 3600\,J$

Q48. What is the advantage of using an electromagnet in an electric motor rather than a permanent magnet?

Answer.
A permanent magnet has a fixed field pattern as a result can not be run from an alternating current supply. An electromagnet is a temporally magnet therefore produces a field pattern that matches the alternating current source.

Q49. Use the following circuit diagram to answer the questions.



a. What is the reading of ammeters X and Y?
b. What is the p.d across each of the bulbs?

Answers: *a.* *X reads 2A*
Y reads 2A.
b. *The p.d across each bulb is 6V.*

Q50. A resistor has a steady resistance of 8Ω.
a. If the current through the resistor is 2A, what is the p.d across it?
b. What p.d is needed to produce a current of 4A?
c. If the p.d falls to 6V, what is the current?

Answers.

a. *Potential difference = current x resistance = 8 x 2 = 16V.*
b. *Potential difference = current x resistance = 4 x 8 = 32 V.*
c. $Current = \frac{voltage}{resistance} = \frac{6}{4} = 1.5\,A$

Q 51. Why should the switch always be in the live wire rather than the neutral?

Answer.
If connected in the neutral wire, the live wire would still be live with the switch off.

Q52. Give one advantage of a secondary cell over a primary cell.

Answer: *Secondary cells can be recharged while primary cells can not be recharged.*

Q53. Differentiate between ohmic and non-ohmic conductor.

Answer: *An ohmic conductor obeys ohm's law while a non-ohmic conductor does not obey ohm's law.*

Q54. A light bulb has a power of 36 watts when connected to 12 volts supply. What is the current through it?

Answer: $Current = \frac{Power}{Voltage} = \frac{36\ W}{12\ V} = 3\ A$

Q55. a. Define *'electrical power'*

b. What are the SI units of electrical power?

c. What power is dissipated in a 5Ω resistor when the current through it is 2A?

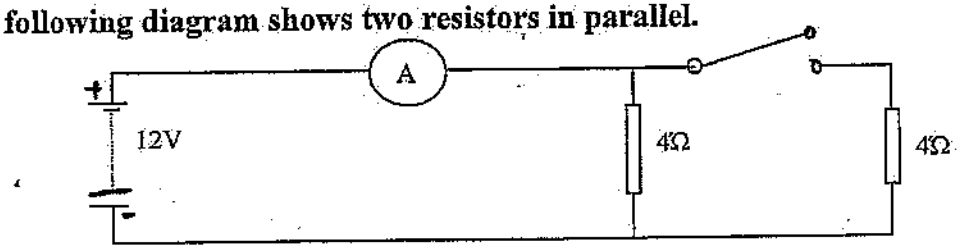
Answers.

a. Electrical power is the rate of using electrical energy.

b. Electrical power is measured in watts.

c. $Power = voltage\ x\ current$
$= (current)^2\ x\ resistance$
$= 2\ x\ 2\ x\ 5\ watts$
$= 20\ watts$

Q56. The following diagram shows two resistors in parallel.



a. What is the ammeter reading when the switch is open?

b. When the switch is closed, what is the current in each of the 4 ohm resistors?

c. What does the ammeter read when the switch is closed?

d. Calculate the combined resistance when the switch is closed.

Answers.

a. $Current = \frac{voltage}{resistance}$

$= \frac{12}{4} = 3\ A$

c. The ammeter reads 6 A.

d. Combined resistance is 2 Ω

b. $Total\ resistance = \frac{4\ x\ 4}{4\ +\ 4} = \frac{16}{8} = 2\ \Omega$

$Total\ current = \frac{voltage}{resistance} = \frac{12}{2} = 6\ A$

$Current\ in\ each\ resistor = \frac{6A}{2} = 3\ A.$

Q 57. Why is it that some appliances do not have an earth wire?

Answer

This is because their outer casing is made of plastic not metal. There is no immediate danger if the live wire happens to touch the plastic casing.

Q58. Define the kilowatt hour.

Answer: The kWh is the amount of energy supplied in one hour if the power is 1000W.

Q59. A student was provided with the following apparatus; a cell, voltmeter, connecting wires, switch, ammeter, rheostat and a piece of nichrome wire.

a. Draw a circuit diagram to show how these apparatus may be arranged to verify Ohm's Law.

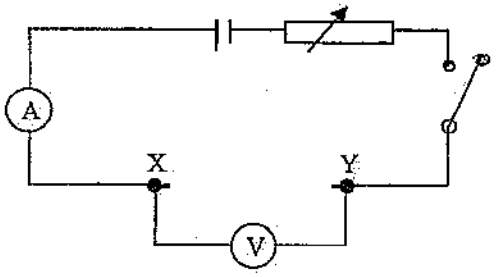
b. Describe a procedure on how the experiment may be done.

c. State the measurements that were to be made.

d. Show how the measurements are to be used.

Answers

a. The apparatus is arranged as shown below.



b/c The nichrome wire is connected between points X and Y. The switch is closed and the voltmeter and ammeter readings taken and recorded. The voltage is varied using the rheostat and each time the voltage is varied, the corresponding current value is taken and recorded.

d. A graph of current against voltage is plotted using the results obtained. A straight line graph verifies Ohm's Law.

Q60. Define the following terms:

a. Potential difference b. Electromotive force c. Electrical resistance.

Answers.

a. Potential difference is the work done when one coulomb of charge moves from one point to another in a circuit.

b. Electromotive force is the potential difference at the terminals of a source in an open circuit.

c. Electrical resistance is the opposition to the flow of current in a circuit.

Q61. An electric kettle comes with the following label.

2400W	240V
AC; 50Hz	

a. Explain the meaning of the following.

i. AC only.

ii. 50 Hz.

b. What is the power rating of the kettle in kilowatts?

Answers.

a. i. AC only means the kettle should be used with alternating current only.

ii. 50Hz means the frequency of the alternating current should be 50 cycles per second.

b. 2.4 kW

Q62. What is the purpose of a circuit breaker?

Answer.
A circuit breaker is an automatic switch which acts as a protective device. It cuts the circuit when there is an electrical fault or a power surge.

Q63. Explain the importance of earthing in electrical appliances.

Answer.
Earth wire provides a safe route for current in case the live wire touches the casing of an appliance.

Q64. a. What is the cause of power loss when transmitting power over long distance?
b. How can the power loss mentioned in (a) above be minimised?

Answers.
a. The heating effect due to resistance of the wire.
b. By using thick wires to reduce resistance.

Q65. How does cross-sectional area of a conductor affect its resistance?

Answer: Resistance is inversely proportional to cross-sectional area of a conductor.

Q66. Give three reasons why transformers are not 100% efficient.

Answer
Some energy is lost inform of heat due to the resistance of the primary and secondary coils.
Eddy currents in the iron core also result in energy loss inform of heat.
Flux leakage.

Q67. Two resistors have a combined resistance of 20 ohms when connected in series and 4.8 ohms when connected in parallel. What are their values?

Answer.
Let the values of the resistors be x and y.
When connected in series

$$x + y = 20$$
$$x = 20 - y$$

When connected in parallel

$$\frac{xy}{x+y} = 4.8$$

Therefore: $\frac{xy}{20} = 4.8$ *(since* $x + y = 20$*)*

$$xy = 4.8 \times 20 = 96.$$

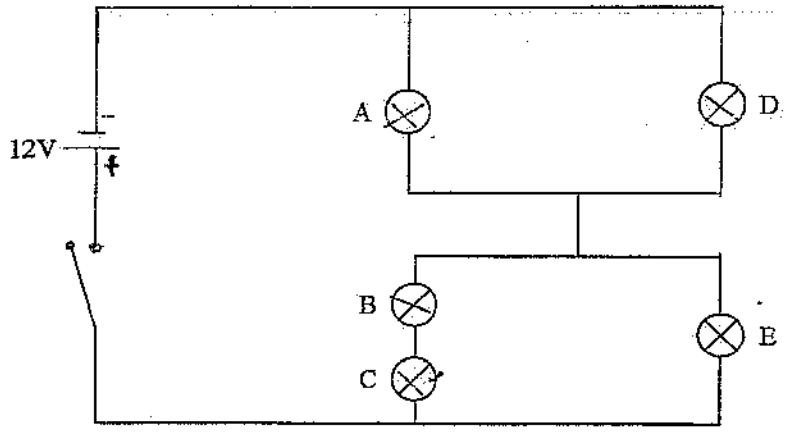
By substitution: $y(20 - y) = 96$

$$20y - y^2 = 96$$
$$y^2 - 20y + 96 = 0$$
$$(y - 12)(y - 8) = 0$$

Therefore: $y = 12$ *or* $y = 8$
If $y = 12$, $x = 8$
If $y = 8$, $x = 12$

The values of the resistors are 8Ω and 12Ω

Q68. The following diagram shows 5 identical bulbs, A to E, in a circuit. Each bulb has a resistance of 6 ohms.



a. Find the total resistance in the circuit. Show your working.

b. When the switch is closed, which bulb or bulbs will be:
i. Brightest.
ii. Most dim.

c. Explain your choices in part (c) above.

d. Draw a circuit diagram to show how the five bulbs can be connected to give maximum equal brightness.

Answers.

a. *Combined resistance of bulbs A and D* $= \frac{6 \times 6}{6 + 6} = \frac{36}{12} = 3\,\Omega$

Combined resistance of B and C $= 6\,\Omega + 6\,\Omega = 12\,\Omega$

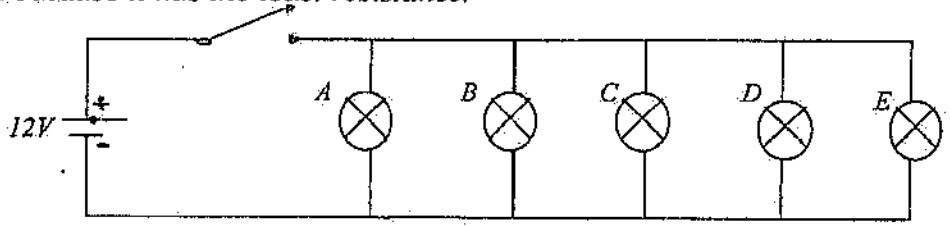
Combined resistance of B, C and E $= \frac{12 \times 6}{12 + 6} = \frac{72}{18} = 4\,\Omega$

Therefore, total resistance in the circuit $= 3\,\Omega + 4\,\Omega = 7\,\Omega$

b. *i. E*
ii. B and C

c. *Least current passes through bulbs B and C because of the high resistance of the two bulbs connected in series consequently highest current passes through bulb E because it has the least resistance.*

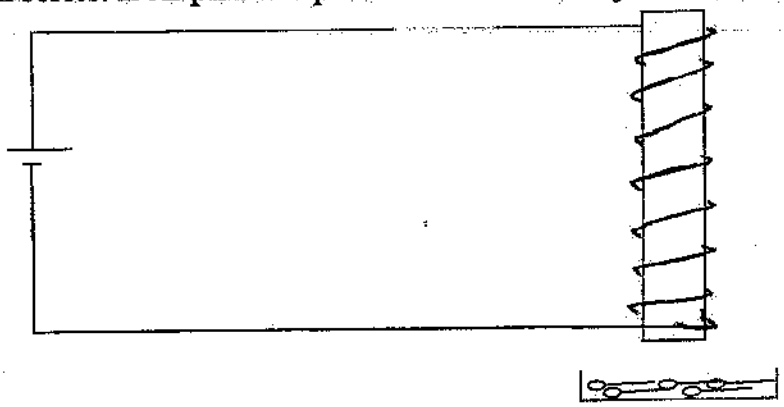
d.



Q69. State two advantages of alternating current over direct current.

Answers.
Alternating current is easy to step up or step down than direct current.
With alternating current it is easy to transfer energy from power station to consumer with minimum energy loses using transformers.

Q70. The following diagram shows a circuit in which a solenoid, a cell and a switch are connected in series. Iron pins are placed in a container just below the solenoid.



a. **What will you observe when the switch is closed for sometime and later opened? Explain your answer.**
b. **Give an example of an appliance where an electromagnet is used.**
c. **Mention two advantages of using an electromagnet instead of a permanent magnet in the appliance mentioned in part (c).**

Answers.

a. When the switch is closed, iron pins will be attracted to the solenoid. When the switch is opened, iron pins drop back into the container.

Iron pins are attracted because when the switch is closed, current flows and the solenoid is magnetised. It therefore attracts the pins. When the switch is opened, current stops flowing, the solenoid is demagnetised and does not attract the pins anymore, the pins fall back into the container.

b. Electric bell.
c. Strength of the electromagnet can be varied easily while the strength of a permanent magnet can not be varied easily.

Easily magnetised and demagnetised making the bell ring continuously while permanent magnet can not be easily magnetised and demagnetised to make the bell work.

Q71. a. Explain how current is produced in the coil of a dynamo.
b. Describe the energy changes that take place when a bulb is connected to a rotating dynamo.

Answers.

a. In a dynamo, a coil is positioned in a magnetic field. As the coil rotates, the wire cuts the magnetic field lines as a result current is induced in the wire of the coil by electromagnetic induction. The wire cuts the field lines from two opposite directions therefore the induced current reverses its direction continuously. The current produced is therefore alternating current.

b. Kinetic energy ⟶ electrical energy ⟶ heat energy + light energy.

Q72. The following information appears on the plate of an electric heater in normal use.

Electrical Supply	*220V*
Maximum Power	*2 200 W*
WARNING: This appliance must be earthed.	

a. Calculate the current which will flow through the element of the heater.
b. Calculate the resistance of the element of the heater.
c. How much electrical energy in joules would this heater use in 5 minutes at maximum power?

Answers.

a. $Power = voltage \times current$, $Current = \frac{Power}{voltage} = \frac{2200W}{220\,V} = 10\,A.$

b. $Voltage = current \times resistance$, $Resistance = \frac{voltage}{current} = \frac{220V}{10\,A} = 22\,\Omega$

c. $Energy = power \times time = 2200W \times 5 \times 60\,s = 660\,000\,J.$

Q73. The voltage in a secondary coil of a transformer is 24V, what is the voltage in the primary coil if the transformer has a turns ratio of 10:1?

Answer: $V_s = 24V$, $V_p = ?$, *Turns ratio* $= 10 : 1.$

$\frac{V_p}{V_s} = \frac{10}{1}$ *Therefore,* $V_p = V_s \times 10 = 24V \times 10 = 240V$

Q74. a. What kind of energy is produced in a 12Ω resistor if 1.5A of electric current flows through it?
b. Calculate the amount of energy produced in the resistor if the current flows for 10 minutes.

Answers.

a. *Heat energy.*

b. $Energy = (current)^2 \times resistance \times time$
$= 1.5 \times 1.5 \times 12 \times 10 \times 60\ joules$
$= 16{,}200\ joules.$

Q75. Explain why voltmeters are connected in parallel while ammeters are connected in series.

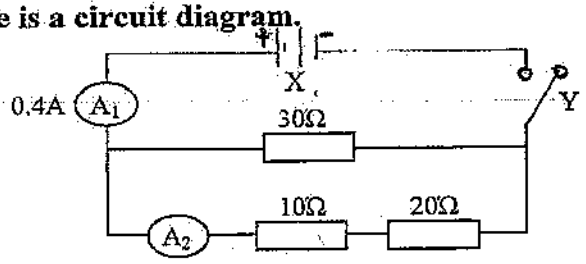
Answer.

A voltmeter is connected in parallel because it measures the potential difference between any two points in the circuit while an ammeter is connected in series because it measures the current passing through a point in the circuit and to do that current has to pass through it.

Q76. Explain the difference between an electric motor and an electric generator.

Answer: *An electric motor converts electric energy into kinetic energy while an electric generator converts kinetic energy into electric energy.*

Q77. The following figure is a circuit diagram.



a. Name components labelled X and Y
b. Calculate the total resistance in the circuit.
c. Calculate the current in the 30Ω resistor.
d. Work out the voltage across the 10Ω resistor.
e. Calculate the electromotive force of the battery ignoring internal resistance.

Answers.

a. X is battery
Y is switch.

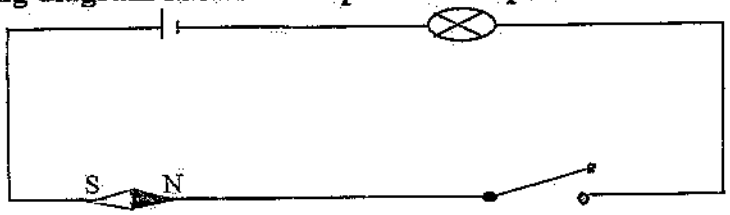
b. Total resistance in the circuit $= \frac{30\,(10 + 20)}{(10 + 20) + 30} = \frac{900}{60} = 15\Omega.$

c. $Current = \frac{0.4A}{2} = 0.2\,A$

d. Voltage = current x resistance = 0.2A x 10Ω = 2V.

e. Electromotive force = total current x total resistance
= 0.4 A x 15Ω = 6 V.

Q78. The following diagram shows a compass needle placed under a connecting wire.

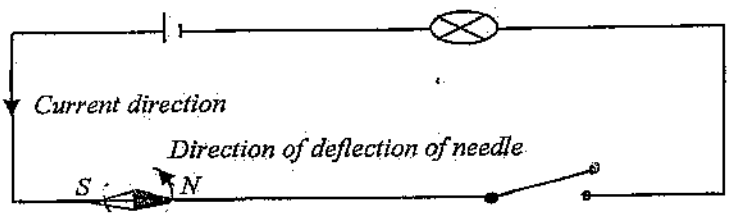


a. Draw arrows on the diagram to show, when the switch is closed, the direction of movement of: i. the compass needle.
ii. the current.

b. What effect would the following changes have on the movement of the compass needle? i. Reversing the cell.
ii. Increasing the number of cells.

Answers.

a.



b. i. Reversing the cell reverses the direction of movement of the needle.

ii. Increasing the number of cell increases the deflection of the needle.

Q79. Are head lamps of a car connected in series or parallel? Give reason.

Answer.
They are connected in parallel because if one head lamp blows off, the remaining head lamp still works.

Q80. The power rating of a television is 150W. How much energy in kWh will it use in 10 hours?

Answer: $150\ W = 0.15\ kW$

$Energy\ in\ kWh = power\ (kW) \times time\ (h)$

$= 0.15kW \times 10\ h = 1.5\ kWh.$

Q81. a. 6kW of power is fed to a transmission cable of resistance 3Ω. Calculate the power wasted in the cable if power is transmitted at 300V.

b. Suggest one way how power wastage can be reduced in the transmission cable in part (a) above.

Answers.

a. $Power = \frac{(Voltage)^2}{resistance} = \frac{300 \times 300}{3} = \frac{90000}{3} = 30{,}000W.$

Power wasted = 30 kW.

b. *By increasing the diameter of the transmission cable.*

Q82. a. Mention any three causes of energy loss in a transformer.

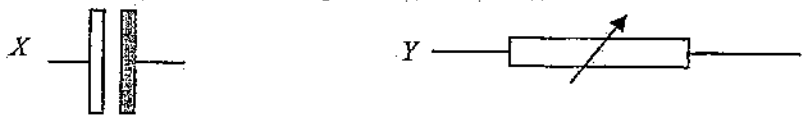
b. Explain how each cause of energy loss mentioned in part (a) can be minimised.

Answers.

a. *Eddy currents*
Resistance of the coil.
Flux leakages

b. *Eddy currents can be minimised by using laminated iron core.*
Resistance of the coil can be minimised by using a thicker copper wire to make the coils.
Flux leakages can be minimised by winding the primary and secondary coils next or close to each other. Alternatively, it can be minimised by winding the secondary coil on top of the primary coil.

Q83. What do the following electrical symbols stand for?



Answers: X is a capacitor

Y is a variable resistor

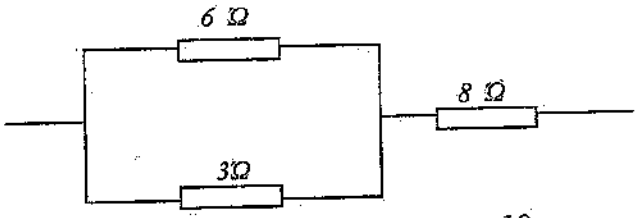
Q84. In a circuit diagram, a 6 Ω and a 3Ω resistor are connected in parallel and an 8Ω resistor is connected in series with them.

a. Draw a circuit diagram using the given the information.

b. Calculate the total resistance in the circuit.

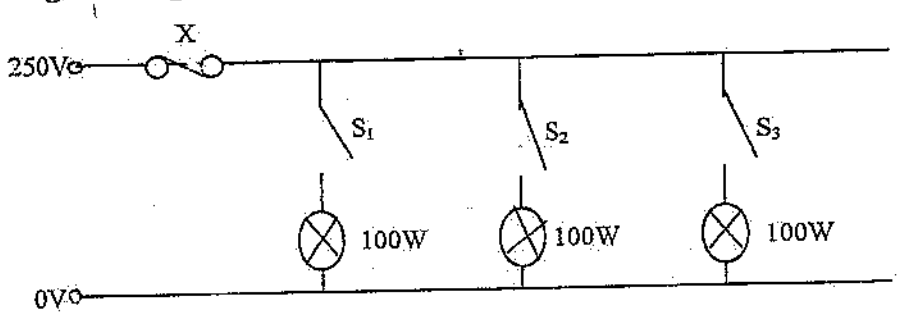
Answers.

a.



b. $Total\ resistance = \frac{6 \times 3}{6 + 3} + 8 = \frac{18}{9} + 8 = 10\,\Omega.$

Q85. The following is a diagram of an electric circuit of a house.



a. Name the type of circuit shown in the diagram.

b. Give two reasons why this type of circuit is preferred in the of wiring houses.

c. Name the device labelled X.

d. Explain the importance of including device X in the circuit.

Answers.

a. Parallel circuit.

b. Each and every component in the circuit functions independently, so if one component stops functioning and there is no current passing through that component, the remaining components function perfectly.

Total resistance in the circuit is reduced allowing the components to work at maximum current.

c. X is a fuse.

d. It melts if there is too much current flowing in the circuit thereby preventing any damage to the components in the circuit.

Q86. Give any two methods of magnetizing a magnet.

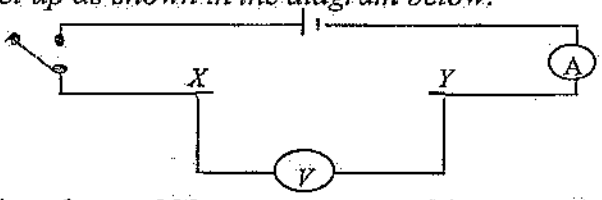
Answers.

a. By stroking method.

b. By using direct current where the material to magnetised is placed inside a solenoid which is part of a complete circuit.

Q87. Describe an experiment that can be done to show that electrical resistance of a wire varies directly proportional to the length of the wire.

Answer.
To show that resistance of a wire varies directly proportional to the length of the wire, the experiment is set up as shown in the diagram below:



A wire of known length say 100 cm is connected between the points X and Y. The switch is closed, the ammeter reading and voltmeter reading are then recorded in a table as shown below. Once the readings have been taken and recorded, the switch is opened.

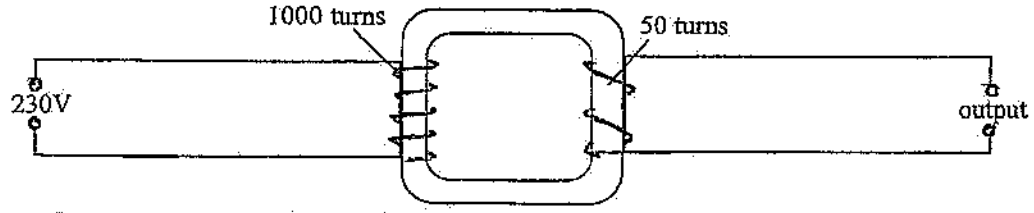
The procedure is repeated for the same wire but varying lengths of say 80cm, 60cm, 40cm and 20cm. For each length of wire, the ammeter and voltmeter readings are recorded as shown in the table below.

LENGTH OF WIRE (cm)	AMMETER READING (I)	VOLTMETER READING (v)	ELETRICAL RESISTANCE (V/I)
100			
80			
60			
40			
20			

From each voltmeter reading and ammeter reading, a corresponding electrical resistance value is obtained by diving the voltmeter reading by the ammeter reading.

A graph of length of wire against electrical resistance is then plotted using a graph paper. The graph obtained is a straight line graph showing that electrical resistance is directly proportional to length of the wire.

Q88. The following figure is a diagram of a transformer.

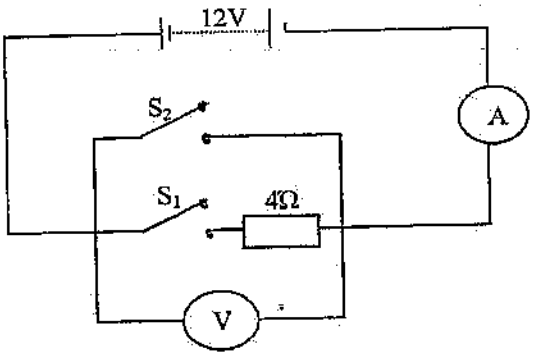


a. Name the type of transformer shown. Give reason.
b. Calculate the output voltage of the transformer.

Answers: *a.* *Step down transformer.*
b. $V_p = 230\ V, \quad N_p = 1000, \quad V_s = ?, \quad N_s = 50.$

$$V_s = \frac{N_s \times V_p}{N_p} = \frac{50 \times 230}{1000} = 11.5\ V$$

Q89. The following figure is a diagram of an electric circuit.



a. **If S_1 is closed and S_2 is open, calculate the ammeter and voltmeter reading.**
b. **What will be the effect on the voltmeter reading if both switches are closed? Give reason for your answer.**

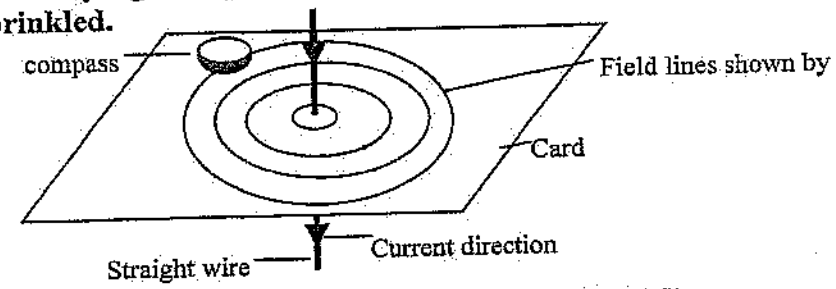
Answers.

a. $Current = \frac{voltage}{resistance} = \frac{12\ V}{4\Omega} = 3\ A.$ *Therefore, the ammeter reads 3A.*

Voltage across the 4 Ω resistor $= 3\ A \times 4\ \Omega = 12\ V$
Therefore, the voltmeter reads 12 V.

b. If both switches are closed, the voltmeter reading is zero because there will be a short circuit and no current flows through the 4 ohm resistor.

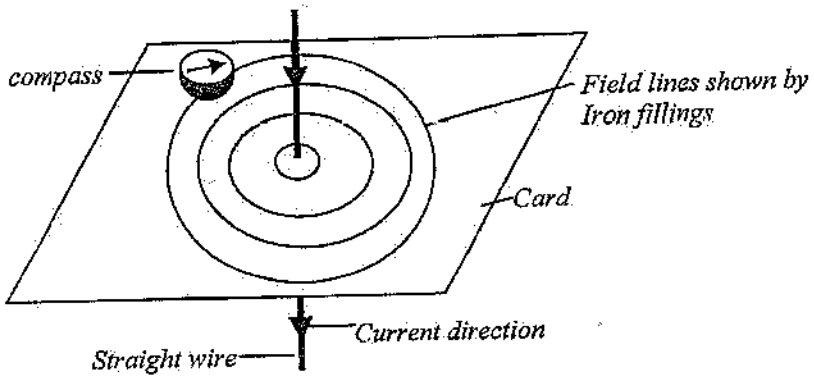
Q90. The following figure is a diagram showing an experiment on electromagnetism in which a current carrying wire passes through the centre of a card on which iron fillings were sprinkled.



a. **Draw an arrow in the compass to show direction of field lines.**
b. **What would happen to the direction of the compass needle if the direction of the current was reversed? Give reason.**

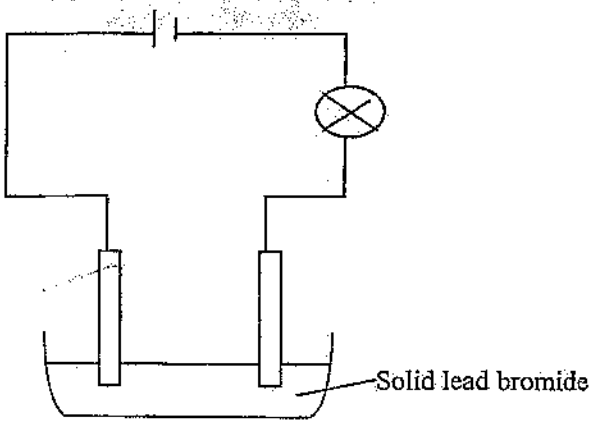
Answers

a.



b. Compass needle would change direction and point in the opposite direction because reversing current reverses direction of filed lines.

Q91. a. In the following diagram, the bulb does not light up, explain.



b. What would you do to make the bulb light up?

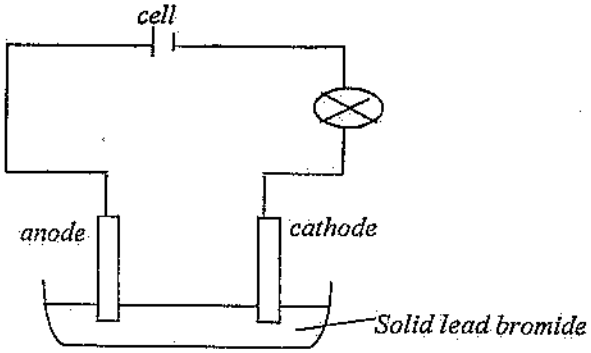
c. Copy the diagram and label the following:
i. cathode ii. anode iii. Cell.

Answers.

a. The ions in solid lead bromide are held in fixed positions by the strong ionic bonds hence are not free to move.

b. Heat the solid lead bromide untill it melts and maintain the heat to keep it in molten state.

c.



Q92. A current of 2A flows through an electric heater connected to a voltage supply of 240V. Calculate

a. Resistance of the element

b. Power dissipated by the heater.

c. Cost of running the heater for three hours at K5/kWh.

Answers.

a. $Resistance = \frac{voltage}{current} = \frac{240\ V}{2\ A} = 120\ \Omega.$

b. $Power = voltage \times current = 240\ V \times 2\ A = 480\ W$

c. $480\ W = 0.48\ kW$

$Energy\ used\ in\ kWh = 0.48\ kW \times 3h$

$= 1.44\ kWh$

$Cost\ of\ running\ the\ heater = 1.44kWh \times K5/kWh$

$= K7.20$

Q93. Explain the difference in total resistance between similar resistors connected in series and in parallel.

Answer: *Total resistance in series is greater than total resistance in parallel.*

Q94. Give any two methods of demagnetizing a magnet.

Answers: *By heating the magnet.*
By hammering the magnet.

CHAPTER 6.

INTRODUCTORY ELECTRONICS

27 QUESTIONS WITH ANSWERS

To the student.

Before attempting the following questions, you are STRONGLY ADVISED to read the chapter in your notes or one of the books listed below.

After reading the chapter, test your understanding by answering the 27 questions in this chapter. Cross check your answers with the answers provided.

The following list of books is not exhaustive.

1. Keith Wallis, Chanco Physical Science for Malawi, Book 2 (3rd edition), pages 261-273.

2. Samuel Kalea, MSCE Physical Science (New edition), pages 146-150.

3. Tom Duncane, GCSE Physics (4th edition), pages 280-285.

3. Mukabi Murigi etal, KCSE Golden Tips Physics, pages 192-198.

4. Stephen Pople, Complete Physics, pages 239-247.

5. Keith Johnson, Physics for You (Revised edition), pages 322-331.

Q1. What is the effect of temperature rise on electrical resistance of the following materials:

a. Conductors. b. Semi-conductors.

Answers.

a. Increase in temperature increases the electrical resistance of conductors.

b. Increase in temperature decreases the electrical resistance of semi-conductors.

Q2. Define the term *'doping'* in semi-conductors.

Answer.

Doping is the introduction of a foreign element into a semi-conductor to improve its electrical conductivity.

Q3. Mention any two applications of junction diodes.

Answers: Rectification

Protecting equipment such as radios and computers.

Q4. What is the purpose of a rectifier?

Answer: A rectifier transforms alternating current into direct current.

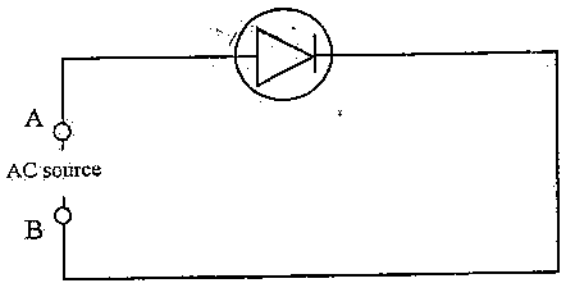
Q5. Why is a capacitor often included in a rectifier circuit?

Answer.

A capacitor ensures that the output voltage is smooth. It stores some energy when charge flows to it and discharges smoothly when the output voltage falls.

Q6. With the aid of a diagram, explain how a p-n junction diode can be used as a rectifier.

Answer.



A p-n junction diode can be used as a rectifier because it only allows current to flow in one direction and blocks current in the reverse direction.

If the diode is part of a circuit with an alternating source as shown in the diagram above, then in the first half cycle A is positive with respect to B . The diode is forward biased and current flows in the circuit from point A through the diode to point B. In the second half cycle A is negative with respect to B. The diode is reverse biased and no current flows in the reverse direction.

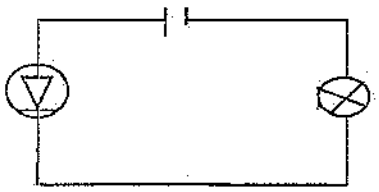
Therefore, although there is an alternating source in the circuit, current flows in one direction because of use of the diode.

Q7. Explain the difference between an extrinsic and intrinsic semiconductor.

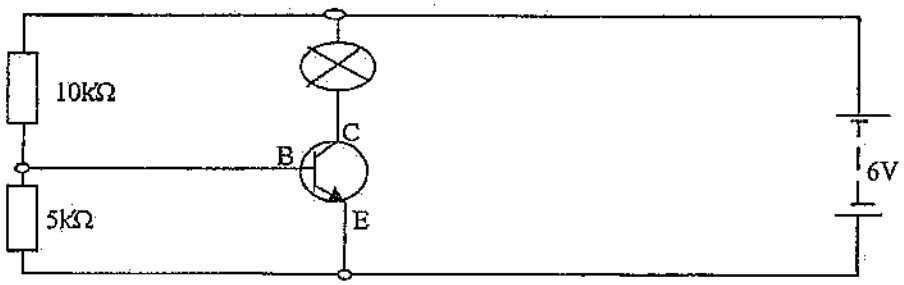
Answer
Extrinsic semiconductors are impure semiconductors produced through a process known as doping while intrinsic semi-conductors are pure semiconductors.

Q8. Draw a circuit diagram in which a bulb, a cell and a diode are connected in series such that the diode is forward biased.

Answer.



Q9. Use the following circuit to answer the questions that follow.



a. What do the letters E, B and C stand for?
b. What it the function of the two resistors?
c. Does the bulb light or not?
d. What would be the effect of replacing the lower resistor with a short piece of connecting wire?

Answers.
a. E: emitter, B: base, C: collector.
b. The two resistors act as potential dividers.
c. The bulb lights.
d. The bulb will not light.

Q10. Mention two types of semiconductors.

Answer: Extrinsic and intrinsic semi-conductors

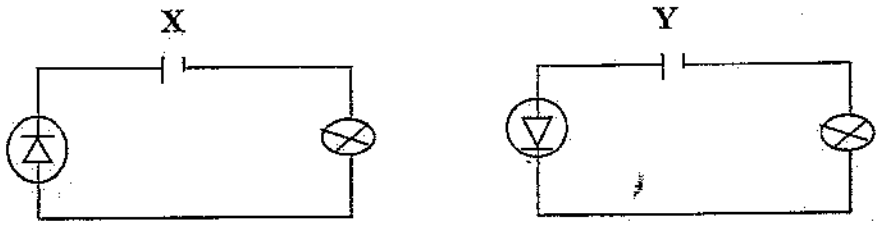
Q11. Mention two types of extrinsic semiconductors.

Answer: p-type and n-type semiconductors.

Q12. State two functions of transistors.

Answers: Used to amplify current.
Used as a switch.

Q13. Use circuits X and Y to answer the following questions



In which circuit:

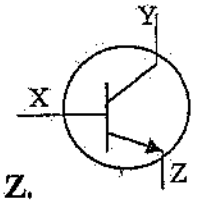
a. Does the bulb light up?
b. Does the diode have a very high resistance?
c. Is the diode forward biased?

Answers: a. Circuit Y b. Circuit X c. Circuit Y

Q14. Hoe does the output from a full wave rectifier differ from that of a half wave rectifier?

Answers.
No gaps exist in the output voltage from a full wave rectifier while gaps exist in the output voltage from a half-wave rectifier because for every full cycle of alternating current, half-cycle is in the reverse direction and is blocked by the diode.

Q15. The following figure is a diagram of a transistor.

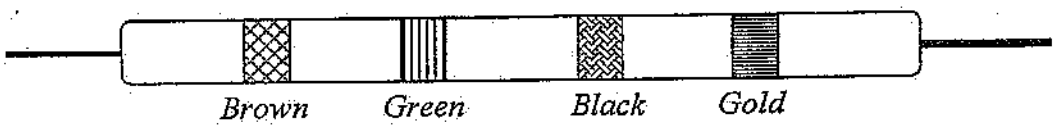


Name the parts labelled X, Y and Z.
Answers: X is Base. Y is Collector and Z is Emitter.

Q16. What is a semi-conductor?

Answer: Is a material that conducts electricity only under certain conditions such as at high temperature.

Q17. The following figure is a diagram of a resistor. What is its resistance?



Answer: The resistance is 15Ω ± 5%.

Q22. What is meant by the following?

a. P-type material. b. n-type material.

Answers.

a. Is a semiconductor material which has got holes in it due to deficiency of electrons.

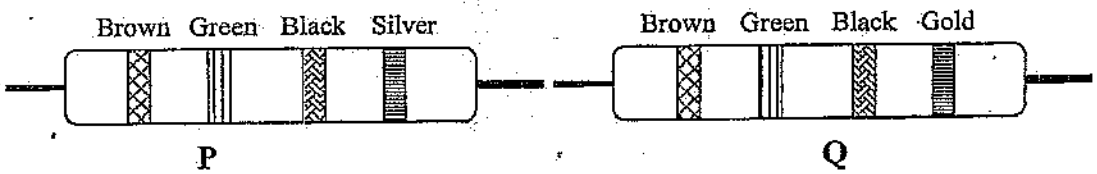
b. Is a semiconductor material which has an excess of electrons.

Q23. In terms of the band theory of conduction in solids, what is the main difference between conductors and insulators?

Answer.

Insulators have a wide forbidden gap. Electrons need a lot of energy to move from the valence band across the forbidden gap to occupy the conduction band as a result, there are no electrons in the conduction band. On the other hand, conduction band and valence band overlap in conductors as a result, electrons move freely to occupy the conduction band even at low temperatures leaving the conduction band always occupied by electrons.

Q24. The following is a diagram of two resistors marked P and Q.



a. What is the resistance of resistor P?

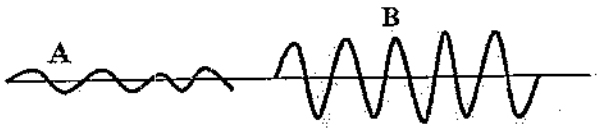
b. What is the advantage of using resistor P in the circuit than resistor Q?

Answers.

a. The resistance is 15Ω ± 10%.

b. P can operate over a wider range of current values without breaking when used in a circuit compared to Q.

Q25. Study the diagram below and answer the questions that follow.



a. Which wave form is in the base circuit of the transistor? Explain.

a. Which wave form is in the collector-emmiter circuit of the transistor? Explain.

c. What transducer was used in the base circuit to produce wave form in (A)?

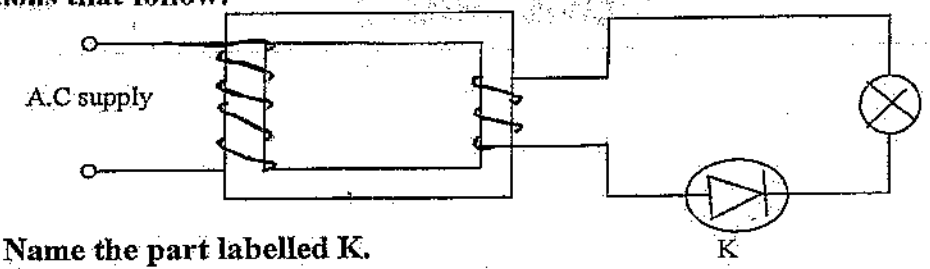
Answers.

a. Wave form A. This is because a small current flows in the base circuit. This is shown by the small wave amplitude.

b. Wave form B. this is because a large current flows in the collector-emitter circuit. This is shown by the large wave amplitude.

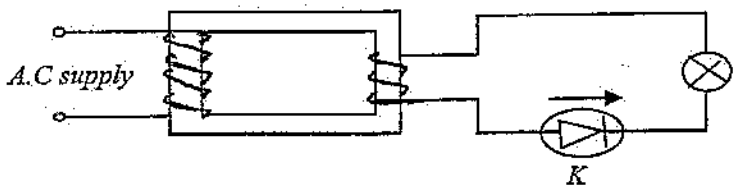
c. A resistor was used.

Q18. Examine the following diagram which is part of an electric circuit and answer the questions that follow.

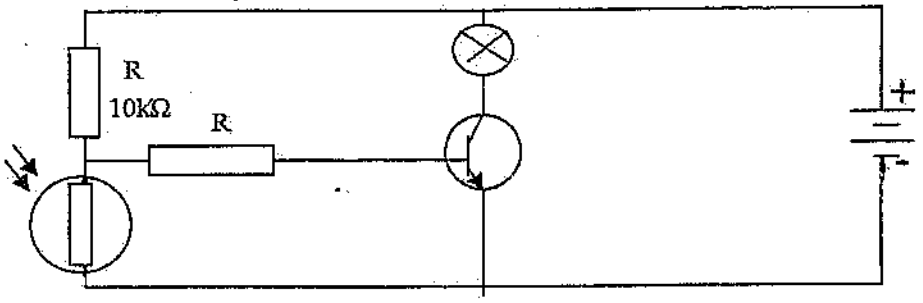


a. Name the part labelled K.
b. How is K being used in the circuit?
c. Draw an arrow above K in the circuit to show the direction of flow of the current.

Answers: *a. K is a diode.* *b. K is used as a rectifier*
c.



Q19. Study the following diagram carefully and answer the questions that follow.



a. What happens to the bulb when there is bright light? Explain your answer.
b. What happens to the bulb when it is dark? Explain your answer.

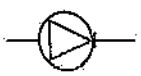
Answers.
a. The bulb lights because sunlight causes the light dependant resistor to conduct a small current which passes through the base circuit of the transistor. This causes a large collector current to flow through the transistor.
b. The bulb switches off because no current flows through the light dependant resistor, so there is no base current. Without the small base current, the transistor does not conduct.

Q20. Explain one use of a variable resistor in a circuit.

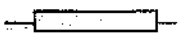
Answer: Used as a potential divider.

Q21. Draw circuit symbols for diode, resistor and transistor.

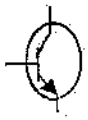
Answers:



diode

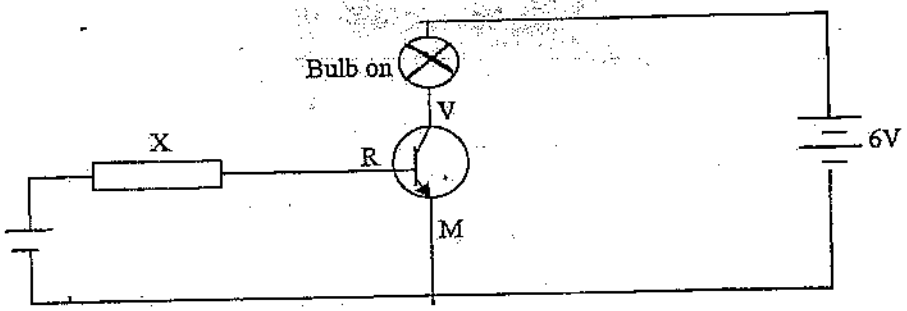


resistor



transistor

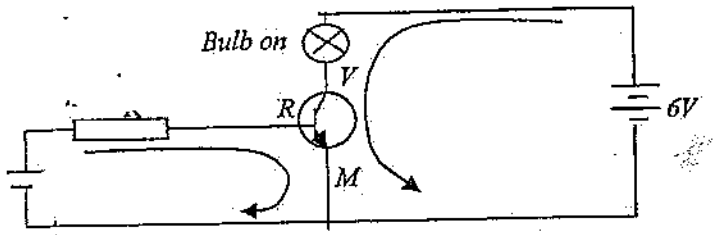
Q26. A working transistor circuit is shown in the diagram below.



a. **Copy the circuit and on it draw the directions of the two electron currents flowing in the circuit.**
b. **Name the part marked X**

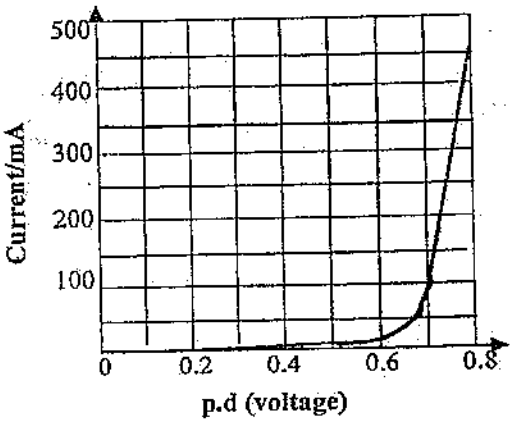
Answers.

a.



b. X is a resistor.

Q27. The following diagram is a graph showing the current flowing through a diode when the potential difference across its ends is increased.



a. **What voltage is necessary before the diode starts conducting reasonably well? What name is given to this voltage?**
b. **What is the current flowing through the diode for an applied voltage of 0.8V?**
c. **Sketch a current against voltage graph for a diode which is reverse biased.**

Answers.

a. 0.60 volts.
It is called threshhold voltage.
b. 475mA

c. *Current against voltage graph for a reverse biased diode.*