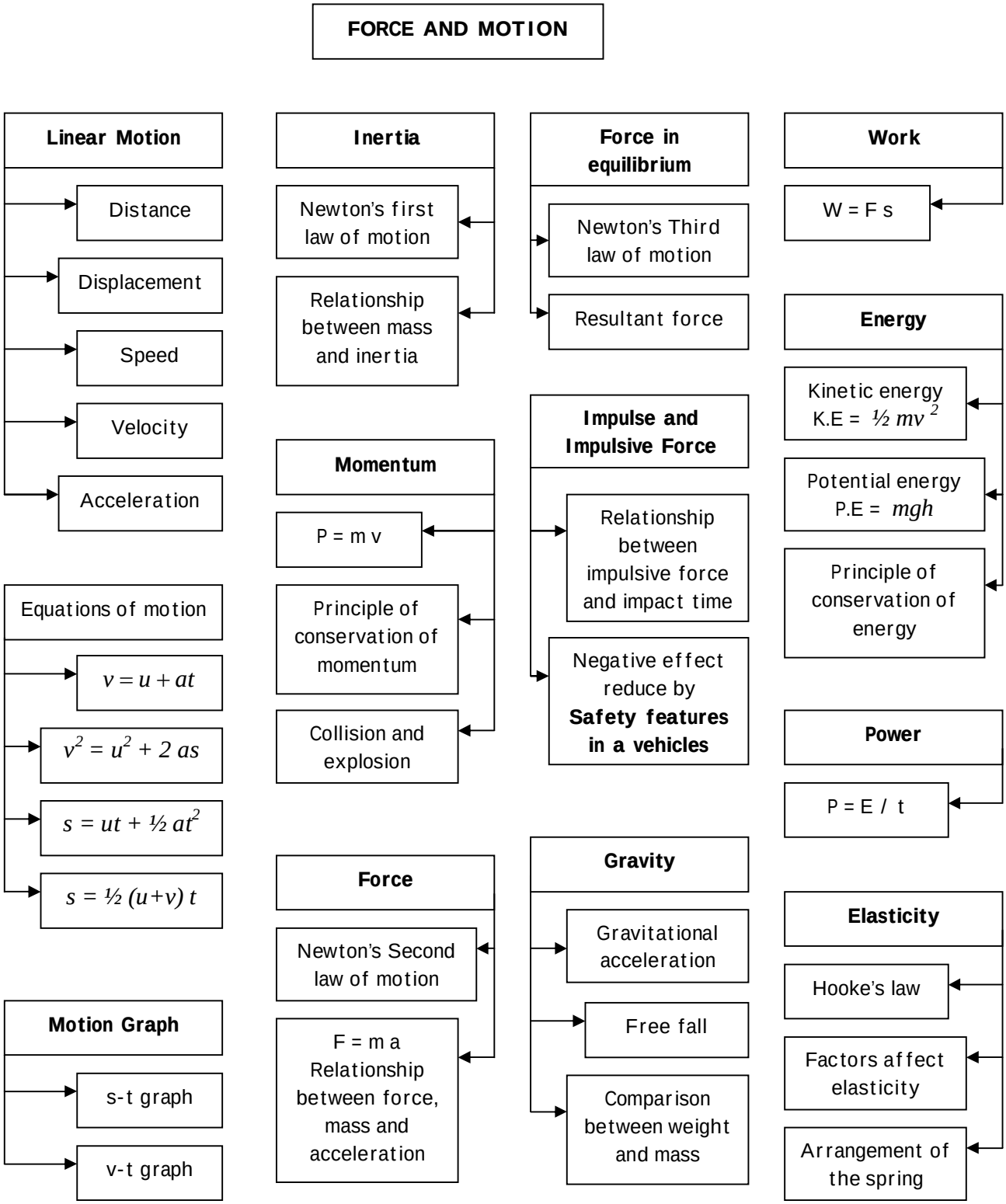
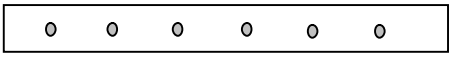
TOPIC 2 : FORCE AND MOTION



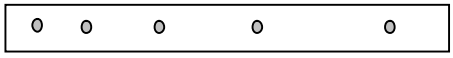
Notes

Physical Quantity	Definition
Distance , d	Total path traveled from one location to another. SI unit – metre, m
Displacement, s	Distance between two location measured along the shortest path connecting them in a specific direction. SI unit – metre, m
Speed, v	Speed, v = $\frac{\text{distance, d}}{\text{Time taken, t}}$ SI unit – ms^{-1}
Velocity, v	Velocity, v = $\frac{\text{displacement, s}}{\text{Time taken, t}}$ SI unit – ms^{-1}
Acceleration, a	Acceleration, a = $\frac{\text{velocity, v}}{\text{Time taken, t}}$ SI unit – ms^{-2}

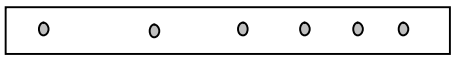
Ticker tape
1 tick = time interval between two dots
Time taken to make 50 ticks = 1 s
Hence 1 tick = 0.02s



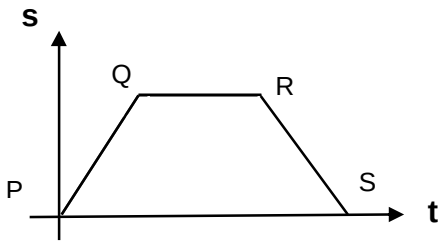
- Constant velocity
- zero acceleration



- increasing velocity
- acceleration



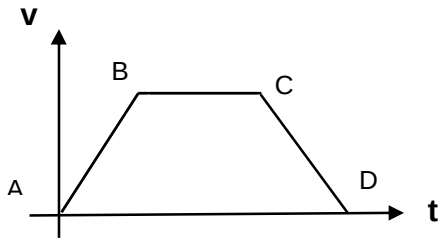
- decreasing velocity
- deceleration



Displacement – time graph

PQ - constant velocity
QR - zero velocity, object at rest
RS - opposite direction with constant velocity

Gradient = velocity

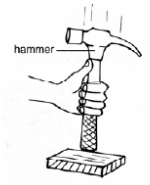
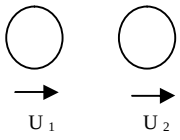
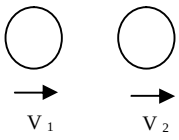
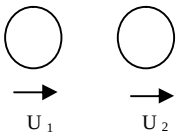
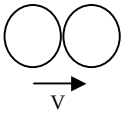
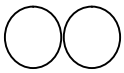
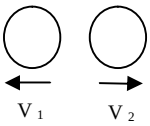
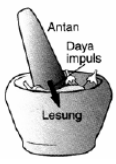
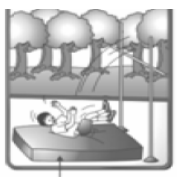


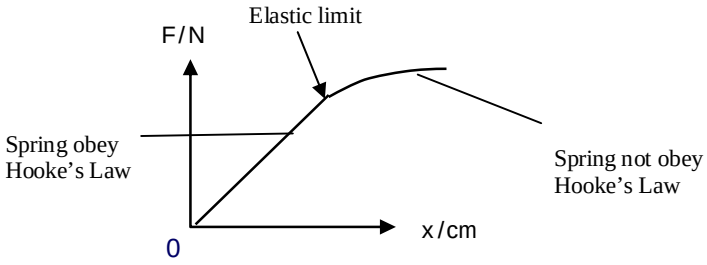
Velocity – time graph

AB – increasing velocity, acceleration
BC – constant velocity, zero acceleration
CD – decreasing velocity, deceleration

Gradient = acceleration
Area under graph = displacement

Inertia	tendency of the object to remain at rest or, if moving, to continue its uniform motion in a straight line
Newton's first law of motion	Object remain at rest or in uniform motion unless it's acted upon by external force
Relationship between mass and inertia	The larger the mass, the larger its inertia

Situation related to inertia	  
Momentum	Momentum, p = mass, m x velocity, v SI unit= kg m s^{-1}
Principle of conservation of momentum	In the absence of an external force, the total momentum of a system remains unchanged.
Elastic collision	 Before collision  After collision
Inelastic collision	 Before collision  After collision
Explosion	 Before collision  After collision
Force	Force, F = mass, m X acceleration, a SI unit= Newton, N
Newton's Second law of motion	The rate of change of momentum is directly proportional to the applied force an acts in the direction of the force
Relationship between a and F	acceleration is directly proportional to force
Relationship between a and m	acceleration is inversely proportional to mass
Impulse	The change of momentum, Ft = mv – mu SI unit= kg m s^{-1}
Impulsive force	$F = \frac{mv - mu}{t}$, SI unit= Newton, N
Relationship between impulsive force and impact time	Longer impact time – impulsive force decrease Shorter impact time – impulsive force increase
Situation related to impulsive force	  
Safety features in vehicles	- Air bags - Crumple zones

	- Shatter-proof windscreen - Safety seat belt - Padded dashboard
Gravitational force	Pulled by the force of gravity – tends to pull everything towards the earth's centre
Free fall	Object is fall freely when it's falling under the gravitational force only with acceleration due to gravitational force, g = *10.0 N kg*$^{-1}$
Weight	Gravitational force acting on the object. W = m g SI unit= Newton, N
Forces in equilibrium	When an object is in equilibrium, the resultant force is zero. The object will either be at rest or move with constant velocity
Newton's Third law of motion	For every action there is an equal an opposite reaction
Work	Work, W = Force, F X Displacement, s SI unit= Joule, J
Kinetic energy	K.E = $\frac{1}{2} mv^2$ SI unit= Joule, J
Potential energy	P.E = mgh SI unit= Joule, J
Principle of conservation of energy	Energy cannot be created or destroyed but can be changed from one form to another form.
Power	Power, P = $\frac{workdone}{timetaken} = \frac{W}{t}$ SI unit= Watt, W
Hooke's law	the extension of a spring is directly proportional to the applied force provided that the elastic limit is not exceeded F = kx, k = Force constant of the spring
Force constant	$k = \frac{F}{x}$ SI unit N m^{-1}, N cm^{-1} or N mm^{-1}
Elastic limit	maximum force that can be applied to spring such that the spring will return to its original length when the force released
Graph	
Elastic potential energy	E = ½ k x ^{2} = ½ F x
Factors that effect elasticity	-Type of material -Diameter of spring wire -Diameter of spring -Length of spring

Exercises

1. Diagram show two watermelons fall off the table and drop on to the surface A and surface B respectively

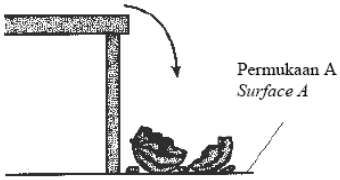


Diagram 1 (a)

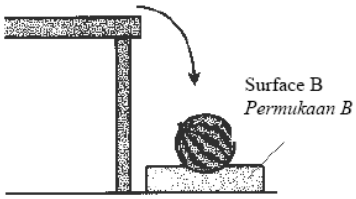


Diagram 1 (b)

a) What is mean by impulse ?

.....

(1 mark)

b) With reference to Diagram 1(a) and 1(b)

i) Compare the force on the watermelons that strikes on surface A and surface B

.....

(1 mark)

ii) Compare the time of impact of the watermelons on surface A and surface B

.....

(1 mark)

iii) State the relationship between the force produced in a collision and the time of impact

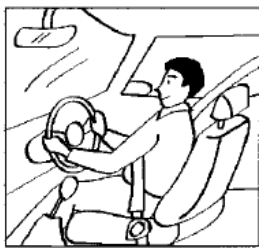
.....

(1 mark)

c) Suggest a suitable material for surface B

.....

(1 mark)



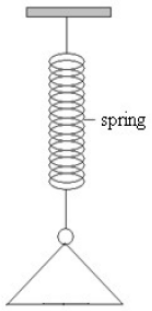
d) Explain how the driver is able to avoid serious injuries when the car stopped suddenly

.....

.....

(2 mark)

2.



a) When a load is attached to the spring

i) What happen to the length of the spring ?

.....

(1 mark)

ii) What is the energy stored in the spring ?

.....

(1 mark)

iii) If the number of load is increased, what will happen to the energy in 2(a)(ii) ?

.....

(1 mark)

b) The initial length of a spring is 15 cm. When a load with mass 300 g is attached to the spring, the length of the spring is 21 cm. What is the length of the spring if a load with mass 500 g is attached to the spring?

(3 mark)

3. Diagram 3.1 and Diagram 3.2 show a student throwing a javelin using different throwing techniques. The forces used by the student are the same. The angles of projection are different.

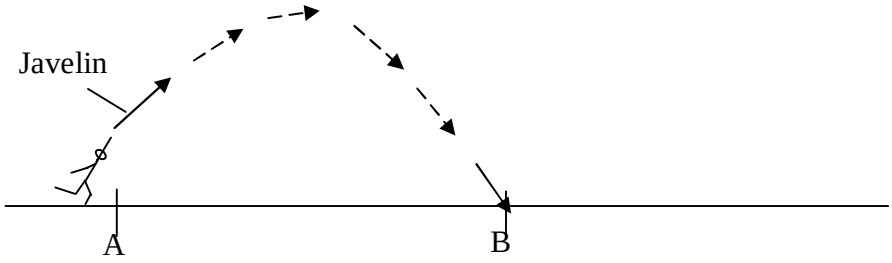


Diagram 3.1

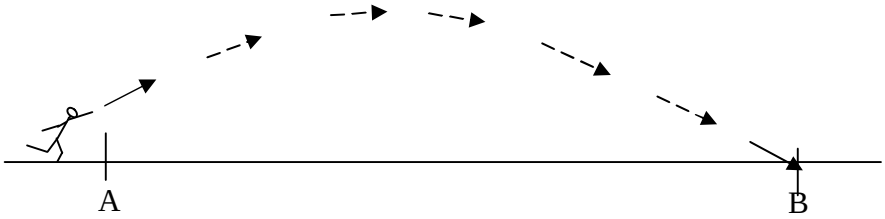


Diagram 3.2

(a) Observe Diagram 3.1 and Diagram 3.2.

(i) Compare the distance traveled by the javelin from A to B.

.....

(1 mark)

(ii) What happens to the distance of the javelin when the angle of projection is less than the angle of projection shown in Diagram 3.2?

.....

(1 mark)

(b) State the shape of the javelin so that it moves with minimum resistance through air

.....

(1 mark)

(c) The force acting on the javelin is 10 N and the throwing distance 70 m.
Calculate the work done by the student in Diagram 3.2.

[2 marks]

(d) (i) State the changes of energy experienced by the javelin from A to B for techniques.

.....

(1 mark)

(ii) State the energy produced when the javelin touches the ground.

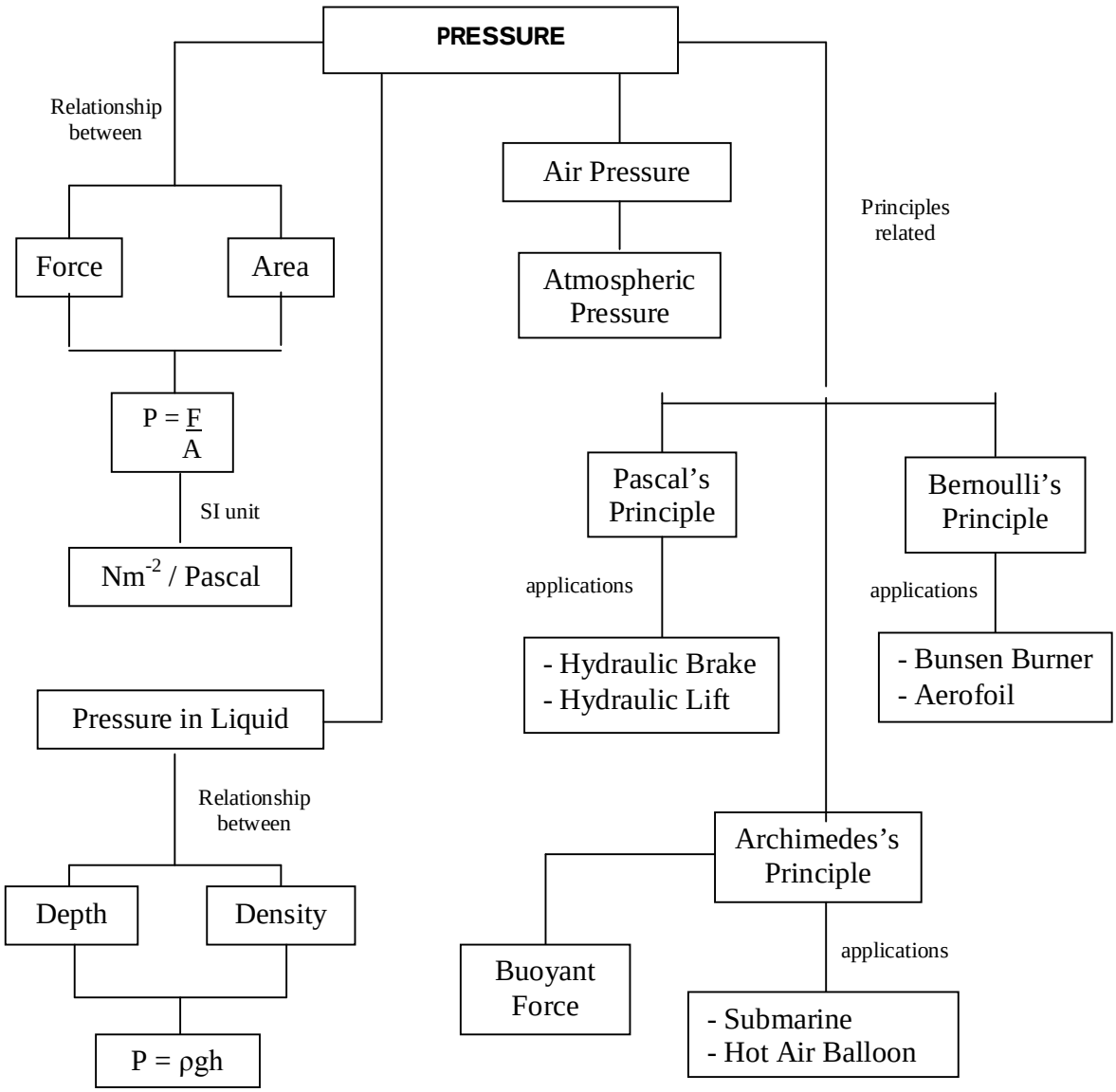
.....

(1 mark)

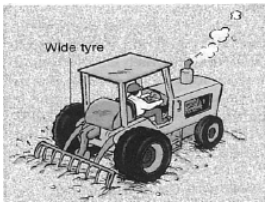
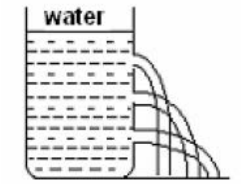
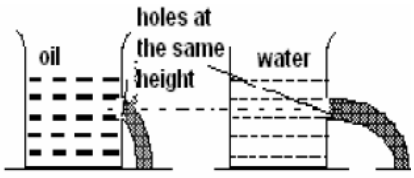
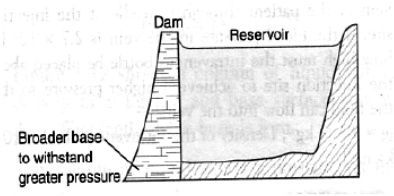
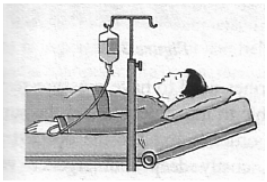
Answer scheme

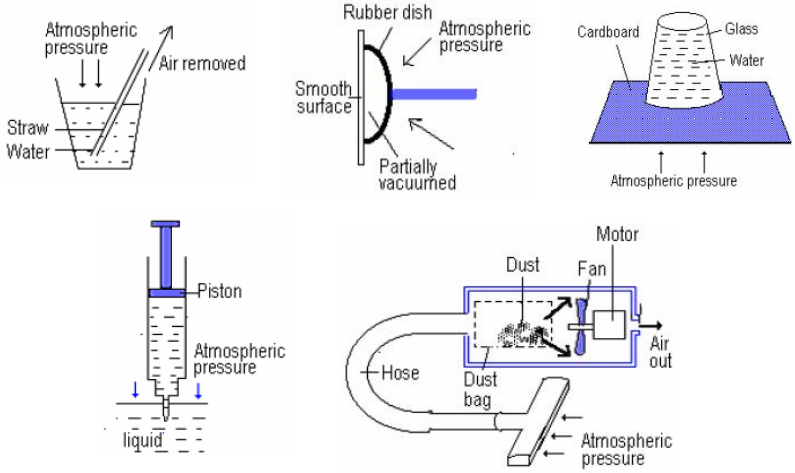
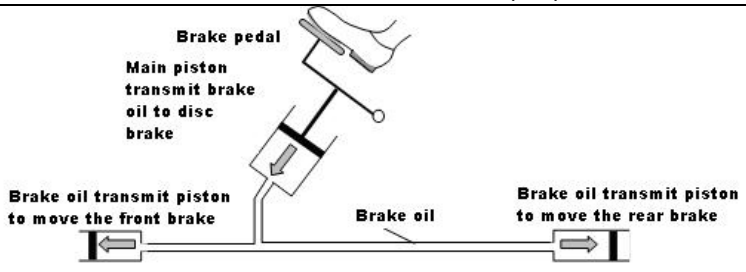
Question no.	Suggested answer	Mark
1. a)	Change of momentum / product of force with time of impact	1
b) (i)	Force of watermelon in diagram 1(a) is larger than force of watermelon in diagram 1 (b)	1
(ii)	Time impact on surface A is shorter than time impact on surface B	1
(iii)	The shorter the time impact, the larger the force	1
c)	Sponge / carpet / towel / cloth	1
d)	Body will be hold back by the seat belt when car stopped suddenly The seat belt will lengthen slightly, the impulsive force inflicted on the body will be less	1 1
	TOTAL	**7**
2. a) (i)	Length increase / longer	1
(ii)	Elastic potential energy	1
(iii)	increase	1
b)	Extension (21-15) cm = 6 cm 300 g ⟶ 6 cm 100 g ⟶ 2 cm 500 g ⟶ 2 x 5 = 10 cm Length of spring = 15 + 10 = 25 cm	1 1 1
	TOTAL	**6**
3 (a) (i)	Further in Diagram 3.2 compare to Diagram 3.1	1
(ii)	Decreases	1
(b)	streamline	1
(c)	W = 10 x 70 = 700 J	1 1
(d) (i)	Kinetic energy to potential energy to kinetic energy	1
(ii)	Sound / heat	1
	TOTAL	**7**

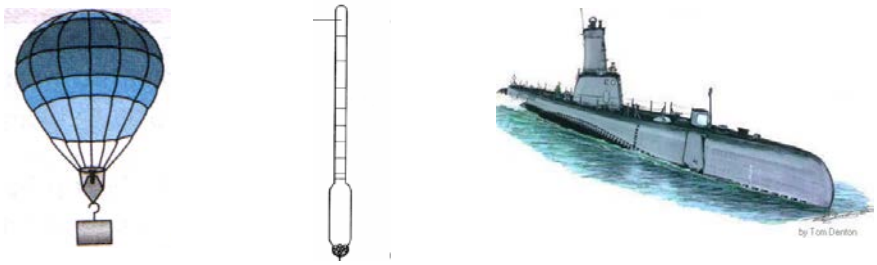
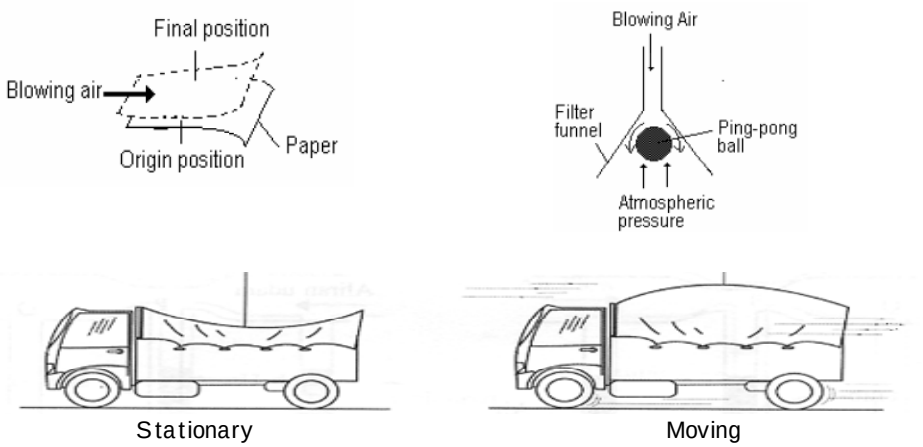
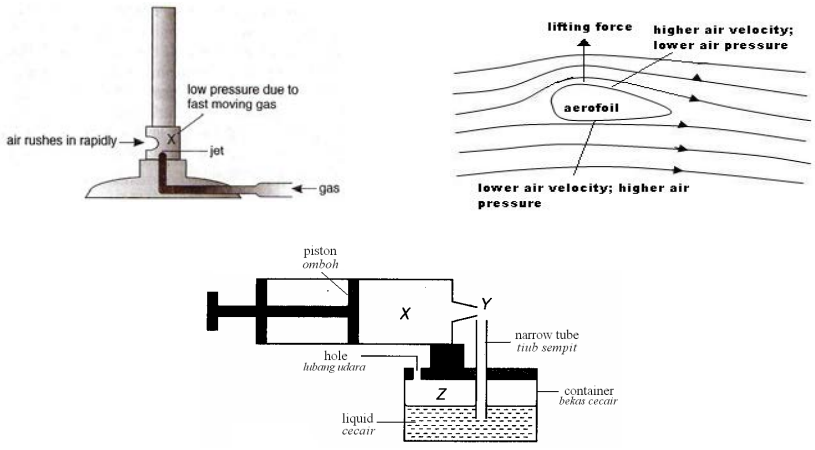
TOPIC 3 : FORCE AND PRESSURE



Notes

Definition of Pressure	Pressure is force per unit area
Formula	$P = \frac{F}{A}$ Where P = Pressure F = Force A = Area
SI Unit	Nm^{-2} / Pascal (Pa)
Relationship involving pressure, force and area	- The higher the force, the higher the pressure (where area is constant) - The smaller the area, the higher the pressure (where force is constant)
Situations involving the higher pressure	 
Situations involving the lower pressure	 
Pressure in liquid	pressure in a liquid is the product of depth, density and gravitational acceleration
Formula	Pressure in liquid = ρgh where ρ = density of the liquid g = gravitational force h = depth
Characteristics of pressure in liquid	- acts equally in all directions - not depends on surface area and shape of the container
Relationship between pressure in liquid, depth and density of liquid	- The deeper the depth, the higher the pressure in liquid - The higher the density of the liquid, the higher the pressure in liquid  
Applications of pressure in liquid	 

Gas Pressure	Force exerted on a surface by air molecules per unit area of the surface
Instruments for Measuring Atmospheric Pressure	- Manometer - Bourdon Gauge
Atmospheric pressure	caused by the downward force exerted by the air, which is the weight of the atmosphere on the Earth's surface
Instruments for Measuring Atmospheric Pressure	- Aneroid Barometer - Fortin Barometer
Relationship between altitude and atmospheric pressure	The greater the altitude from the sea level, the smaller the atmospheric pressure
Situations and applications involving Gas & Atmospheric Pressure	
Pascal's Principle	Pressure applied to an enclosed liquid is transmitted equally to every part of the liquid
Formula	$P_1 = P_2$ $\frac{F_1}{A_1} = \frac{F_2}{A_2}$ where P_1 = input pressure P_2 = output pressure F_1 = input force F_2 = output force A_1 = input piston area A_2 = output piston area
Applications involving the Pascal's Principle	
Archimedes's Principle	when an object is wholly or partially immersed in a fluid, it experiences a buoyant force equal to the weight of the fluid displaced
Buoyant Force	Upward force resulting from an object being wholly or partially immersed in a fluid

Formula	- Buoyant Force = Actual weight – Apparent weight - Buoyant Force = Weight of fluid displaced = ρvg Where ρ = density of fluid V = volume of fluid displaced g = gravitational acceleration
Relationship between floatation	- Buoyant force = weight → object float and stationary - Buoyant force > weight → object moves upward - Buoyant force < weight → object moves downward
Applications involving the Archimedes's Principle	
Bernoulli's Principle	When the speed of a fluid increases, the pressure of the fluid decreases and vise versa
Situations involving Bernouli's Principle	
Applications involving the Bernoulli's Principle	

Exercises

1. Diagram 1 shows a man standing still on reflexology therapy stones. He exerts a pressure on the reflexology therapy stones.
Rajah 1 menunjukkan seorang lelaki berdiri pegun di atas batu terapi refleksologi. Dia mengenakan tekanan pada batu terapi refleksologi

Diagram 1 / *Rajah 1*

a) What is meant by pressure?
Apakah yang dimaksudkan dengan tekanan?

.....

(1 mark)

b) The mass of the man is 50 kg and the area of contact of the man with the reflexology therapy stone is 40 cm^2 . Calculate the pressure exerted by the man on the reflexology therapy stones.
Jisim lelaki adalah 50 kg dan luas sentuhan yang yang dikenakan pada batu terapi refleksologi adalah 40cm^2 . Hitungkan tekanan yang dikenakan oleh lelaki pada batu terapi refleksologi.

(2 marks)

c) Explain why a bulldozer uses broad tyres
Terangkan mengapa sebuah jentolak mempunyai tayar yang lebih lebar.

.....

.....

(2 marks)

2. Diagram 2 shows a model of a hydraulic jack. The force F_1 applied on the small piston R is able to support two loads which placed on piston S and T.

Rajah 21 menunjukkan sebuah jek hidraulik. Daya F_1 bertindak pada omboh kecil R untuk menyokong dua beban yang diletakkan pada omboh S dan T.

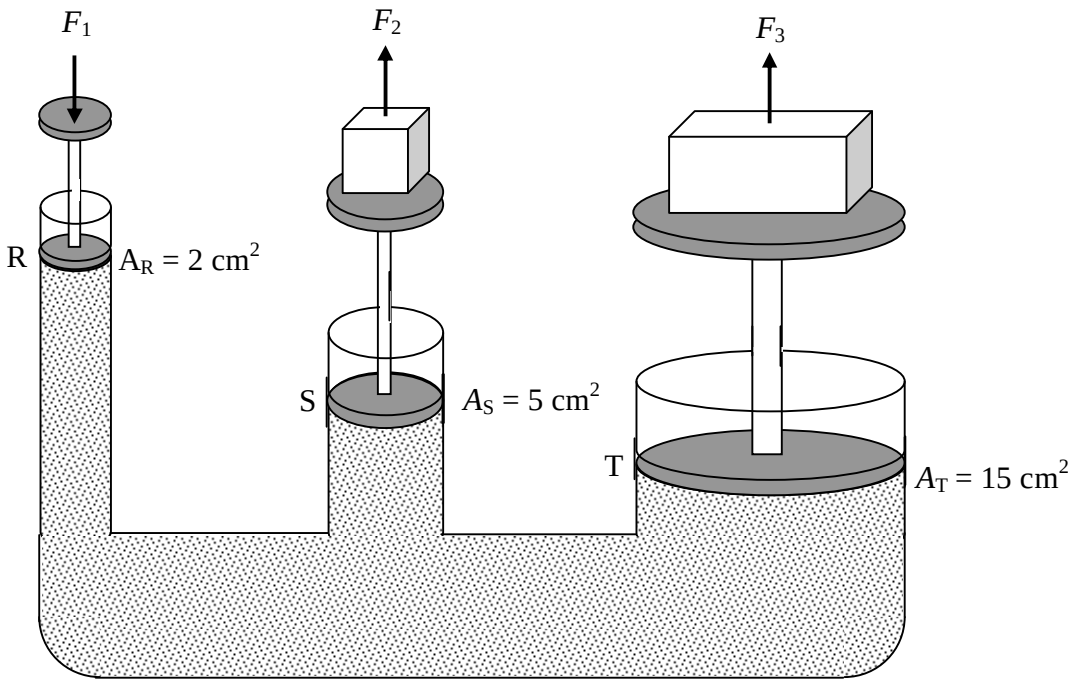


Diagram 2 / *Rajah 2*

(a) Name the principle used in the hydraulic jack.

Namakan prinsip yang digunakan dalam jek hidraulik.

……

[1 *mark*]

(b) (i) If F_1 = 4.0 N, calculate the pressure exerted on piston R.

Jika F_1 = 4.0 N, hitungkan tekanan yang dikenakan pada omboh R.

[2 *mark*]

(ii) Compare the fluid pressure at S and T to the pressure at R

Bandingkan tekanan bendalir pada S dan T dengan tekanan bendalir pada R.

……

[1 *mark*]

(iii) Determine the magnitude of the force F_2.
Tentukan magnitude daya F_2.

[2 *marks*]

(c) Give one reason why it is more suitable to use a liquid instead of air as the hydraulic fluid.
Berikan satu sebab mengapa cecair lebih sesuai digunakan sebagai bendalir hidraulik berbanding udara.

……..……

[1 *mark*]

3. Diagram 3 shows a cross-section of a Bunsen burner

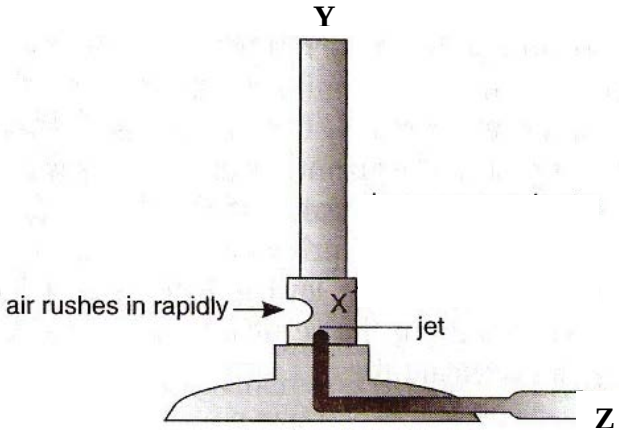


Diagram 3 / *Rajah 3*

a) i) Name the Physics's principle related to the working principle of Bunsen burner
Namakan prinsip fizik yang terlibat dalam prinsip kerja penunu Bunsen

……

(1 mark)

ii) Which region X, Y or Z, experiences low pressure
Kawasan manakah X, Y atau Z yang mengalami tekanan rendah

……..

(1 mark)

b) State one reason for your answer in 2 (a)(ii)
Nyatakan satu sebab bagi jawapan anda di 2 (a)(ii)

.....

(1 mark)

c) Explain how a Bunsen burner can produced blue flame
Terangkan bagaimana penunu Bunsen boleh menghasilkan nyalaan api yang bewarna biru

……

……

(2 mark)

d) State another application that is related to the Physics's principle in (a)(i)
Nyatakan aplikasi lain yang berkaitan dengan prinsip fizik dalam (a)(i)

……

(1 mark)

4. Diagram 4 shows a submarine floats on the sea surface. The weight of the submarine is equal to the buoyant force acting on the submarine
Rajah 3 menunjukkan sebuah kapal selam terapung di atas permukaan laut. Berat kapal selam adalah sama dengan daya julangan yang bertindak ke atas kapal selam itu

Diagram 4 / *Rajah 4*

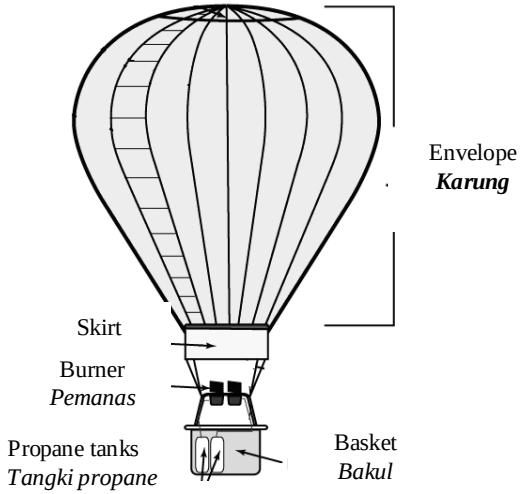
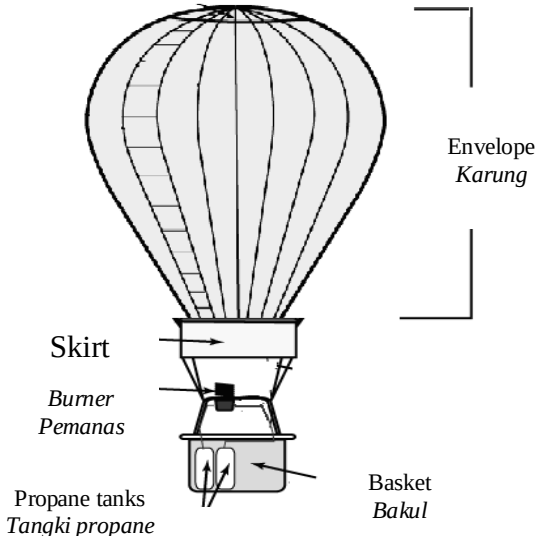
a) What is mean by buoyant force ?
Apakah yang dimaksudkan dengan daya julangan ?

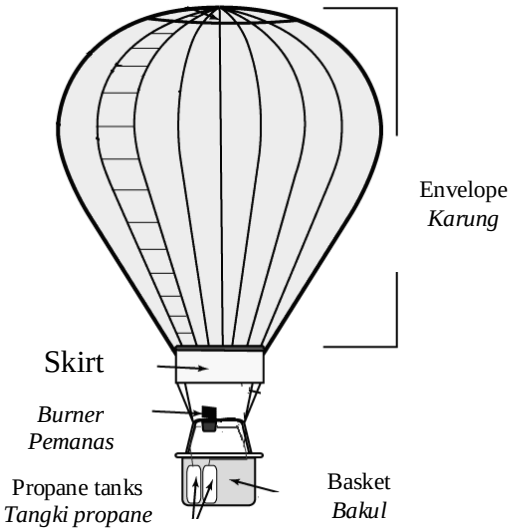
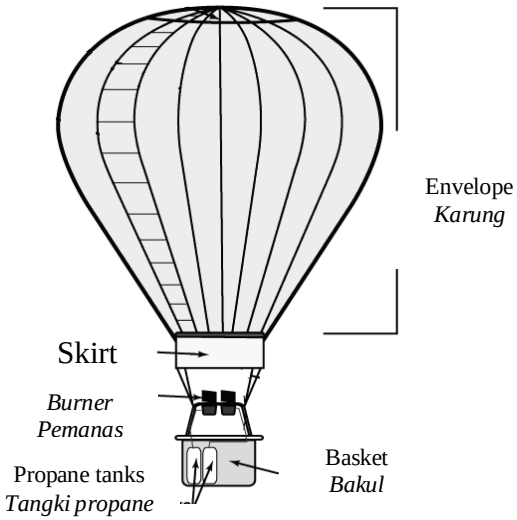
(1 mark)

b) The submarine is able to submerge in the sea. Explain how a submarine on the sea surface submerge and float on the sea surface.
Kapal selam boleh masuk ke dalam laut. Terangkan bagaimana kapal selam di atas permukaan laut itu boleh bergerak di bawah permukaan laut dan kemudiannya boleh berada semula di permukaan laut

(4 marks)

c) Table 1 show four hot air balloons, P, Q, R and S, with different specifications.
Rajah 1 menunjukkan empat belon udara panas, P, Q, R dan S, dengan spesifikasi yang berbeza

	Size of the envolope and number of burners used. *Saiz karung dan bilangan pemanas yang digunakan.*	Material of envelope *Bahan untuk karung*	Material of basket *Bahan untuk bakul*
P		Canvas *Kanvas*	Iron *Besi*
Q		Nylon *Nilon*	Rattan *Rotan*

	Size of the envolope and number of burners used. *Saiz karung dan bilangan pemanas yang digunakan.*	Material of envelope *Bahan untuk karung*	Material of basket *Bahan untuk bakul*
R		Canvas *Kanvas*	Iron *Besi*
S		Nylon *Nilon*	Rattan *Rotan*

You are required to determine the most suitable balloon which can be used for safe recreation. Study the specifications of all the four balloons from the following aspects:
Anda dikehendaki untuk menentukan belon yang paling sesuai untuk digunakan secara selamat untuk rekreasi. Kaji spesifikasi keempat-empat belon berdasarkan aspek-aspek berikut:

- the balloon envelope
  Karung belon

- the size of the balloon
  saiz belon

- the number of burner used
  bilangan pemanas yang digunakan

- the type of basket used to carry the passenger.
  jenis bakul yang digunakan untuk mengangkut penumpang.

Explain the suitability of the aspects. Justify your choice.
Terangkan kesesuian aspek-aspek itu. Beri sebab bagi pilihan anda.

[10 marks]

d) A hot air balloon is adhered to the ground. The balloon contains 1200 m^3 of hot air of density 0.8 kg m^{-3}. The mass of the balloon (not including the hot air) is 400 kg . The density of the surrounding air is 1.3 kg m^{-3}.
Sebuah belon udara panas diikat ke tanah. Belon tersebut mengandungi 1200 m^3 udara panas dengan ketumpatan 0.8 kg m^{-3}. Jisim belon (tidak termasuk udara panas) ialah 400 kg. Ketumpatan udara di sekitarnya ialah 1.3 kg m^{-3}.

Calculate
Hitung

(i) the total weight of the balloon and the hot air.
jumlah berat belon dan udara panas.

[3 marks]

(ii) the buoyant force exerted on the balloon.
daya apungan yang bertindak ke atas belon itu.

[1 mark]

(ii) the net force exerted on the ballon when it is released?
daya paduan yang bertindak ke atas belon apabila ia dilepaskan?

[1 marks]

5. Diagram 5 shows the cross-section of a water dam. The wall has to be thicker at the bottom of the dam.
Rajah 5 menunjukkan keratan rentas empangan. Dinding bahagian bawah empangan mestilah lebih tebal berbanding dengan bahagian atas empangan

Diagram 5 / *Rajah 5*

Based on the above information and observation:
Berdasarkan maklumat dan pemerhatian di atas:

(a) State one suitable inference.
Nyatakan satu inferens yang sesuai . [1 mark]

(b) State one suitable hypothesis .
Nyatakan satu hipotesis yang sesuai . [1 mark]

(c) With the use apparatus such as a measuring cylinder, manometer, rubber tube and other apparatus, describe an experiment framework to investigate your hypothesis stated in 3(b).
Dengan menggunakan radas seperti silinder penyukat, manometer, tiub getah, dan lain-lain radas,terangkan satu rangka kerja eksperimen untuk menyiasat hipotesis yang dinyatakan di (b).

In your description, state clearly the following :
Dalam penerangan anda jelaskan perkara berikut:

i. Aim of the experiment .
Tujuan eksperimen

ii. Variables in the experiment.
Pembolehubah dalam eksperimen.

iii. List of apparatus and materials.
Senarai radas dan bahan.

iv. Arrangement of apparatus.
Susunan radas.

v. The procedures of the experiment which include the method of controlling the manipulated variable and the method of measuring the responding variable.
Prosedur eksperimen termasuk kaedah mengawal pembolehubah dimanipulasi dan kaedah mengukur pembolehubah bergerak balas)

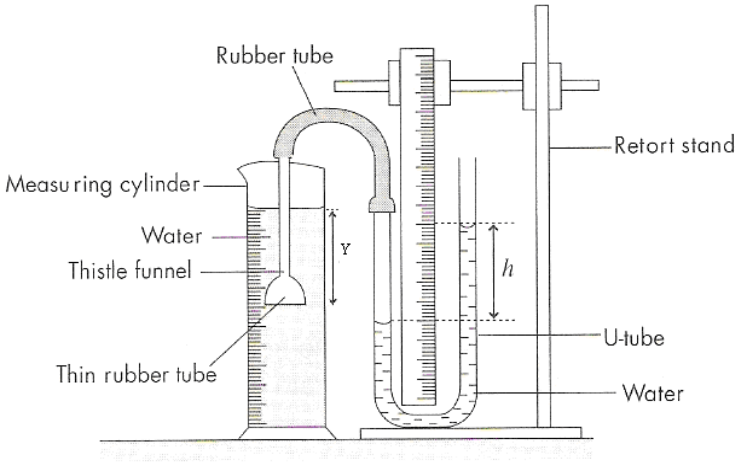
vi. The way you would tabulate the data.
Cara anda menjadualkan data

vii. The way you would analyse the data.
Cara anda menganalisis data.

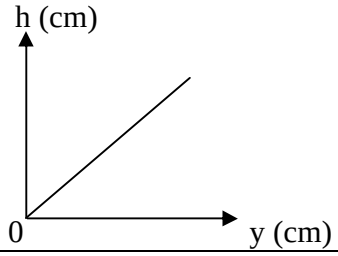
[10 marks]

MARKING SCHEME

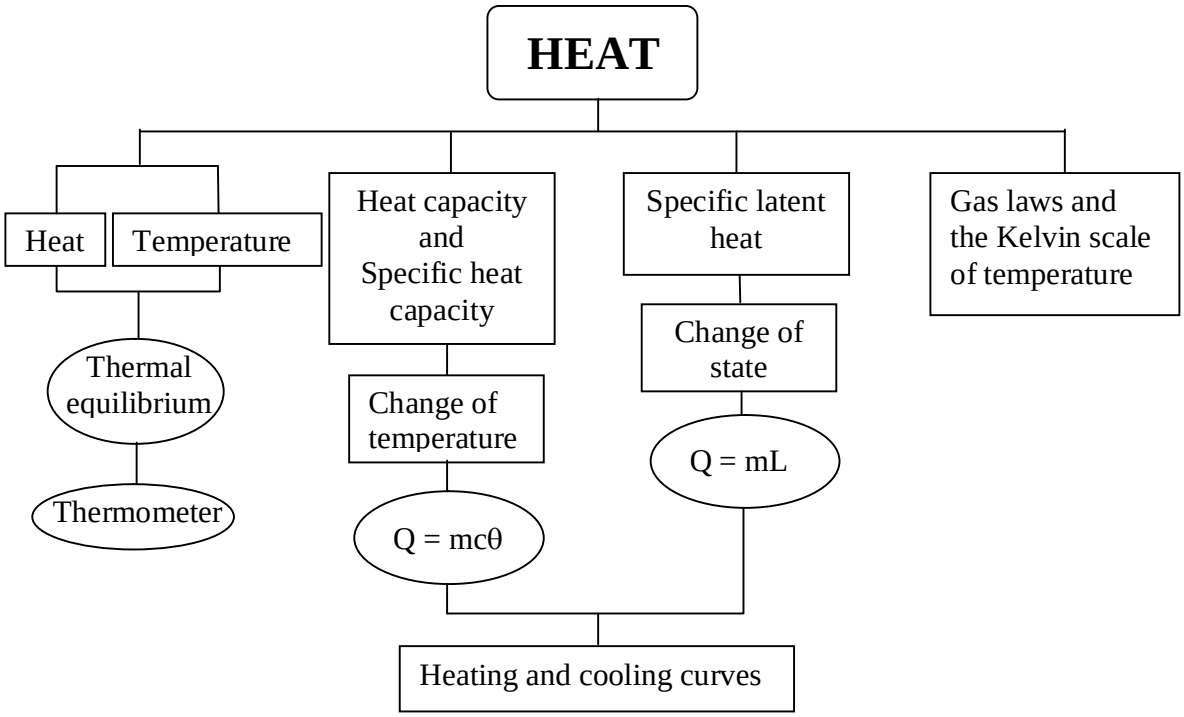
No.			Answer	Mark
1	a		Force per unit area	1
	b		(50 X 10) ÷ (40/1000) 12 5000 N m^{-2} // 1.25 X 10^5 N m^{-2}	1 1
	c		- Wider tyre, less pressure - To avoid the bulldozer sink into the soil	1 1
				5
2	a		Pascal's principle	1
	b	i	$P = \frac{4\ N}{2\ cm^2}$ $= 2.0\ N\ cm^{-2}$ // $2.0 \times 10^4\ N\ m^{-2}$	1 1
		ii	same pressure	1
		iii	$2.0\ N\ cm^{-2} = \frac{F_2}{5\ cm^2}$ $F_2 = 10.0\ N$	1 1
	c		Liquid cannot be compressed easily	1
				7
3	a	i	Bernoulli's principle	1
		ii	X	1
	b		Gas flow out the nozzle at highest speed	1
	c		- Air from outside is pushed into the hole - complete combustion occur there	1 1
	d		- insecticide sprayer	1
				6
4	a		Upward force resulting from an object being wholly or partially immersed in a fluid	
	b		- when the ballast tank is filled with water - the buoyant force is smaller than the weight of the submarine. It will sink / submerges - when the ballast tank is filled with air / when the water pumps out - the buoyant force is larger than the weight of the submarine and it will float	1 1 1 1
	c		<table><tr><td>envelopes – construct from nylon</td><td>- Lightweight material - Reduce the total weight of the balloon. - Strong, can withstand the strong winds which could easily wreck the balloon.</td></tr><tr><td>balloon should be large size</td><td>- Displace more volume of air - Weight of air displaced is greater - To create sufficient buoyant force. Lift up the balloon higher.</td></tr></table>	

<table>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td>use two burners</td><td>- To warm up the air in the balloon quickly
- To keep the balloon rising</td></tr>
<tr><td>the basket must be made of rattan</td><td>- Light and flexible/safe material
- Prolong the collision time between basket and ground / reduce impulsive force</td></tr>
</table>
S because the material of envelope is nylon, large size of the envelope, use two burners and the basket is made of rattan
</td><td></td></tr>
<tr><td></td><td>d</td><td>i</td><td>Weight of air = 0.8 X 1200 X 10 = 9600 N
Total weight = 9600 + 4000 = 13 600 N</td><td>2
1</td></tr>
<tr><td></td><td></td><td>ii</td><td>Buoyant force = 1.3 X 1200 X 10 = 15 600 N</td><td>1</td></tr>
<tr><td></td><td></td><td>iii</td><td>Net force = 15 600 N - 13 600 N = 2000 N</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>20</td></tr>
<tr><td>5</td><td>a</td><td></td><td>The wall of the dam is thicker at the bottom of the dam</td><td>1</td></tr>
<tr><td></td><td>b</td><td></td><td>Water pressure increases with depth</td><td>1</td></tr>
<tr><td></td><td>c</td><td>i</td><td>to investigate the relationship between the pressure in a liquid and the depth</td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>Manipulated Variable : Depth of liquid, y
Responding Variable : Pressure in liquid, h
Fixed Variable : Density, p</td><td>1
1</td></tr>
<tr><td></td><td></td><td>iii</td><td>Measuring cylinder, thistle funnel, rubber tube, manometer, and retort stand</td><td>1</td></tr>
<tr><td></td><td></td><td>iv</td><td> 
</td><td>1</td></tr>
<tr><td></td><td></td><td>v</td><td>i) The measuring cylinder is completely filled with water.
ii) The thistle funnel is connected to the manometer with a rubber tube.
iii) The thistle funnel is lowered with the water to a depth y = 10.0m
iv) The manometer reading, h is measured by using the ruler
v) Step 3 is repeated with values of depth y = 20.0m, 30.0 cm, 40.0 cm and 50.0 cm.</td><td>

1
1
1</td></tr>
</table>

<table>
<tr><td></td><td></td><td>vi</td><td><table><tr><th>Depth, y (cm)</th><th>h (cm)</th></tr><tr><td>10</td><td></td></tr><tr><td>20</td><td></td></tr><tr><td>30</td><td></td></tr><tr><td>40</td><td></td></tr><tr><td>50</td><td></td></tr></table></td><td>1</td></tr>
<tr><td></td><td></td><td>vii</td><td> 
</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>12</td></tr>
</table>

TOPIC 4 : HEAT

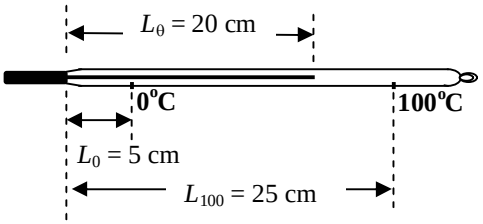


Notes:

Heat is a form of energy. In matter, heat is stored in the form of random kinetic energy and potential energy of the molecules (also called internal energy).
Temperature is a measure of the degree of hotness.
Thermal equilibrium between two bodies means that there is **no net heat flow** between them. At thermal equilibrium, both bodies have the **same temperature**.
Thermometric property is the physical property of a substance which varies linearly with temperature.
Celsius scale of temperature: The temperature, θ is defined as

$$\theta = \frac{\text{thermometric property at } \theta \text{ - thermometric property at ice point}}{\text{thermometric property at steam point - thermometric property at ice point}} \times 100\,^{o}\text{C}$$

Example: What is the temperature reading of the thermometer shown below?



$$\text{Temperature, } \theta = \frac{L_\theta - L_0}{L_{100} - L_0} \times 100$$

$$\theta = \frac{20-5}{25-5} \times 100$$

$$\theta = 75^{o}\text{C}$$

Heat capacity of a body is the amount of heat required to raise the temperature of the body by 1^oC.

$$\text{heat capacity} = \frac{\text{heat}}{\text{change of temperature}}$$

$$C = \frac{Q}{\theta}$$ The S.I. units of heat capacity are J $^oC^{-1}$ or J K^{-1}

Specific heat capacity of a substance is the amount of heat required to raise the temperature of 1 kg of the substance by 1^oC.

$$\text{specific heat capacity} = \frac{\text{heat}}{\text{mass} \times \text{change of temperature}}$$

$$c = \frac{Q}{m\theta}$$ The S.I. units of heat capacity are J kg^{-1} $^oC^{-1}$ or J kg^{-1} K^{-1}

Latent heat is the heat absorbed or released at constant temperature during a change of phase of a substance.

Specific latent heat of fusion is the quantity of heat required to change 1 kg of a substance from solid state to liquid state without change of temperature.

$$\text{specific latent heat} = \frac{\text{heat to change substance from solid to liquid}}{\text{mass of the substance}}$$

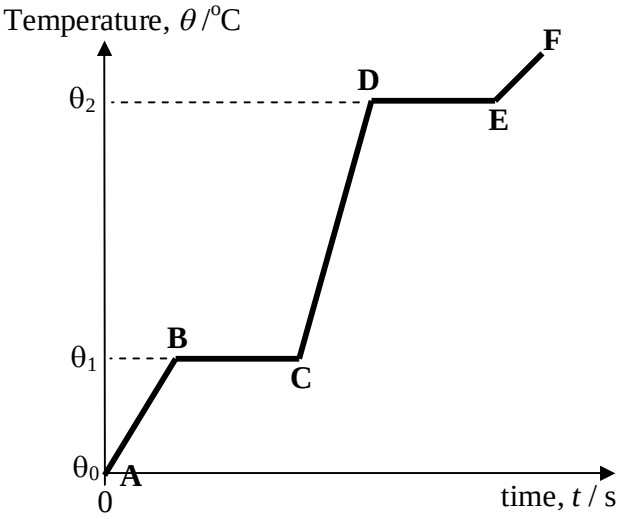
$$L = \frac{Q}{m}$$ The S.I. units of specific latent heat of fusion is J kg^{-1}

Specific latent heat of vaporisation is the quantity of heat required to change 1 kg of a substance from liquid state to gaseous state without change of temperature.

$$\text{specific latent heat} = \frac{\text{heat to change substance from liquid to gas}}{\text{mass of the substance}}$$

$$L = \frac{Q}{m}$$ The S.I. units of specific latent heat of vaporisation is J kg^{-1}

A **temperature-time graph** representing heating process. At **A**, the substance heated is in the solid state.



Important notes:

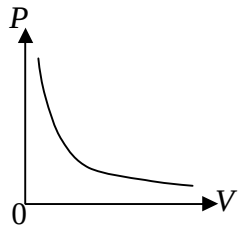
Part of graph	Phase of material	Formula for calculation of heat.
AB	solid	$Q = mc\theta$
BC	solid + liquid (melting)	$Q = mL$
CD	liquid	$Q = mc\theta$
DE	liquid + gas (boiling)	$Q = mL$
EF	gas	$Q = mc\theta$

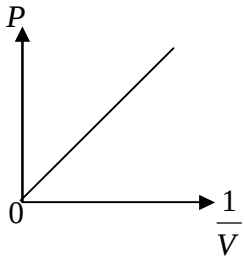
θ_1 is the **melting point** of the substance
θ_2 is the **boiling point** of the substance

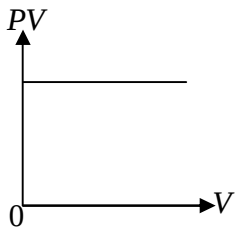
Gas Laws:

a) **Boyle's law**: ***PV* = constant** provided mass and temperature is kept constant.

Graphs of gases obeying Boyle's law.

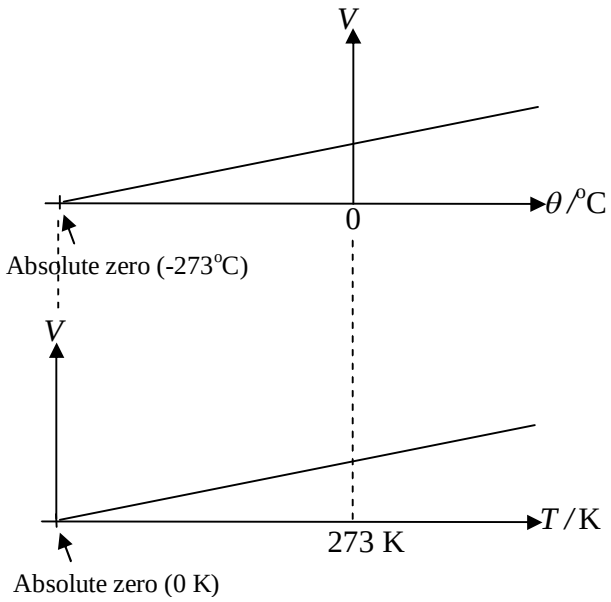






b) **Charles'law**: $\frac{V}{T}$ = constant provided mass and pressure is kept constant.

Graphs of gases obeying Charles' law.

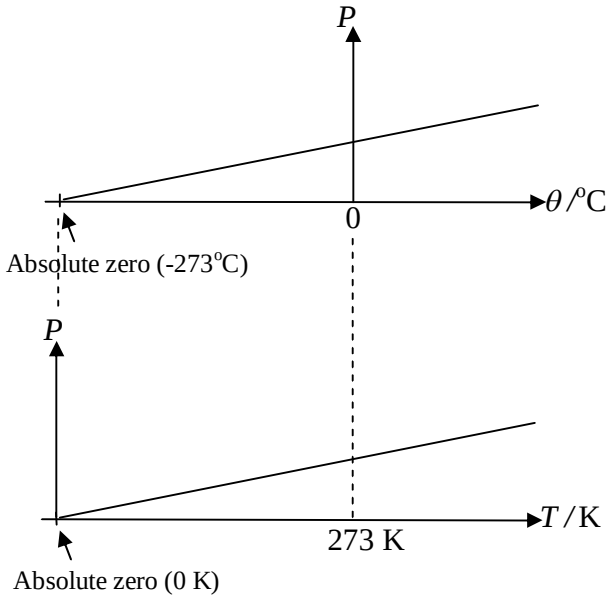


Note:
a) Zero Kelvin, 0 K = -273°C
b) Relationship between absolute temp. and Celsius temperature is given by

$T = \theta + 273$

c) **Pressure law**: $\frac{P}{T}$ = constant provided mass and volume is kept constant.

Graphs of gases obeying Pressure law.



Note:
a) Zero Kelvin, 0 K = -273°C
b) Relationship between absolute temp. and Celsius temperature is given by

$T = \theta + 273$

EXERCISE 1:
PART I

State whether the following statements are true or false.

a) Heat is a form of energy. (true / false)
b) A body at 0°C does not contain heat. (true / false)
c) Heat is stored in a body as internal energy. (true / false)

d) Heat flows both from a hot body to a cold body as well as from a cold body to a hot body. (true / false)
e) When thermal equilibrium between two bodies is achieved, the flow of heat stops. (true / false)
f) Two bodies in thermal equilibrium must have the same temperature. (true / false)
g) The Celsius scale of temperature consists of 100 fixed points. (true / false)
h) The upper fixed point and the lower fixed point must be calibrated at atmospheric pressure. (true / false)
i) To calibrate the lower fixed point of a thermometer, it is placed in melting ice. (true / false)
j) To calibrate the upper fixed point of a thermometer, it is place in boiling water. (true / false)

PART II

State whether the following statements are true or false.

a) The amount of heat stored in a body is directly proportional to is mass. (true / false)
b) The amount of heat stored in a body is independent of the type of material it's made of. (true / false)
c) When the temperature of a body decreases, heat is released. (true / false)
d) If the specific heat capacity of a substance is high, it means it is easily cooled. (true / false)
e) When a solid is melting, its temperature remains the same even though heating continues. (true / false)
f) During the melting process, heat absorbed is used to increase the separation between molecules. (true / false)
g) When steam condenses to water at a fixed temperature of 100^{o}C, no heat is absorbed or released because there is no change of temperature. (true / false)
h) Sea and land breezes are caused by the differences between the specific latent heat of sea water and the specific latent heat of land material. (true / false)
i) To be scalded by steam is worse than to be scalded by boiling water even though their temperatures are the same. (true / false)
j) An accurate thermometer must have a large heat capacity. (true / false)
k) The thermometric property used in the mercury in glass thermometer is length. (true / false)
l) A frying pan should be made of material with high specific heat capacity. (true / false)
m) A thermometer must be made from materials which are poor heat conductors. (true / false)

PART III

State whether the following statements are true or false.

a) Boyle's law is always correct even if the temperature of the gas varies. (true / false)
b) According to Boyle's law, when pressure is doubled, the volume of gas is halved. (true / false)
c) Gas pressure exerted on the walls of a container is caused by the bombardments of the gas molecules on the walls. (true / false)
d) When temperature increases, the kinetic energy of gas molecules increases. (true / false)
e) According to **Charles' law**, the pressure of a gas increases when temperature increases. (true / false)

f) According to **Pressure law**, the pressure of a gas is directly proportional to its temperature measured in degree Celsius. (true / false)
g) The pressure of air in a car tyre will increase after the car has traveled a long distance. (true / false)

EXERCISE 2:

PART 1:

1) The S.I. unit of heat energy is
A. Watt B. Joule C. Ampere D. Coulomb

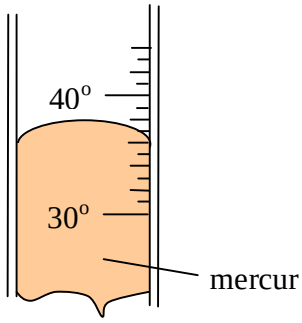
2) Heat is stored in a body as
A. potential energy only B. kinetic energy only C. potential and kinetic energy

3) Two bodies P and Q are in thermal contact. The temperature of P is higher.
A. Heat flows only from P to Q
B. Heat flows only from Q to P
C. Rate of heat flow from P to Q is greater than that from Q to P

4) Thermal equilibrium between two bodies is reached when
A. both bodies have the same amount of internal energy
B. the flow of heat between the two bodies stops
C. both bodies looses heat to the surrounding at the same rate
D. the rate of transfer of heat from each body to the other is the same

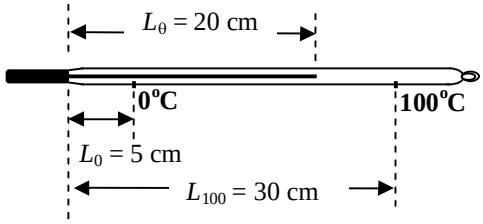
5) The sensitivity of a mercury in glass thermometer can be increased by
A. using thicker glass to make the thermometer
B. using a larger bulb for the thermometer
C. using a larger bore for the capillary tube

6) What is the thermometer reading in the diagram?



A. 36°C B. 37°C C. 38°C

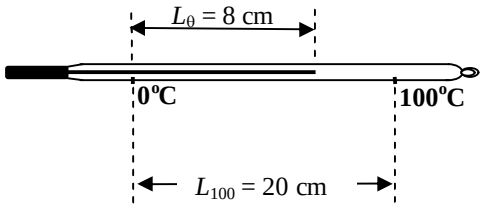
7)



Based on the values shown in the diagram above, what is the temperature reading of the thermometer?

A. 30°C B. 40°C C. 50°C D. 60°C

8) Based on the values shown in the diagram above,



what is the temperature reading of the thermometer?
A. 30°C B. 40°C C. 50°C D. 60°C

9) When calibrating the lower fixed point for a mercury thermometer, the thermometer must be placed in

A. solid ice at atmospheric pressure
B. solid ice at any pressure
C. melting ice at atmospheric pressure
D. melting ice at any pressure

10) Which of the following is **not** the reason why mercury is suitable for making a laboratory thermometer?

A. high density
B. low freezing point
C. high boiling point
D. good conductor of heat
E. does not stick to glass

11) A substance with low specific heat capacity means

A. it melts easily when heated
B. it boils easily when heated
C. it expands quickly when heated
D. its temperature increases quickly when heated

12) When 2000 J of heat is absorbed by 0.2 kg of substance X, its temperature increases from 20°C to 30°C. The specific heat capacity of substance X is

A. 1000 J kg^{-1} $^oC^{-1}$ B. 1500 J kg^{-1} $^oC^{-1}$ C. 2000 J kg^{-1} $^oC^{-1}$ D. 2500 J kg^{-1} $^oC^{-1}$

13) It takes 3000 J of heat to melt 0.2 kg of substance Y at constant temperature. What is the specific latent heat of substance Y?

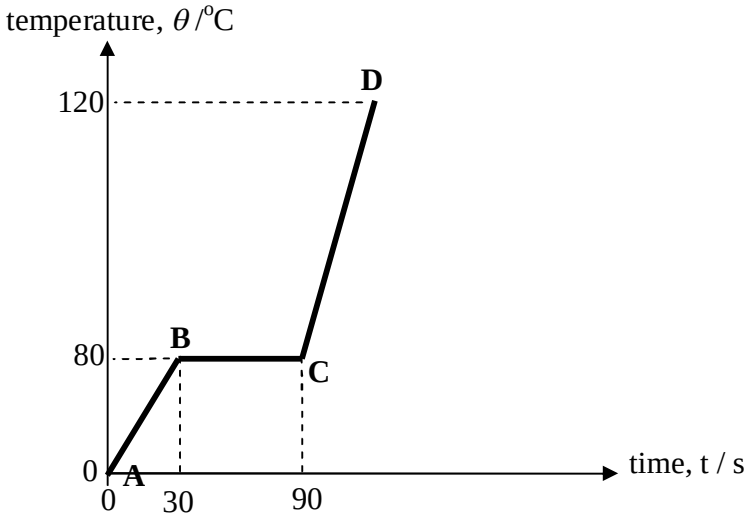
A. 6000 J kg^{-1} B. 9000 J kg^{-1} C. 12000 J kg^{-1} D. 15000 J kg^{-1}

14) The specific latent heat of vaporization of substance Z is 5000 J kg-1. What is the amount of heat required to vaporize 0.4 kg of substance Z at its boiling point?

A. 5500 J kg^{-1} B. 10500 J kg^{-1} C. 12500 J kg^{-1} D. 15500 J kg^{-1}

Questions 15 – 18 refers to the temperature-time graph given.

15)



0.01 kg of substance Q (solid) is heated at a constant rate. Its temperature rises as shown in the graph. If the specific latent heat of substance Q is 1200 J kg^{-1} oC^{-1}, how much heat is required to raise its temperature from 0^{oC} to its melting point?

A. 120 J B. 960 J C. 8000 J D. 12000 J

16) What is rate of heat supplied to substance Q in question 15?

A. 32 W B. 64 W 96 W 120 W

17) What is the amount of heat required to completely melt substance Q at constant temperature?

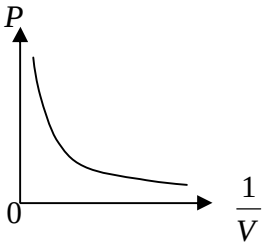
A. 1200 J B. 1920 J C. 3200 D. 6400 J E. 9600 J

18) The specific latent heat of fusion of the substance Q is

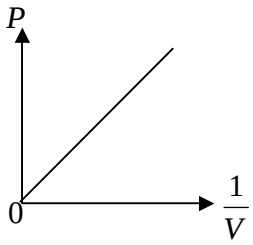
A. 19.2×10^4 J kg^{-1} B. 26.4×10^4 J kg^{-1} C. 32.0×10^4 J kg^{-1} D. 64.0×10^4 J kg^{-1}

19) Which of the following graphs is true of a gas which obeys Boyle's law?

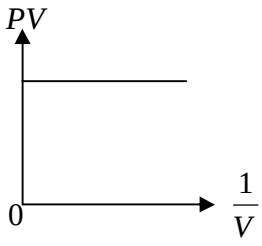
A.



B.

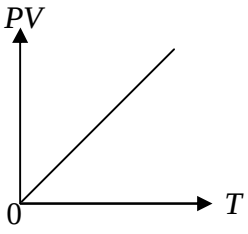


C.

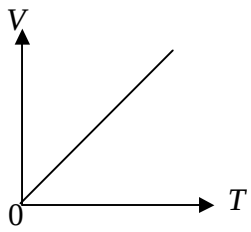


20) Which of the following graphs is true of a gas which obeys Charles' law?

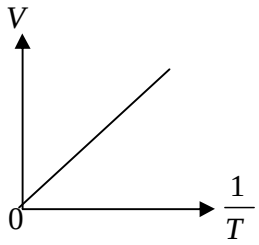
A.



B.



C.



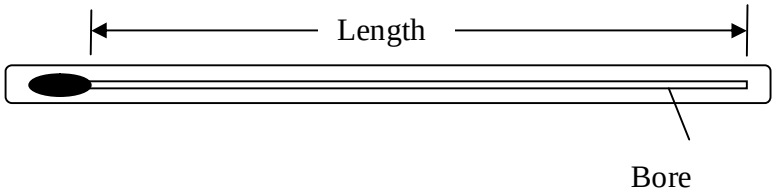
21) Heat is supplied at the same rate to 100g of paraffin and to 100g of water in similar containers. Why does the temperature of paraffin rises more quickly?

A. The paraffin has a larger specific heat capacity than water
B. The paraffin has a smaller specific heat capacity than water
C. Paraffin is less dense than water
D. Paraffin is more dense than water

22) A new liquid is tested to decide whether it is suitable to be used in a liquid-in-glass thermometer. It is found that the liquid does not expand uniformly with change of temperature.
What will be the effect of this on the scale of the thermometer?

A. It has a short range
B. It is not linear
C. The markings are too close together
D. The markings are too far apart

23) Four mercury-in-glass thermometers are made with different dimensions.



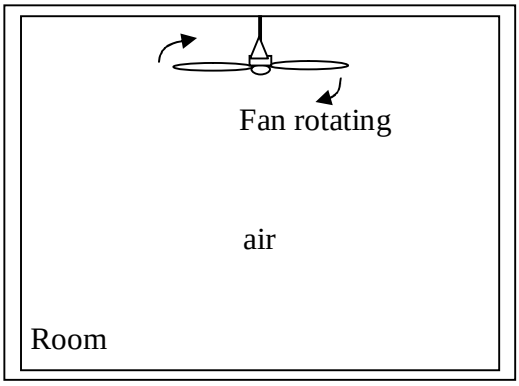
Which will have the greatest sensitivity?

A. 10 cm long and bore 0.75 mm wide
B. 15 cm long and bore 0.50 mm wide
C. 25 cm long and bore 0.10 mm wide
D. 30 cm long and bore 0.25 mm wide

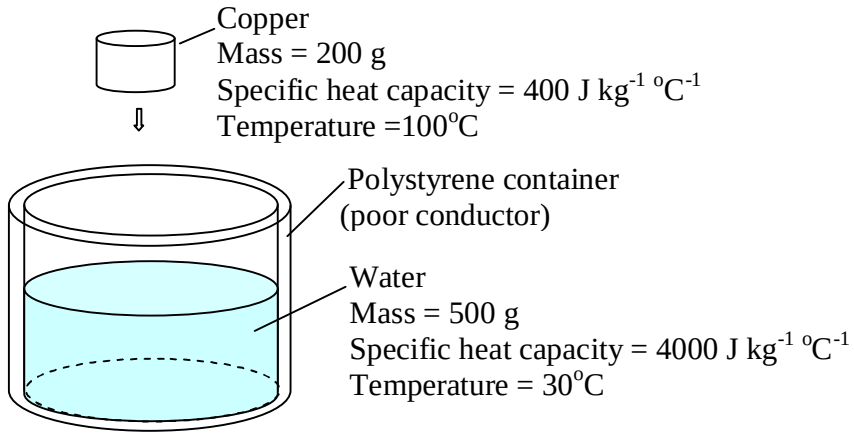
24. The electric fan in an enclosed room is switched on.

If the walls of the room are made of good insulating materials, which is true about the temperature in the room after several hours?

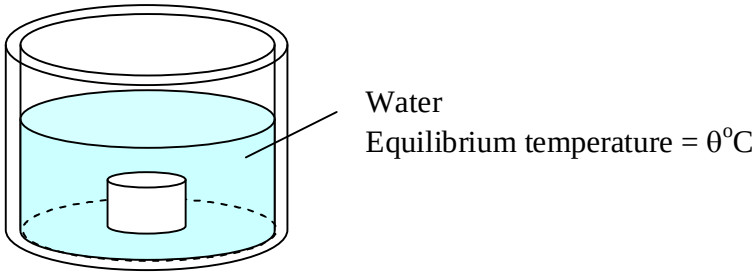
A. increased
B. unchanged
C. decreased



25. A copper weight is dropped into a polystyrene container which contains water.



Initial condition (before copper is dropped into water_



Final condition (after copper is dropped into water)

Based on the information given, what is the equilibrium temperature, θ?
(Assume no loss of heat to the surroundings).

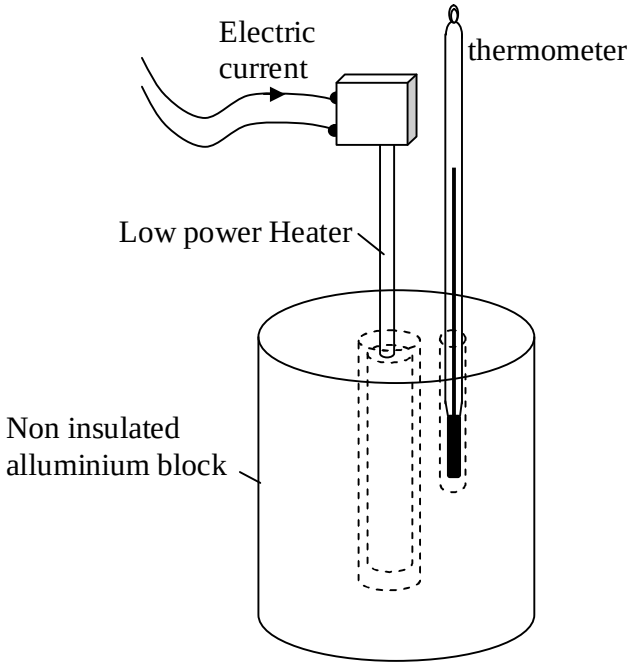
A. 32.7 °C B. 36.2 °C C. 40.5 °C D. 65.4 °C

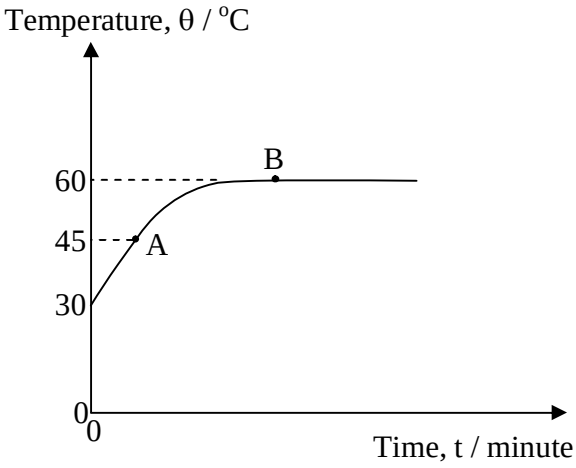
EXERCISE 2:

PART II:

1. A non-insulated alluminium block is heated at a constant rate using a low power immersion heater.

The result is shown by the temperature against time graph.





a) What is the room temperature?

……..

[1 mark]

b) Explain why the temperature becomes constant at 60°C even though heat is still supplied to the block?

……

……

[2 marks]

c) What does the gradient of the graph represent?

……

[1 mark]

d) Compare the rate of heat loss to the surroundings at point A and point B.

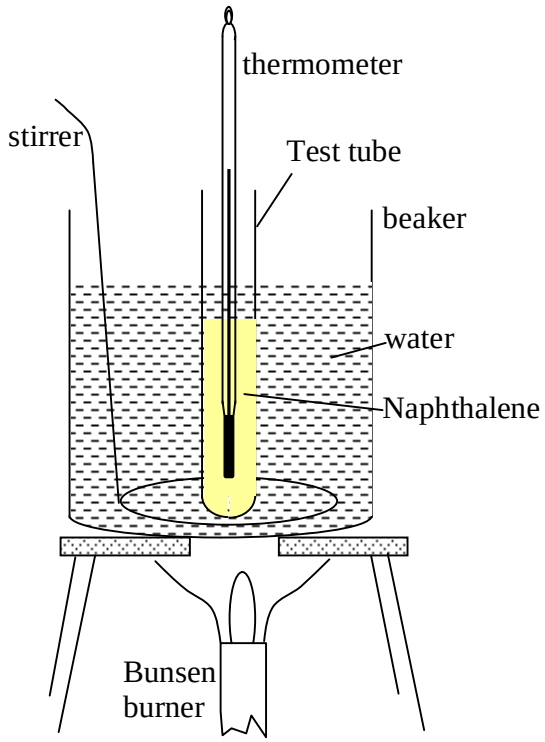
……

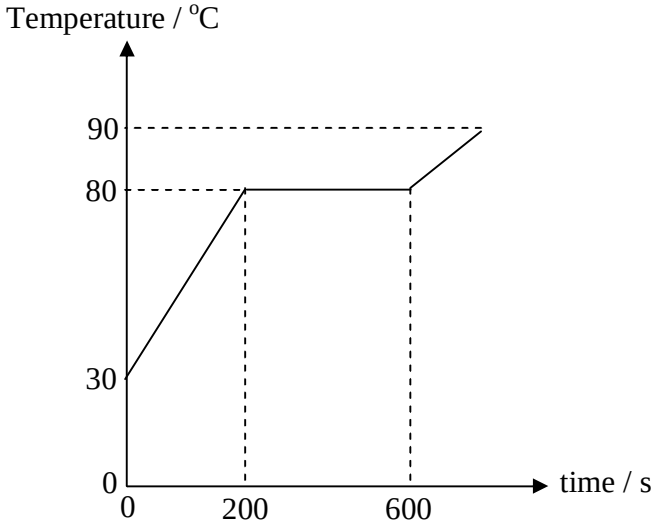
[1 mark]

e) The specific heat capacity of alluminium is 900 J kg^{-1} $^oC^{-1}$ and the mass of the alluminium block is 1 kg. How much heat is required to raise the temperature of the block from 30^{o}C to 60^{o}C if there is no heat loss?

[2 marks]

2. Solid naphthalene is placed in a test tube and then heated as shown in the diagram. The graph shows how the temperature of the naphthalene changes with time.





a. What is the use of the stirrer?

……

[1 mark]

b. State the melting point of naphthalene.

……

[1 mark]

c. (i) What is happening to the state of the naphthalene between time 200 s and 600 s?

……

[1 mark]

c. (ii) Explain why the temperature of the naphthalene is constant even though heat is still supplied

……

……

[2 marks]

d. Why does the temperature rise again after 600 s?

……

……

[2 marks]

e. If the rate of heat supplied to the naphthalene is constant at 100 W, and the mass of the naphthalene is 200 g, calculate the specific latent heat of fusion of naphthalene.

[3 marks]

3. Diagram 1 shows two weights P and Q, of the same mass but of different materials, placed in a steam bath. On the right are two polystyrene cups containing the same amount of water. Diagram 2 shows the situation after the two weights are transferred into separate cups and thermal equilibrium is reached.

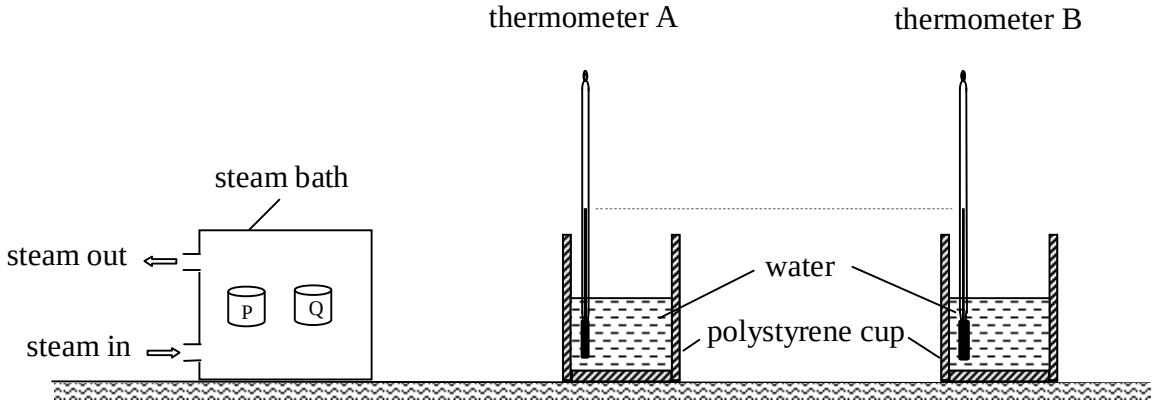


Diagram 1

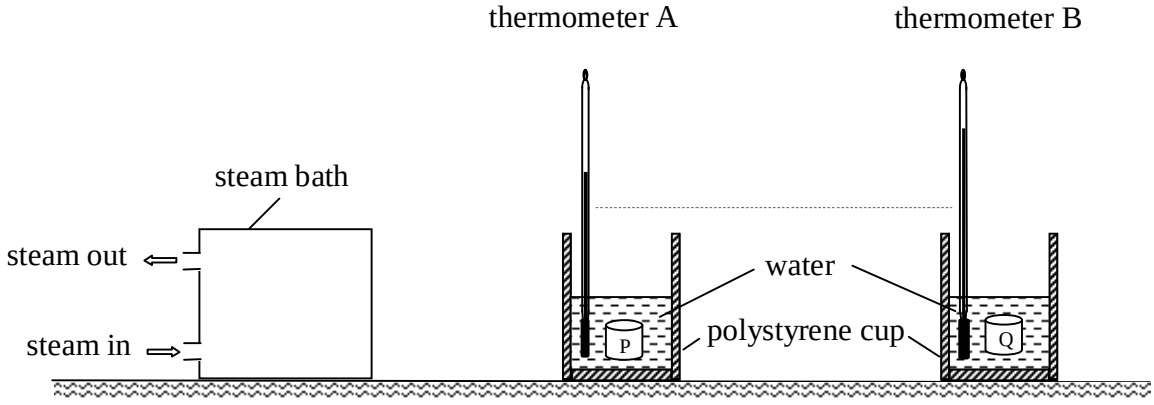


Diagram 2

a) What is meant by thermal equilibrium?

[1 mark]

b) Bases on Diagram 1 and Diagram 2, compare the temperature of the weights P and Q when they are in the temperature bath and when they are in the polystyrene cups. Relate the change of water temperature in each cup to the amount heat given out by P and Q. Hence determine which weight contains more heat and name the physics concept relating to the amount of heat stored in an object.

[5 marks]

c) i) When a cannon ball is dropped to the ground from a tall building, its temperature is found to be higher after hitting the ground. Explain why.

[1 mark]

ii) State the transformations of energy of the cannon ball.

[1 mark]

iii) What happens to temperature of the cannon ball after some time? Explain.

[2 marks]

d. Diagram 3 shows an electric oven being used to roast a chicken. It is found that the chicken is not evenly cooked and the oven consumes too much electricity.

Suggest modifications that can be made to the oven so that the problem stated can be solved. Explain each medication suggested.

[10 marks]

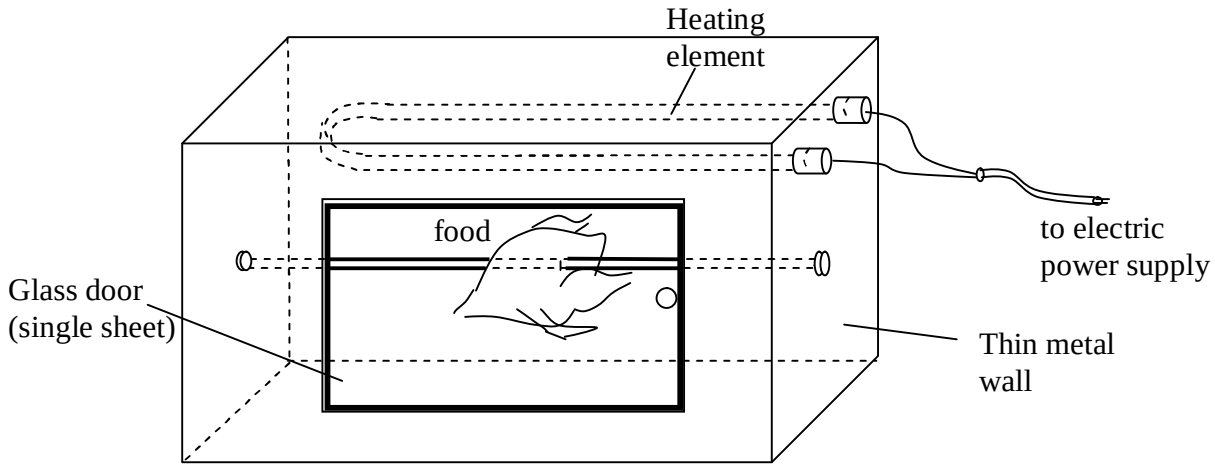
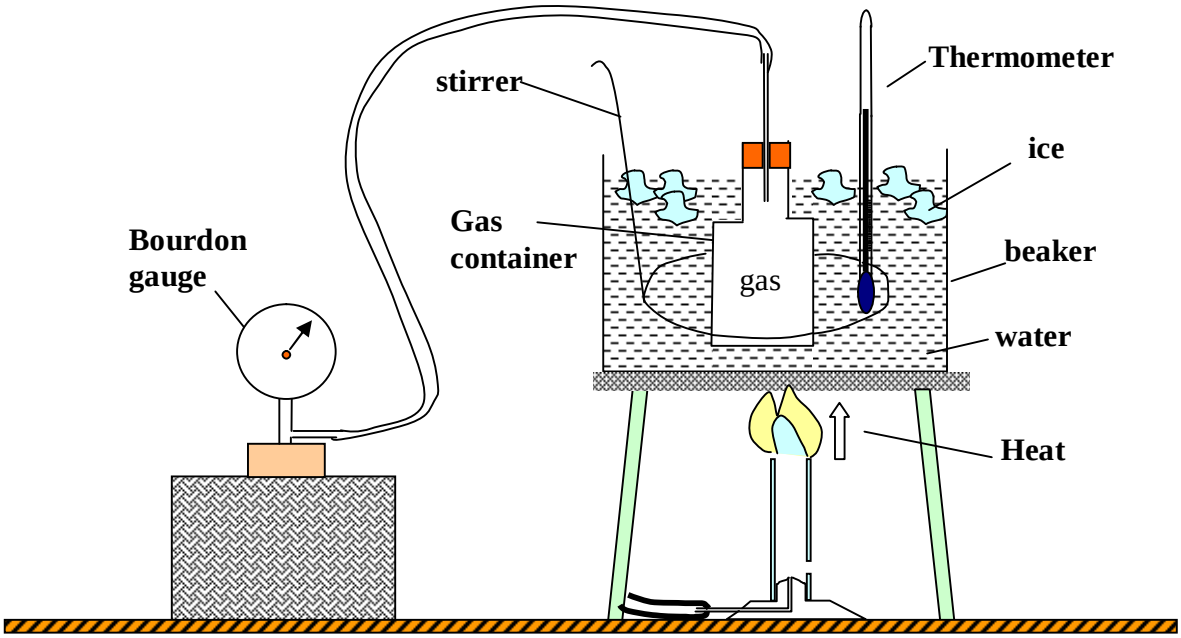


Diagram 3

4. Diagram 4 shows the experimental setup to investigate the Pressure Law for gas.



Several types of gas containers are available for the above experiment as shown in the table. Study and explain the suitability of each property of the containers. Choose the most suitable container and give a reason for your choice.

Gas container	Properties of the material of the container			
	Conduction of heat	Specific heat capacity / J kg^{-1} $^oC^{-1}$	Expansion when heated	Thickness of wall
P	good	390	large	thick
Q	poor	900	large	thin
R	good	450	little	thin
S	poor	1200	little	thick

[10 marks]

ANSWERS
HEAT

EXERCISE 1:

PART I

a) true b) false c) true d) true e) false f) true g) false h) true i) true j) false

PART II

a) true b) false c) true d) false e) true f) true g) false h) false i) true j) false
k) true l) false m) false

PART III

a) false b) true c) true d) true e) false f) false g) true

EXERCISE 2:

PART I:

1) B 2) C 3) C 4) D 5) B 6) C 7) D 8) B 9) C 10) A

11) D 12) A 13) D 14) C 15) B 16) A 17) B 18) A 19) B 20) B

21) B 22) B 23) C 24) A 25) A

PART II:

1.
   a. 30°C
   b. Rate of heat loss increases with temperature difference over the room temperature. At 60oC, the rate of heat loss = rate of heat supplied by the heater.
   c. rate of change of temperature
   d. the rate of loss of heat at B is greater than the rate of heat loss at A
   e. Heat = $mc\theta$
      = 1 x 900 x (60 – 30)
      = 27000 J

2.
   a. to keep the temperature uniform throughout the water
   b. 80°C

c. i) changing from solid to liquid (melting)
ii) During melting, heat supplied is used only to separate/increase distance between the molecules to form liquid. Heat supplied is not used to increase the random kinetic energy of the molecules.

d. All the naphthalene has melted and energy supplied increases the kinetic energy of the molecules.

e. Heat supplied = 100 x 400 J = 40000 J
Heat supplied = mL
40000 = 0.2 L
L = 200000 J kg^{-1}.

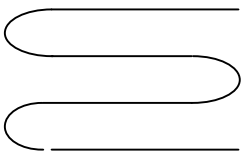
3.

a. No nett heat flow between 2 bodies

b. -In the steam bath both P and Q have the same temperature
-The temperature of P is lower than Q when they are in the cups
-The bigger the change of temperature, the larger the amount of heat given out by the weight
-Q contains more heat
-The concept of heat capacity- the larger the heat capacity of a body, the more heat is stored in the body at a certain temperature

c. i) The kinetic energy of the cannon ball is converted to heat after hitting the ground.
ii) Potential energy → kinetic energy → heat
iii) same as the surrounding temperature.
Thermal equilibrium is reached

d.

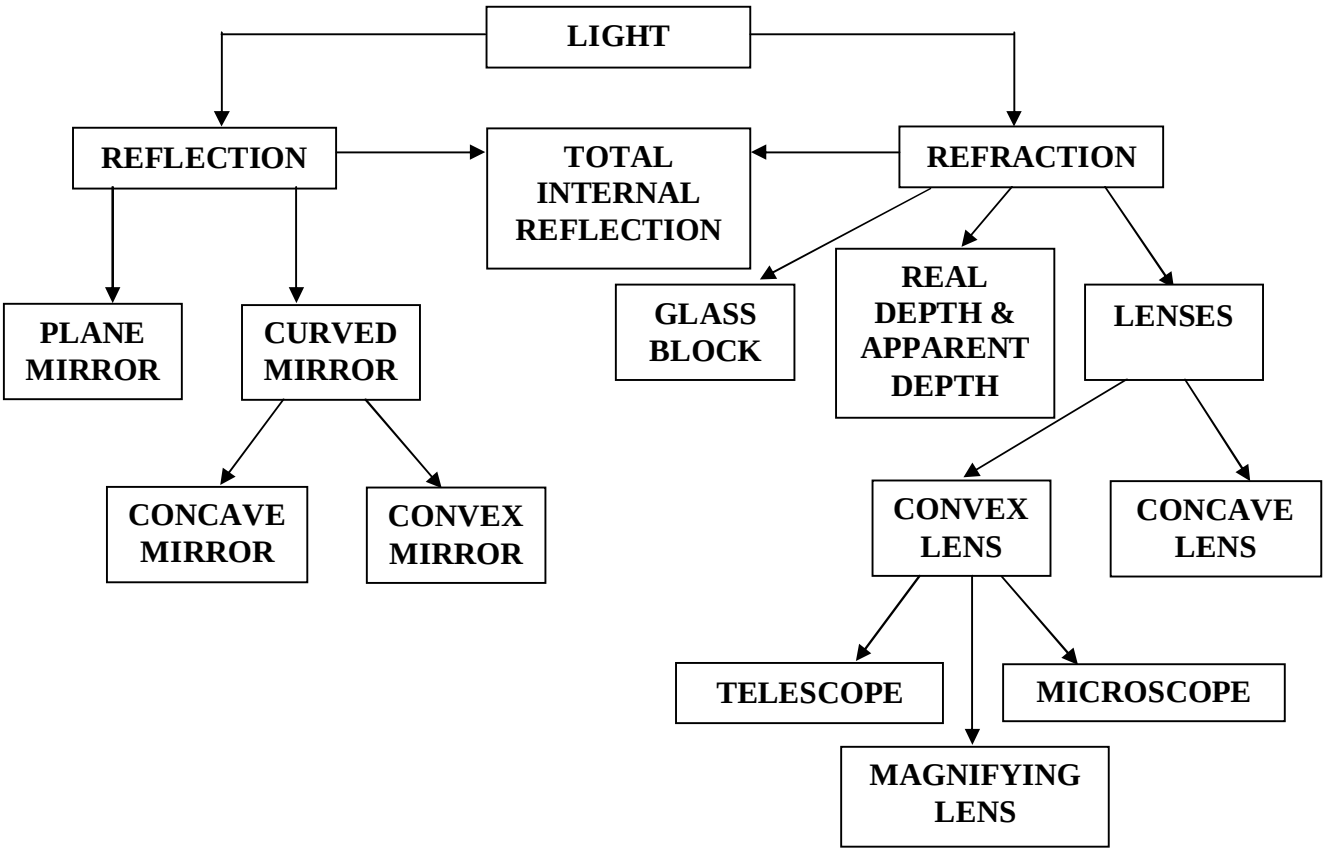
	Modification	Reason
1	Length and shape of heating element 	Covers larger area to spread heat more evenly
2	Have another heating element at the bottom	Bottom part of food is heated evenly
3	Inner-wall of the oven made of insulating heat resistant material	Less heat loss to surrounding – saves energy
4	Glass door made double layer with air in between.	Air is poor conductor -less heat loss – saves energy
5	Add electric motor to rotate the food	Chicken is roasted evenly

4.

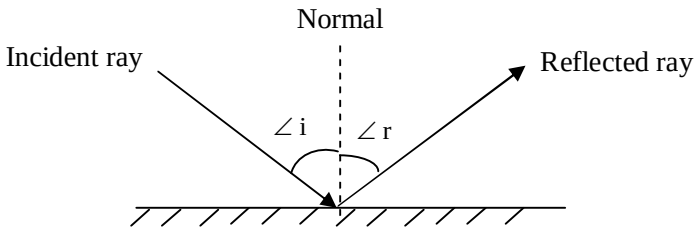
Property of material suitable for gas container	Reason
Good conductor of heat	Gas in container absorbs heat quickly
Specific heat capacity must be low	Temperature of container attains the temperature of surrounding water quickly
Little expansion	Volume of gas in container kept constant
Wall of container must be thin	Heat quickly transferred to gas in container

Choose container R
Because its made of good conductor, low specific heat capacity, expand very little and has thin wall.

TOPIC 5 : LIGHT



5.0 Reflection of light



The laws of reflection:

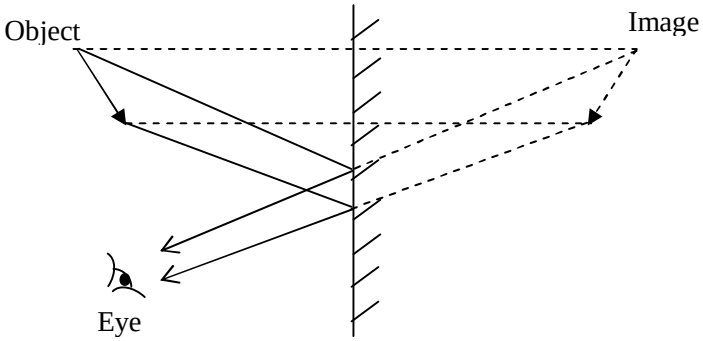
(i) The incident ray, the reflected ray and the normal all lie in the same plane.

(ii) The angle of incidence is equal to the angle of reflection.

$\angle i = \angle r$

5.1 Plane mirror

1. Ray diagram



Step 1 :
Draw the image equal distance from the object.

Step 2:
Draw rays (straight lines) from the image to the eye.

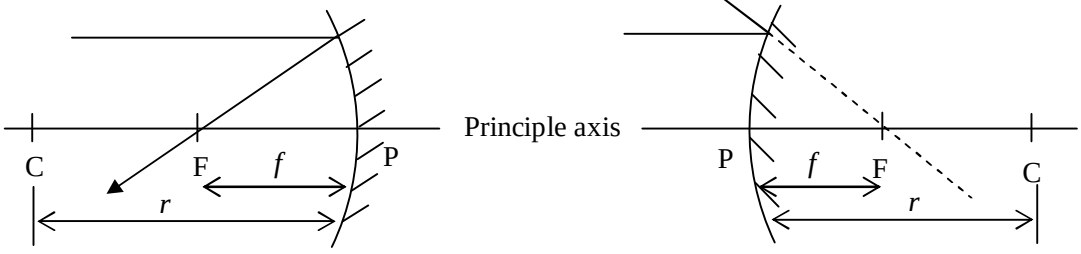
Step 3:
Complete the rays from the object to the mirror.

2. Characteristics of image of plane mirror:
   (i) Upright
   (ii) Laterally inverted
   (iii) Virtual image
   (iv) Same size
   (v) Object distance = Image distance

3. Applications of plane mirror:
   (i) Periscope
   (ii) Kaleidoscope

5.2 Curved mirror

Important terms in curved mirror:



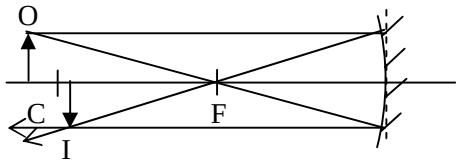
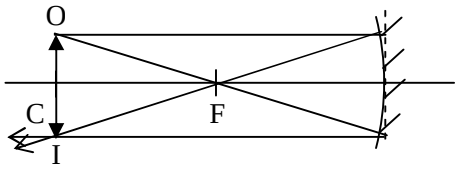
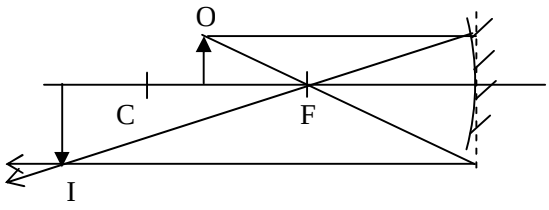
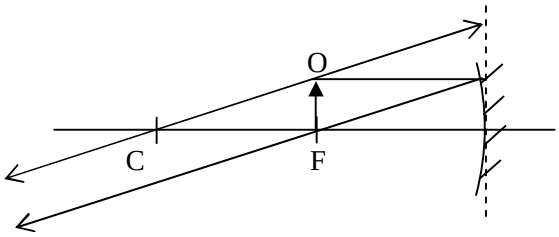
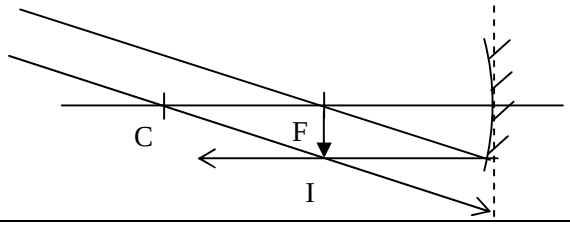
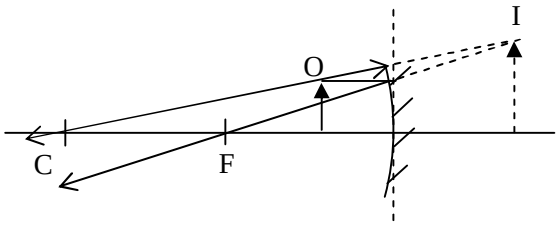
Concave mirror Convex mirror

C = Centre of curvature F = Focal point

P = Pole f = Focal length

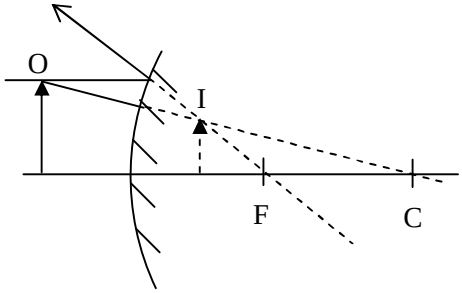
r = radius of curvature $f = \frac{r}{2}$

5.2.1 Convex mirror

Ray diagram	Characteristics of image
1. u > C 	▪ Inverted ▪ Real ▪ Diminished ▪ Image between C and F
2. u = C 	▪ Inverted ▪ Real ▪ Same size ▪ Image at C
3. F < u < C 	▪ Inverted ▪ Real ▪ Magnified / Enlarged ▪ Image further than C
4. u = F 	▪ Upright ▪ Virtual ▪ Image at infinity ▪ Parallel ray is produced Application: Car head lamp
5. u = infinity 	▪ Inverted ▪ Real ▪ Diminished ▪ Image at F
6. u < F 	▪ Upright ▪ Virtual ▪ Magnified / Enlarged ▪ Image behind the mirror Application: Dentist mirror Make-up mirror

5.2.2 Convex mirror

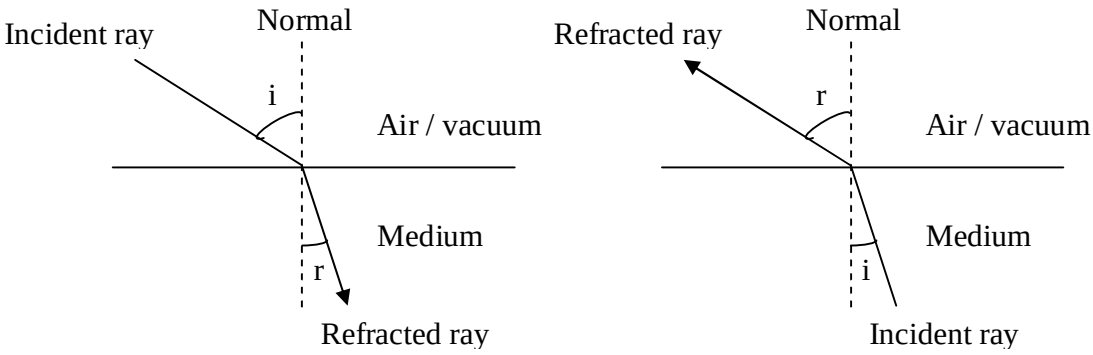
1. Ray diagram



2. Characteristics of image of convex mirror:
   (i) Upright
   (ii) Diminished
   (iii) Virtual

3. Applications of convex mirror:
   (i) Security mirror
   (ii) Corner blind spot mirror

5.3 Refraction of light



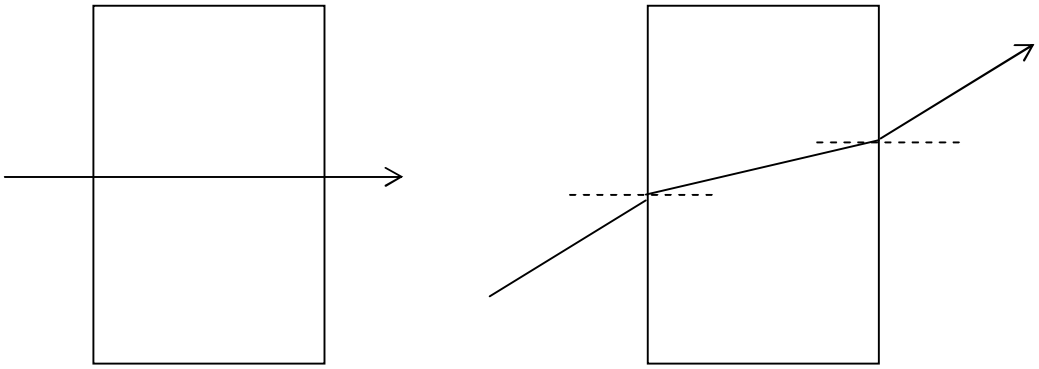
1. Snell's law:
   (i) The incident ray, the refracted ray and the normal all lie in the same plane.
   (ii) $\frac{\sin i}{\sin r} = \text{constant}$, where i = angle of incidence and r = angle of refraction

2. Refractive index, n
   (i) To find refractive index, n the light ray **must** travel <u>from air/vacuum to a medium</u>.
   (ii) Formula of refractive index, n:
   (a) $n = \frac{\sin i}{\sin r}$ (b) $n = \frac{D}{d}$, where D = real depth and d = apparent depth
   (c) $n = \frac{c}{v}$ (d) $n = \frac{1}{\sin c}$, where c = critical angle

   where c = speed of light in vacuu
   v = speed of light in medium

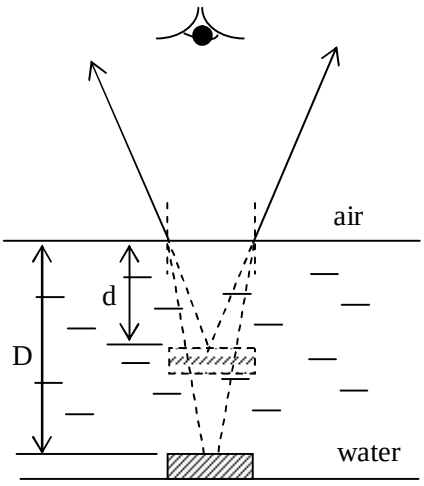
5.3.1 Glass block

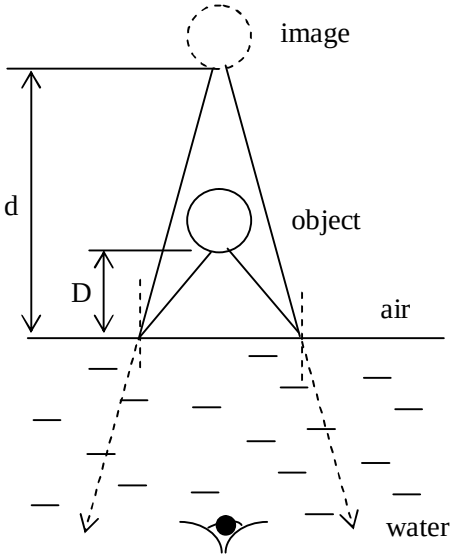
1. Ray diagram



5.3.2 Real depth and apparent depth

1. Ray diagram



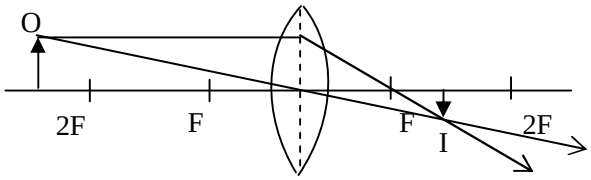
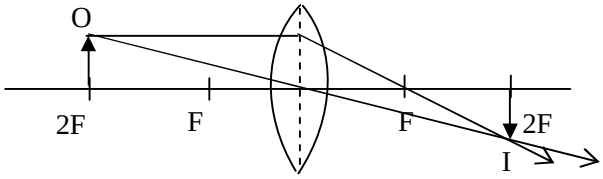
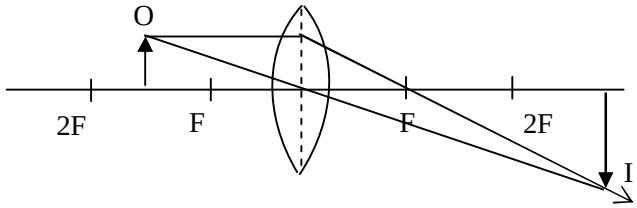
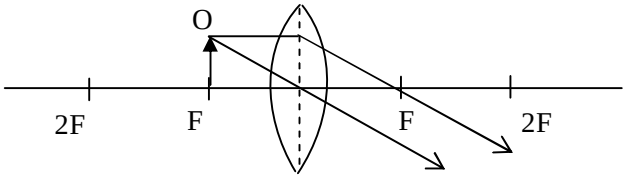
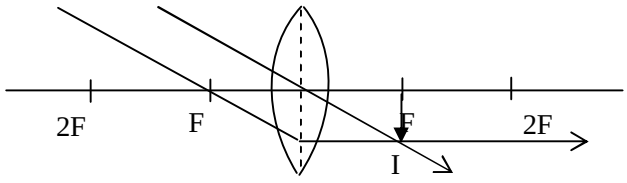
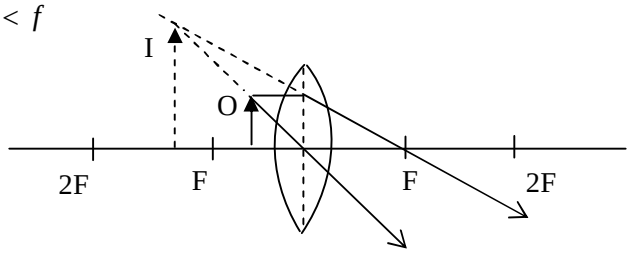


Characteristic of image:
(i) Virtual
(ii) Shallower
(iii) Same size
(iv) Upright

Characteristic of image:
(i) Virtual
(ii) Further away
(iii) Same size
(iv) Upright

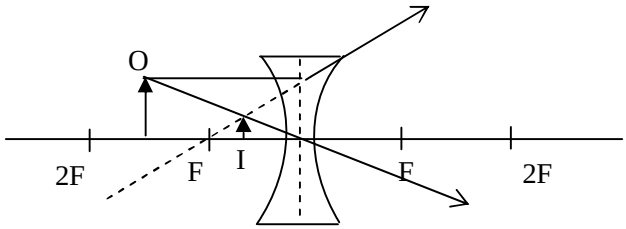
5.3.3 Lens

5.3.3.1 Convex lens

Ray diagram	Characteristics of image
1. u > 2*f*  	▪ Inverted ▪ Real ▪ Diminished ▪ Image between F and 2F
2. u = 2*f*  	▪ Inverted ▪ Real ▪ Same size ▪ Image at 2F
3. *f* < u < 2*f*  	▪ Inverted ▪ Real ▪ Magnified / Enlarged ▪ Image further than 2F
4. u = *f*  	▪ Upright ▪ Virtual ▪ Image at infinity ▪ Parallel ray is produced
5. u = infinity  	▪ Inverted ▪ Real ▪ Diminished ▪ Image at F
6. u < *f*  	▪ Upright ▪ Virtual ▪ Magnified / Enlarged ▪ Image in the same side of object Application: Magnifying lens

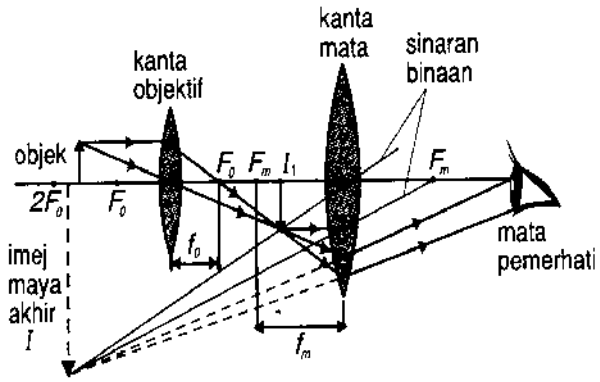
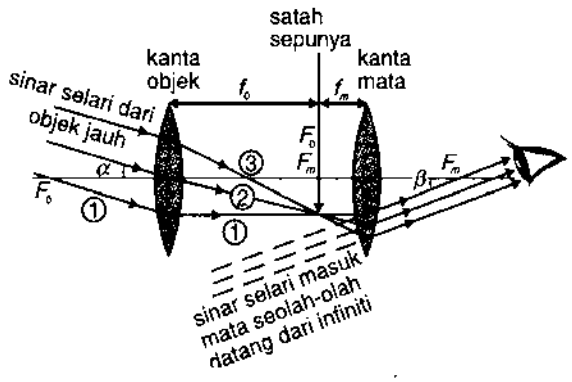
5.3.3.2 Concave lens

1. Ray diagram



2. Characteristics of concave lens:
   (i) Upright
   (ii) Diminished
   (iii) Virtual
   (iv) Image in the same side of object

5.3.3.3 Applications of lens:

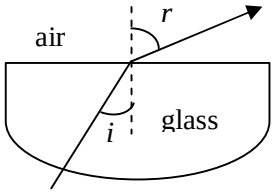
Compound microscope	Telescope
	

1. Similarities of compound microscope and telescope
   (i) Consists of two lenses.
   (ii) The first image is real, inverted and acts as the object for the eyepiece.
   (iii) The eyepiece acts as a magnifying lens.
   (iv) The final images are virtual, inverted and magnified.

2. Differences between the compound microscope and the telescope

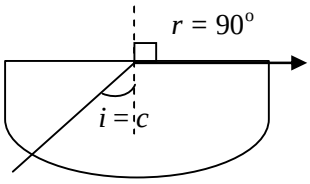
Aspect	**Compound microscope**	**Telescope**
Type of lens	Two high powered convex lenses	A low powered convex lens and a high powered convex lens
Focal length	$f_e > f_o$	$f_o > f_e$
Power of lenses	Objective lens > Eyepiece	Eyepiece > Objective lens
First image	Magnified	Diminished
Position of final image	At near point to the observer's eye	At infinity
Distance between lenses	Greater than $f_o + f_e$	Equal to $f_o + f_e$ (at normal adjustment)
Linear magnification, m	$m = \frac{\text{image height, I}}{\text{object height, I}_0}$	$m = \frac{f_o}{f_e}$

5.4 Total internal reflection



Refraction
i = angle of incidence
r = angle of refraction

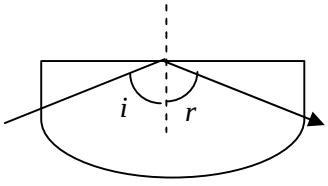
$$n = \frac{\sin r}{\sin i}$$



Refraction
c = critical angle
r = angle of refraction

$$n = \frac{\sin 90^o}{\sin c}$$

$$n = \frac{1}{\sin c}$$



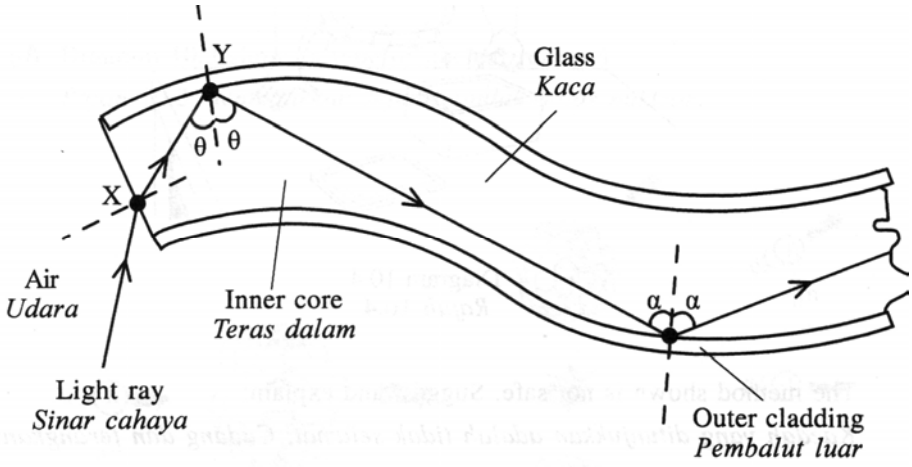
Total internal reflection
i = angle of incidence
r = angle of reflection

$\angle i = \angle r$

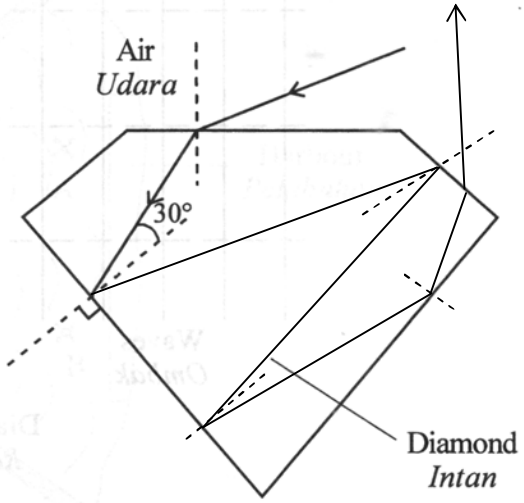
Note: When determine the refractive index, *n* the light ray must assume move from air to glass. However, the phenomenon of total internal reflection only occur when the light ray travel from glass to air.

5.4.1 Applications of total internal reflection

1. Optical fibre

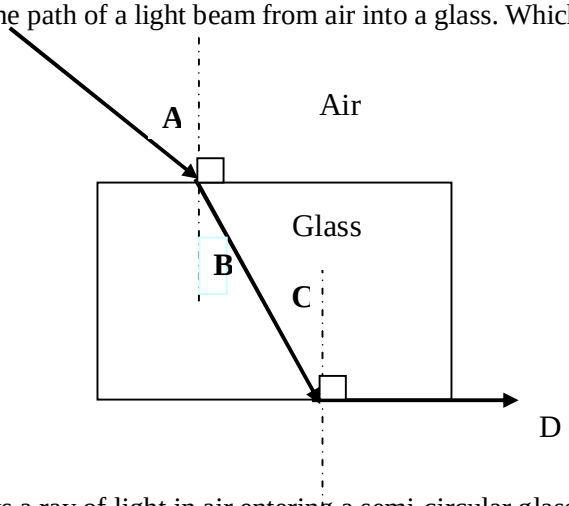


2. Diamond



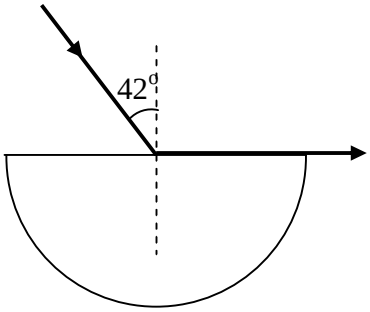
SECTION A:MULTIPLE CHOICE

1 Diagram shows the path of a light beam from air into a glass. Which of the angle is the critical angle?

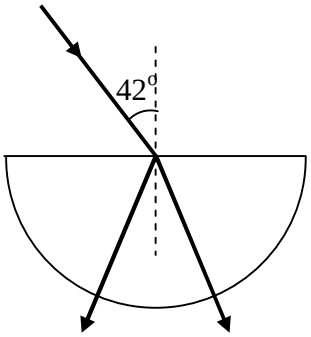


2 Diagram shows a ray of light in air entering a semi-circular glass block at an angle of incidence 42^{o}. Which diagram shows the subsequent path of the ray?

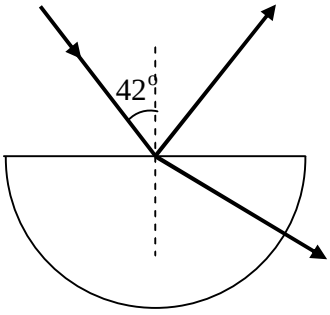
A



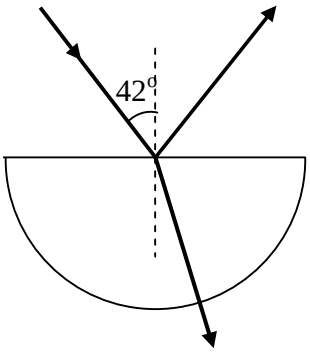
B



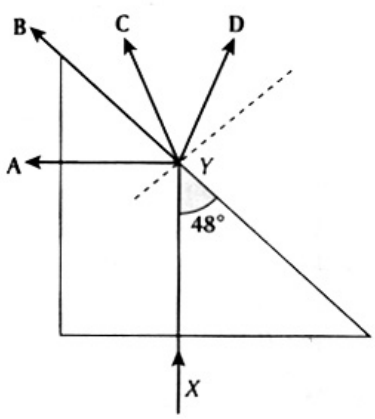
C



D



3. Diagram shows a ray, X, is directed into a glass block. The critical angle of the glass is 42^{o}. Which direction does the light travels from point Y?



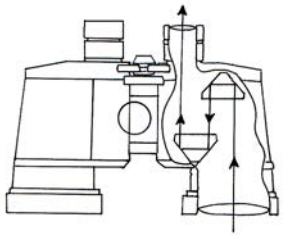
4.

$$n = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in a medium}}$$

n represents

A. Snell's law
B. power of lens
C. refractive index
D. linear magnification

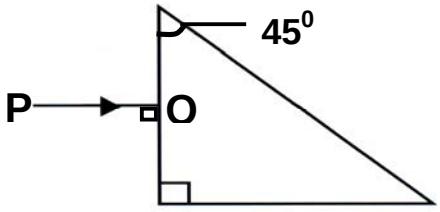
5. The figure shows a pair of binoculars.



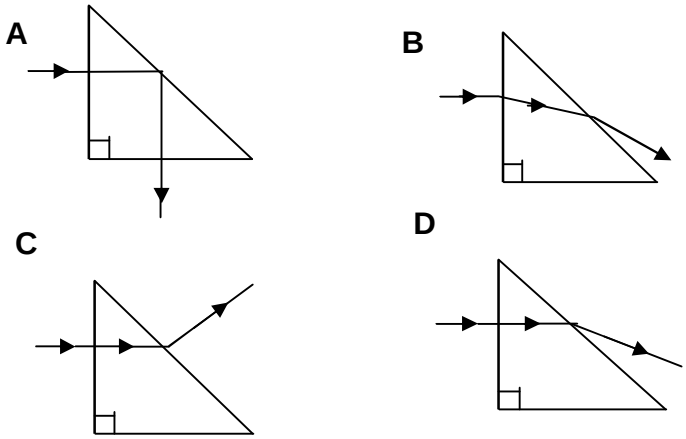
What is the light phenomenon that occurs when a light ray passes through the prisms?

A. Refraction
B. Diffraction
C. Reflection
D. Total internal reflection

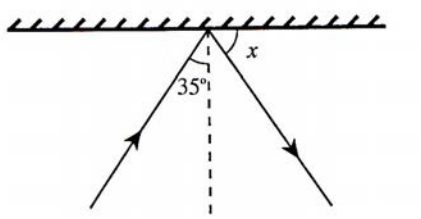
6. The figure shows a glass prism. The critical angle of glass is 42°. A light ray PQ is incident on its surface.



Which figure shows the correct path of the light ray?



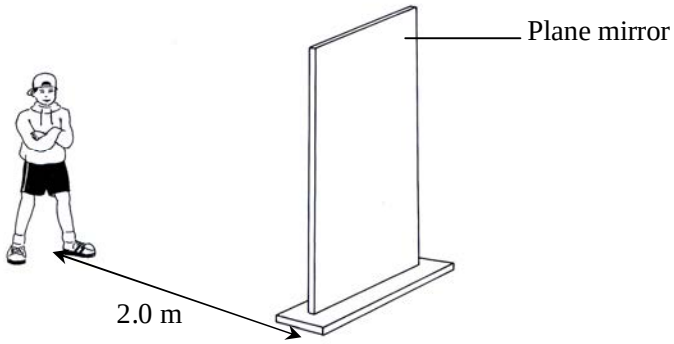
7. The figure shows a light ray which is incident onto a plane mirror.



What is the value of x ?

A. 35^{O}
B. 40^{o}
C. 55^{o}
D. 70^{o}

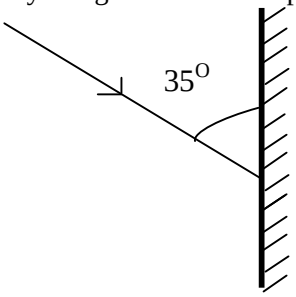
8. A student is standing at a position of 2.0 m from a large plane mirror. Then he walks 0.5 m towards the mirror.



What is the distance between the student and his image in the mirror now?

A. 0.5 m
B. 1.5 m
C. 3.0 m
D. 4.0 m

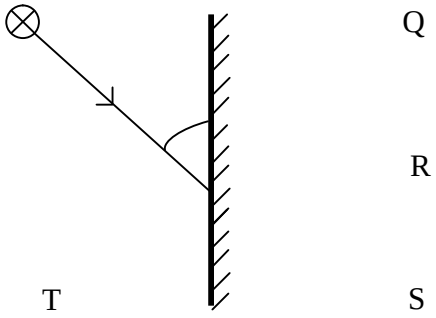
9. Diagram 2 shows a ray of light directed to a plane mirror.



What are the angles of incidence and reflection?

	Incidence	Reflection
A	55	55
B	35	35
C	55	35
D	35	55

10. Diagram 3 shows a bulb and a plane mirror.



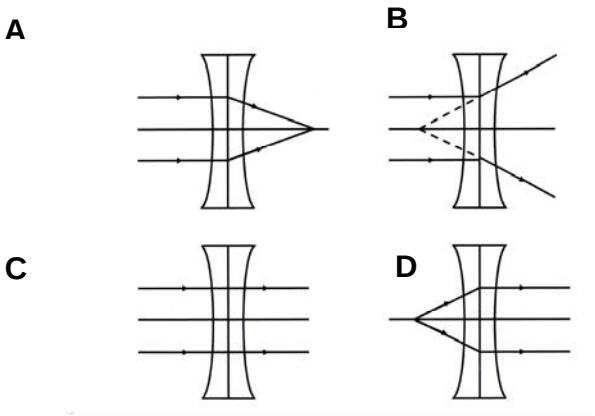
The image formed by the plane mirror is at

A Q
B R
C S
D T

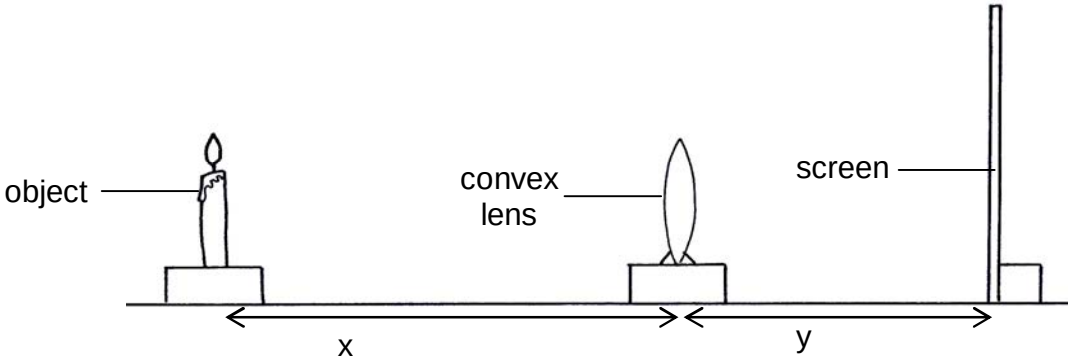
11 Which of the following are the characteristics of the image formed by a plane mirror?

A. Inverted, same size and real
B Upright, same size and real
C Upright, magnified and laterally inverted
D Laterally inverted, same size and virtual

12. Which figure shows correctly light rays passing through a concave lens?



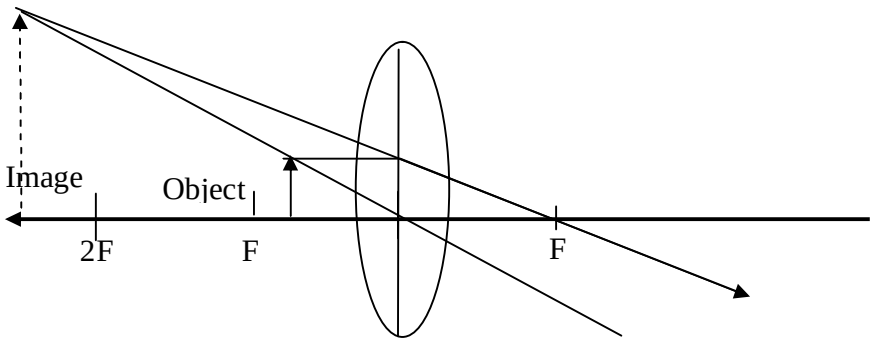
13. The figure shows a convex lens.



x represents the

A. focal length
B. principal axis
C. object distance
D. image distance

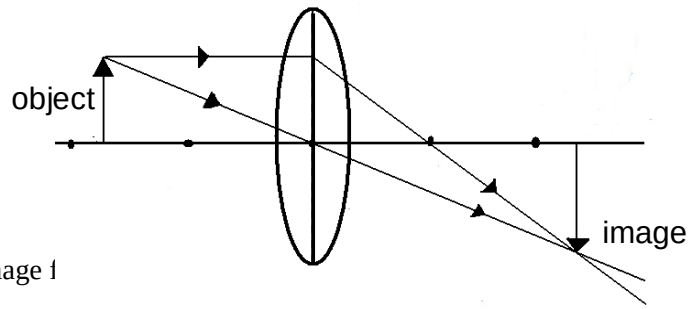
14. Diagram 4 shows a convex lens and an object placed less then one focal length



Which optical instrument uses this arrangement?

A Camera
B Projector
C Magnifying glass

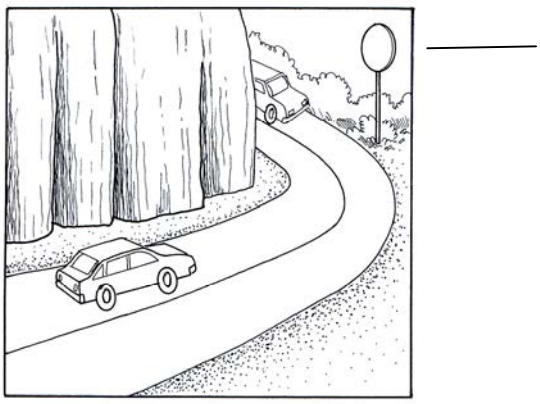
15. The figure shows an object placed in front of a convex lens.



The image f

A virtual
B. upright
C. inverted

16. The figure shows a convex mirror used as a blind corner mirror at a sharp corner.



An advantage of using a convex mirror is that the image is magnified

A. it has a wide field of view
B. the size of a near object can be estimated
C. the distance of a near object can be estimated

17. For questions 8 to 10, choose the best terminology that best relates to each photograph shown.

A. Critical angle
B. Inverted image
C. Diminished image
D. Magnified image

18. Diagram 7 shows the word **sport** viewed through lens X and lens Y of two different pairs of spectacles.

What type of lens are X and Y?

	Lens X	Lens Y
A	Convex	Convex
B	Convex	Concave
C	Concave	Convex
D	Concave	Concave

19 Which of the following combinations is the characteristics of a photostate machine?

	Focal length/ cm	Object distance/ cm
A	5	10
B	8	5
C	10	5
D	20	8

20 A convex lens is used as a magnifying glass. What are the characteristics of the image?

A magnified, upright, virtual

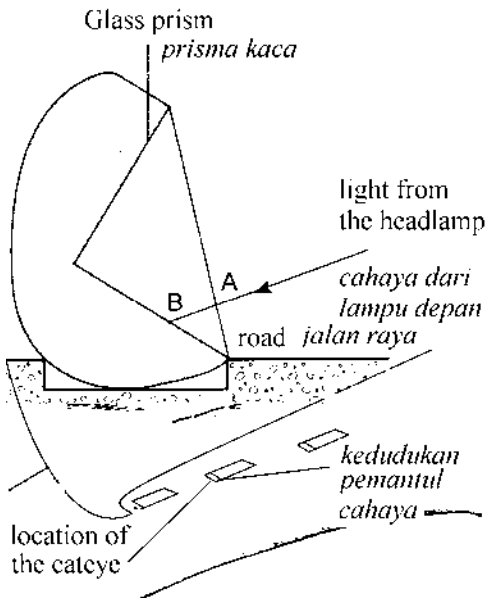
B magnified, upright, real

C magnified, inverted, virtual

D magnified, inverted, real

SECTION B: STRUCTURED QUESTION

Diagram 1 shows a cat's eye fixed into a road to help drivers when it is dark or foggy.



(a) What is meant by critical angle?
Tick (√) the correct answer in the box provided.

The angle of incidence when the angle of refraction is 90^o .

☐ The angle of incidence when the incident ray is totally reflected.

[1mark]

(b) Based on diagram 1 what happen to the light ray after passing point B?

……

[1mark]

(b) Based on diagram 1 how does the cat's eye help the driver?

……

……

[2 marks]

2. Diagram 2.1 and Diagram 2.2 show an identical pencil is immersed in the distilled water and sea water respectively.

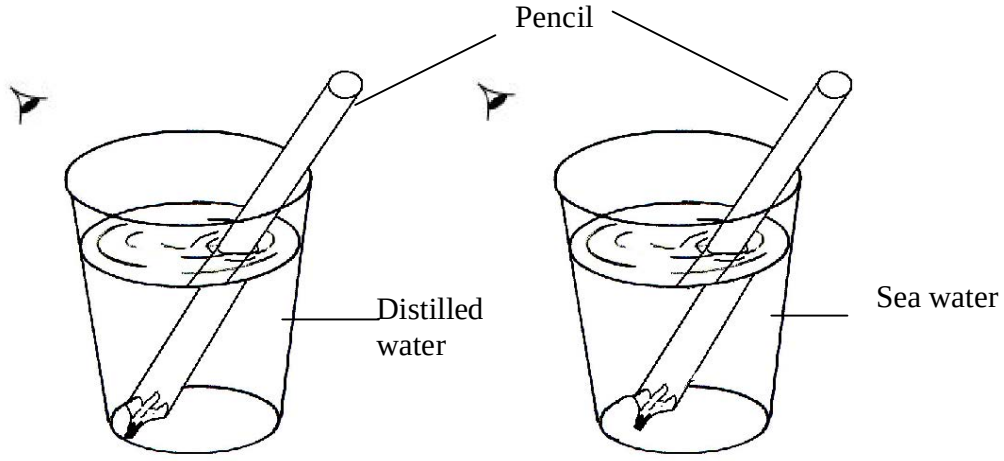


DIAGRAM 2.1 DIAGRAM 2.2

Based on Diagram 2.1 and Diagram 2.2,

(a) compare the bending of the pencil

…...……

...……

[1 *mark*]

(b) compare the density of distilled water and the sea water

...

.....

[1 *mark*]

(c) state the relationship between the density of water with the bending of the pencil

...

[1 *mark*]

(d) Based on Diagram 2.1, compare the size of the observed pencil inside and outside the distilled water

.....

.....

[1 *mark*]

(e) Name the phenomenon shown in Diagram 2.1 and Diagram 2.2

.....

[1 *mark*]

3. Diagram 3.2 shows the formation of the image of an object by a lens X. In Diagram 3.3, another lens, Y, is used to form the image of the same object.

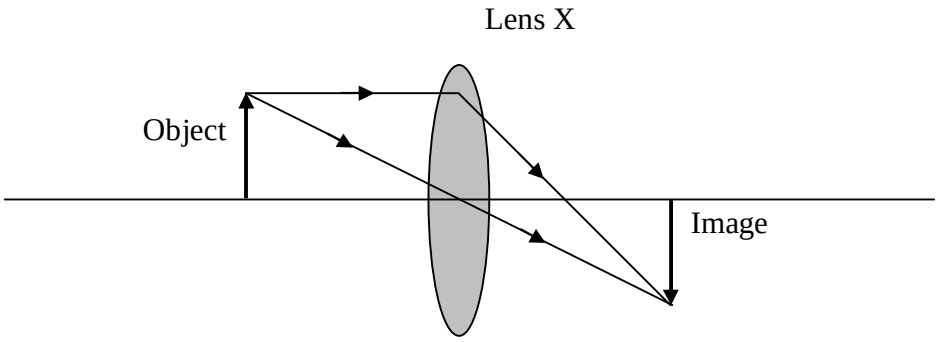


Diagram 3.2

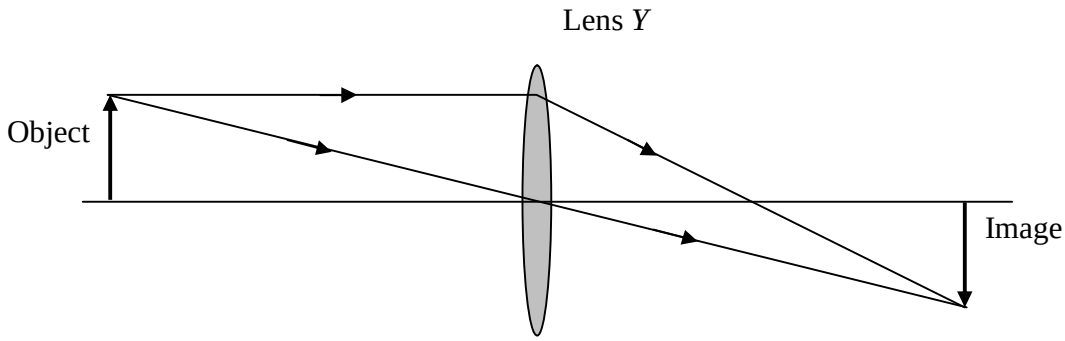


Diagram 3.3

(a) (i) State the light phenomenon that takes place in the endoscope.

…….

[1 *mark*]

(ii) State two advantages of using a fibre optic cable.

……

…….

[2 *marks*]

(b) For each case, compare;

(i) the size of the object and the size of the image

…….

[1 *mark*]

(ii) the object distance and the image distance

.....

[1 mark]

(c) (i) Compare the focal length of lens X and lens Y.

……..

[1 mark]

(ii) Compare the thickness of lens X and lens Y.

…….

[1 mark]

(d) Relate the focal length with the thickness of the lens.

.....

[1 mark]

4. Diagram 4 shows an object, O with height 2 cm placed on the left side of a convex lens, X. The focal length of the convex lens is 10 cm.

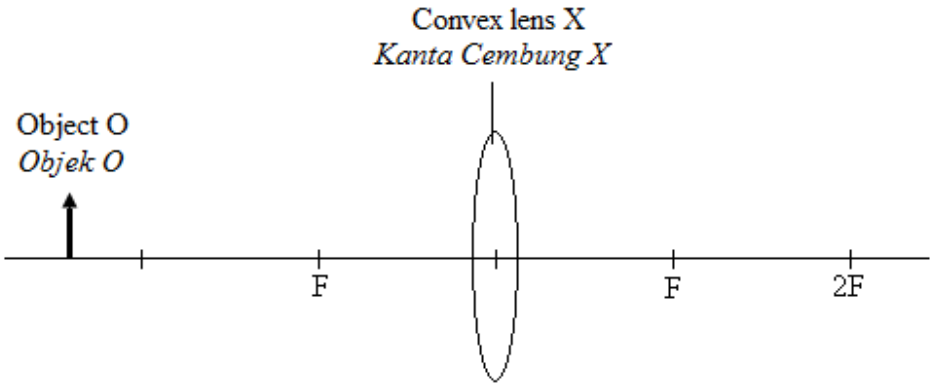


Diagram 8
Rajah 8

(a) In Diagram 8 draw the ray path from the object to form an image.

[2 *mark*]

(b) State the characteristics of the image formed.

……

[1 *mark*]

(c) If the object is placed at a distance 30 cm from the lens, calculate:

(i) the image distance.

……

[2 *mark*]

(ii) Linear magnification.

……

[1 *mark*]

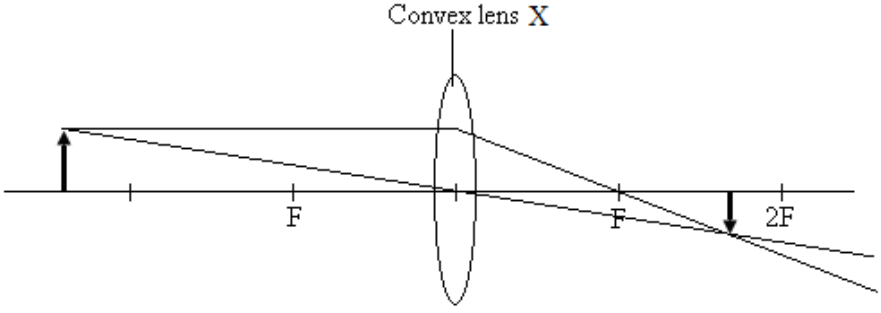
1	D
2	A
3	B
4	D
5	D
6	A
7	C
8	C
9	C
10	A
11	D
12	B
13	C
14	C
15	C
16	A
17	D
18	B
19	A
20	A

SECTION B: STRUCTURED

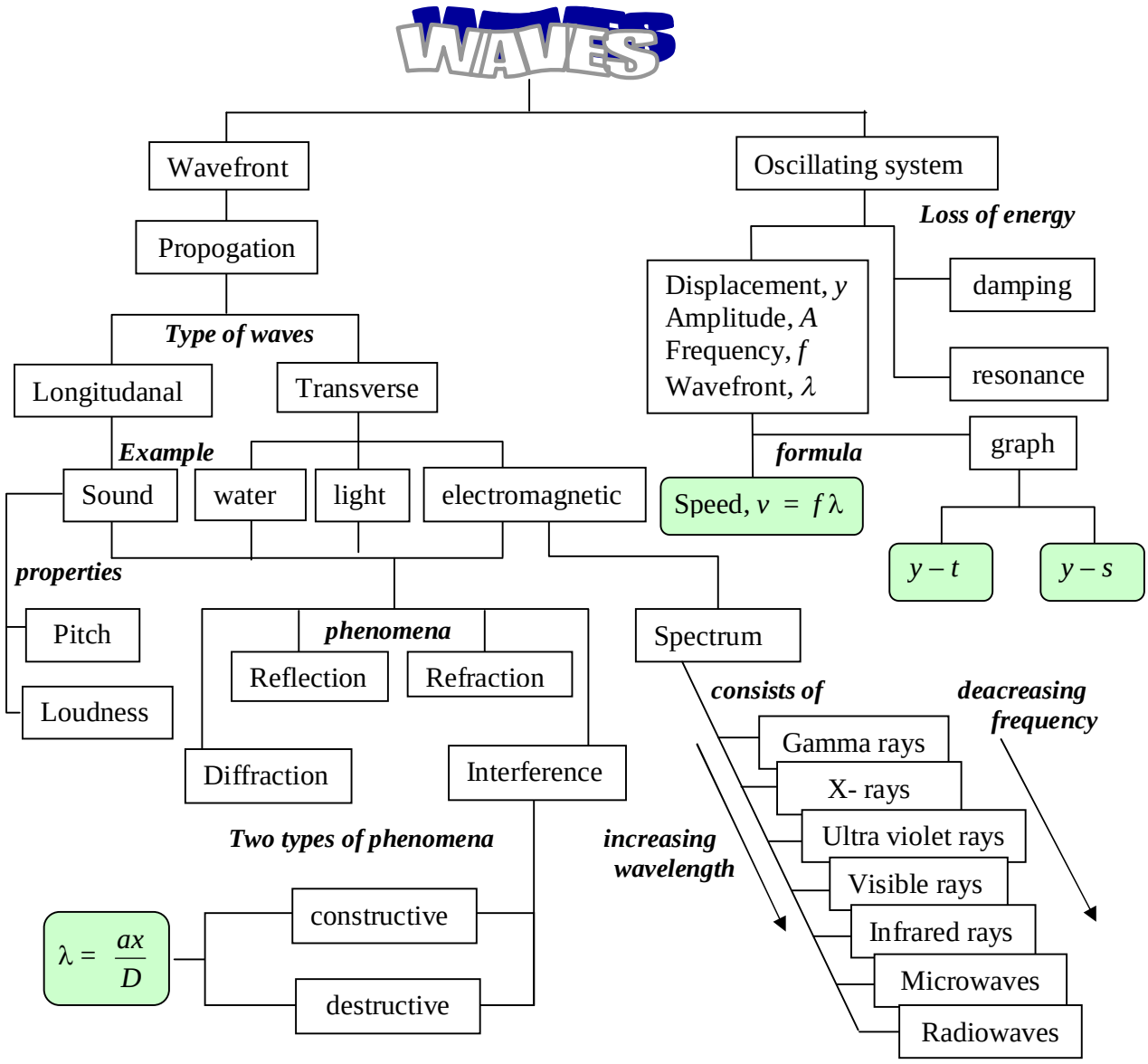
1(a)	The angle of incidence when the angle of refraction is 90^o.	1
(b)	Reflection/total internal reflection//totally reflect//reflect	1
(c)	Reflection of light from the car headlight back to the driver giving an indication of its position.	2
	TOTAL	**4**

2 (a)	Pencil in Diagram 6.2 more bending/vice versa	1
(b)	Density of seawater is higher/ vice versa	1
(c)	The higher the density the greater the bending	1
(d)	The size of the pencil in the water is greater	1
(e)	Refraction	1
	TOTAL	**5**

3 (a)(i)	Total internal reflection	1
(ii)	- can carry large amount of data/information - transmit signals with very little loss - can transmit large amount of signals at one time - very much thinner and lighter	1 1 1 1
(b)(i)	in diagram 2.2 / 2.3 the size of object is equal to the size of image	1
(ii)	in diagram 2.2 / 2.3 the object distance is equal to the image distance	1
(c)(i)	Focal length of lens X is shorter than the focal length of Y	1
(ii)	Lens X is thicker than lens Y	1
(d)	The thicker the lens, the shorter the focal length	1
	TOTAL	**10**

4 (a)		1 1
(b)	Real, diminished, inverted	1
(c)	1/f = 1/u +1/v v = 15 cm	1
(d)	m = v/u m = 0.5	1
(e)		1
	TOTAL	**6**

TOPIC 6 : WAVES



6.1 Understanding Waves

1. Waves transfer energy without transferring matter.
2. There are two types of waves, transverse and longitudinal waves.
3. The direction of propagation of a wave is perpendicular to its wavefront.
4. The amplitude, A of an oscillation is the maximum displacement from the mean position.
5. The period, T of the oscillation is the time taken to complete one oscillation.
6. The frequency, f of the oscillation is the number of complete oscillations made in one second.
7. The wavelength, λ is the horizontal distance between two successive crests or troughs.
8. Wave speed , v

$$\boxed{v = f\lambda}$$

9. Damping is said to have occurred in an oscillating system when the system loses energy to the surroundings, usually in the of heat energy.
10. Resonance in an oscillating system occurs when it is driven at its natural frequency by a periodic force.

6.2 Analysing Reflection of Waves

1. Reflection of waves refers to the return of all or part of the waves when they encounter an obstacle.
2. In the reflection of waves, the angle of reflection is equal to the angle of incidence.
3. The wavelength, frequency and speed of the reflected waves are the same as that of the incident waves.

6.3 Analysing Refraction of Waves

1. Refraction of waves is a phenomenon where there is a change of direction in the propagation of waves when they move from one medium to another due to a change of speed.
2. The frequency of the refracted waves is the same as that of the incident waves.

6.4 Analysing Diffraction of Waves

1. Diffraction is the spreading out of waves when they move through a gap or round an obstacle.
2. The wavelength, frequency and speed of the diffracted waves are the same as that of the incident waves.
3. The amplitude of the incident waves is bigger than the diffracted waves.

6.5 Analysing Interference of Waves

1. The principle of superposition states that when two waves overlap, the resultant displacement is equal to the sum of the displacements of the individual wave.
2. Interference occurs when two wavefronts meet. The waves either interfere constructively or destructively.
3. The approximate formula for interference : $\lambda = \dfrac{ax}{D}$

6.6 Analysing Sound Waves

1. Sound wave is a longitudinal wave.
2. Sound wave needs a medium for its propagation.
3. Loudness of sound increases if its amplitude increases.
4. Pitch of sound increases if its frequency increases.

6.7 Analysing Electromagnetic Waves

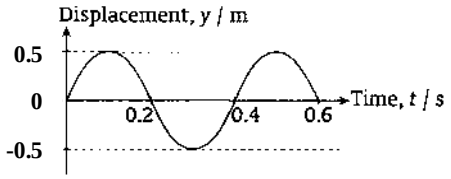
1. The electromagnetic spectrum consists of gamma rays, X-rays, ultraviolet rays, visible light, infrared rays, microwaves and radio waves.
2. All electromagnetic waves are transverse in nature and undergo the phenomena of reflection, refraction, diffraction and interference.
3. All electromagnetic waves do not carry any charge and travel through a vacuum with the speed of $c = 3.00 \times 10^8 \text{ m s}^{-1}$
4. Electromagnetic waves consist of a combination of oscillating electric and magnetic fields perpendicular to each other.

Excercise

Section A : Master the concept

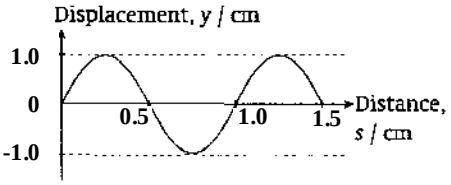
1. Base on the graph describes the motion of a particular wave.
Determine the

(a) amplitude,
(b) period,
(c) frequency of the wave.

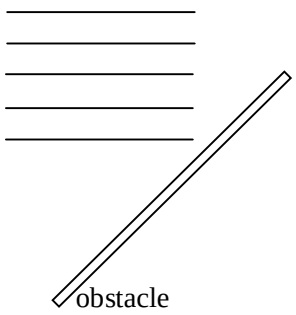


2. The displacement-distance graph in Figure 1.14 describes the motion of a particular wave with a frequency of 50 Hz. Determine the

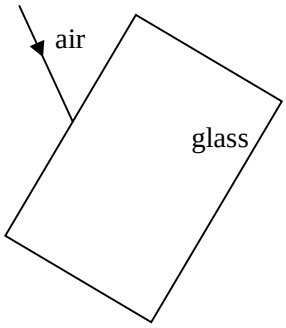
(a) amplitude,
(b) wavelength,
(c) wave speed.



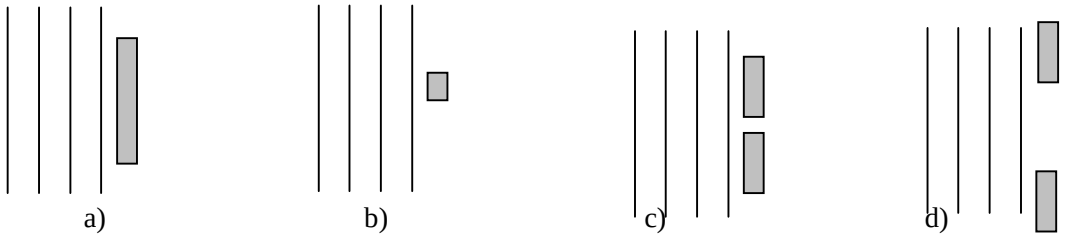
3. Figure below shows the wavefronts of a incident plane wave. Complete the diagram to show the refracted wavefronts. Your diagram should include the *normal*, *directions of propagation* of incident and reflected waves, and labels for *angle of incidence*, *i* and *angle of reflection*, *r*.



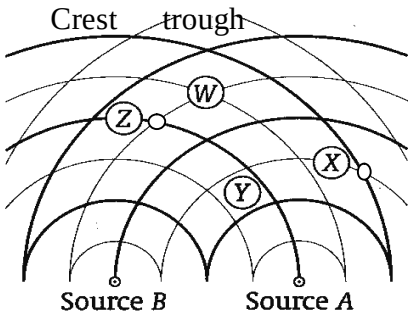
4. Complete the diagram below to show the refracted wave. Your diagram should include the *normal*, *directions of propagation* of incident and refracted waves, and labels for *angle of incidence*, *i* and *angle of refraction*, *r*



5. Complete the following diagrams by drawing the wavefronts to show the diffraction of caer waves.

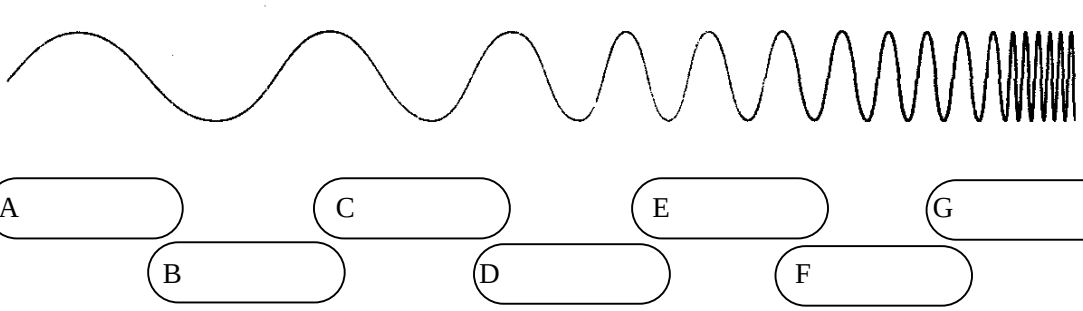


6. Complete the table by describing the state of motion of each bead and the type of interference that occurs at W, X, Y and Z.

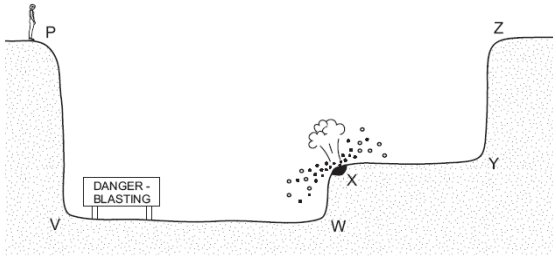


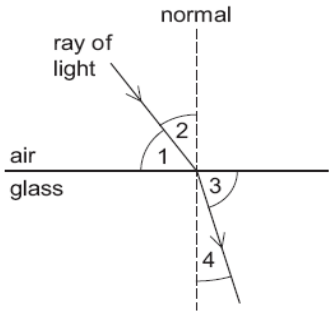
Bead	State of motion	Type of interference
W		
X		
Y		
Z		

7. Figure shows the electromagnetic spectrum. Name A – G



8. An engineer standing at P hears the sound of an explosion at X.
After the explosion, he hears two bangs.
One bang is heard a fraction of a second after the other.
The second bang is an echo from ……..



9. 

Which number is

i) the incident angle : ……

ii) the refracted angle : ……

10. In a Young double-slit experiment, a student recorded the following data.

Distance between the double slits and the screen = 1.5 m Distance between two adjacent bright fringes = 1.8 mm Wavelength of the light waves = 600 nm

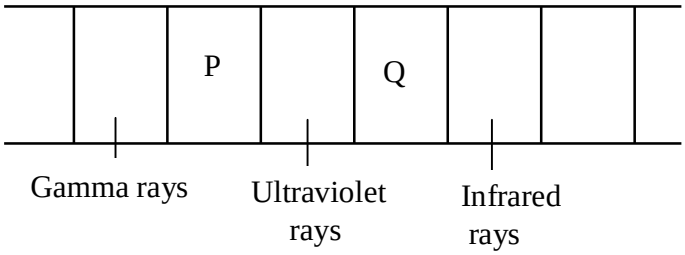
Calculate the distance of separation between the slits.

Section B : Objectif questions

1. Which of the following statements is true?

A Sound waves travel very slowly in vacuum
B Sound waves travel faster in air than in water
C Sound waves are transverse waves
D Sound waves travel faster in solid than in air

2. The figure shows an electromagnetic spectrum.



What are waves P and Q?

	P	Q
A	X-rays	Microwaves
B	X-rays	Visible lights
C	Microwaves	Visible lights
D	Visible light	Microwaves

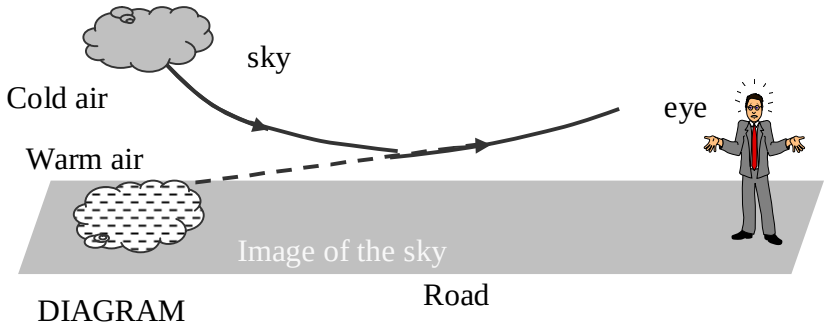
3. The diagram shows a light ray which travels from air to glass.

What is the refractive index of the glass?

A $\frac{\sin S}{\sin Q}$ B $\frac{\sin P}{\sin R}$

C $\frac{\sin Q}{\sin R}$ D $\frac{\sin R}{\sin S}$

4.

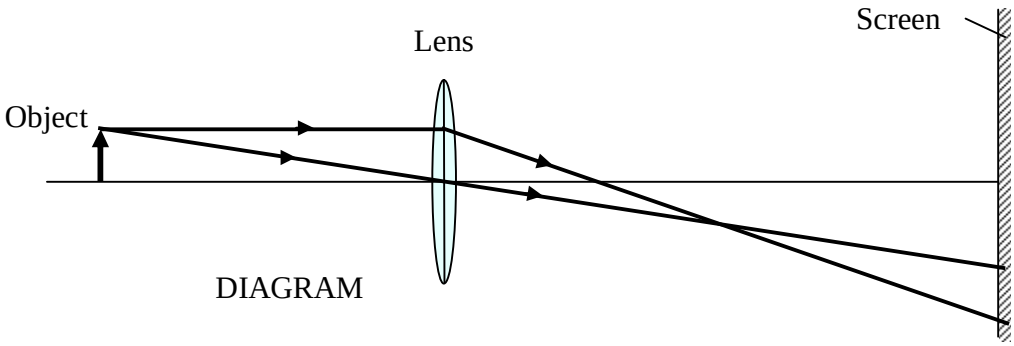


DIAGRAM

The diagram shows the mirages are formed on a hot day. What is the phenomenon involved?

A. Reflection
B. Refraction
C. Diffraction
D. Total internal reflection

5. In the following ray diagram, the image formed on the screen is not clear (not sharp).



DIAGRAM

Which of the following changes will produce a sharp image on the screen?

A. Replace the lens with another convex lens of longer focal length.
B. Replace the lens with another concave lens of shorter focal length.
C. Move the object further from the lens.
D. Move the screen further from the lens.

6. Diagram shows the graph of displacement against time for a load which is oscillating at the end of a light spring in air.

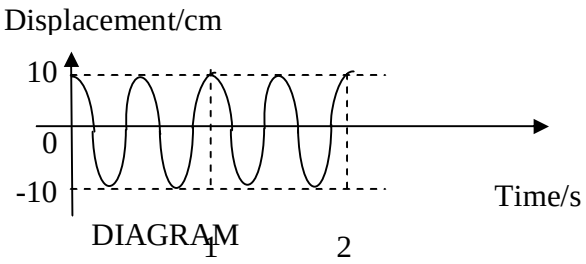
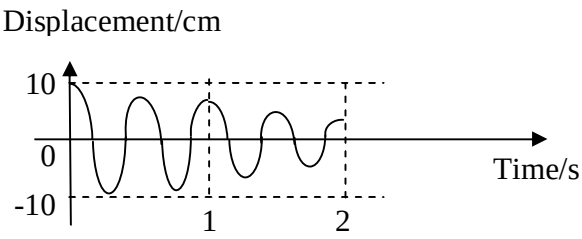


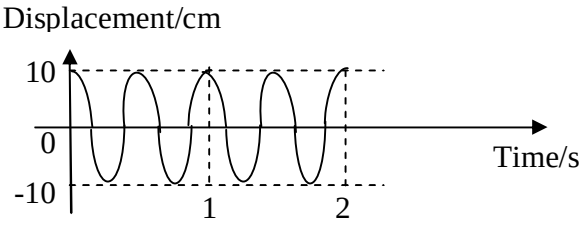
DIAGRAM 1

Which graph correctly shows the oscillating of the load when it is oscillating in water?

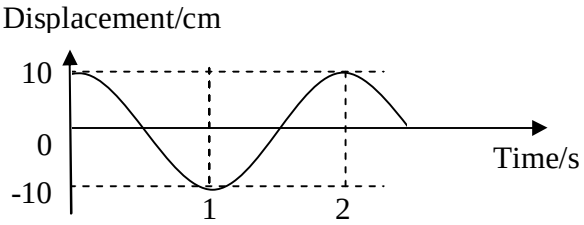
A



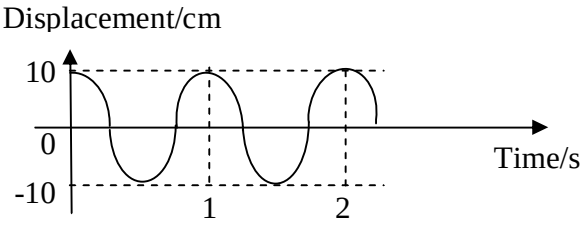
B



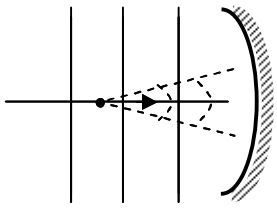
C

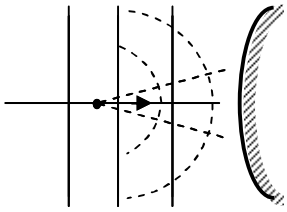


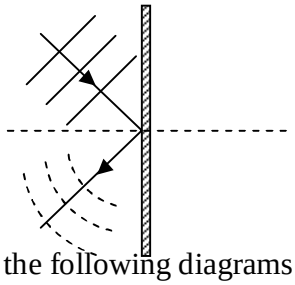
D

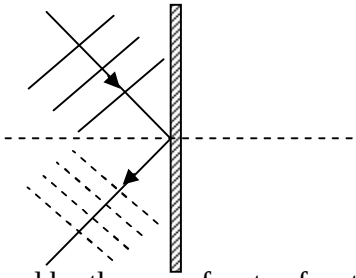


7. Which diagram shows the correct reflection pattern produced when plane water waves are incident on a barrier?

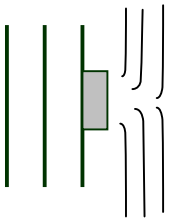
A 

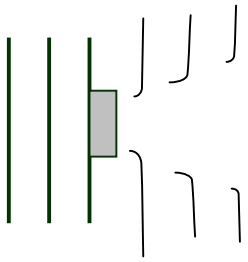
B 

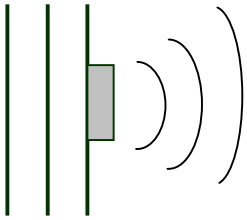
C 

D 

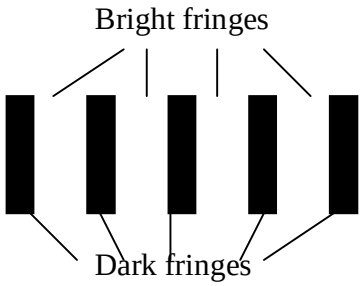
8 Which of the following diagrams show the pattern formed by the wavefronts of water waves passing by an obstacles?

A 

B 

C 

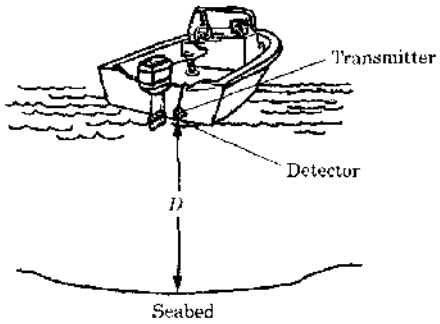
9. The diagram shows the fringe pattern produced from Young's double slit experiment using the monochromatic red light source.



What happens to the fringes if monochromatic yellow light source is used?

A The bright fringes are wider than the dark fringes
B The dark fringes are wider than the bright fringes
C The distance between consecutive fringes decrease
D The distance between consecutive fringes increase

10. The diagram shows an ultrasonic waves transmitted from a boat to the seabed to determine the depth, D, of the sea. The speed of the ultrasonic waves in water is 1 500 m s^{-1}. The echo of the waves is received 2.0 s after the transmission.



What is the value of D

A	375 m	D	3 000 m
B	750 m	E	6 000 m
C	1 500 m		

Section C : Structure Question

1. (a) Fig. 1.1 shows a machine for making loud sounds. It is called a siren. This consists of a rotating disc with 25 holes. As each hole passes the jet, a puff of air passes through the hole

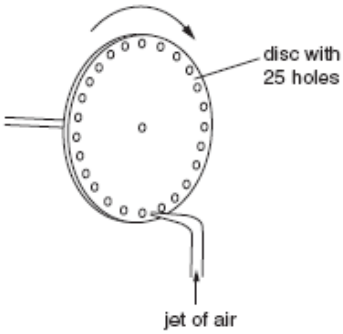


figure 1.1

(i) How many puffs of air will there be during one revolution of the disc?

(ii) The disc rotates 40 times per second. Calculate the frequency of the note produced by the siren.

(b) The siren described in **(a)** is located some distance from a large building, as shown in Fig. 1.2.

Figure 1.2

The siren is briefly sounded once. A short time later, the sound is heard again.

(i) Why is this second sound heard?

.....

(ii) What is the frequency of this second sound?……

(iii) What is the amplitude of this second sound?……

2. Boy A throws a large stone into a large still pond, as illustrated in Fig. 2.1.

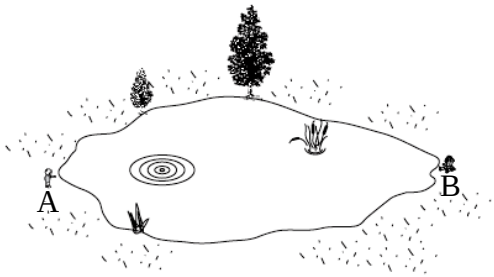


Figure 2.1

(a) Girl B hears the 'plop' sound of the stone entering the water a very short time after she sees the splash, but it is many seconds before the water wave reaches the edge of the pond where she is sitting.
Use this information to decide which wave travels fastest and which travels slowest.

……

(b) Based on answer in a. state each type of wave.

……..

(c) State the wave that do **not** need a substance as the medium to travel.……

3. Fig.3.1 shows three wavefronts in a beam of yellow light passing through air. The wavefronts are one wavelength apart. The beam meets a glass surface. AB is a ray of light that shows the direction of travel of the wavefronts.

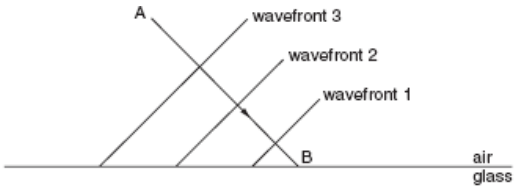


Figure 3.1

(a) Complete Fig. 3.1 by
(i) continuing the ray AB to show the ray inside the glass,
(ii) continuing wavefront 1 inside the glass.

(b) State what happens to the speed and wavelength of the waves as the beam moves from the air to the glass.

(i) speed .....

(ii) wavelength .....[2]

(c) The glass in Fig. 3.1 is replaced with a denser glass.
Describe two ways in which the completed Fig. 3.1 would change.

1. .....

……..

2. ….....

.....[2]

Section D : ESSAY

1. Diagram 1.1 and Diagram 1.2 show the water waves and sound waves propagating towards a reflector.

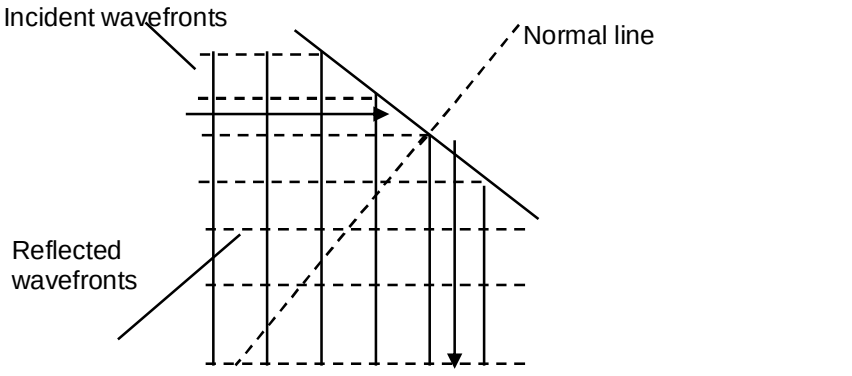


DIAGRAM 1.1

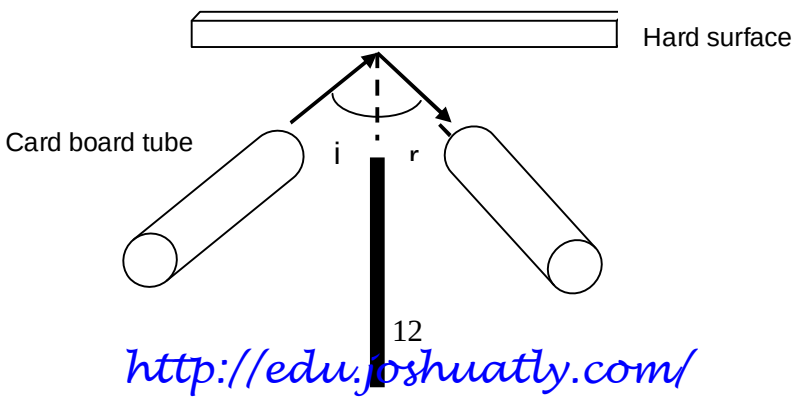


DIAGRAM 1.2

(a) (i) What is meant by **reflected waves**? [1 *mark*]

(ii) With reference to Diagram 1.1 and Diagram 1.2, compare the incident and reflected angle, wavelength, frequency, speed and direction of propagation of the reflected wave.

[5 *marks*]

(iii) State the principle of reflection of waves.

[1 *mark*]

(b) Discuss on how you would use the sound wave to determine the depth of the sea.

[3 *marks*]

(c) You have been assigned as a consultant to assemble a speaker system and to improve the acoustics of a school hall. Using the appropriate physics concept explain how the installation of the speaker system and other modifications that can improve audible sound. In your explanation, elaborate on the following points:

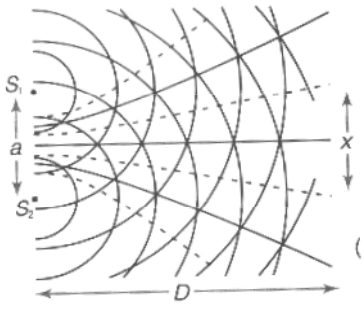
(i) The arrangement of the speakers.

(ii) Wall and floor finishing.

(iii) Power of the loud speakers [*10 marks*]

2. Diagrams 2.1 and 2.2 show interference patterns using coherent sources of waves, λ.

a.



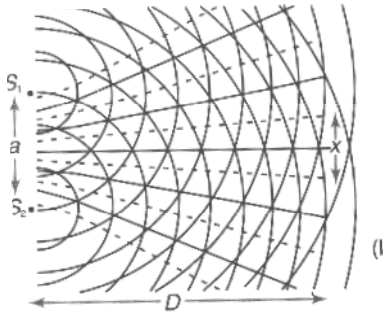


Diagram 2.1 Diagram 2.2

i) What is meant by coherent waves ?

(1 mark)

ii) Compare Diagrams 2.1 and 2.2

Relate λ and x to make a deduction regarding the relationship of both quantities.

(5 marks)

b) Two loudspeakers placed 1.5 m apart are connected to an audio signal generator adjusted to a frequency 600 Hz. When a student walks at a distance of 3.0 m infront of the loudspeakaers he hears four consecutive loud and 3 soft sounds Explain why? (4 marks)

c) i) Explain why the wavefronts in the sea follow the shape of the coastline as the water becomes shallower.

(4 marks).

ii) You plan to build a safe port for the convenience of the fishermen. Suggest relevant steps to be taken in order to build it.

(6 marks)

Answer of exercises for critical topic.

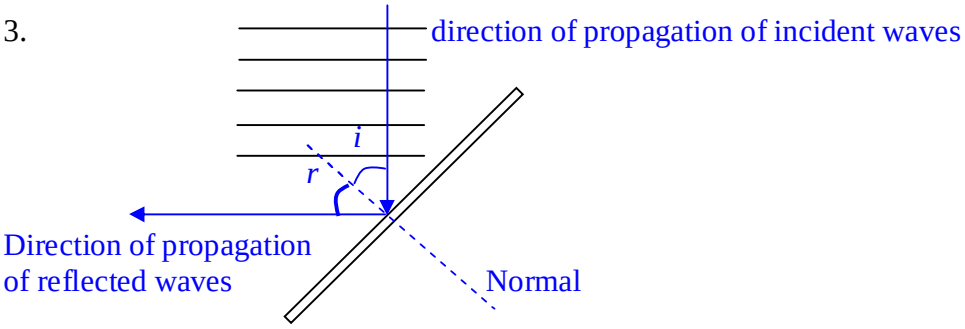
Topic 6 : Waves

Section A : Master the concept

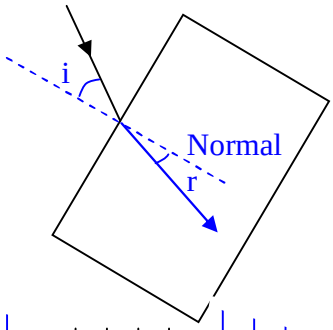
1. (a) 0.5 m (b) 0.4 s (c) 2.5 Hz

2. (a) 1.0 m (b) 1.0 m (c) 50 ms^{-1}

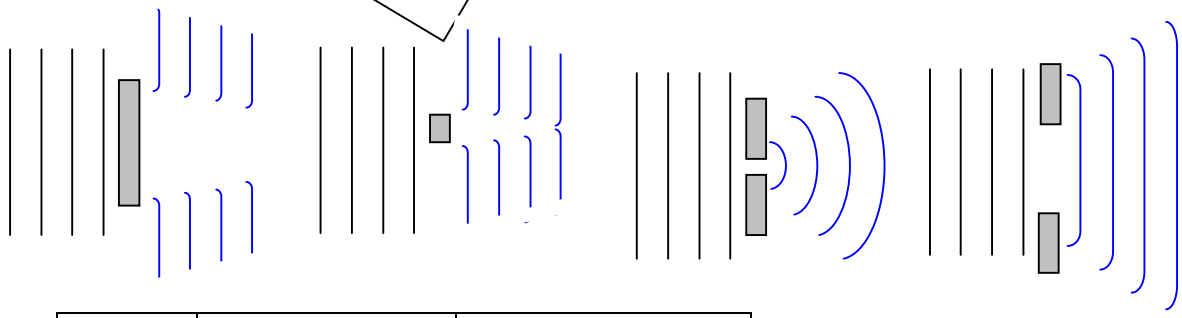
3.



4.



5.



6.

Bead	State of motion	Type of interference
W	Trough & trough	Constructive
X	Trough & crest	desructive
Y	Crest & crest	constructive
Z	Trough & crest	Destructive

7. A : radio waves B : microwaves C : Infrared D : visible light
E : Ultra violet F : X-rays G : Gamma rays

8. YZ

9. i) 2 ii) 4

10. 5.0×10^{-8} m

Section B : Objectif question

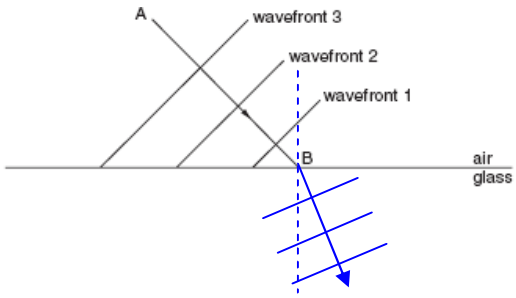
1. C 2. B 3. B 4. D 5. A 6. A 7. A 8. B 9. C 10. C

Section C : Structure Question

1. (a) (i) 25 times
(ii) 25 x 40 = 1000 Hz
(b) (i) Reflection
(ii) 1000 Hz
(iii) same with initial sound waves

2. (a) Light waves move faster
(b) Light waves : transverse waves , Sound waves : longitudinal waves
(c) Light waves

3. (a)



(b) (i) speed : decrease
(ii) wavelength : decrease (because $v = f\lambda$, f : unchanged & v decrease)

(c) 1. decrease the angle of refraction
2. decrease the distance between two wavefront (λ)

Section D : Essay

1. (a) (i) Waves that occurs when it strike the obstacle.
(ii) - i = r
- λ of incident wave = λ of refracted waves
- f of incident wave = f of refracted waves
- v of incident wave = v of refracted waves
- Direction of incident wave is change

(iii) - transmit the ultrasound with known velocity to the seabed
- Take the time taken until the echo detected
- Calculate the sea depth, d by using the equation $2d$ = v x

(d)
- Two speakers arranged distance to each others
  - To get nearer position of constructive interference
- Two speakers arranged on the straight line in front of hall
  - Easier to find the louder point (constructive interference) as the audience position
- The surface of wall made by soft materials such as carpet or foam.
  - To reduce the effect of reflection
- Use the parquet as the floor
  - To reduce the effect of reflection
- Use powerful loud speaker
  - To get a good effect of sound and reduce the rate of energy lost.

2. a) i) Two waves that have same phase or same different phase // same frequency and amplitude.

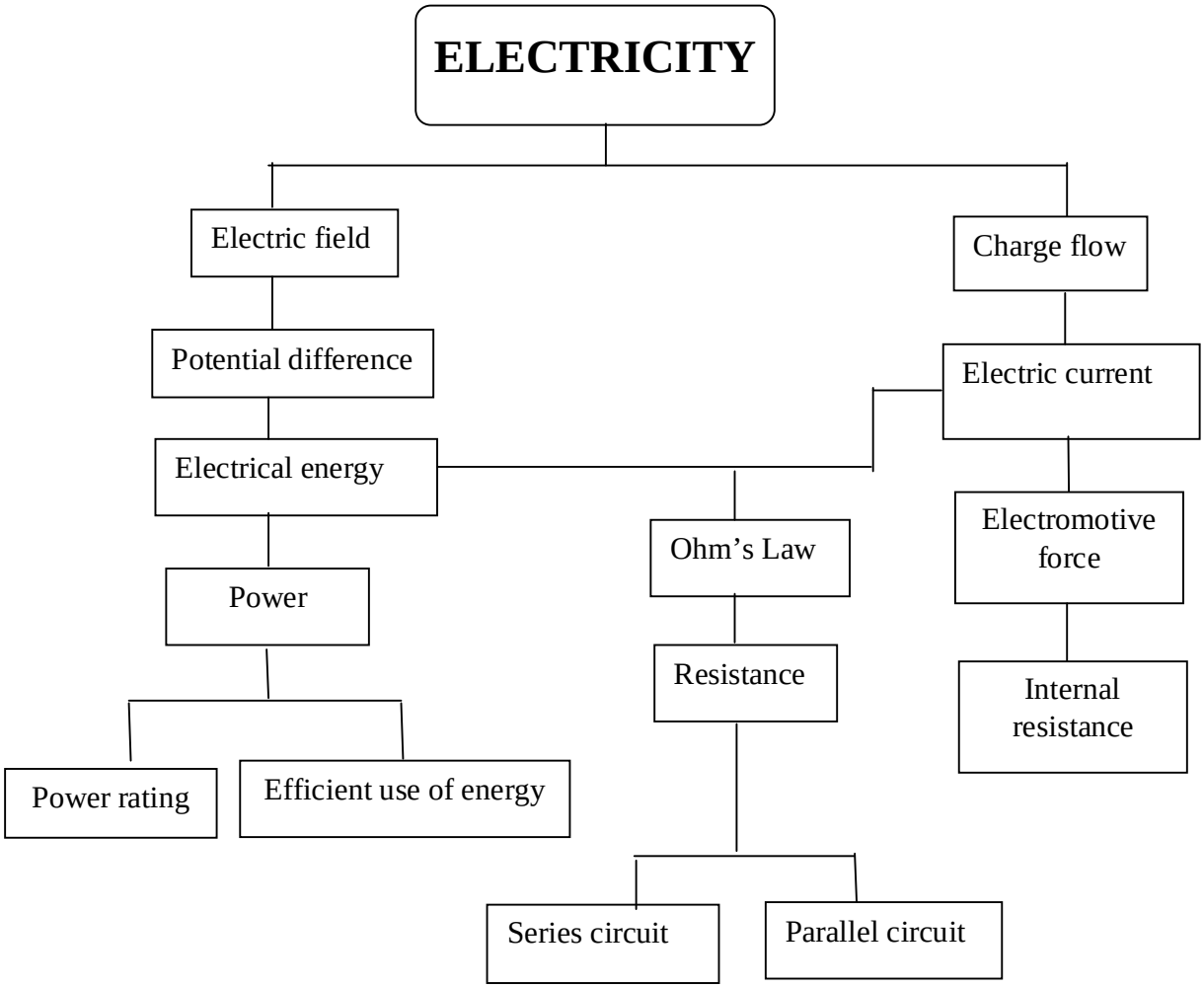
ii)
- *a* for both diagram 2.1 and 2.2 are same
- D for both diagram 2.1 and 2.2 are same
- λ diagram 2.1 greater
- x diagram 2.1 greater
- the grater the λ the grater the x

b)
1. There are two coherent sources placed far to each others, then produced the good effect of interference.
2. The student walks far from the sources, to hear the effect of constructive interference and destructive interference.
3. The student hears 4 time of constructive interference as the louder sound.
4. Soft sounds are the destructive interference occurs in between the constructive interference.

c) i)
- The phenomenon of refraction occurs when the water becomes shallower.
- There are some normal line produced, depend on the shape of coastline.
- The refracted angle produce based on normal line and the change of the depth of water.
- The direction of propagation will change based on how it refract due to the shape of coastline.

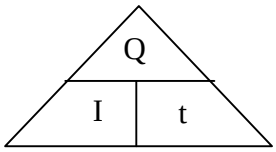
ii)
- Build slanting barrier to reduce speed of wave
- Build the rough barrier to reduce reflection of the waves
- Build the new jetty at the bay because the water is calm at the bay
- Build the small opening surround the bay because diffraction happens at the opening
- Build the barrier at the bay because the wave is spread according to the shape of the bay

CRITICAL TOPIC
TOPIC 6 : ELECTRICITY

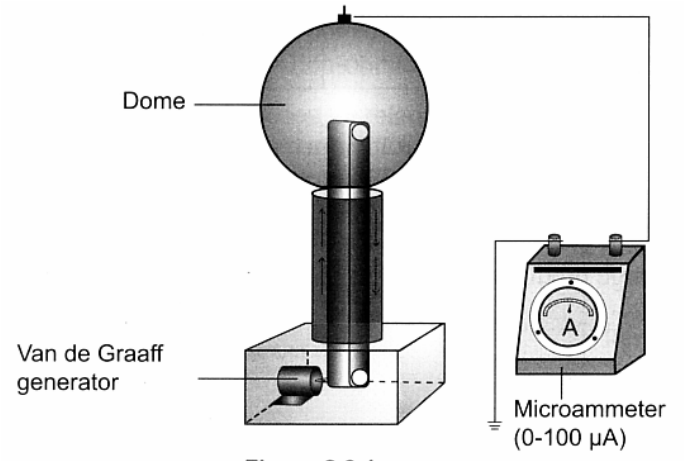


7.1 Electric current

1. The rate of flow of electric charge
2. Current, I = $\frac{\text{charge, Q}}{\text{time, t}}$, unit : Ampere (A)

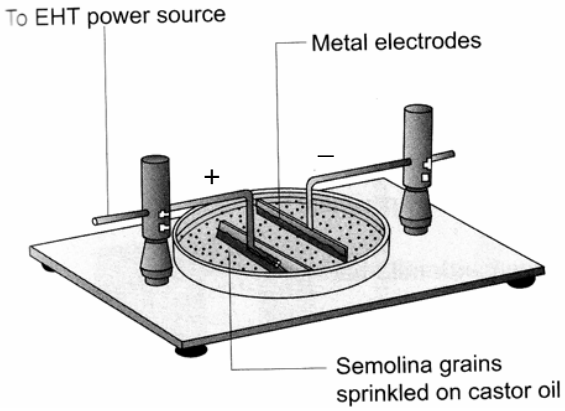


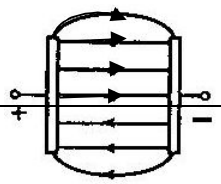
3. Measure by ammeter in series circuit.
4. Activity :-
   (i) To investigate the relationship between electric charges and electric current.



Procedure	Observation
Bring finger close to the dome of the generator.	Feel a brief electric shock

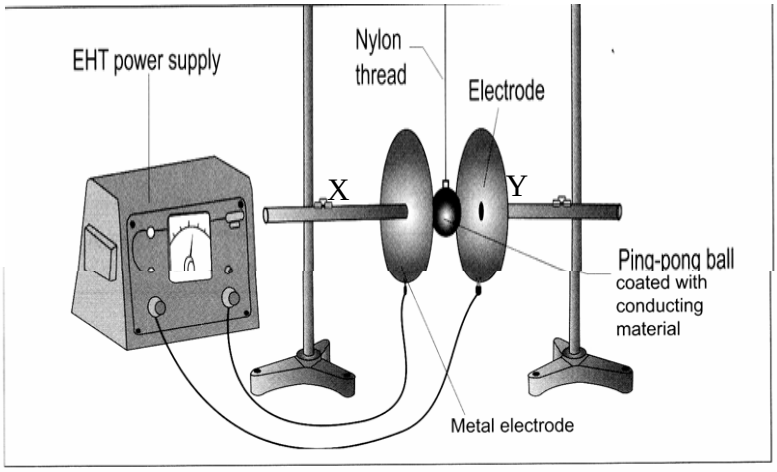
(ii) To study the electric field around metal electrodes



Procedure:	Observation
Two plane electrodes connected to the terminals of an EHT power supply are dipped into a dish of castor oil.	

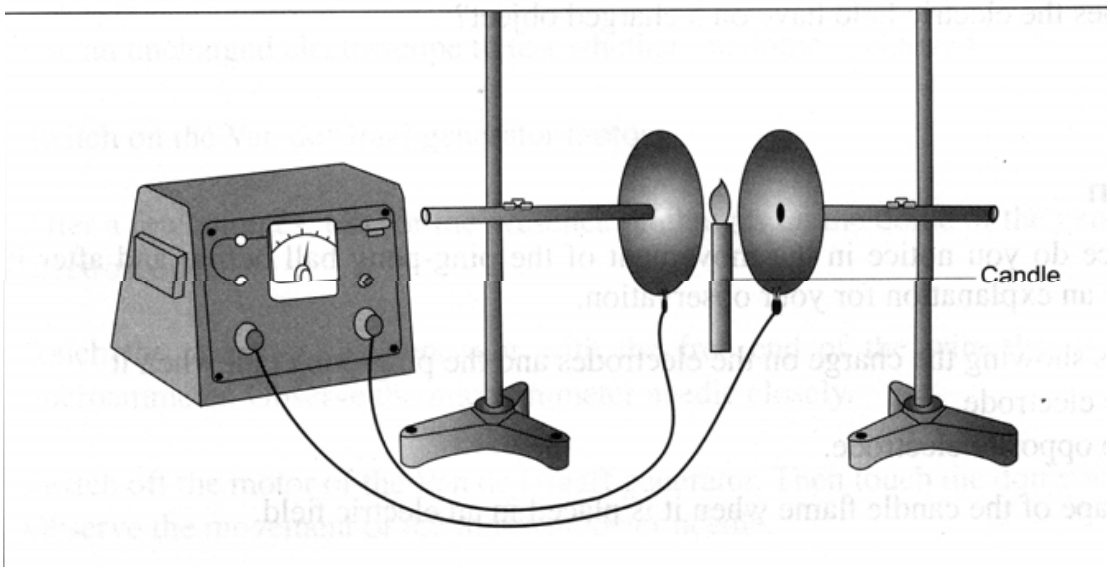
and some semolina grains is sprinkled on the surface	

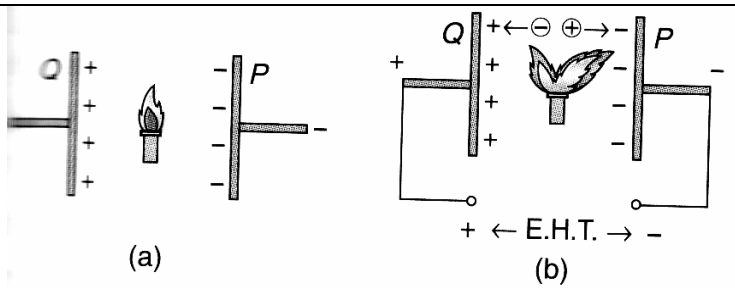
(iii) **Ping pong ball**



Procedure	Observation
Switch on the EHT power supply and charge the ping-pong ball by contact with one of the electrodes	1. When switched on, plate X is positively charged and plate Y is negatively charged. 2. When the ping-pong ball touches the positively charged plate X, the ball receives positive charges , then pushed to negatively charged plate Y. 3. When the ball touches plate Y, the positive charges are neutral by the negative charges. The ball then negatively charged and repels toward plate X. The process is repeated and the ball oscillate to and fro between the two metal plates X and Y.

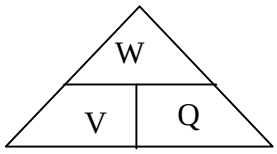
(iv) **Candle flame**



Procedure	Observation
To investigate the effect of an Electric field on a Candle Flame	 The bigger portion of the flame is attracted towards the negative plate as the mass of the positive ions is larger than of the negative ions.

Potential Difference

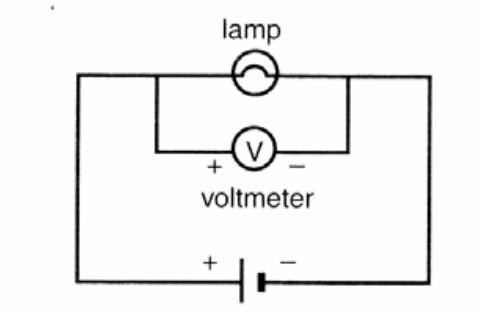
1. The potential difference, V, is defined as the work done when 1 C of charge moves between two points in an electric field.
2. Potential difference, V = $\frac{\text{Work done, W}}{\text{Charge, Q}}$ or V = $\frac{\text{Energy,E}}{\text{Charge,Q}}$



3. SI unit is Volt (V)

   1 Volt = 1 joule per coulomb.

3. It can be measured using a voltmeter.
   Voltmeters must always be connected in parallel between the points concerned.



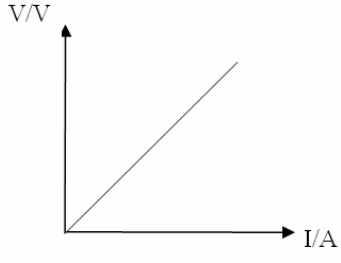
4. The greater the potential difference or voltage, the greater the current flow.

Ohm's Law

1. The electric current, I flowing through a conductor is directly proportional to the potential difference across it if the temperature are constant.

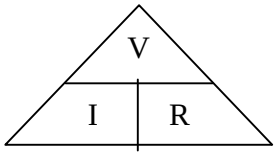
   From Ohm's Law,

   $V \propto I$



2. The resistance (R) of a conductor is defined as the ratio of the potential difference (V) across the conductor to the current (I) flowing through it.

   $$\mathbf{R = \frac{V}{I}}$$



   unit = VA^{-1} = ohm, Ω

4. **Disadvantage of resistance**
   Resistance causes some of the electrical energy to turn into heat , so some electrical energy is lost along the way if we are trying to transmit electricity from one place to another through conductor.

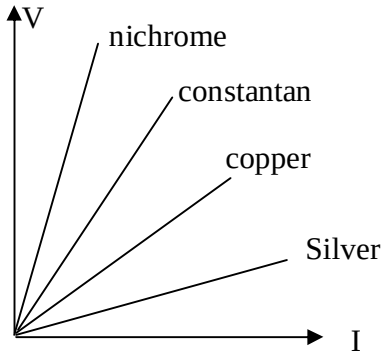
5. **Advantage of resistance**
   It is resistance that allows us to use electricity for heat and light. In a light bulb, the current flowing through a resistance filament causes it to become hot and then glow.

6. The factors that effect the resistance, R

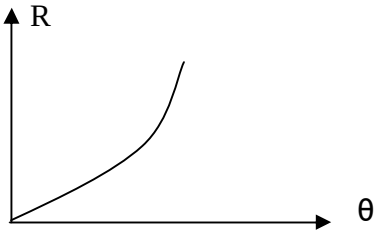
   (i) length **[*R* is directly proportional to its length, *l*]**

   (ii) cross sectional area, A **[*R* is inversely proportional to *A*]**

   (iii) material it is made from.



(iv). temperature **[*R* is increases with temperature]**



SERIES AND PARALLEL CIRCUITS

Series Circuit

1. In a series circuit, two or more resistors are connected one end after another to form a single path for current flow.

2. The bulbs share the potential difference from the battery, so each glows dimly.

3. If one bulb is removed, the other goes out because the circuit is broken.

Parallel circuits

1. All the components are connected with their corresponding ends joined together to form separate and parallel paths for current flow.

2. Each bulb gets the full potential difference from the battery because each is connected directly to it. So each bulb glows brightly.

3. The brightness of each bulb in a parallel circuit is brighter than those in a series circuit with the same number of bulbs.

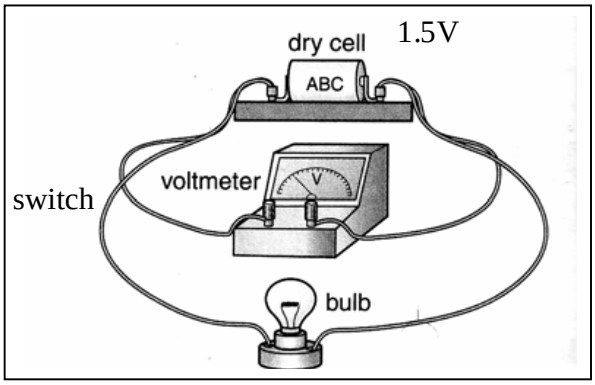
4. If one bulb is removed, the other keeps working because it is still part of an unbroken circuit.

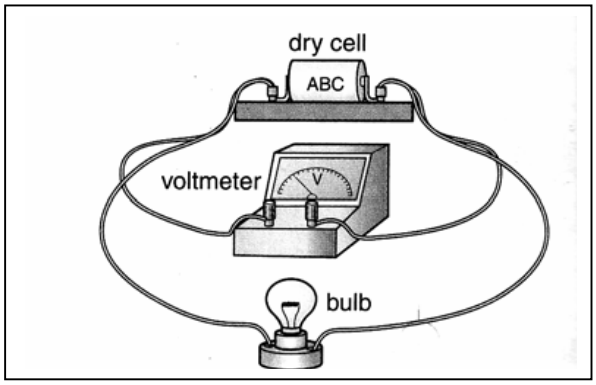
ELECTROMOTIVE FORCE AND INTERNAL RESISTANCE

1. The **electromotive force, *E*** (e.m.f.) is defined as the work done by a source in driving one coulomb of charge around a complete circuit.
   Unit of e.m.f. is the volt, $V = J\,C^{-1}$

2. The voltage label on a battery or cell indicates its e.m.f .
   (i) The **label 1.5 V** on a dry cell indicates the e.m.f. of the cell is 1.5 V.
   (ii) A cell has an e.m.f. of 1.5 V if a flow of 1 C of charge produces 1.5 J of electrical energy to the whole circuit.

3. Compare e.m.f. and potential difference

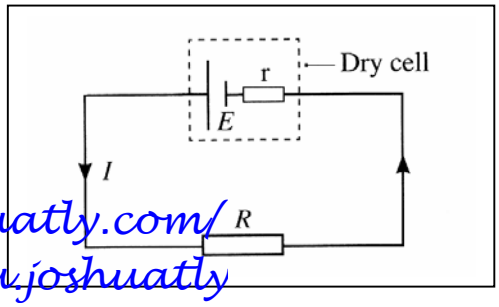




• **Open circuit (switch off)** • No current flows through the circuit • The voltmeter reading is 1.5 V. • e.m.f. = 1.5 V	• **Closed circuit (switch on)** • Current flows through the circuit • The reading of the voltmeter will drop a little if a bulb is connected in series to the cell. • This drop in potential difference across the cell is caused by the internal resistance of the cell. • If the voltmeter reading is 1.2 V, then the potential difference across the lamp = 1.2 V.

E = E.m.f of the cell
V = Potential different the external circuit
Ir = Drop in P.d. inside the cell

$Ir = E - V$
$E = V + Ir$



$E = IR + Ir$

ELECTRICAL ENERGY AND POWER

1. **Electrical energy** is defined as the ability of the electric current to do work.

2. It is supplied by a source of electricity such as cell or battery when current flows in a closed circuit.

3. It can be converted by an electrical appliance into other forms of energy such as heat, light, mechanical when current flows in it.

4. The **potential difference, V** across two points is defined as the energy, E dissipated or transferred by 1 C of charge, Q that moves through the two points.

$$V = \frac{E}{Q}$$

(i) $E = VQ$ [From V=IR]
(ii) $E = VIt$

(iii) $E = IR(It)$
$E = I^2Rt$

(iv) $E = \frac{V^2 t}{R}$ [The unit of electrical energy is Joule, J]

5. **Power** is the rate of electrical energy dissipated or transferred.

Unit = $J\ s^{-1}$ = Watt = W

$$\text{Power} = \frac{\text{Energy}}{\text{Time}}$$

$$P = \frac{E}{t}$$

$P = \frac{VIt}{t}$ ➤ (i) $P = VI$

(ii) $P = I^2R$

(iii) $P = \frac{V^2}{R}$

6. An electrical kettle which is marked **240 V 1500 W** means that the electric kettle will consume 1500 J of electrical energy every 1 second if it is connected to the 240 V.

7. The amount of electrical energy consumed in a given time:

Energy consumed = Power rating x time

E = P t

8. The larger the power rating in the electrical appliance, the higher energy is used for every second.

9. The longer the usage time, the higher electrical energy is consumed.

10. **1 kilowatt-hour** represents the amount of energy consumed in 1 hour by an electrical appliance at the rate of 1 kilowatt.

1 kWh = 1 unit energy

11. **Efficiency** is a percentage of the output power to the input power.

$$\text{Efficiency} = \frac{\text{Energy output}}{\text{Energy input}} \times 100\% = \frac{\text{Output power}}{\text{Input power}} \times 100\%$$

The efficiency of an electrical appliance is always less than 100% as some energy is lost in the form of heat and sound.

12. **Several ways to increase energy efficiency includes**:

(i) Use more energy efficient lightings
- Replace regular incandescent (filament) light bulbs with compact fluorescent light bulbs.

(ii) Proper utilization of all electrical appliances
- Run your washing machine only when it is fully loaded & Iron your clothes only when you have at least a few pieces to iron.
- Regular cleaning of air filters in air-condition units and clothes dryers.
- Defrost refrigerators regularly

13. **A fuse** is a short piece of thin wire which overheats and melts if current of more than a certain value flows through it.
If a short circuit develops in the appliance, a current which is too high will flow. The fuse will melt and prevents overheating of the wire that can cause a fire.

14. **Three-pin plug**
- Live wire, L (brown). A current flows through the circuit
- Neutral wire, N (blue). It is a zero potential difference.
- Earth wire, E (green)

15. **Safety wire** which connects the metal body of the appliance to earth. If a live wire touches the metal body of appliance, a large current would immediately flow to the earth and breaks the fuse. This will prevent a person from electrocution.

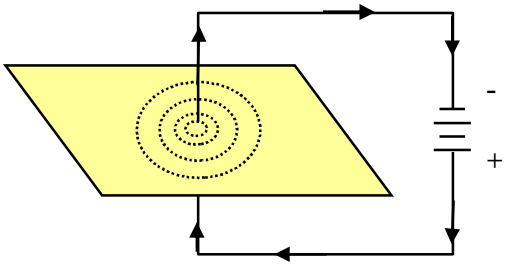
TOPIC 8 : ELECTROMAGNETISM

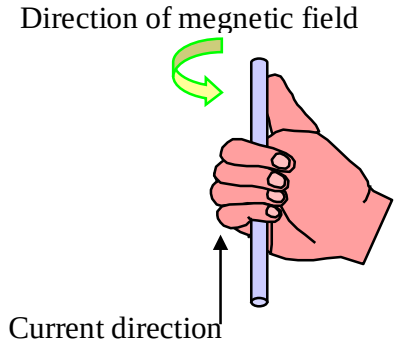
ELECTROMAGNETISM

8.1 Analysing the Magnetos Effect of a Current-carrying Conductor

1. An ***electromagnet*** is made by winding a coil of insulated wire round a sofá iron core where is becomes magnetised when a current flows.
2. The pattern of the ***magnetic field*** due to a current depend on the shape of conductor while the direction of the magnetos field depends on the direction of the current.

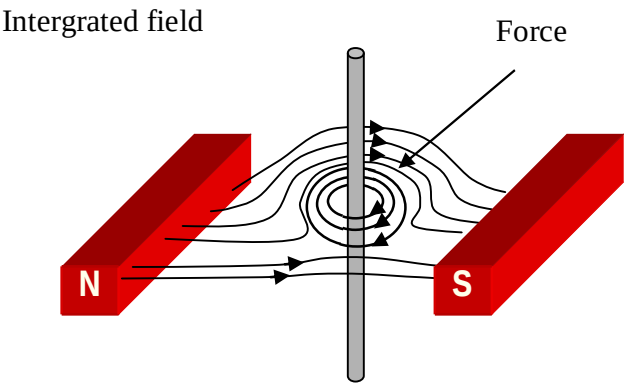
Right-hand Grip Rule

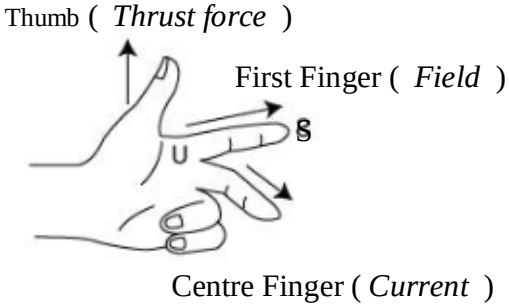




8.2 Understanding the Force on a Current-carrying Conductor in a Magnetic Field

1. A ***magnetic force*** is exerted on a current-carrying conductor in a magnetic field.
2. The direction of magnetic force can be determined by ***Fleming's left-hand rule.***

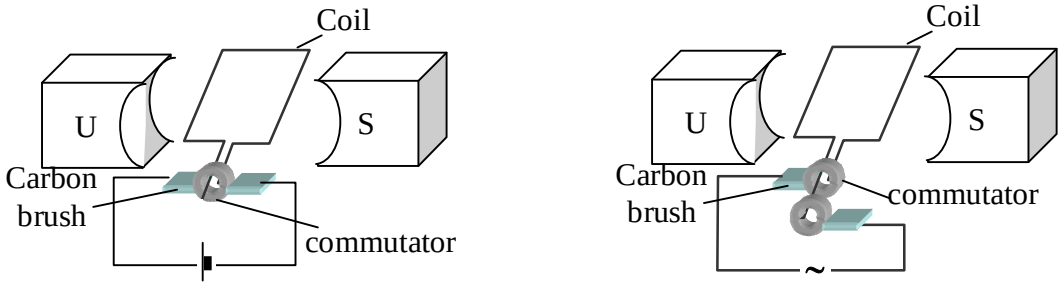




Fleming's left-hand rule.

3. The magnitude of the magnetic force on a current-carrying conductor depend on the size of the current and the strength of the magnetic field.
4. A current-carying coil in a magnetic field will experience a turning effect due to the action of a pair of magnetic forces.
5. The magnitude of the turning effect depends on the size of the current, the number of turn of the coil.

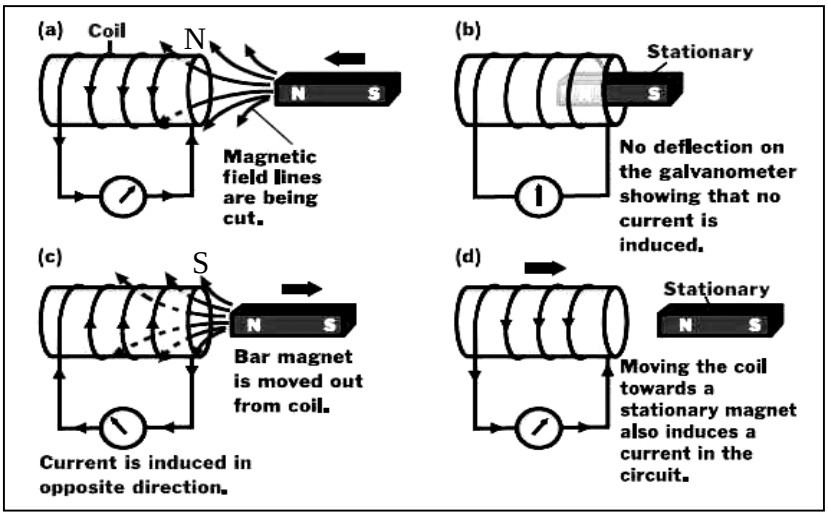
6. There are two types of electric motor, the direct curren motor and the alternating current motor.



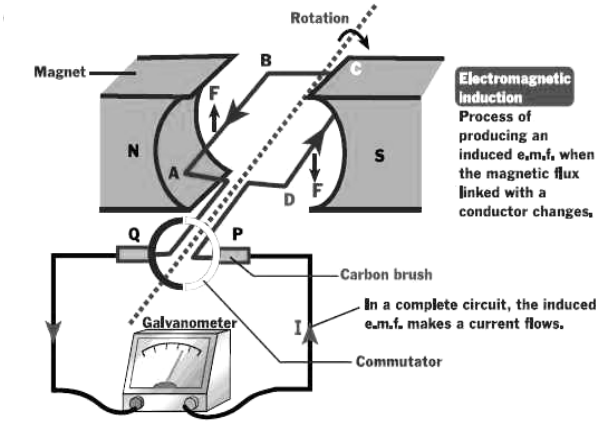
DC motor AC motor

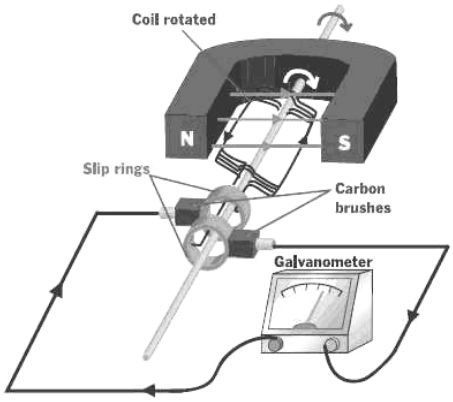
8.3 Analysing Electromagnetic Induction.

1. An electromotive force is induced in a conductor when there is a relative motion that causes the conductor to cut the magnetic field lines.
2. ***Faraday's law*** status that the magnitude of the induced current is directly proportional to the rate of change or the rate of cutting of the magnetic flux.
3. ***Lenz's law*** status that the direction of the induced current is such that the change producing it will be opposed.



4. The direction of the induced current can be determined by ***Fleming's righ-hand rules.***
5. There are two types of generator, the direct current generator and the alternating current generator.
6. A direct current flows in one direction only.
7. The direction and magnitude of an alternating current changes with time.

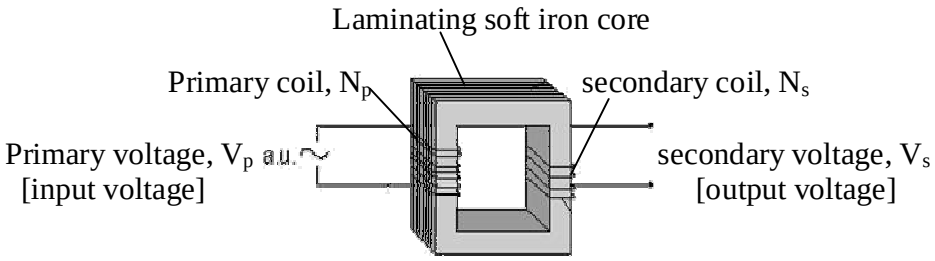




DC generador AC generator

8.4 Analysing Transformer.

1. A transformer changes the magnitude of an alternating current voltage.



Symbol of transformer: V_p V_s N_p N_s

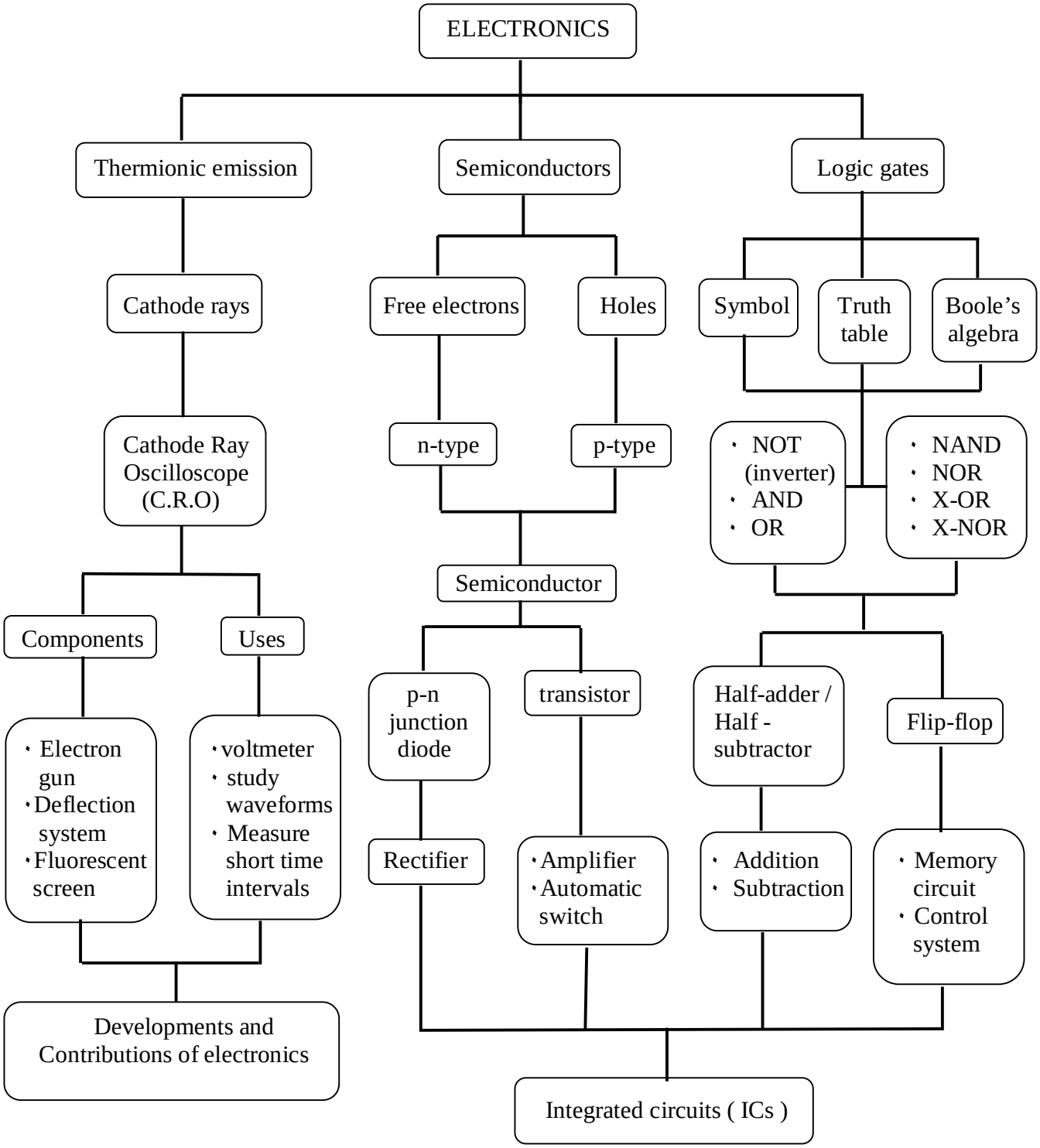
Transformer equation : $\frac{V_s}{V_p} = \frac{N_p}{N_s}$

2. A ***step-up transformer*** supplies an output voltage that is higher than the input voltage.
3. A ***step-down transformer*** supplies an output voltage that is lower than the input voltage.

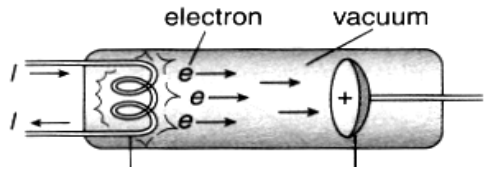
8.5 Understanding the generation and tranmission of ekectricity.

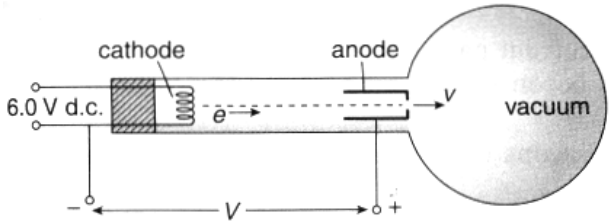
1. Elctricity can be generated from various sources of energy Duch as fósil fuel, nuclear, hydro, wind and solar.
2. Electricity is transmitted through the ***National Grid Network*** system.
3. Electricity is transmitted at very high voltage to reduce energy loss.
4. ***Renewable energy*** sources such as biomasas, hydro, wind and solar are replaceable.
5. ***Non-renewable energy*** sources such as oil, diesel, natural gas and coal are not replaceable.

TOPIC 4 : ELECTRONICS



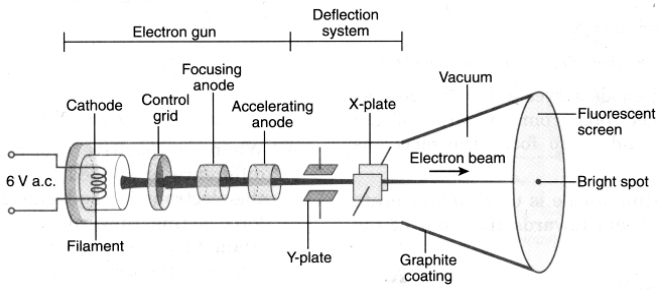
Notes :

<table>
<tr><td>Definition of thermionic emission</td><td>The release of electrons from a heated metal cathode</td></tr>
<tr><td>Vacuum tube</td><td> 

Filament / cathode Anode
• When the filament is heated, electrons gain sufficient kinetic energy and are released from the surface of the filament
• The electrons are emitted and accelerated towards the anode by high potential difference between the anode and cathode</td></tr>
<tr><td>Factors influence rate of thermionic emission</td><td>
<table>
<tr><th>Factor</th><th>Effect on the rate of thermionic emission</th></tr>
<tr><td>Temperature of the cathode</td><td>When the temperature of cathode increase, the rate of thermionic emission increase</td></tr>
<tr><td>Surface area of the cathode</td><td>Larger surface area of cathode, rate of thermionic emission increase</td></tr>
<tr><td>Potential difference between the anode and cathode.</td><td>The rate of thermionic emission is unchanged, when the potential difference increases, but the emitted electrons accelerate faster towards the anode</td></tr>
</table>
</td></tr>
<tr><td>Cathode ray</td><td> 

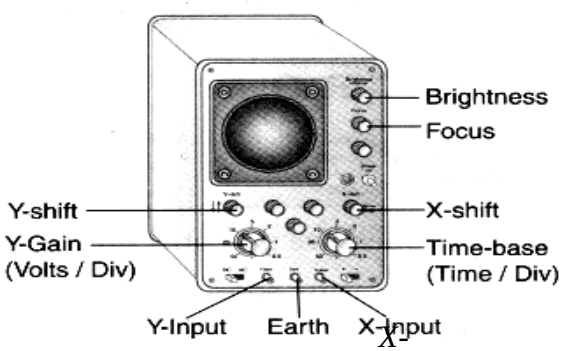
Properties of cathode ray :
• They are negatively charged particles
• They travel in straight lines
• They possess momentum and kinetic energy
• They are deflected by magnetic and electric field</td></tr>
</table>

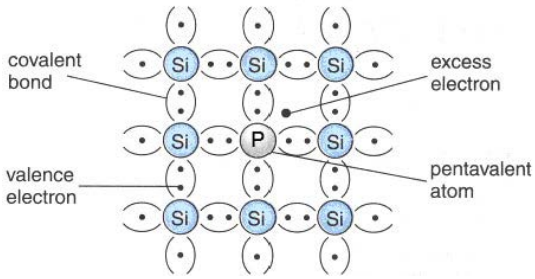
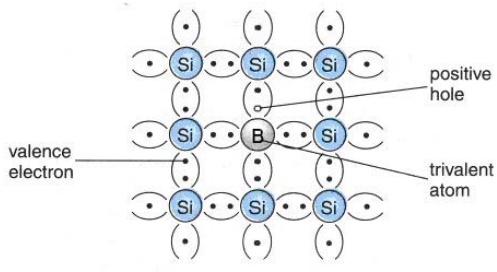
Cathode ray oscilloscope

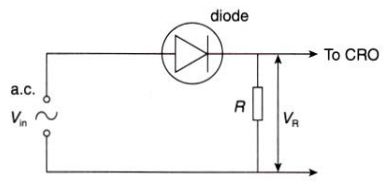
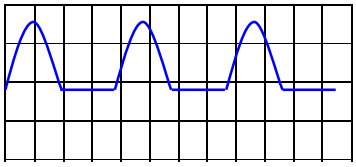
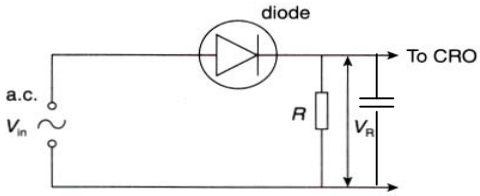
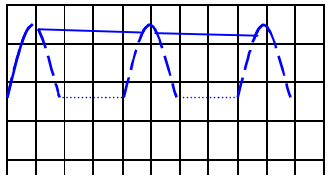
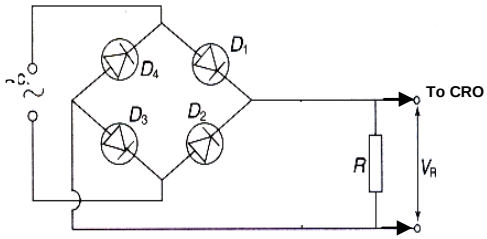
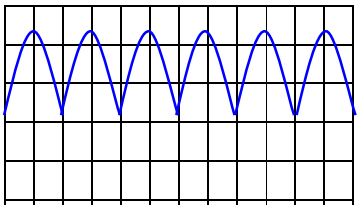
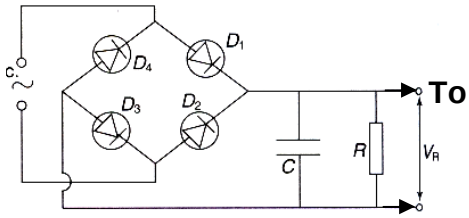
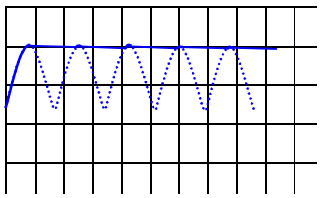
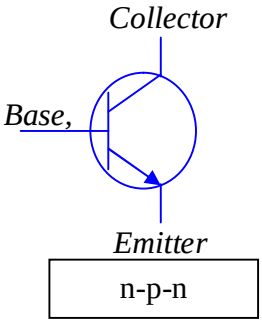
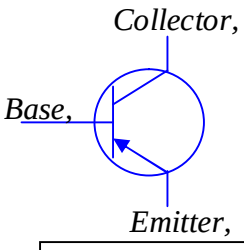


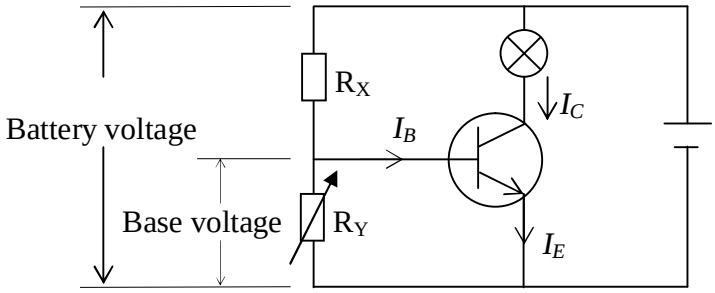
Main part	Component	Function
Electron gun	*Filament*	*When a current passes through the filament, the filament becomes hot and heats up the cathode.*
	Cathode	*Emits electrons when it is hot*
	Control Grid	*→ Control the number of electrons hitting the fluorescent screen.* *→ Control the brightness of the spot on the screen*
	Focusing Anode	*To focus the electrons onto the screen*
	Accelerating Anode	*To accelerate the electrons to high speed*
Deflecting system	*Y-Plates*	*To deflect the electron beam vertically*
	X-Plates	*To deflect the electron beam horizontally*
Fluorescent screen	*Glass surface coated with a fluorescent material*	*To convert the kinetic energy of the electrons to heat and light energy when the electrons hit the screen.*

Working principle of CRO

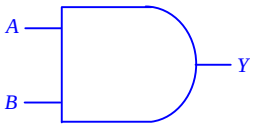


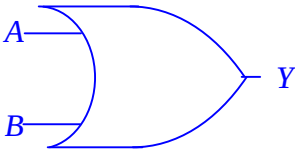
Calculation in CRO	<u>To measure a D.C voltage:</u> The unknown voltage, V = (Y-gain) × h <u>To measure a A.C voltage:</u> Peak-to-peak voltage, V_{pp} = (Y-gains) × h Peak voltage, V_p = (Y-gains) × $\frac{1}{2}(h)$ Effective voltage or root-mean-square voltage, $V_{r.m.s} = \frac{1}{\sqrt{2}}V_p$ Short time intervals, t = no. of divisions between two pulses × time-base value.
Definition of semiconductor	a group of materials that can conduct better than insulators but not as good as metal conductors
Doping process	Doping is a process of adding a certain amount of other substances called **dopants** such as **Antimony** and **Boron** to a semiconductor, **to increase its conductivity**
n-type semiconductor	 • Semiconductor like Silicon doped with **pentavalent** atoms increase the number of **free electron** • The silicon will has **negative electron** as **majority** charge-carriers and it thus known as an **n-type semiconductor**.
p-type semiconductor	 • Semiconductor like Silicon doped with **trivalent atoms** such as has **more positive holes** • One of the covalent bonds has a missing electron called a 'positive hole' • The majority charge-carriers in this semiconductor are the positive holes thus known as a **p-type semiconductor**.

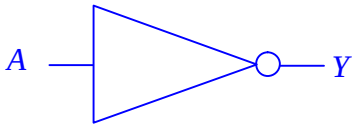
Function of semiconductor diode	allow current to flow through it in **one direction** only.
Rectification	Rectification is a process to convert an alternating current into a direct current by using a diode
Half-wave rectifier	  When a capacitor is connected in parallel across a resistor, R.  
Full-wave rectifier	  When a capacitor is connected in parallel across a resistor, R.  
Transistor	A transistor is a silicon chip which has three terminals labeled as base, collector and emitter  n-p-n  p-n-p transistor

<table>
<tr><td>Transistor as automatic switch</td><td>


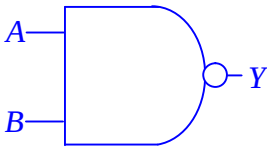
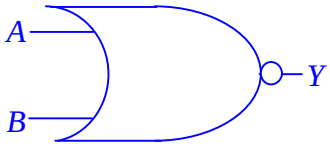
A resistor, R_x and a variable resistor, R_Y are being used to form a potential divider
If the variable resistor is set to zero, the base voltage is zero and the transistor switches off
If the resistance of the variable resistor is increased, the base voltage will Increases
When the base voltage reached a certain minimum value, the base current, I_B switches on the transistor. A large collector current, I_C flows to light up the bulb.

</td></tr>
<tr><td>Definition of a logic gate</td><td>A switching circuit that is applied in computer in computer and other electronic devices</td></tr>
<tr><td>AND gate</td><td>


Y = A · B
<table>
<tr><th colspan="2">Input</th><th>Output</th></tr>
<tr><td>A</td><td>B</td><td>Y</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>OR gate</td><td>


Y = A + B
<table>
<tr><th colspan="2">Input</th><th>Output</th></tr>
<tr><td>A</td><td>B</td><td>Y</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>NOT gate</td><td>


Y = $\overline{A}$
<table>
<tr><th>Input</th><th>Output</th></tr>
<tr><td>A</td><td>Y</td></tr>
<tr><td>0</td><td>1</td></tr>
<tr><td>1</td><td>0</td></tr>
</table>
</td></tr>
</table>

NAND gate	 $Y = \overline{A \bullet B}$ Input: A, B; Output: Y 0 0 1 0 1 1 1 0 1 1 1 0
NOR gate	 $Y = \overline{A + B}$ Input: A, B; Output: Y 0 0 1 0 1 0 1 0 0 1 1 0

Exercises

1. Diagram 29.1 shows the oscilloscope trace produced by an input of 2 V at a frequency of 50 Hz.
Rajah 29.1 menunjukkan surihan osiloskop yang dihasilkan oleh input 2 V pada frekuensi 50 Hz.

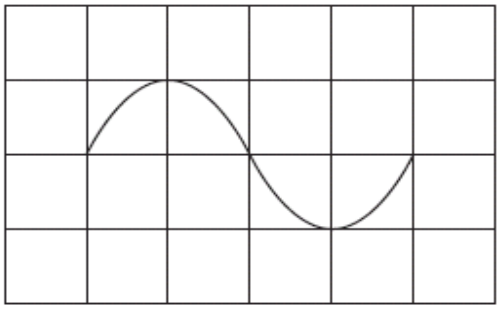


Diagram 29 .1

Diagram 29.2 shows the trace from a new input on the same oscilloscope.
Rajah 29.2 menunjukkan surihan dari input baru pada osiloskop yang sama.

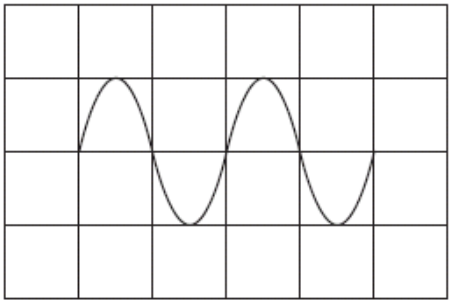


Diagram 29.2

What is the value of the new input ?
Berapakan nilai input yang baru ?

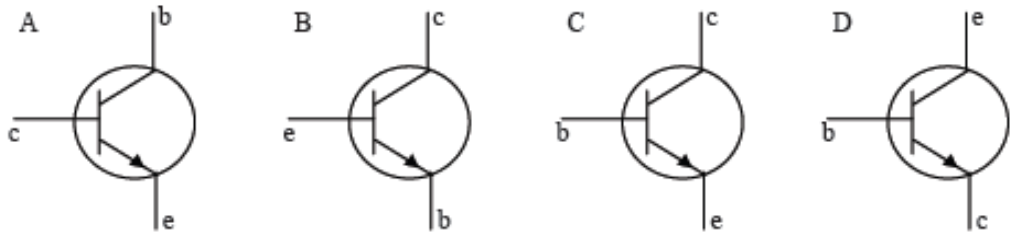
A 1 V at 50 Hz
1 V pada 50 Hz

B 2 V , 50 Hz
2 V pada 50 Hz

C 2 V at 100 Hz
2 V pada 100 Hz

D 4 V at 50 Hz
4 V pada 50 Hz

2. If c, b and e have the usual meanings for a transistor, which one of the transistors above is correctly labelled?
Jika c, b dan e mempunyai maksud yang biasa bagi sebuah transistor, antara transistor di atas, yang manakah dilabelkan dengan betul ?



3. Diagram 31.2 shows the change of current, *I* with time, *t* for the current which is flowing through $\mathbf{R_1}$ in Diagram 31.1 . Which of the following is most suitable to represent the current which flows through $\mathbf{R_2}$?
Rajah 31.2 menunjukkan perubahan arus, I dengan masa, t bagi arus yang sedang mengalir melalui $\boldsymbol{R_1}$ *dalam Rajah 31.1 . Antara berikut, yang manakah paling sesuai untuk mewakili arus melalui* $\boldsymbol{R_2}$ *?*

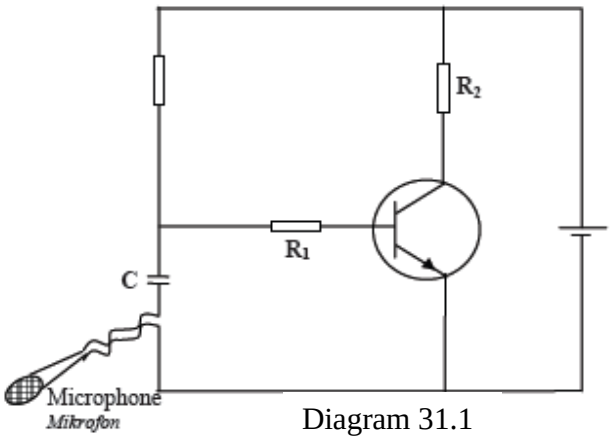


Diagram 31.1
Rajah 31.1

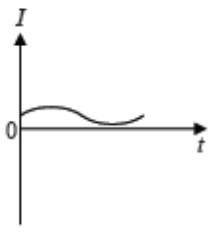
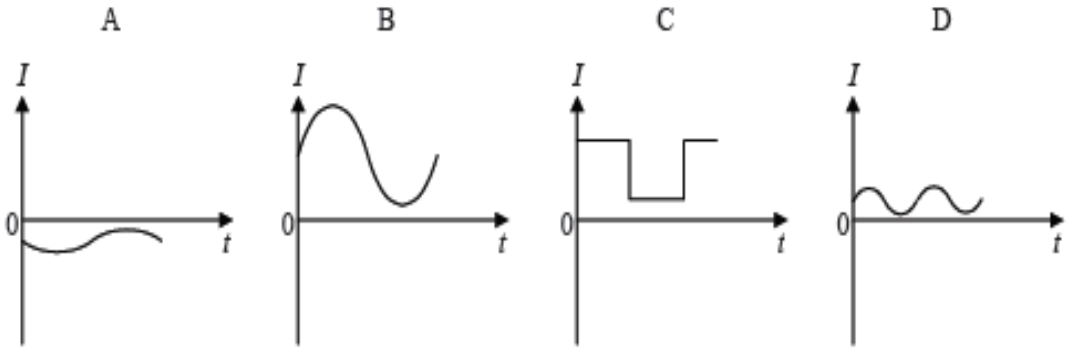


Diagram 31.2
Rajah 31,2



4. Diagram 32 shows a combination of logic gates. The input logics at A, B and C are respectively 1, 0 and 0.

Rajah 32 menunjukkan satu kombinasi get logik. Logik input di A, B *dan* C *adalah masing-masing* 1, 0 *dan* 0.

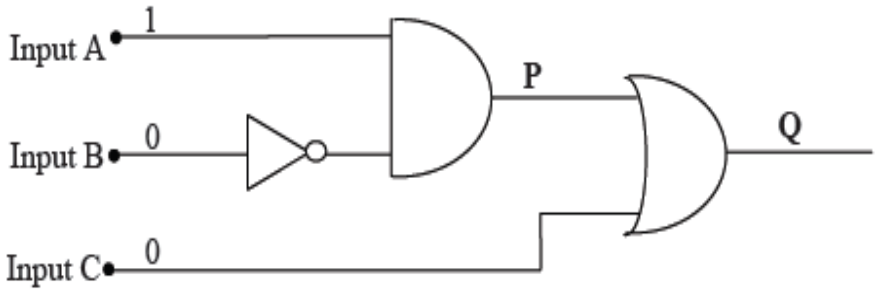


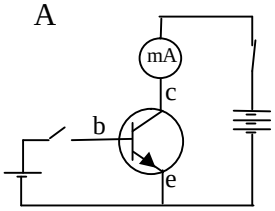
Diagram 32
Rajah 32

The output logics at **P** and **Q** are
Logik output di **P** *dan* **Q** *adalah*

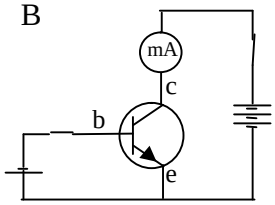
	P	**Q**
A	0	0
B	0	1
C	1	0
D	1	1

5. In which of the following circuits will the miliammeter show a **non-zero** reading?
*Dalam litar-litar berikut, yang mana satu miliammeter akan menunjukkan bacaan **bukan sifar**?*

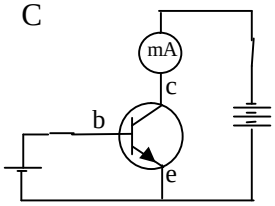
A



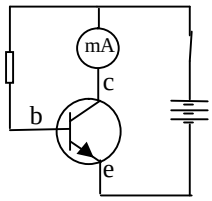
B



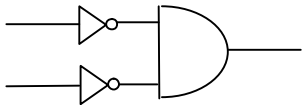
C



D



6.



Which of the following logic gates is equivalent to the one shown above?
Antara get-get berikut, yang manakah setara dengan get yang ditunjukkan di atas?

A B C D

7. The function of a capacitor in a rectifier circuit is
Fungsi kapasitor dalam litar rektifikasi ialah

A to smooth out the output voltage
Meratakan voltan output
B to prevent the a.c. from passing through the resistor
Menghalang a.u. melalui perintang
C to allow d.c. to pass through the capacitor
Membenarkan a.t. melalui kapasitor
D to convert a.c. to d.c.
Menukar a.u. ke a.t.

1. (a) Diagram 1.1 below show the a logic gate. Name the logic gate.
Rajah 1.1 menunjukkan satu get logik. Namakan get logik tersebut.

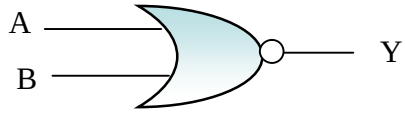


Diagram 1.1
***Rajah* 1.1**

_____

[1 mark]

(b) Base on the Diagram 1.1, complete the true table 1.1 below.
Berdasarkan Rajah 1.1, lengkapkan Jadual kebenaran 1.1 di bawah.

Input		Output
A	B	Y
0	0	
1	1	

Table 1.1
***Jadual* 1.1**

[2 marks]

(c) Table 1.2 below show true table for AND get, state the output of X.
Jadual di bawah menunjukkan jadual kebenaran bagi get logik DAN, nyatakan output bagi X

Input		Output
A	B	Y
0	0	0
0	1	0
1	0	X
1	1	1

Table 1.2
Jadual 1.2

[1 mark]
[1 *markah*]

2. Diagram 6.1 and Diagram 6.2 show two situations of electronic circuit.
Rajah 6.1 dan Rajah 6.2 menunjukkan dua situasi untuk litar elektronik.

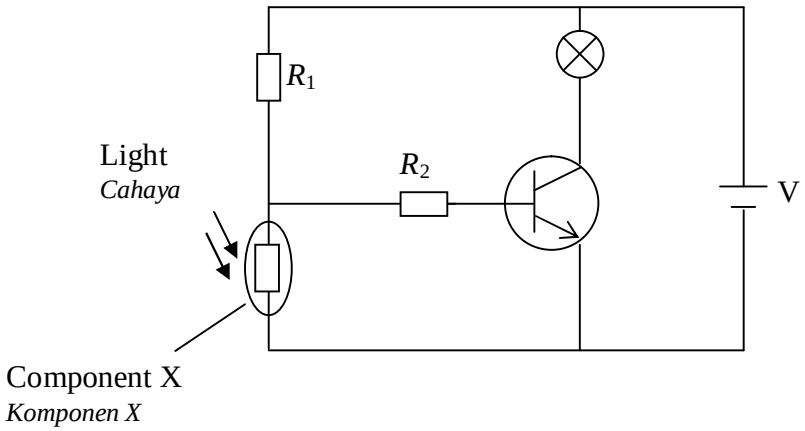


Diagram 6.1
Rajah 6.1

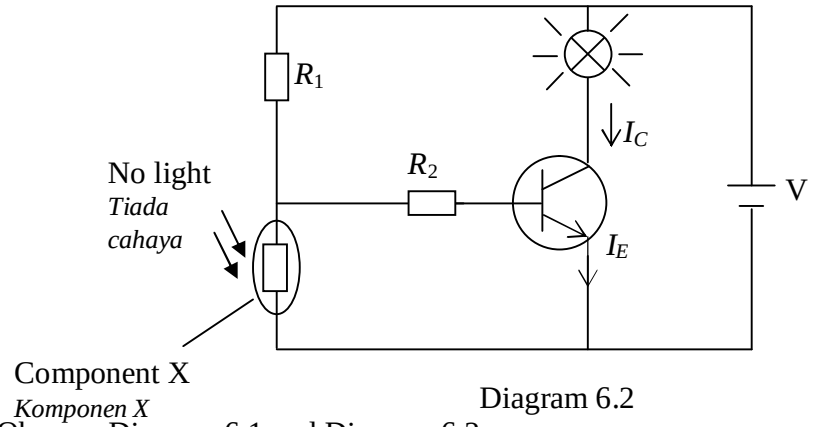


Diagram 6.2

(a) Observe Diagram 6.1 and Diagram 6.2.
Perhatikan Rajah 6.1 dan Rajah 6.2.

(i) Compare the resistance of component X in these two situations.
Bandingkan rintangan komponen X dalam kedua-dua situasi ini.

…….....

[1 *mark*]
[1 *markah*]

(ii) Compare the potential difference across the component X.
Bandingkan beza keupayaan merentasi komponen X.

…….....

[1 *mark*]
[1 *markah*]

(iii) State the relationship between the resistance and the potential difference.
Nyatakan hubungan di antara rintangan dan beza keupayaan.

…….....

[1 *mark*]
[1 *markah*]

(iv) Name the component X involved.
Namakan komponen X yang terlibat.

…….....

[1 *mark*]
[1 *markah*]

(v) Give **one** application of transistor.
*Beri **satu** kegunaan transistor.*

…….....

[1 *mark*]
[1 *markah*]

(b) The resistance R_1 is increased in Diagram 6.2.
Rintangan R_1 ditinggikan dalam Rajah 6.2.

(i) What is the meaning of resistance?
Apakah maksud rintangan?

…….....

[1 *mark*]
[1 *markah*]

(ii) What happens to the brightness of the bulb?
Apakah yang berlaku kepada kecerahan mentol itu?

…….....

[1 *mark*]
[1 *markah*]

(iii) Give **one** reason for the answer in **6**(b)(ii).
*Beri **satu** sebab bagi jawapan di **6**(b)(ii).*

…….....

[1 *mark*]
[1 *markah*]

3. Diagram 4 shows a simple control system using logic gates which can switch on an air conditioner automatically.
Rajah 4 menunjukkan satu sistem kawalan menggunakan get logik yang boleh menghidupkan sebuah penyaman udara secara automatik.

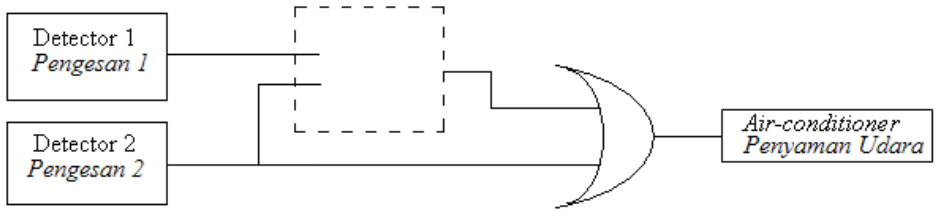


Diagram 4
Rajah 4

(a) What is logic gates?
Apakah get logik?

……..

[*1 mark*]

(b) The air conditioner only switches on during ***hot days or hot nights***.
Penyaman udara hanya dihidupkan pada ***hari yang panas atau malam yang panas***.

(i) Complete the truth table to show the operation of the logic gates in the circuit above. Use the keys below to complete your truth table.
Bina sebuah jadual kebenaran untuk menunjukkan operasi get logik di atas.
Guna kekunci dibawah untuk melengkapkan jadual kebenaran anda.

Keys:
Kekunci:

Detector 1 ***Pengesan 1***		**Detector 2** ***Pengesan 2***		**Air Conditioner** **Penghawa dingin**	
In the day *Waktu siang*	1	Hot *Panas*	1	Switch on *Dihidupkan*	1
At night *Waktu malam*	0	Cool *Sejuk*	0	Switch off *Dimatikan*	0

Detector 1 ***Pengesan 1***	**Detector 2** ***Pengesan 2***	**Air Conditioner** **Penghawa dingin**
0	0	
0	1	
1	0	
1	1	

Truth table
Jadual Kebenaran

[*2 marks*]

(ii) Using diagram 4 and your answer in b(i), name a suitable logic gate which can carry out the required operation
Berdasarkan jawapan anda dalam diagram 4 dan b(i) , namakan satu get logik yang boleh melaksanakan operasi tersebut..

……..……..……...……...

[*1 mark*]

(iii) In Diagram 4 , draw the logic gate in the box provided.
Dalam Rajah 4 lukiskan get logik tersebut di dalam kotak yang disediakan

[*1 mark*]

(c) Suggest suitable electrical components that can be used as detector 1 and detector 2 in the circuit above.
Cadangkan komponen- komponen elektrik yang sesuai digunakan sebagai pengesan 1 dan pengesan 2 dalam litar di atas.

Detector 1: ……...
Pengesan 1

Detector 2: ……..
Pengesan 2

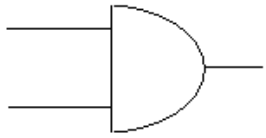
[*2 marks*]

MARKING SCHEME ELECTRONICS

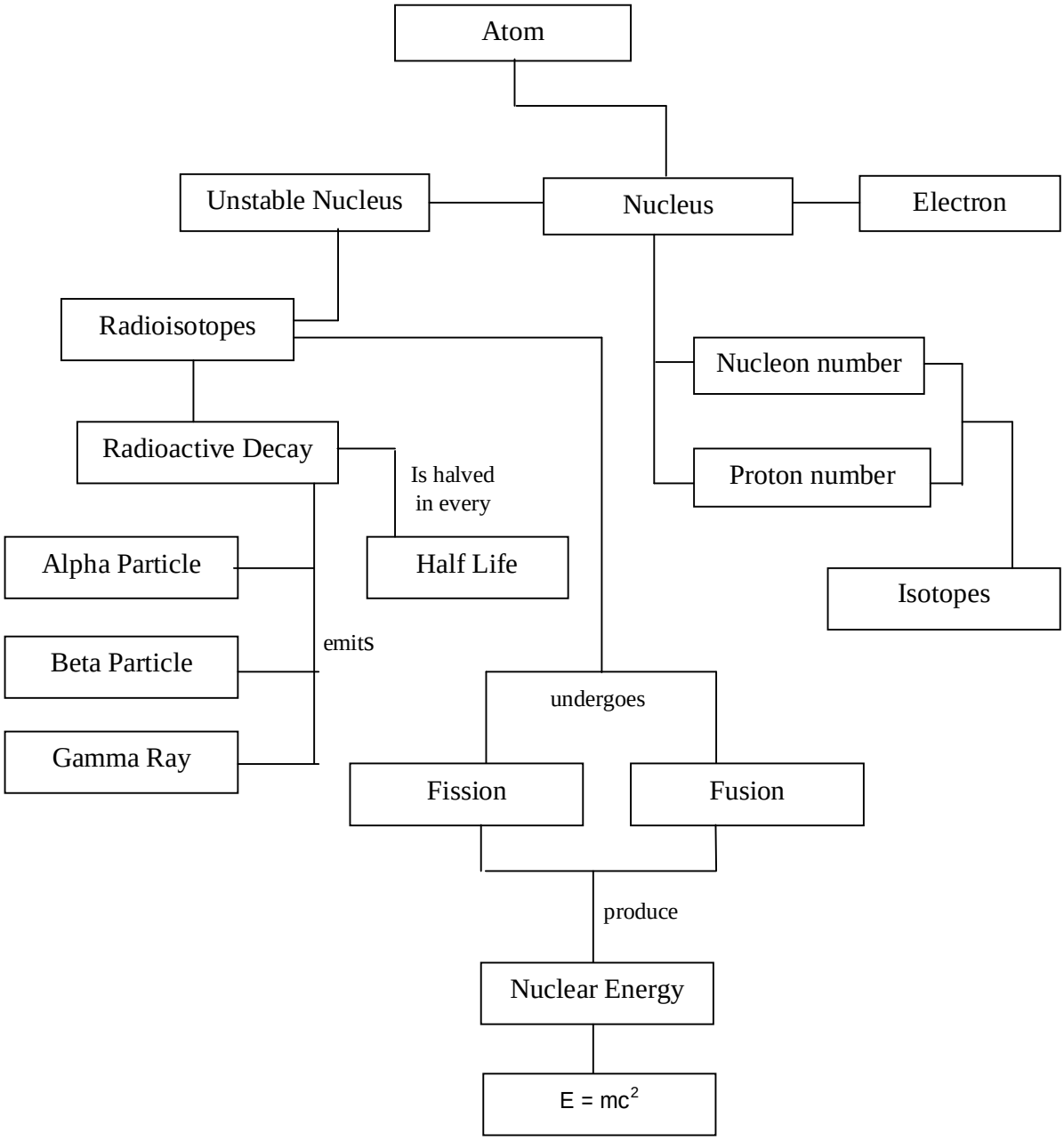
PAPER 1

1. C
2. C
3. B
4. D
5. D
6. B
7. A

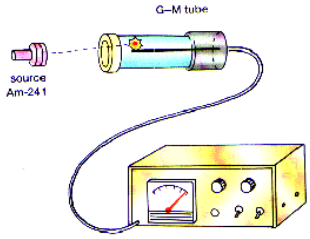
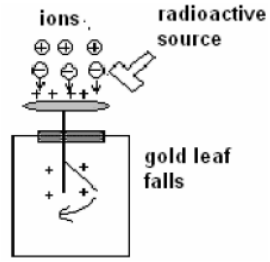
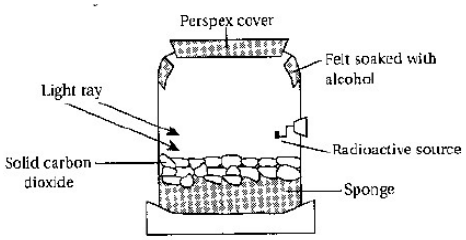
<table>
<tr><th>No</th><th>Answers</th><th>Marks</th></tr>
<tr><td>1 (a)</td><td>NOR gate</td><td>1</td></tr>
<tr><td>(b)</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>A</td><td>B</td><td>Y</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td>2</td></tr>
<tr><td>(c)</td><td>X = 0</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>4</td></tr>
<tr><td>2(a) (i)</td><td>The resistance in diagram 6.2 is larger than in diagram 6.1</td><td>1</td></tr>
<tr><td>(ii)</td><td>The potential difference in diagram 6.2 is larger than in diagram 6.1</td><td>1</td></tr>
<tr><td>(iii)</td><td>When the resistance increases, the potential difference increases</td><td>1</td></tr>
<tr><td>(iv)</td><td>Light dependent resistance</td><td>1</td></tr>
<tr><td>(v)</td><td>Automatic switch / Current amplifier</td><td>1</td></tr>
<tr><td>(b)(i)</td><td>Ratio potential difference to current</td><td>1</td></tr>
<tr><td>3 (a)</td><td>Logic gates are electronic switches with one or more inputs and one output</td><td>1</td></tr>
<tr><td>(b) (i)</td><td><table><tr><th>Detector 1
Pengesan 1</th><th>Detector 2
Pengesan 2</th><th>Air Conditioner
Penghawa dingin</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>Row 1 and 2 correct – 1 mark
Row 3 and 4 correct – 1 mark</td><td>2</td></tr>
</table>

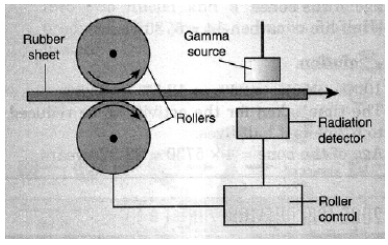
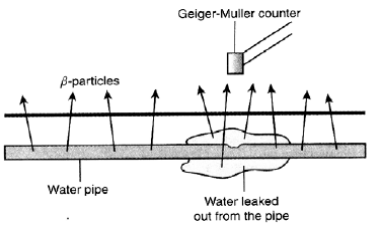
(ii)	AND gate	1
(iii)	Symbol correctly drawn 	1
(c)	1. Detector 1 : LDR / light detecting resistor. 2. Detector 2 : Thermistor / heat detecting resistor	1 1
	Total	**7**

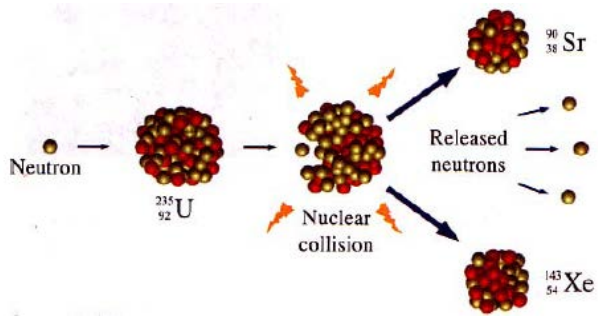
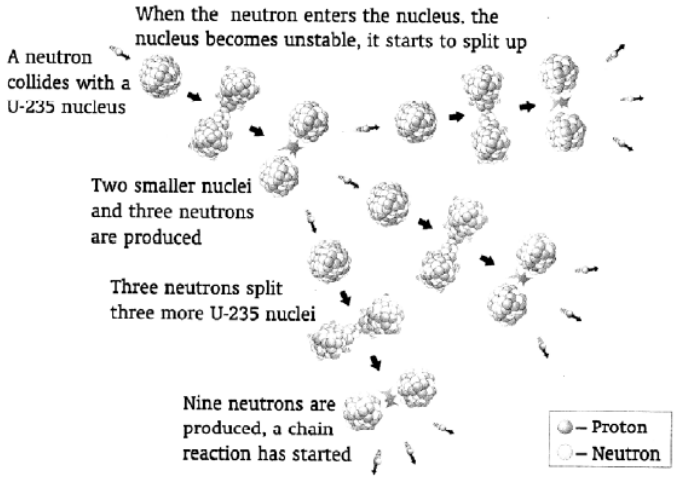
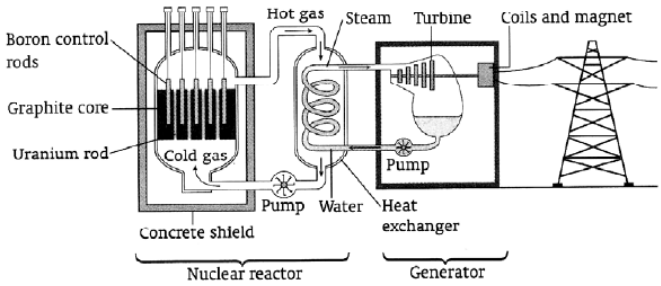
TOPIC 5 : RADIOACTIVITY

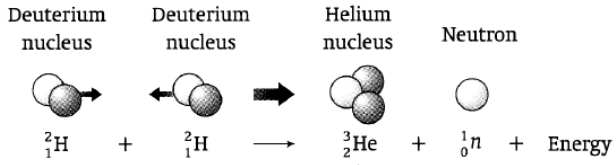


Notes

Atom	Has nucleus consists of proton and neutron with electron move in orbit around the nucleus
$_{Z}^{A}X$	- X is a chemical symbol of the element - A is a nucleon number - total number of protons and neutrons in a nucleus - Z is a proton number - number of protons in a nucleus / equal to number of electrons
Isotopes	atoms with the same proton number but different nucleon number
Characteristics of an isotopes	- same chemical properties - different physical quantities - different mass
Radioactivity	the spontaneous and random disintegration of an unstable nucleus into a more stable nucleus with the random emission of energetic particles or photons
Radioactive emission	- Alpha particles - Beta Particles - Gamma rays
Alpha particles $_{2}^{4}He$	- Positively charged - strongest ionizing power and low penetrating power - can be stopped by a thin sheet of paper - deflected by electric and magnetic field
Beta Particles $_{-1}^{0}e$	- negatively charged - moderate ionizing power and moderate penetrating power - can be stopped by a few millimeters of aluminium - deflected by electric and magnetic field
Gamma Rays γ	- Neutral charge - weakest ionizing power and highest penetrating power - can be stopped by A few centimeters of lead or concrete -not deflected by electric and magnetic field
Detectors of Radioactive emission	 Geiger-Muller Tube  Gold leaf electroscope  Cloud Chamber

Radioactive decay	The nucleus of an atom which is unstable will become more stable nucleus by emitting radioactive emission and will decay further until a stable nucleus is formed
Alpha Decay	$^{A}_{Z}\mathbf{X} \rightarrow {}^{A-4}_{Z-2}\mathrm{Y} + {}^{4}_{2}\mathrm{He} + \text{energy}$ Example : $^{230}_{90}\mathbf{Th} \rightarrow {}^{226}_{88}\mathrm{Y} + {}^{4}_{2}\mathrm{He} + \text{energy}$
Beta Decay	$^{A}_{Z}\mathbf{X} \rightarrow {}^{A}_{Z+1}\mathrm{Y} + {}^{0}_{-1}\mathrm{e} + \text{energy}$ Example : $^{14}_{6}\mathbf{C} \rightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e} + \text{energy}$
Gamma Decay	$^{A}_{Z}\mathbf{X} \rightarrow {}^{A}_{Z}\mathbf{X} + \gamma + \text{energy}$ Example : $^{60}_{27}\mathrm{CO} \rightarrow {}^{60}_{27}\mathrm{C0} + \gamma + \text{energy}$
Half-life, T½	the time taken for half of radioactive nuclei to decay.
Radioisotopes	Unstable isotopes which decay and give out radioactive emissions
Applications of Radioisotopes	Thickness control  detecting leaks in underground water pipe  - Smoke detector - Sterilising - Radioactive tracer - Cancer treatment - Radioactive dating - Controlling pest

Nuclear Energy	Energy released during the splitting and fusing of atomic nuclei
Formula	$E = mc^2$ Where E = the energy released m = mass defect, in kg (sum of the masses before reaction - sum of the masses after reaction) c = speed of light, 3.00×10^{8} m s^{-1}
Nuclear Fission	Process in which a heavy nucleus splits into two or more lighter nuclei 
Chain Reaction	a self – sustaining reaction in which the products of a reaction can initiate another similar reaction 
Generating Electricity	Electricity can be generated from the energy released by fission reaction. A nuclear power station consists of a nuclear reactor and a generator 

Nuclear Fusion	Two light nuclei combine to form a heavier nucleus, releasing a vast amount of energy during the process 

Exercises

1. The following equation represents the reaction that occurs in the core of the sun.
Persamaan di bawah adalah tindak balas yang berlaku diteras matahari.

$$^{2}_{1}H + {}^{2}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{Energy}$$

(a) (i) Name the reaction that occurs.
Namakan tindak balas yang berlaku.

……
[1 *mark*]

(ii) State **one** conditions that is required for the reaction in (a) (i) to accur.
*Nyatakan **satu** syarat yang diperlukan untuk tindak balas dalam (a) (i) berlaku.*

……
[1 *mark*]

(b) (i) State the charges of $_{2}^{4}He$

Nyatakan cas bagi $_{2}^{4}He$

……
[1 *mark*]

(ii) State the number of neutron in $_{2}^{4}He$

Nyatakan bilangan neutron pada $_{2}^{4}He$.

……
[1 *mark*]

2. Radioisotopes Uranium-238 decays to become Thorium-234 as shown in the equation below.
Radioisotop Uranium-238 mereput untuk menjadi Thorium-234 seperti dalam persamaan berikut

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + P + \text{energy}$$

a) i) What is mean by radioisotope?
Apakah yang dimaksudkan dengan radioisotop?

.....

(1 mark)

ii) What is radiation P?
Apakah sinar P?

.....

(1 mark)

b) If the mass defect in the above radioactive decay is 3.35×10^{-27} kg, calculate the energy released in joule. (speed of light, $c = 3.0 \times 10^{8}$ m s^{-1})
Jika cacat jisim dalam pereputan di atas ialah 3.35×10^{-27} kg, hitung tenaga yang dibebaskan dalam joule. (laju cahaya, $c = 3.0 \times 10^{8}$ m s^{-1})

(2 marks)

c) A radioactive source which emit radiation P is placed near an electric field as shown in Diagram 1
Satu sumber radioaktif yang memancarkan sinaran P diletakkan berdekatan medan elektrik seperti dalam Rajah 1

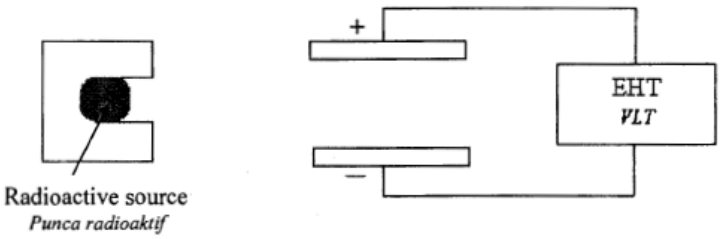


Diagram 1 / *Rajah 1*

i) On Diagram 1, draw the path of radiation P in the electric field
Dalam rajah 3, lukiskan laluan sinaran P di dalam medan elektrik

(1 mark)

ii) Explain your answer in (c) (i)
Terangkan jawapan anda dalam (c) (i)

.....

(1 mark)

3. Diagram 2 shows a system used in a factory to ensure the volume of dragon fruit juice is uniform. (As stated on the bottle label)
Rajah 2 menunjukkan satu system yang digunakan di sebuah kilang membuat jus buah naga untuk memastikan ketepatan isipadu yang yang diisi.(seperti dicatat dalam label perekat)

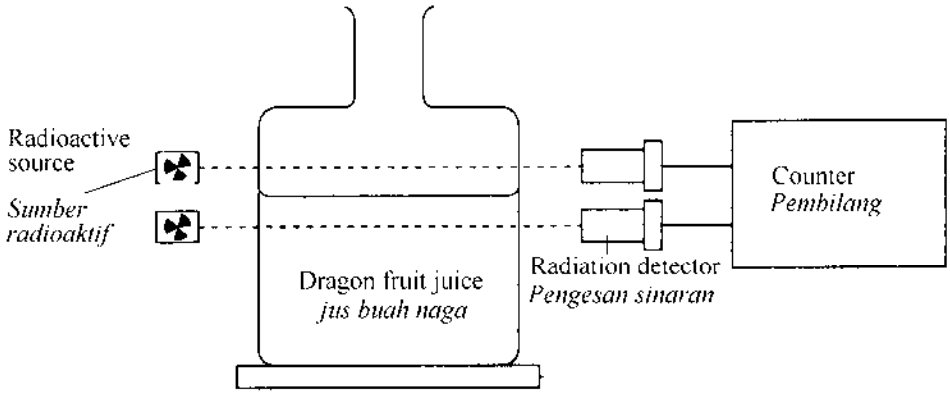


Diagram 2 / Rajah 2

The radioactive source, radiation detector and counter are used to detect the volume of dragon fruit juice. The radioactive source contains a radioisotope. β particle is radiated
Sumber radioaktif, pengesan sinaran dan pembilang digunakan untuk mengesan isipadu jus buah naga. Sumber radioaktif itu mengandungi radioisotop. Zarah β dipancarkan.

a) What is meant by a radioisotope?
Apakah yang dimaksudkan dengan radioisotop?

……
[1 mark]

b) i) What is a β particle?
Apakah sebenarnya zarah β?

……
[1 mark]

ii) State **one** detector suitable used for this purpose.
*Nyatakan **satu** alat pengesan yang sesuai digunakan untuk tujuan ini.*

……
[1 mark]

c) Explain why the following radiation is not used.
Terangkan mengapa sinaran berikut tidak menggunakan

i) α particle / *zarah α*

…….

[1 mark]

ii) γ particle / *zarah γ*

…….

[1 mark]

d) What is the container used to keep the radioactive source?
Bekas apakah yang digunakan untuk menyimpan sumber radioaktif.

…….

[1 mark]

e) Table 8 shows reading of the rate meter for 6 bottles through detector and radioactive source ?
Jadual 8 menunjukkan bacaan meter kadar bagi 6 botol yang melalui pengesan dan sumber radioaktif

Bottle/Botol	A	B	C	D	E	F
Rate meter reading Bacaan meter kadar (count per minute) (Bilangan per minit)	464	468	467	462	568	470

i) Which bottle shows least volume of juice?
Botol yang manakah menunjukkan isipadu yang tidak cukup?

…….

[1 mark]

ii) State your reason for the answer in 3(e)(i).
Nyatakan sebab jawapan anda di 3(e)(i).

…….
…….

[1 mark]

f) Now, all the bottles and radioactive sources are removed.
Sekarang, semua botol dan sumber radioaktif dikeluarkan.

i) What can you observe at the rate meter reading?
Apakah yang dapat diperhatikan pada bacaan meter kadar?

…….
[1 mark]

ii) State your reason for the answer in 3(f)(i).
Nyatakan sebab jawapan anda di 3(f)(i).

…….
…….
[1 mark]

4. Diagram 3 and 4 below show the rate of decay of radioactive Xenon-133 & Iodine-131 respectively
Rajah 3 dan 4 masing-masing menunjukkan kadar penyusutan radioaktif Xenon-133 & Iodine-131

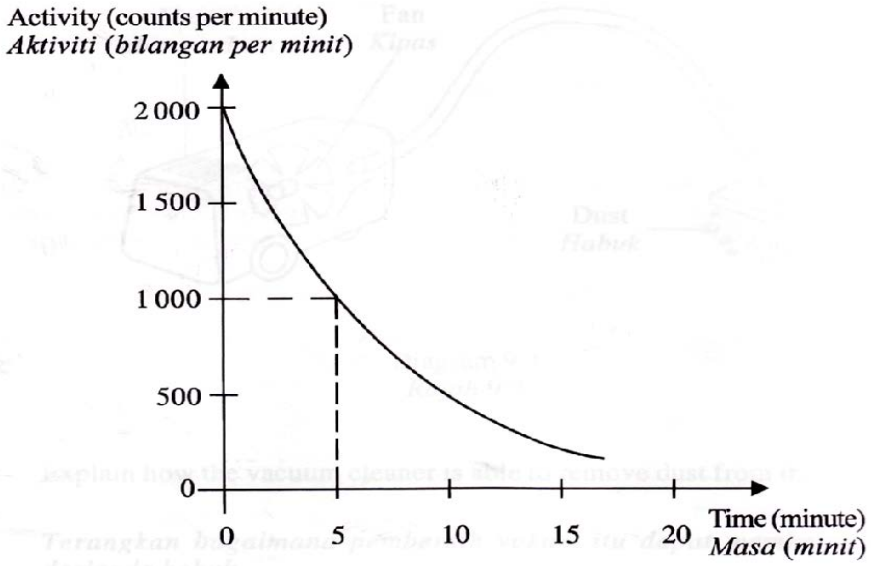


Diagram 3 / *Rajah 3*

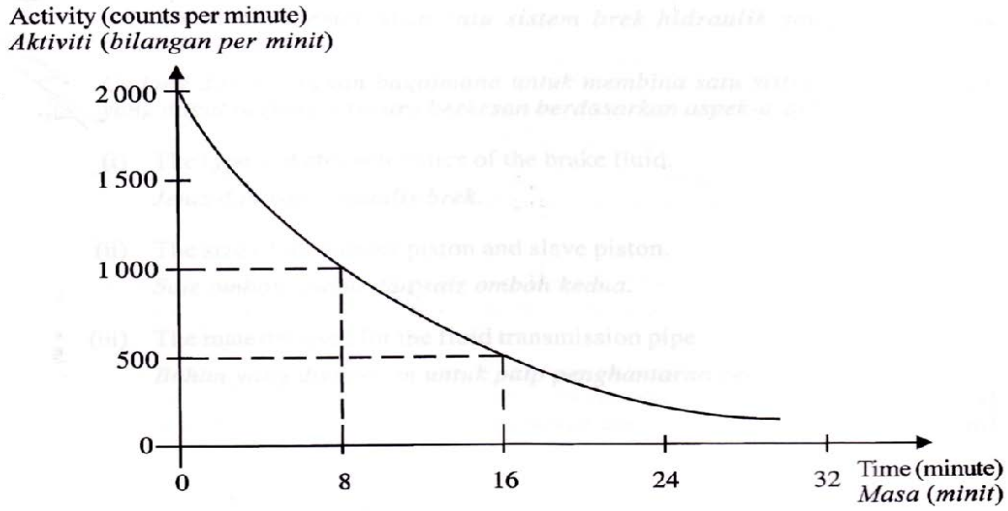


Diagram 4 / *Rajah 4*

(*a*) (i) What is the meaning of radioactive decay? [1 *mark*]

Apakah maksud penyusutan radioaktif? [1 *markah*]

(ii) Based on Diagram 10.1 and Diagram 10.2, compare the shape of the graphs, the way the activity changes with time and the time taken for the activity to become half of the original activity.

Name the time for the activity to become half of the original activity. [5 *marks*]

Berdasarkan Rajah 10.1 *dan Rajah* 10.2, *bandingkan bentuk graf, cara aktiviti berubah mengikut masa dan masa yang diambil untuk aktiviti menjadi separuh daripada aktiviti asal.*

Namakan masa untuk aktiviti menjadi separuh daripada aktiviti asal. [5 *markah*]

(*b*) Why is an isotope that emits alpha particles not suitable for use as a tracer in medicine? [4 *marks*]

Mengapakah isotop yang memancarkan zarah alfa tidak sesuai digunakan sebagai penyurih dalam bidang perubatan? [4 *markah*]

(*c*) Radiotheraphy is used in the treatment of cancer. The radioactive ray used can cause side effects to the patient.

Using the knowledge about radioactivity, explain the steps taken to reduce the side effects. In your explanation, emphasize the aspects of:

Radioterapi digunakan untuk merawat kanser. Sinaran radioaktif yang digunakan boleh menghasilkan kesan sampingan kepada pesakit.

Menggunakan pengetahuan tentang keradioaktifan, terangkan langkah-langkah yang perlu diambil untuk mengurangkan kesan sampingan tersebut. Dalam penerangan anda, berikan penekanan kepada aspek-aspek berikut:

(i) The type of ray used.
Jenis sinaran yang digunakan.

(ii) How the radioactive radiation is targetted on the cancer cells.
Bagaimana pancaran radioaktif disasarkan ke atas sel kanser.

(iii) The dosage of the ray required.
Dos sinaran yang diperlukan.

(iv) The time of the ray exposure.
Masa pendedahan kepada sinar.

[10 *marks*]
[10 *markah*]

5. Radioactive material has some important uses in the field of agriculture such as to study the effectiveness of fertilizers and control the population of pests.
Bahan radioaktif mempunyai beberapa kegunaan penting dalam bidang pertanian seperti mengkaji keberkesanan baja dan pengawalan populasi serangga.

(a) A researcher conducted an investigation using posphorus-32 to study the absorption and movement of fertilizers in the plant. Diagram 5 shows how radioisotope posphorus-32 is injected to the stem of the plant. The half-life of posphorus-32 is 14 days and emits β-particles.

Seorang penyelidik telah menjalankan satu penyiasatan menggunakan fosforus-32 untuk mengkaji penyerapan dan pergerakan baja dalam satu tumbuhan .Rajah 5 menunjukkan bagaimana fosforus-32 disuntik kedalam batang tumbuhan itu. Separuh hayatbagi fosforus-32 ialah 14 hari dan memancarkan zarah-β.

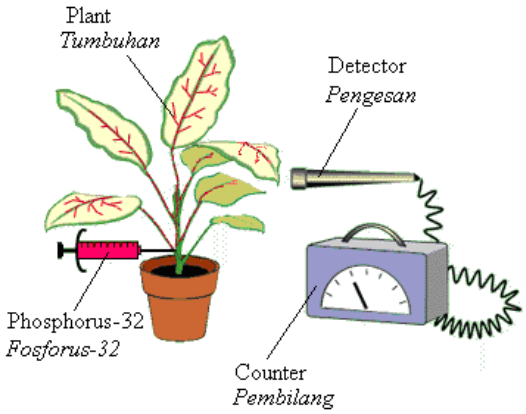


Diagram 5 / *Rajah 5*

Based on the information on radioactivity and Diagram 5 :
Berdasarkan maklumat dalam keradioakifan dan Rajah 5:

(i) What is meant by half life?
Apakah yang dimaksudkan dengan separuh hayat?

[1 *mark*]

(ii) What is β-particles.
Apakah zarah-β.

[1 *mark*]

(iii) Name the most suitable detector could be used to detect β-particles.
Namakan satu alat pengesan yang paling sesuai digunakan untuk mengesan zarah-β.

[1 *marks*]

(b) The initial posphorus-32 activity is 800 counts per second.
Calculate the time taken for the phosphorus-32 activity to decrease to 50 counts per second.
Keaktifan awal fosforus-32 ialah 800 bilangan per saat.
Hitung masa yang diambil untuk keaktifan fosforus-32 berkurang menjadi 50 bilangan per saat.

[2 *marks*]

(c) The population of pests can be controlled using radiation from radioactive source. You are assigned to study the characteristics of some radioisotopes that are suitable for use in controlling the population of pests.
Table 12.2 shows the characteristics of four radioisotopes.

Populasi serangga dapat dikawal dengan menggunakan sinaran radioaktif dari satu sumber radioaktif.
Anda ditugaskan untuk mengkaji ciri-ciri bagi beberapa radioisotope yang sesuai untuk digunakan dalam mengawal populasi serangga.
Jadual 12.2 menunjukkan ciri-ciri bagi empat radioisotop.

Radioisotope *Radioisotope*	Characteristics of radioisotope *Ciri-ciri radioisotop*		
	State of matter *Keadaan jirim*	Types of ray *Jenis sinar*	Half-life *Separuh hayat*
Iodine-131 *Iodin-131*	Liquid *Cecair*	Gamma *Gama*	8 days *8 hari*
Xenon-133 *Xenon-133*	Solid *pepejal*	Beta *Beta*	5 days *5 hari*
Cobalt-60 *Kobalt-60*	Solid *Pepejal*	Gamma *Gama*	5 years *5 tahun*
Strontium-90 *Strontium-90*	liquid *cecair*	Beta *Beta*	8 years *8 tahun*

Table 12.2 / *Jadual 12.2*

Explain the suitability of the characteristics of the radioisotope to be used in the controlling the population of pests based on the following aspects:
Terangkan kesesuian ciri-ciri radioisotope untuk digunakan dalam mengawal populasi serangga berdasarkan aspek-aspek berikut:

- State of matter
  Keadaan jirim

- Types of ray
  Jenis sinar

- Half-life
  Separuh hayat

Determine the most suitable radioisotope to be used and give the reason for your choice.
Tentukan radioisotope yang paling sesuai digunakan dan beri sebab bagi pilihan anda.

[8 *marks*]

d) The following equation shows a fission reaction of Uranium-235.
Persamaan berikut menunjukkan satu persamaan tindakbalas pembelahan nukleus Uranium-235.

$$ {}^{1}_{0}n + {}^{235}_{92}\mathrm{U} \longrightarrow {}^{91}_{36}\mathrm{Kr} + {}^{142}_{56}\mathrm{Ba} + 3\,{}^{1}_{0}n + \text{Energy} $$

(i) What is meant by a nuclear fission?
Apakah yang dimaksudkan dengan pembelahan nucleus?

[1 *mark*]

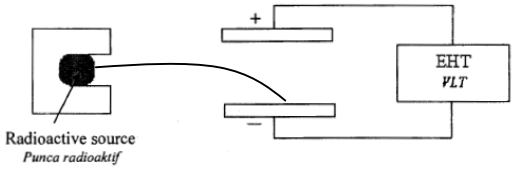
(ii) Nuclear fission produces a chain reaction.
Describe how the chain reaction occurs in a nuclear fission of an atom of Uranium- 235.
Pembelahan nukleus menghasilkan tindakbalas berantai. Huraikan bagaimana tindakbalas berantai berlaku dalam pembelahan satu atom uranium-235.

[4 *marks*]

(iii) The nuclear energy produced in the fission reaction of uranium-235 is 2.9×10^{-11} J. Calculate the total lost of mass in the reaction. [$c = 3.0 \times 10^{8}$ ms^{-1}]
Tenaga nuklear yang dihasilkan dalam tindakbalas pembelahan itu ialah 2.9×10^{-11} J. Hitungkan jumlah kehilangan jisim dalam tindakbalas itu [$c = 3.0 \times 10^{8}$ ms^{-1}]

[2 *marks*]

Marking Scheme

No			Answer	Mark
1	a	i	Nuclear Fusion	1
		ii	High temperature	1
	b	i	Positive (+ve)	1
		ii	2	1
				4
2	a	i	Unstable isotopes which decay and give out radioactive emissions	1
		ii	Alpha particle	1
	b		$E = mc^2$ $= 3.35 \times 10^{-27} \times (3.0 \times 10^{8})^2$ $= 3.02 \times 10^{-10}$ J	 1 1
	c	i		1
		ii	An alpha particles is positively charged	1
				6
3	a		Unstable isotopes which decay and give out radioactive emissions	1
	b	i	Electron	1
		ii	G-M tube	1
	c	i	not strong enough to pass through the juice	1
		ii	will not stop by the juice	1
	d		Lead container	1
	e	i	E	1
		ii	the most radioactive emission pass through the juice	1
	f	i	there is still show a reading	1
		ii	because of the back ground reading	1
				10
4	a	i	A process where an unstable nucleus becomes stable with the emitting of radioactive ray	1
		ii	- Curve shape is the same / exponential - The activity reduces with time - The activity reduces faster in Diagram 10.2 - The time for the activity to become half of the original activity is more for diagram 10.2 - Half-life $T_{1/2}$	1 1 1 1 1
	b		- The power of ionisation is high - so it will effect the human body - The power of penetration is low	1 1 1

<table>
<tr><td></td><td></td><td></td><td>- so that it cannot be detected by detector</td><td>1</td></tr>
<tr><td></td><td>c</td><td>i</td><td>
<table>
<tr><td>Gamma</td><td>- The power of penetration is high
- The power of ionisation is low</td></tr>
<tr><td>use MRI / X-ray</td><td>- Identify the position of cancer cells conectly</td></tr>
<tr><td>point out to the target accurately</td><td>- To avoid other living cells from being destroyed</td></tr>
<tr><td>Suitable dose</td><td>- If high dose, other cells will destroy
- If low dose not all the cancer cells will be destroyed</td></tr>
<tr><td>Time of exposure is not too long</td><td>To prevent other healthy cells from destroy</td></tr>
</table>
</td><td>2
2
2
2
2</td></tr>
<tr><td></td><td></td><td></td><td></td><td>20</td></tr>
<tr><td>5</td><td>a</td><td>i</td><td>The time taken for half of nucleus radioactive material to decay</td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>Fast moving electron / electron</td><td>1</td></tr>
<tr><td></td><td></td><td>iii</td><td>Geiger-Muller tube</td><td>1</td></tr>
<tr><td></td><td>b</td><td></td><td>800 -----> 400 -----> 200 -----> 100 -----> 50
14 days 14 days 14 days 14 days

4 x 14 days / 64 days</td><td>1

1</td></tr>
<tr><td></td><td>c</td><td></td><td>
<table>
<tr><td>solid</td><td>Easier to handled</td></tr>
<tr><td>gamma-ray</td><td>Penetrating power is high</td></tr>
<tr><td>Long half-life</td><td>Last longer</td></tr>
</table>
Cobalt-60
Because the state of matter is solid, emits gamma-ray and long half-life
</td><td>2
2
2

1
1</td></tr>
<tr><td></td><td>d</td><td>i</td><td>The process of breaking up of on heavy nucleus into lighter nucleus.</td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>- Neutron bombarded a uranium nucleus // Diagram
- Three neutrons produced // Diagram
- The new neutron bombarded a new uranium nucleus // Diagram
- For every reaction, the neutrons produced will generate a chain reaction // Diagram</td><td>1
1
1

1</td></tr>
<tr><td></td><td></td><td>iii</td><td>$E = mc^2$
$2.9 \times 10^{-11} = m \times (3.0 \times 10^8)^2$
$m = 3.22 \times 10^{-28}$ kg</td><td>
1
1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>20</td></tr>
</table>