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Cambridge IGCSE

Cambridge IGCSE® Physics (0625)
Past paper questions and answers

Contents

Light

CORE questions

Core 1

At night, the light beam from a torch is shone into a swimming pool along the line TSA. Instead of striking the bottom of the pool at A, the beam travels to B, as shown on Fig. 1.

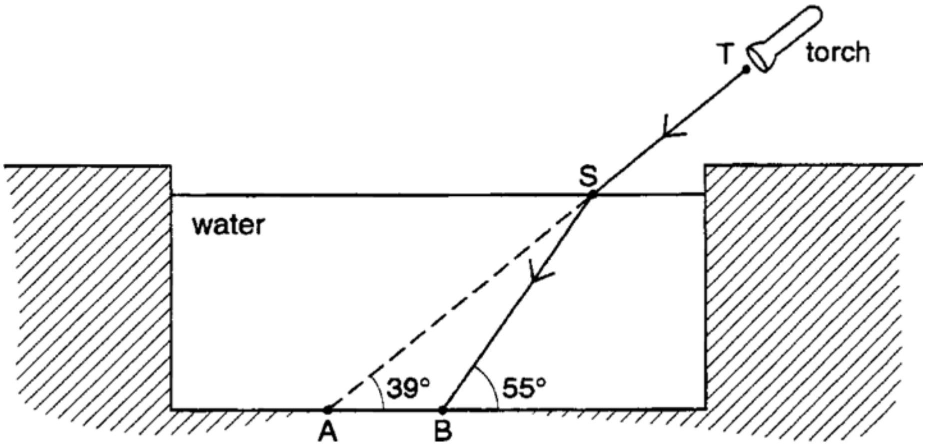


Fig. 1

(a) At S, the direction of the beam changes. State the name we use to describe this change.

....[1]

(b) **(i)** On Fig. 1, draw the normal to the surface at S.

(ii) Clearly mark and label the angle of incidence. [2]

(c) Fig. 2 shows the same pool and the same points A, B, S and T. The critical angle for the water is 50°.

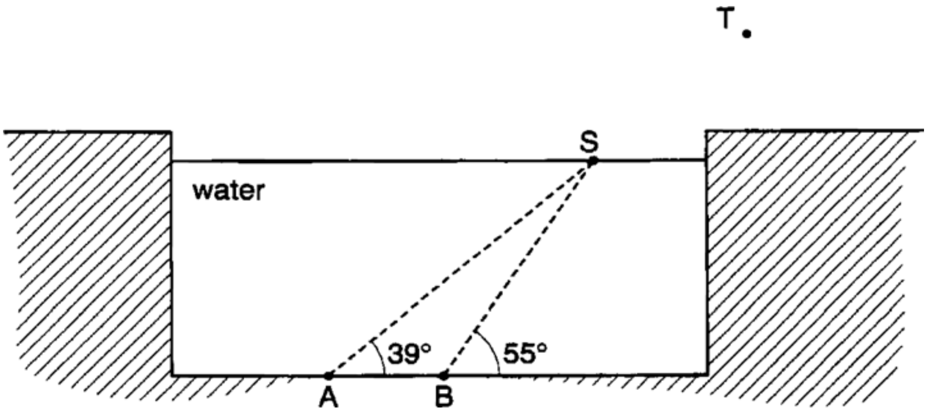


Fig. 2

(i) A beam of light is directed up from B to S. On Fig. 2, carefully draw the path of the ray from B to S and then out into the air.

(ii) 1. A beam of light is directed upward from A to S. Describe what happens to the beam at S.

....

....

2. Explain why this happens.

....

....[4]

Core 2

(a) A ray of red light passes through a glass prism, as shown in Fig. 3.

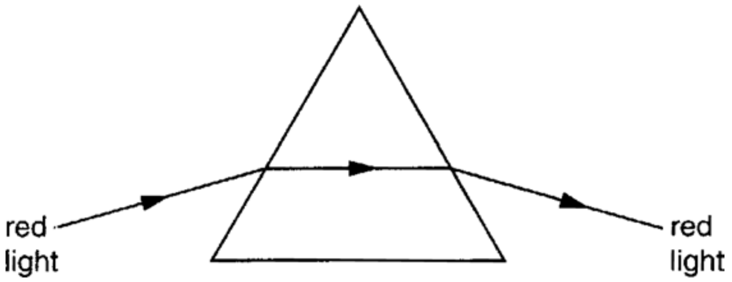


Fig. 3

What name do we use for the change of direction of the ray as it enters the glass?

....[1]

(b) Fig. 4 shows the same prism, with white light passing through it.
The path of red light is shown.

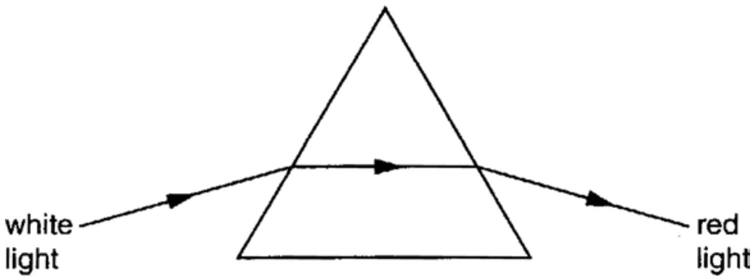


Fig. 4

(i) On Fig. 4, draw a possible path for blue light.

(ii) Something else is happening to the white light, in addition to what is shown in Fig. 3.

What name do we use for this?..[5]

(c) Light from the Sun is now passed through the prism. The path of red light is shown in Fig. 5

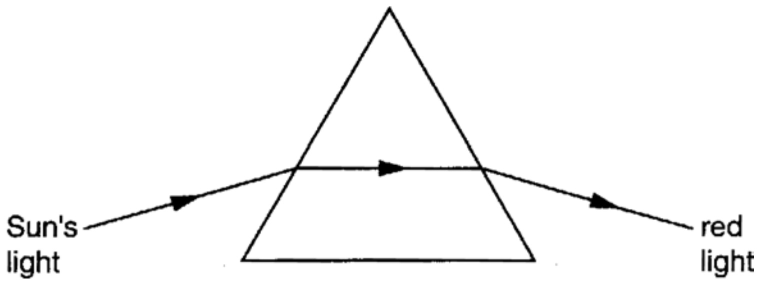


Fig. 5

We can detect infra-red rays using a thermocouple. On Fig. 5, mark with the letter **T** a position where the thermocouple could detect the infra-red rays after they have passed through the prism. [1]

Core 3

Fig. 6 shows a view from above of a vertical mirror. A small lamp is placed at the point marked L.

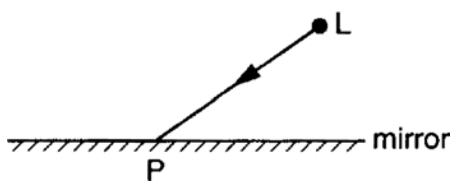


Fig. 6

(a) One ray, LP, from the lamp has been drawn.

(i) At P, draw and label the normal to the mirror.

(ii) At P, draw and label the reflected ray.

(iii) Mark, using an X for each, two angles which are equal. [3]

(b) Carefully mark, using a clear dot, the position of the image of the lamp. [1]

(c) If you were looking into the mirror from point L, you might see something like Fig. 7 "looking back at you". (Apologies if you are better looking than this!)

Fig. 7

(i) Mark clearly with the letter **R**, the image of your right ear.

(ii) Your nose is 30 cm from the mirror.
How far from your nose is its image?..[2]

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

Fig. 8 represents the apparatus an IGCSE class is using for an optics experiment, in which a glass beaker filled with water acts like a lens.

The glass beaker filled with water is placed with C, the centre of its base, on a line labelled LL'. An optics pin is placed at the point labelled O, so that the pin is touching the side of the beaker.

Two points A and A' are on the surface of the beaker at equal distances from the line LL'. The pin at point O acts as an optical object. The ray emerging from A is located by using two pins placed at two points labelled P_1 and P_2.

(a) Draw a neat, thin and accurate line to show the path of the ray from O to A in the water. Complete the path, in air, of the emerging ray along AP_1P_2. [3]

(b) Produce the line P_2P_1A backwards so as to cut the line LL'. Label, with the letter **I**, the point where the two lines cross. Point **I** is the position of the image of the pin O when it is touching the side of the beaker. [2]

(c) Draw the line OA' to represent a ray in water from O passing through A'. Using the information you gained in **(b)**, draw a line to show the path of the ray in air after is passes through the point A'. Mark your diagram in such a way as to show how you found the direction of the ray in air. [1]

(d) Take measurements to calculate the following ratio.

IR : OC = ……. : 1

Record your measurements and show your working.

Alternative to Practical 1

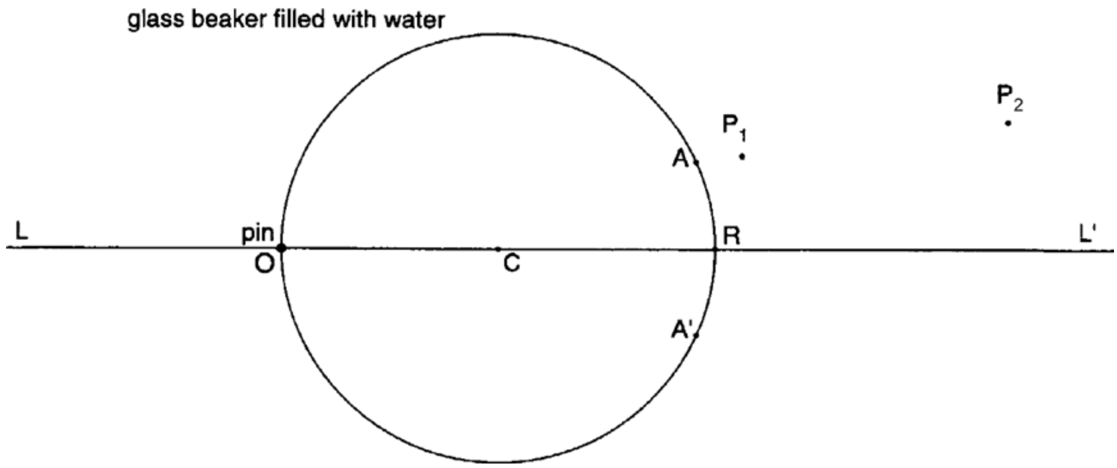


Fig. 8

EXTENSION questions

Extension 1

Fig. 9 shows an object placed 2.0 cm from a thin lens, which is to be used as a magnifying glass.

The focal length of the lens in 3.0 cm. The diagram is drawn to full scale.

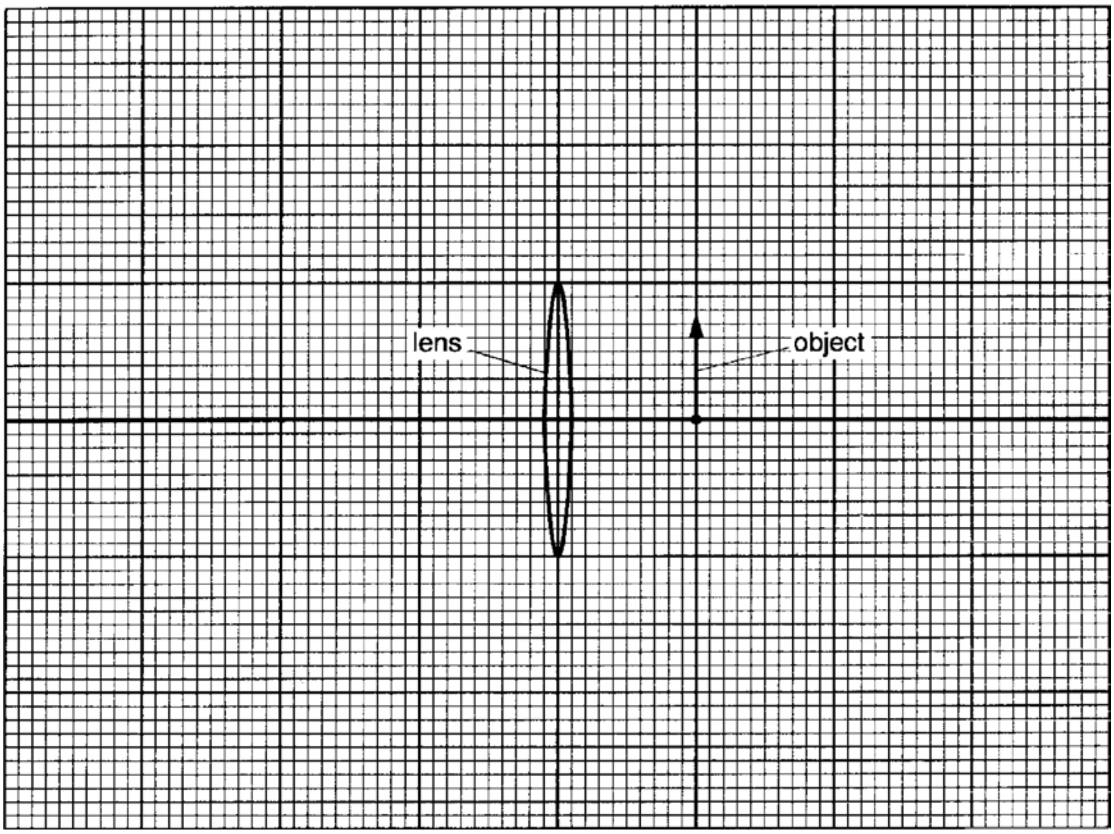


Fig. 9

(a) On Fig. 9, draw any two rays from the tip of the object which enable you to locate the tip of the image. Draw in the image and label it **I**. [3]

(b) On Fig. 9, draw in an eye position which would enable image **I** to be seen. [1]

(c) By taking measurements from Fig. 9, work out how many times bigger the image is than the object.

The image is …………….. times bigger than the object. [2]

Extension 2

Fig. 10 shows how a right-angled prism may be used to change the direction of a ray of light.

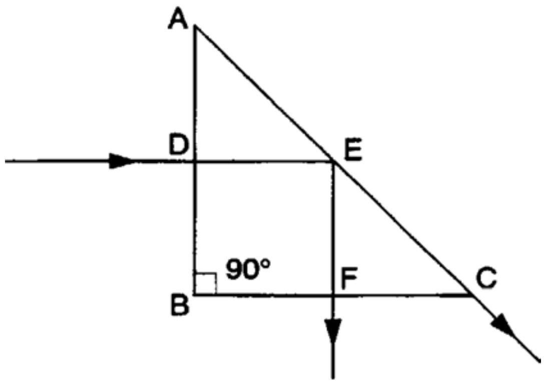


Fig. 10

(a) Explain why the ray of light does not change direction at D and at F.

....[1]

(b) State **one** property of the light which does change at D and at F. At each point say whether it increases or decreases.

....

....[2]

(c) At E the light splits, with one ray along the surface of the prism and one ray along EF. Draw the normal at E. Label the critical angle with the letter X and state its value.

critical angle = ...[2]

(d) The refractive index of this glass may be calculated using the formula

refractive index of glass = 1 / sin *c*,

where *c* is the critical angle.

Use your value of the critical angle of this glass to calculate its refractive index.

refractive index = ...[2]

Light – answers

Core 1

(a) refraction

(b) **(i)** the normal should be drawn at right angles to the surface of the water at S

(ii) the angle of incidence should be shown between the normal and the incident ray

(c) **(i)** the beam should be reflected away from the normal along ST

(ii) 1 total internal reflection

2 the angle in the water is greater than the critical angle

Core 2

(a) refraction or deviation

(b) **(i)** the blue path should show 2 downward refractions (i.e. below the path for red), one at each face

(ii) dispersion

(c) T should be shown just above the emergent red ray

Core 3

(a) **(i)** the normal should be shown at right angles to the mirror at P

(ii) the reflected ray should be shown at the same angle to the normal as the incident ray by eye

(ii) either angles *i* and *r* or the angles between the rays and the mirror

(b) the dot should be shown on the reflected ray as far from the mirror as L is

(c) **(i)** the ear on the right should be identified

(ii) 60 cm

Alternative to Practical 1

(a) three marks are gained by
a neat thin line OA
a neat, thin line AP_1P_2
an arrow from O

(b) two marks are gained by
a neat line extended to LL'
labelled **I**

(c) the line should be a continuation of **I**A'

(d) **I**R /OC should lie between 2.9 and 3.1 or to scale of diagram reproduced

Extension 1

(a) two of these
through either focus
through centre of curvature
ray produced back to form an image

(b) the eye should be in a sensible position to the left of the lens

(c) the image length should be 4.5 ± 0.2, approximately 3 times bigger than the object or according to the scale of the diagram

Extension 2

(a) the ray hits at right angles to the surface
or angle $I = 0°$
it travels along the normal

(b) the velocity / speed / wavelength
increases at F
decreases at D

(c) the value 45° should be stated or shown on the diagram

(d) the refractive index = 1 / sin 45°

Electricity 1

CORE questions

Core 1

A laboratory technician wants to make a resistor of value 64 Ω, using some resistance wire. He takes 1.0 m of this wire. The wire is shown in Fig. 1 as AC. He connects up the circuit shown.

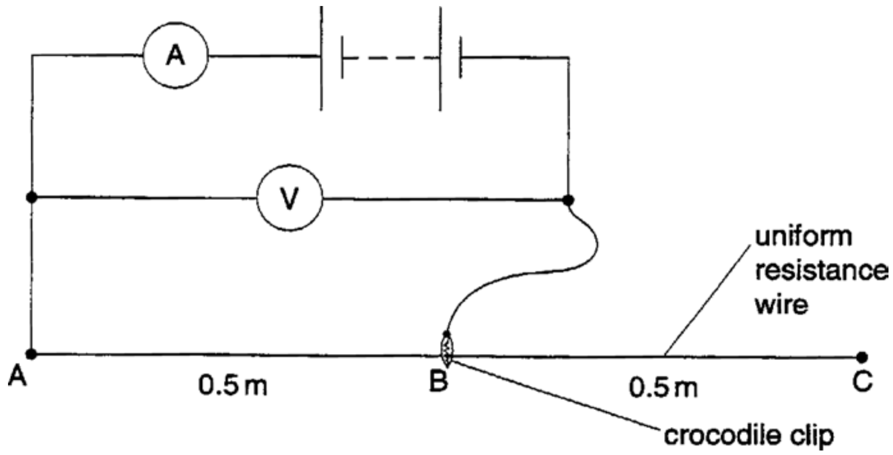


Fig. 1

(a) He connects the crocodile clip at B, which is 0.5 m from A.
Here are the readings he gets.

voltmeter reading 12 V

ammeter reading 1.5 A

Calculate the resistance of wire AB.

ANSWER: resistance of AB = ……………Ω [3]

(b) The laboratory technician now connects the crocodile clip to C, to measure the resistance of 1 m of the wire. The wire has constant thickness.

(i) In the spaces below, write the readings he obtains. Ignore the effects of the resistance of the ammeter, voltmeter and battery.

voltmeter reading ……….. V

ammeter reading ……….. A

(ii) What is the resistance of wire AC?

ANSWER: resistance of AC = ... Ω [3]

(c) Use your answer to **(b)** to answer the following questions.

(i) What is the resistance per metre of this wire?

ANSWER: resistance per metre = ... Ω / m

(ii) What length of wire does the laboratory technician need for the 64 Ω resistor?

ANSWER: length needed = ... m [3]

Core 2

(a) On Fig 2, sketch the graph you would expect to get if you plotted values of the potential difference V across a metallic conductor at constant temperature and the current *I* through it. [2]

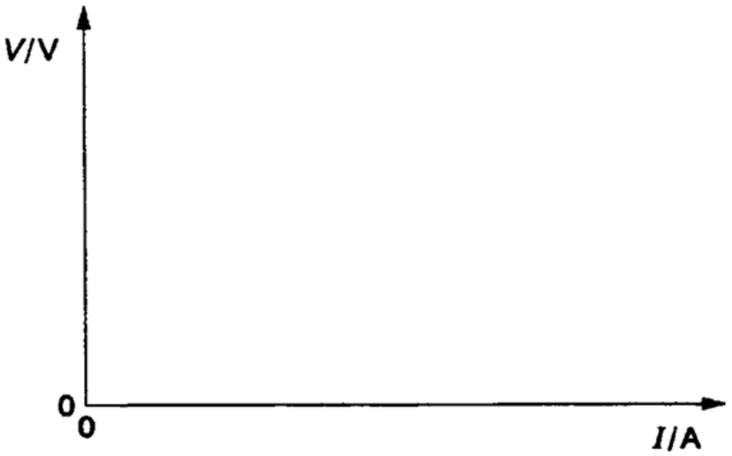


Fig. 2

(b) How would you use the graph to find the resistance of the conductor?

....

....

....[1]

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

Fig. 3 shows the top of a variable resistor that has a scale of resistance, which gives the resistance in use.

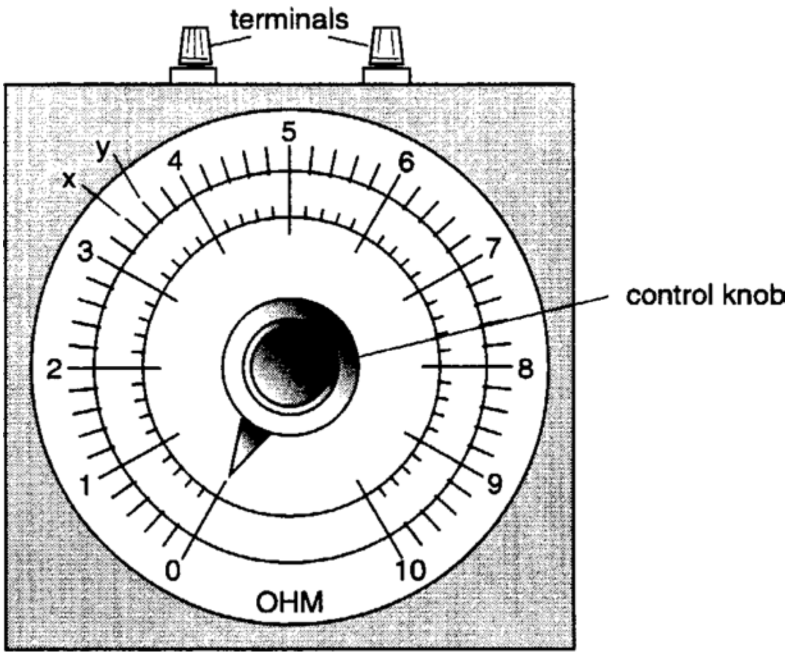


Fig. 3

(a) What range of values of resistance are available with this resistor?

range of values of resistance available = ... [1]

(b) On Fig. 3, draw a line representing the position of the pointer when the value of the resistance in use is 6.3 Ω. [1]

(c) Between the numbers 3 and 4, there are two letters x and y.

(i) What is the resistance when the pointer is at x?

resistance at x = ...

(ii) What is the *change* in resistance when the pointer moves from x to y?

change in resistance = ... [2]

(d) Draw the circuit symbol for a variable resistor.

[1]

Alternative to Practical 1

(e) A student is asked to connect a circuit so that the current through a filament lamp can be changed by using a variable resistor.

The student makes a mistake when connecting the circuit.

Fig. 4 represents the student's **wrongly** connected circuit. (In this diagram the circuit symbol is not used for the variable resistor.)

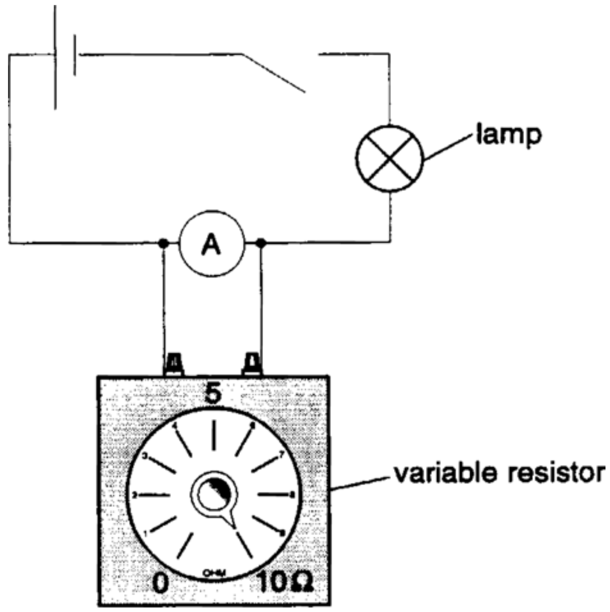


Fig. 4

When the variable resistor is varied from 10 Ω to 5 Ω, the **change** in the current is very small.

What could the student do to obtain a larger change in the current when the variable resistor is changed from 10 Ω to 5 Ω?

....

....[1]

Alternative to Practical 2

The circuit shown in Fig. 5 was used to determine *R*, the resistance of a resistor, using the equation

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

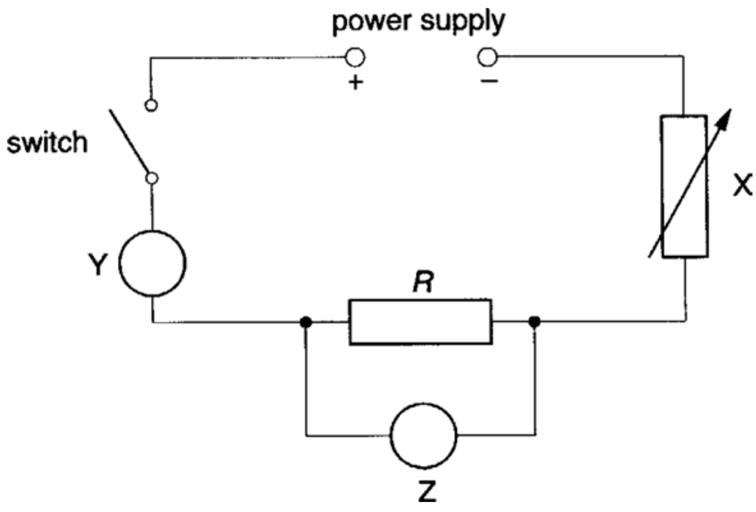


Fig. 5

The value for *R* is to be determined for different values of current *I*.

(a) Name the components labelled X and Y.

X ....

Y ....[2]

(b) What is the purpose of the component X?

....

....[1]

(c) Explain how you would use the apparatus to determine values of *R*. Your answer should include what you would do before you close the switch.

....

....

....

....[4]

(d) The value of *R* is about 9.5 Ω and the current through it must not exceed 0.10 A. What would be a good choice for the maximum reading of the component labelled Z?

maximum reading = ……………………… [1]

Alternative to Practical 3

Fig. 6 is a series circuit in which a variable resistor is used so as to control the magnitude of the current in the circuit. The circuit is designed so as to obtain any value of current from 0.2 A to 2 A.

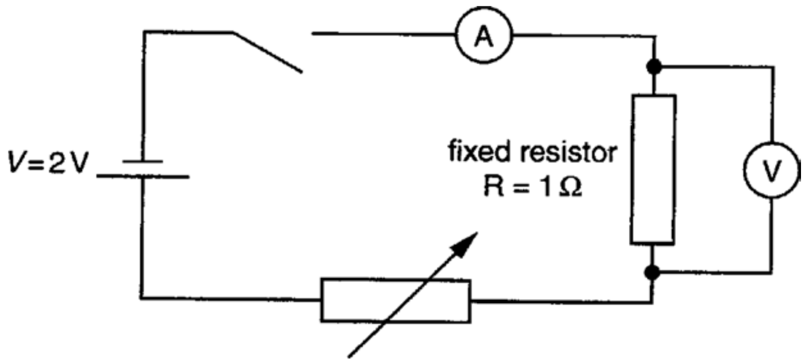


Fig. 6

(a) **(i)** The variable resistor is marked "0 to 10 Ω".

What is meant by the phrase "0 to 10 Ω"?

....[1]

(ii) Why is it important that the value of the variable resistance may be changed smoothly?

....[1]

(b) **(i)** A 1 m length of nichrome wire has a resistance of 10.0 Ω.

How would you use 1 m of this wire, and a jockey-slide contact, as the variable resistor shown in Fig. 6?

Your answer should

1. include a diagram showing the wire in use,
2. explain how you would achieve smooth changes in the value of the variable resistance,
3. explain why the wire must be bare and clean.

Diagram

....

....

....

....

....[3]

(ii) If the current in the nichrome wire becomes 2.0 A, then the wire becomes very hot and has a temperature of about 300 °C. The wire is then dangerous to touch.

A safe current to use in the circuit is about 0.6 A. To obtain a current of 0.6 A, the **total** resistance in the circuit should be about 3.3 Ω. The length of resistance wire in use is then 23 cm.

What could you do to the apparatus you have been given in **(b)(i)** to prevent anyone using a length of resistance wire that is less than 23 cm?

You may draw a diagram if you wish.

....

....

....

....[2]

EXTENSION question

Extension 1

Fig. 7 shows how a student set up a circuit using three identical lamps. Assume that the resistance of each lamp does not change with the brightness of the lamp.

Each lamp is labelled 12 V, 2.0 A.

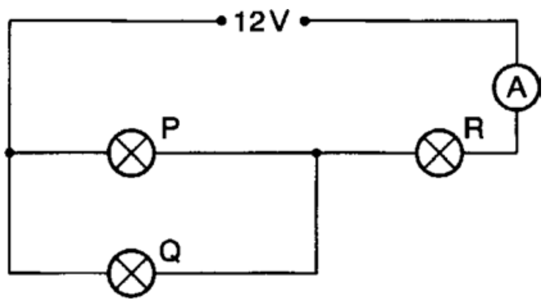


Fig. 7

(a) Calculate the resistance of one of the lamps.

resistance = ... [2]

(b) Calculate the combined resistance of the three lamps as connected in Fig. 7

combined resistance = ... [2]

(c) Calculate the current which would be shown on the ammeter in Fig. 7

current = ... [2]

(d) Explain why lamp A is less bright than normal and why lamps P and Q are both equally very dim.

....

....

....

....[3]

(e) In the space below draw a circuit diagram which shows P, Q and R connected so that they will all work at normal brightness.

[1]

Electricity 1 – answers

Core 1

(a) R = V / I
= 12 / 1.5
= 8 Ω

(b) **(i)** 12 V
0.75 A

(ii) 16 Ω

(c) **(i)** 16 Ω / m

4 m

Core2

(a) the graph should show a straight sloping line through the origin

(b) calculate the resistance or R = V / I

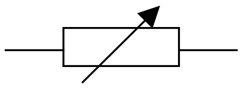
Alternative to Practical 1

(a) 0 – 10 Ω

(b) a line drawn between 6.2 and 6.4

(c) **(i)** 3.4 Ω

0.2 Ω

(d) 

(e) connect a variable resistor in series

Alternative to Practical 2

(a) X = variable resistor / rheostat
Y = ammeter

(b) to change the value of the current

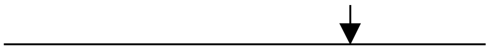
(c) set X to maximum value, close switch
adjust X to obtain desired value of I
measure I and V
repeat settings for a check / zero meters

(d) Full Scale Deflection 1 V (maximum V = $9.5 \times 0.1 = 0.95$ V)

Alternative to Practical 3

(a) **(i)** range of resistance
to obtain any value of current

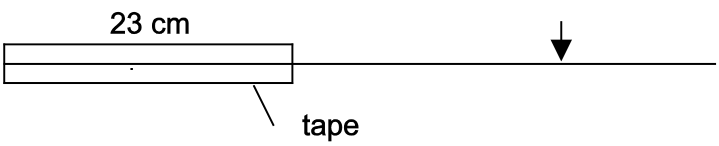
(b) **(i)** 1



move the slider along the line
to ensure good electrical contact

insulate 23 cm
correct end clear

OR



Extension 1

(a) R = V / I
= 60 Ω

(b) combined resistance of P and Q = 3 Ω
whole circuit resistance = 9 Ω

(c) I = V / R
= 1.3 A

(d) the voltage across R is less than 12 V / low / 8 V or the current through R is less than 2 A
the currents through P and Q are equal / voltage across P and Q is equal
the current through P and Q is less than through R or the potential difference across P and Q is less than across R

(e) the diagram should show P, Q and R in parallel

Energy

CORE questions

Core1

A dish of hot food is put on a wooden table.

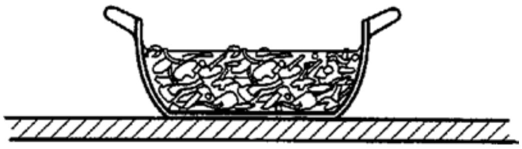


Fig. 1

(a) State three processes by which the dish and its contents could lose heat to the surroundings.

1. ....

2. ....

3. ....[3]

(b) **(i)** Describe one way of reducing the heat loss to the surroundings.

....

....

(ii) Which form of heat loss would this reduce?

....[2]

Core 2

Here are some statements about energy. Complete the statements using words from the following list.

chemical, electrical, geothermal, heat, hydroelectric, light,

movement (kinetic), position (potential), strain, tidal, wave

(a) A coal fire converts .... energy into

.... energy and .... energy. [3]

(b) When a ball falls from rest, its .... energy increases and its

.... energy decreases. [2]

(c) The source of energy, in which hot rocks under the Earth's surface heat water to produce

steam, is referred to as .... energy. [1]

Core 3

Fig. 2 shows an electric kettle.

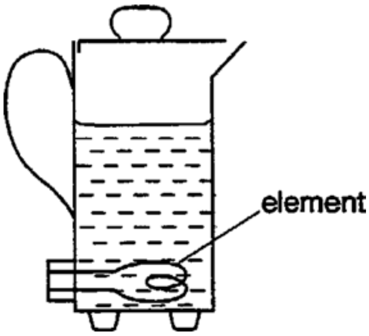


Fig. 2

Explain why the heating element is placed near the bottom of the kettle.

....

....

....[2]

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

A small mass of ammonium chloride is dissolved in some water, causing the temperature of the water to fall. The apparatus, which is used to determine the fall in temperature, is shown in Fig. 3.

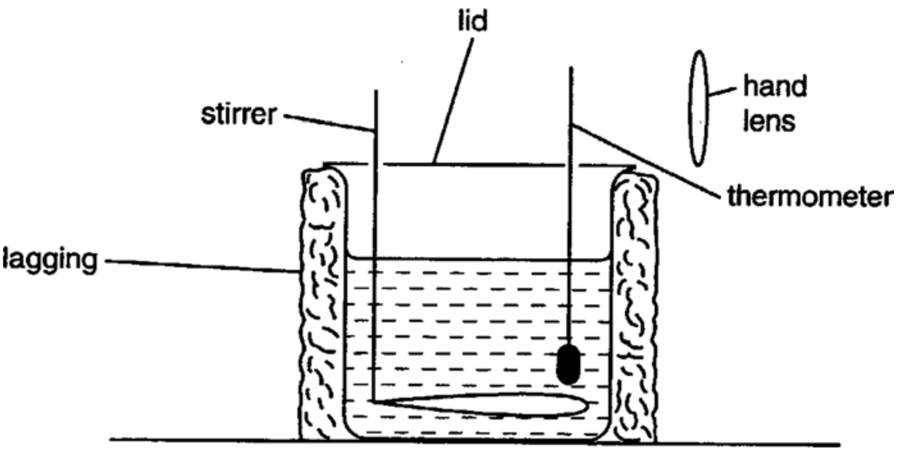


Fig. 3

(a) Give a reason for using each of the following items of apparatus.

(i) the lagging

....

....

(ii) the stirrer

....

....

(iii) the hand lens

....

....[3]

Alternative to Practical 1

(b) Part of the thermometer that is used to determine the fall in temperature is shown in Fig. 4. The diagram shows the thermometer before and after adding the ammonium chloride.

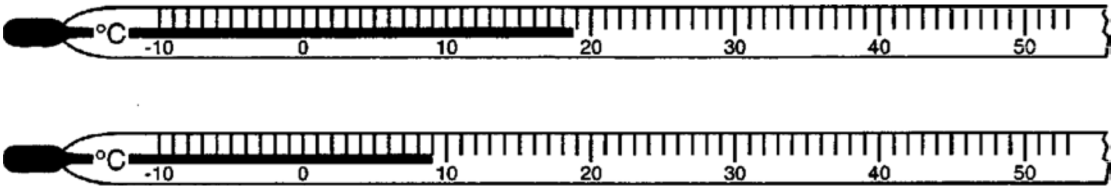


Fig. 4

(i) Record each of the temperatures and determine the fall in temperature.

temperature before adding the ammonium chloride = ...

temperature after adding the ammonium chloride = ...

fall in temperature = ...

(ii) In Fig. 4 the liquid thread is shown along the edge of the scale marks. This is the recommended way to position the liquid thread before reading a temperature. In Fig. 5 the thread is positioned away from the edge of the scale.

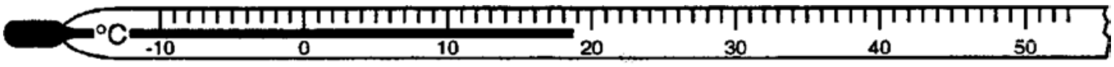


Fig. 5

Suggest a reason for the recommended way to use a thermometer.

....

....[4]

(c) How would you avoid making a parallax error when reading the thermometer shown in Fig. 5? You may draw a labelled diagram if you wish.

EXTENSION questions

Extension 1

Fig. 6 shows the outline of a machine for driving steel pillars (called piles) into the ground.

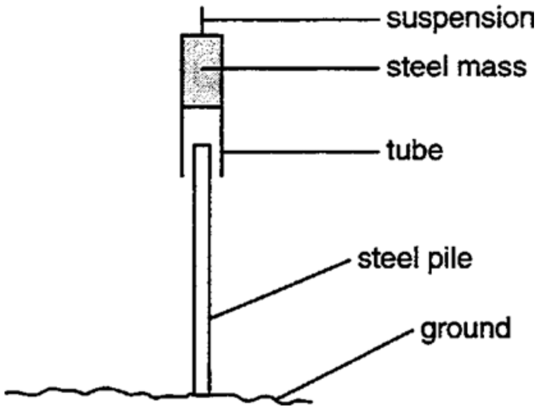


Fig. 6

The steel mass is raised by an electric motor and then falls under gravity.
The falling steel has a mass of 200 kg and falls a distance of 6.0 m.

(a) The acceleration of free fall is $10\,m/s^2$. Calculate

(i) the potential energy gained by the mass each time it is raised,

potential energy gained = ...

(ii) the maximum speed at which the mass hits the pile.

speed= ....

[7]

Extension 1

(b) When the mass hits the pile, it has kinetic energy. This energy is transformed into other forms of energy as the speed of the falling mass rapidly reduces to zero. As this happens, the pile is forced a small distance into the ground.

(i) State the energy conversions which take place, starting from the kinetic energy of the falling mass.

....

....

....

....

(ii) Explain how a large force is produced when the pile is driven a short distance into the ground.

....

....

....

....[8]

(c) In raising the steel mass 6.0 m, the electric motor uses more energy than that calculated in **(a)(i)**

Write down and explain **two** causes of this higher energy requirement.

1. ....

....

....

....

2. ....

....

....

....[4]

Extension 1

(d) The equipment design is changed so that when the mass falls once, the pile is driven further into the ground than before the design was changed.

Suggest **three** changes that could be made to do this.

1. ....

....

2. ....

....

3. ....

....[3]

Energy – answers

Core 1

(a) any three of
conduction
convection
radiation
evaporation

(b) **(i)** any suitable procedure
e.g. a lid
insulating cover or wrap

(ii) it would depend on the choice for **(i)** but from above either evaporation or conduction

Core 2

(a) electrical to heat (thermal) and light

(b) kinetic (motion)
potential (position)

(c) geothermal

Core 3

Answer should include two of these points.

a description of convection

hot water rises

there can be no convection if it is heated at the top / only the top would be heated in this case

smaller amounts of water can be boiled

Alternative to Practical 1

(a) **(i)** to reduce or prevent conduction of heat / to insulate the can

(ii) produce a uniform temperature

(iii) assists in accurate temperature measurement

(b) **(i)** 18.7 or 18.8 °C

8.9 or 9 °C

between 9.7 and 9.9 °C

(ii) assists accuracy
helps avoiding parallax
helps to be more certain when the thread reaches the scale division

(c) take the reading with the line of sight perpendicular to the scale mark

Extension 1

(a) **(i)** the potential energy gained each time it is raised

= m g h

= 200 × 10 × 6

= 12000 J

(ii) the potential energy lost = the kinetic energy on impact

12000 = ½ m v2

v2 = 2 × 12000 / 200

= 120

v = 10.95 or 11 m / s

(b) **(i)** as the mass moves against the resistance of the ground
kinetic energy is transferred to heat energy / sound energy

(ii) at impact the kinetic energy / momentum is large
after impact kinetic energy / momentum is soon zero
kinetic energy / momentum change is large
slows to rest in a very short time / distance
kinetic energy lost = force × distance the pile moves
OR the rate of change of momentum = force

(c)

lifting suspension / pile deeper after each hit	needs more p. e. each time
rising mass gains k.e.	all lost at top
power to stop / brake the rising mass	all lost as heat
efficiency of motor not 100%	lost as heat

(d) greater mass
fall greater distance
use a motor to drive the mass down
use a thinner or pointed pile

Mechanics 1

CORE questions

Core 1

Read the sentences below and then answer the questions which follow.

"When potatoes are bought in a market, the weight of a bag full of potatoes is affected by the density of the potatoes. A lady fills her bag when she buys 5 kg of large potatoes. A man buys 5 kg of small potatoes. He puts them in a bag of the same size as the lady's, but his bag is not filled."

(a) Which word in these sentences describes a quantity which is a force?

....[1]

(b) What does the 5 kg measure? Tick **one** box.

the density of the potatoes ☐

the mass of the potatoes ☐

the volume of the potatoes ☐

the weight of the potatoes ☐ [1]

(c) Suggest one reason why the man's 5 kg of potatoes occupies less volume than the lady's potatoes.

Core 2

Moving cars always experience friction. A driver goes on a short journey in a car.

Fig. 1 shows the car at four places during the journey. The arrows represent the size and direction of the horizontal forces on the car.

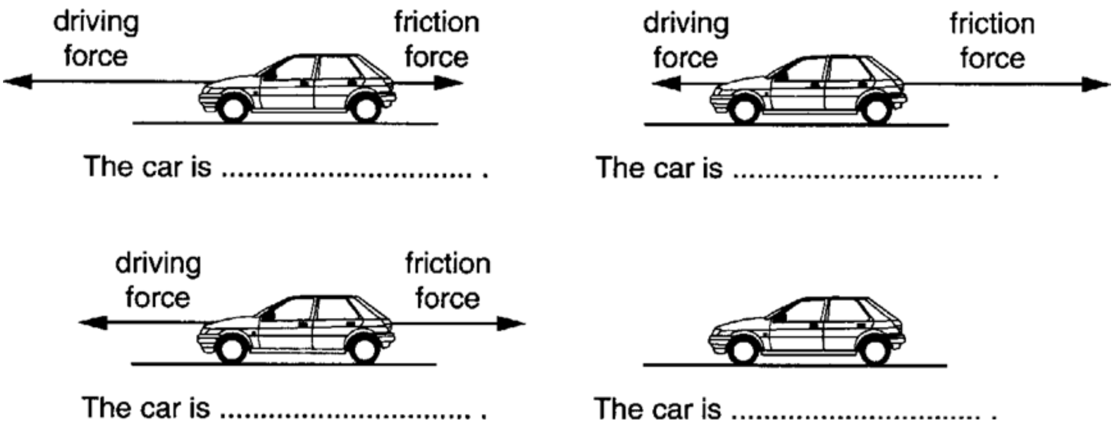


Fig. 1

On the line underneath each picture, state whether the car is

at rest,

speeding up,

going at steady speed,

slowing down. [4]

Core 3

(a) Fig. 2 shows the speed/time graph for a motorcycle.

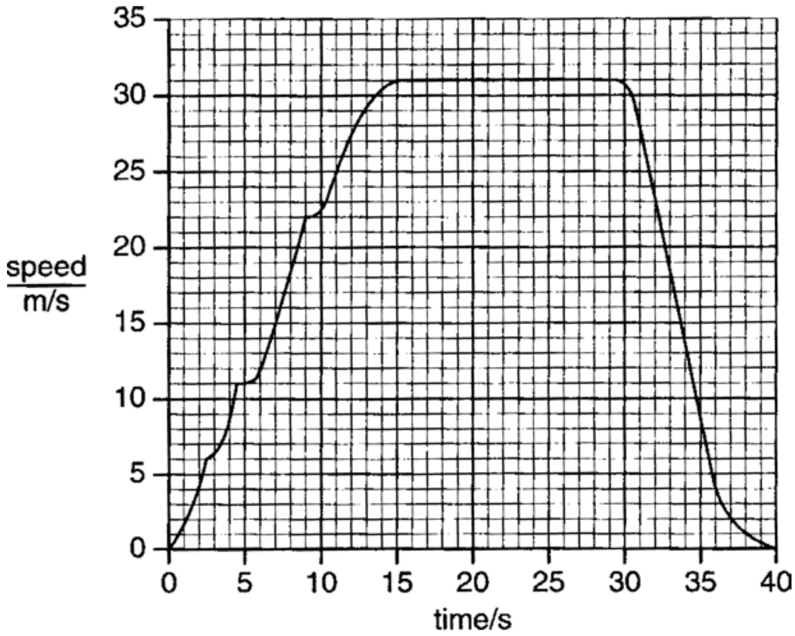


Fig. 2

(i) What is the maximum speed of the motorcycle? .... m / s

(ii) Whilst accelerating, the motorcycle changes gear three times.

State **one** of the speeds at which the gear is changed .... m / s

(iii) For how long is the motorcycle slowing down? .... s

[3]

Core 3

(b) On another occasion, the motorcycle is made to increase its speed at a constant rate for 10 s. The speed / time graph for this is shown in Fig. 3:

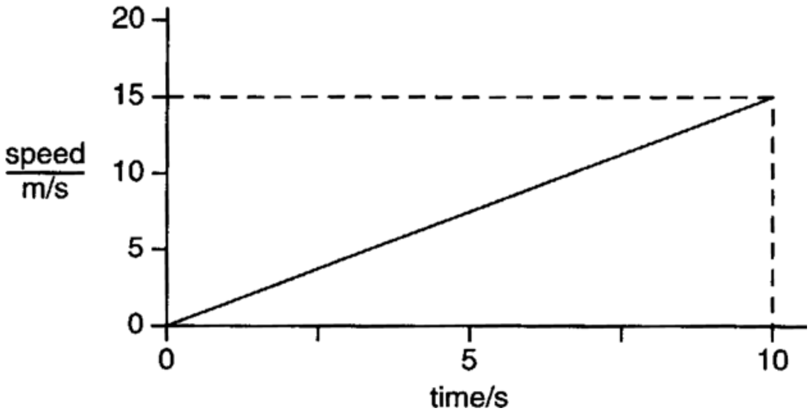


Fig. 3

How far does the motorcycle travel in these 10 s?

distance travelled = ... m [3]

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

The class is investigating the use of nichrome (resistance) wire instead of thin thread as part of a simple pendulum. The apparatus is shown in Fig. 4.

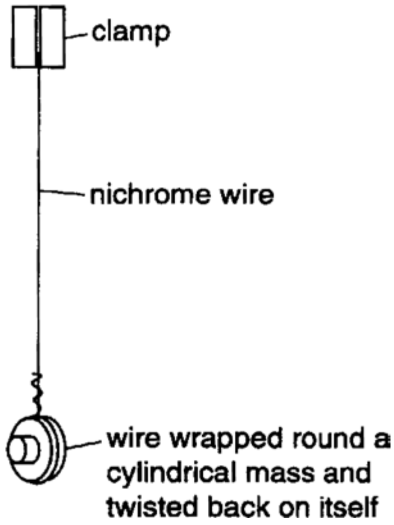


Fig. 4

Four tests are carried out.

Test A using very thin cotton thread for the suspension, (this thread is considered to have a negligible diameter).

Tests B, C and D in which nichrome wires of different diameters, d, are used.

In each test the length of the pendulum is 30.0 cm. The period, *T*, is determined by obtaining the total time, *t*, of a suitable number of oscillations. The period is given by $T = t/N$, where *N* is the number of oscillations.

The table gives the measurements taken by the class.

test	suspension	*d* / mm	*N*	*t* / s	*T* / s
A	cotton thread	negligible	50	54.8	
B	nichrome wire	0.31	50	53.4	
C	nichrome wire	0.56	50	50.3	
D	nichrome wire	0.91	50	43.3	

(a) For each test, determine the value *T* and record it in the table. [1]

(b) Suggest why 50 oscillations are used .

....[1]

(c) **(i)** Plot a graph of *T* / s (y-axis) against *d* / mm (x-axis). Start the *T* / s axis at *T* / s = 0.7. Draw a neat thin curved line through the four points.

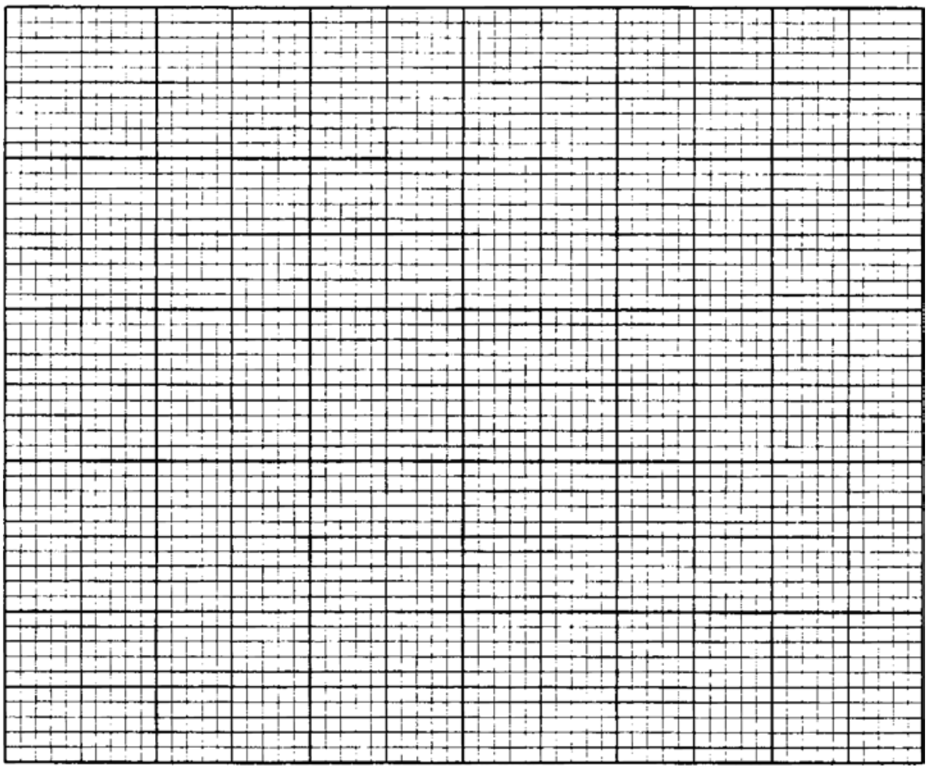
(ii) Label each plotted point with the correct test letter A, B, C or D.

Alternative to Practical 1

(iii) Describe how the values of *T* change when the values of *d*, the diameter of the wire, decrease.

....

....[7]



(d) In the laboratory you have enough time to take another set of measurements for one other value for the diameter of the nichrome wire. Study the shape of your graph line and then suggest an approximate value for the diameter that you think should be used. Give a reason for your choice.

choice for the value of *d* = ... mm

reason for this choice

....

....

....[2]

EXTENSION questions

Extension 1

A firework leaves the ground with an initial velocity of 45 m / s, travelling vertically upwards. It reaches a maximum height of 100 m.

At this point the firework fails to explode and falls back down the same vertical path to the ground.

At any point on its path, the firework has both a velocity and a speed.

(a) Using the terms **vector** and **scalar**, explain the difference between velocity and speed.

....

....

....

....[3]

(b) Fig. 5 is a graph which shows the height of the firework above the ground during the first 5 s of its journey.

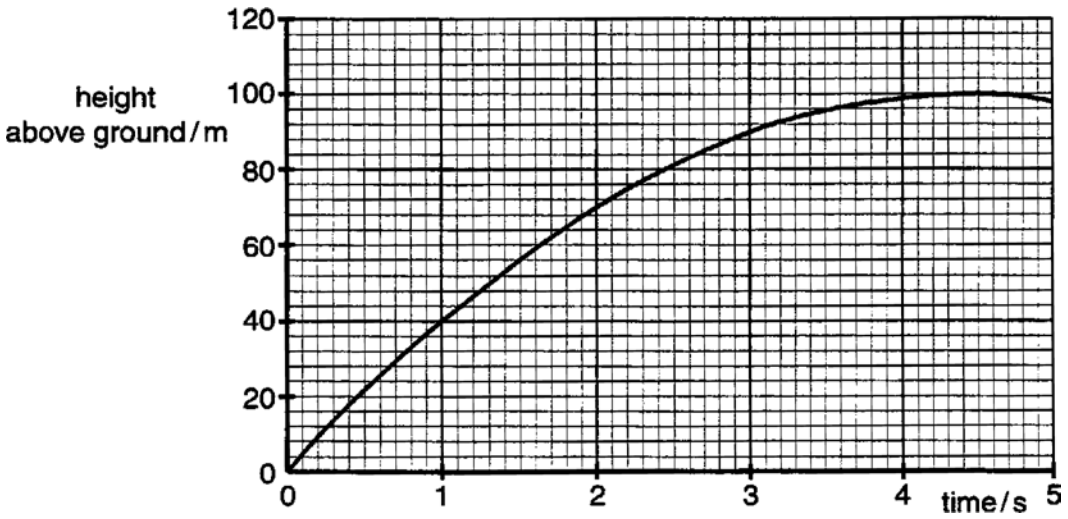


Fig. 5

(i) Use the information on the graph to

1. find the time taken for the firework to reach its maximum height above the ground,

....

2. describe how the motion of the firework changes over the first 5 s of its journey.

....

....

....

....

Extension 1

(ii) The acceleration of free fall Is $10\,m/s^2$ and air resistance on the firework is negligible.

State

1. the deceleration of the firework as it is rising,

deceleration = ...

2. The total time taken for the firework to rise 100 m and then to fall back to the ground.

time taken= ....

(iii) State the velocity with which the falling firework hits the ground.

velocity = ...

[8]

Extension 2

Fig. 6 shows a plan view of a rotating sprayer used for the watering of crops.

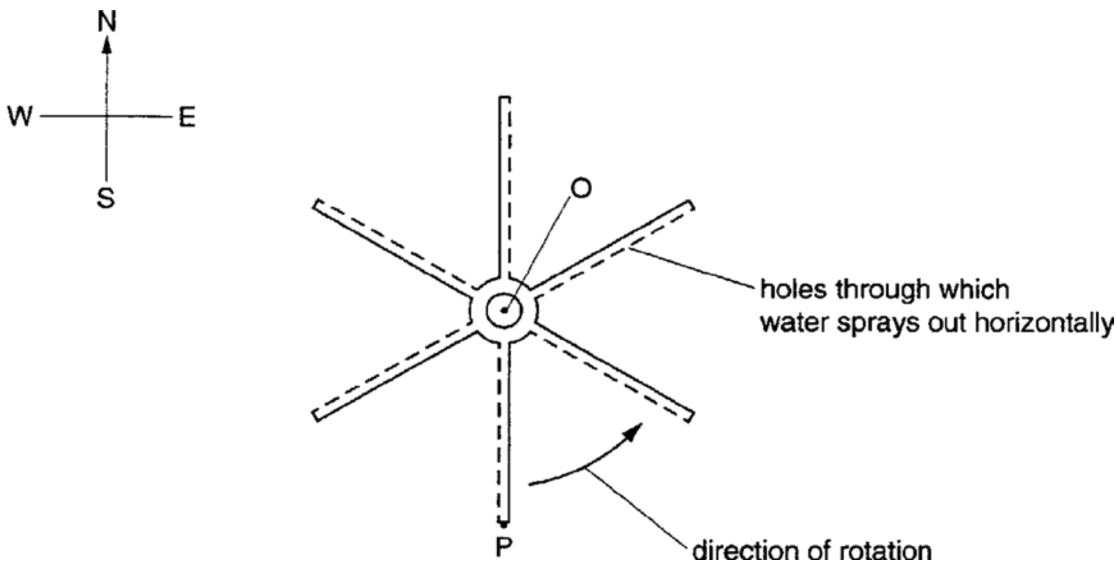


Fig. 6

(a) The device rotates about O at a constant rate of 0.2 revolutions per second. OP is 10 m long.
Calculate the speed of the point P. (The circumference of a circle is $2\pi \times$ radius.)

speed= .... [4]

(b) **(i)** Use your answer to **(a)** to write down the **velocity** of the point P when P is at the point shown in Fig. 6

....

....

(ii) Explain why the **speed** of point P is constant but its **velocity** changes as the sprayer rotates.

....

....

....

....

[4]

Extension 2

(c) Explain how you know that there is a net force at the end of the arm P, acting towards O.

....

....

....

....

....[3]

Mechanics 1 – answers

Core 1

(a) weight

(b) mass

(c) greater density or less air gaps between the potatoes

Core 2

speeding up	slowing down
steady speed	at rest

Core 3

(a) **(i)** 31 m / s

(ii) 6 or 11 or 22 m / s

(ii) 10 s

(b) distance = area under the graph or the average speed × time

= ½ × 10 × 15

= 75 m

Alternative to Practical 1

(a) 1.096 or 1.10
1.068 or 1.07
1.006 or 1.01
0.866 or 0.87

(b) greater accuracy

(c) **(i)** the graph should
show the scales the right way round
cover at least half the grid
suitable scales
scales labelled with quantity or unit
all plots correct to the nearest square

(ii) A B C D labelled

(ii) T increases

the increase is greatest for larger values of d

(d) 1.1
increased range or largest difference in T value with larger d values

Extension 1

(a) velocity is a vector and speed is a scalar
or velocity has direction and a scalar or speed has no direction or only magnitude

(b) **(i)** 1 4.5 ± 0.1 s

2 decelerates uniformly from a high velocity at zero seconds to zero velocity at 4.5 s

(ii) 1 $10\,m/s^2$

2 9.0 s

(iii) $45\,m/s \pm 1\,m/s$

Extension 2

(a) distance moved in one revolution is equal to the circumference

= 62.8 / 63 m

time for one revolution is 5 s

speed = 62.8 / 5
= 12.6 m / s

(b) **(i)** 12.6 m / s to the right / east

(ii) velocity is a vector or has direction or reverse argument for speed
P is moving in a circle / a constantly changing direction
if the direction changes the velocity changes or the speed does not

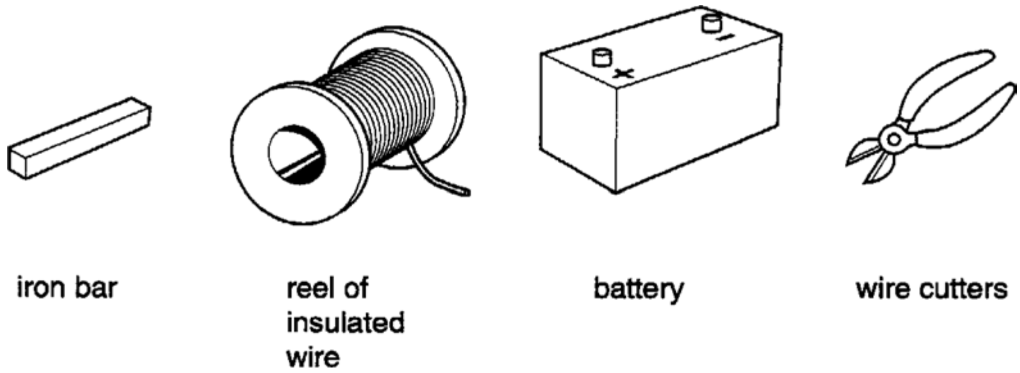
(c) rotation is taking place / direction is changing
the force is the centripetal force
it must act through the centre otherwise the motion is not circular

Electromagnetism

CORE questions

Core 1

You are given an iron bar, a reel of insulated wire, a battery and some wire cutters.



(a) In the space below, describe how you would make an electromagnet. You may use a labelled diagram if it helps you to answer the question.

....

....

....[3]

(b) How would you check that your electromagnet actually works?

....

....

....[1]

Core 2

Fig. 1 shows one way of using water to generate electricity.

(a) Fill in the missing words in the boxes. [4]

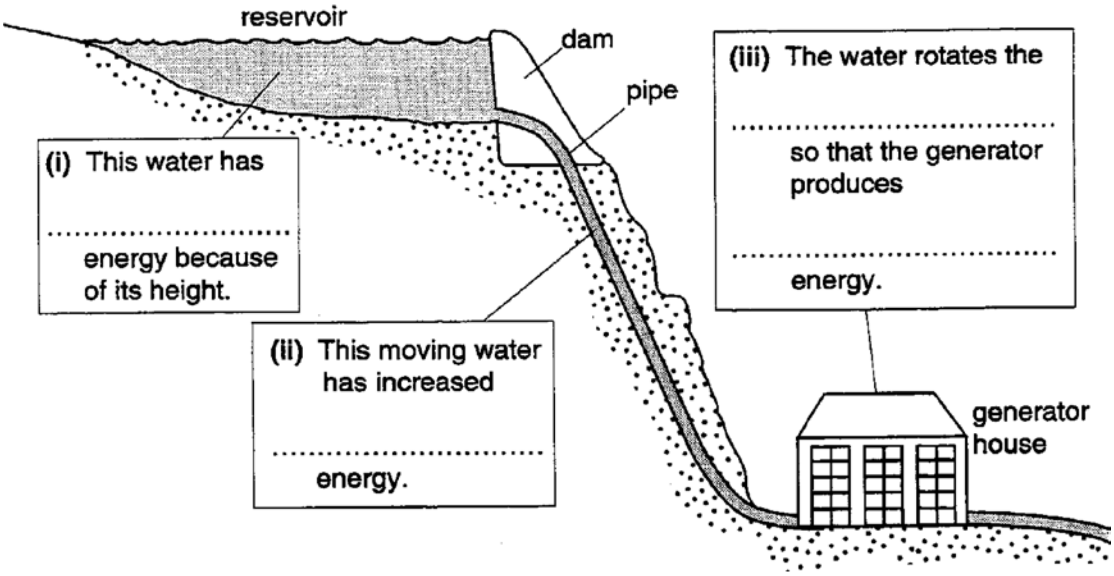


Fig. 1

(b) In other places, water is used in different ways to generate electricity.
State two of these ways.

1. ....

2. ....[2]

Core 3

A student wraps a length of fine wire around a wood block and hangs the block between the poles of a magnet, as shown in Fig. 2

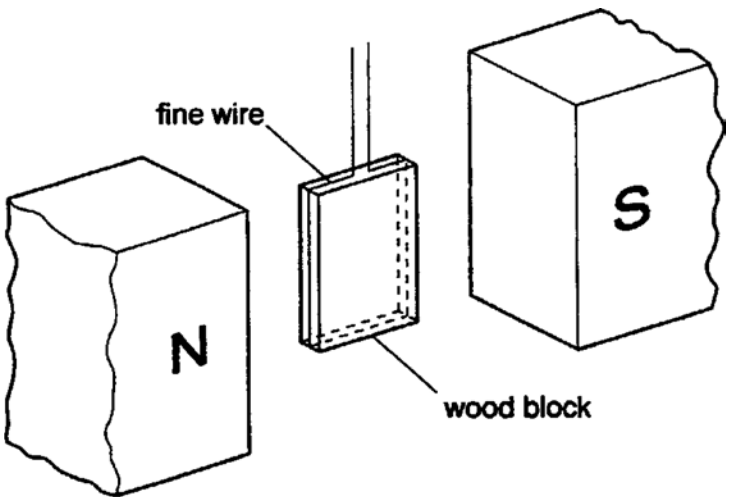


Fig. 2

(a) What is seen to happen when the student passes a current through the fine wire?

....[1]

(b) Why does this happen?

....

....[2]

(c) Name a device which makes use of this effect.

....[1]

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

When investigating the magnetic field due to a bar magnet, a student places the magnet on a sheet of paper as shown in Fig. 3, on page 5. The edge of the paper is placed so that it is parallel to the direction of the Earth's magnetic field. The bar magnet is then placed as shown so that it is at right angles to the direction of the Earth's magnetic field. (In Fig. 3, the lines OX and OY are perpendicular to each other.) A small plotting compass is used to investigate the magnetic field.

(a) It is found that there are positions where the small magnet in the plotting compass points so that it is parallel to the line OX. Some of these positions are located and are labelled A, 8, C, D, E, F, G and H, as shown on Fig. 3. The positions shown in Fig. 3 also lie on straight lines that come from the centre of the bar magnet.

Describe how you would locate the position labelled A. Your answer should explain

(i) what you would do to help you judge when the small magnet in the plotting compass is parallel to OX,

(ii) how you would ensure that the small magnet of the plotting compass is not sticking,

(iii) what you would do so as to mark the point A on the radial line,

(iv) how you would avoid making a parallax error when locating the point A .

....

....

....

....

....

....

....

....[5]

Alternative to Practical 1

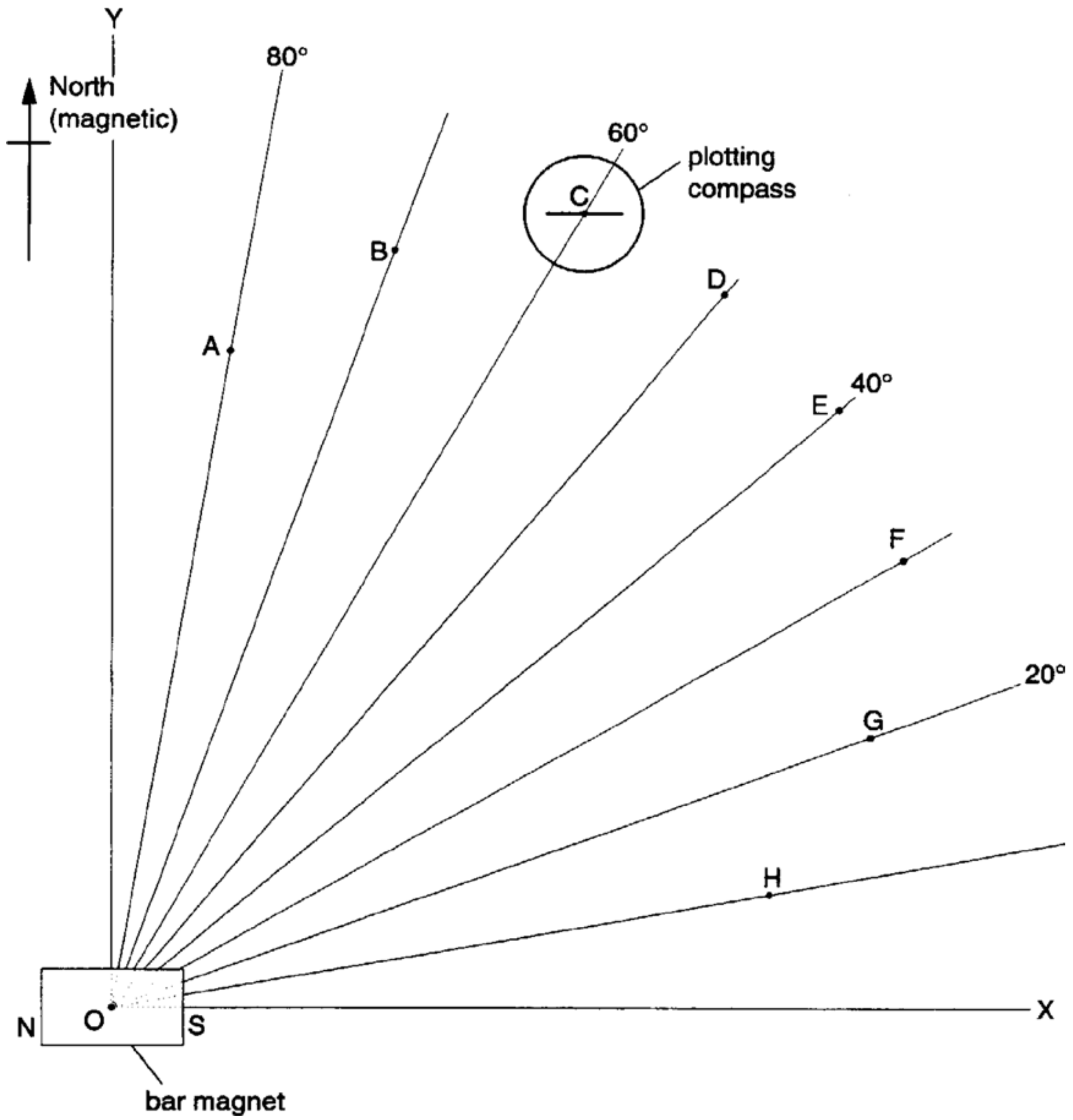


Fig. 3

(b) The plotting compass is at point C as shown in Fig 3

(i) Mark the plotting compass in such a way as to show which end of the small magnet of the plotting compass is a North pole.

(ii) The compass is at point C. It is then moved along the radial line so that it is closer to the bar magnet. Describe and explain what happens to the small magnet of the plotting compass.

....

....

....

....[3]

EXTENSION questions

Extension 1

Fig. 4 shows a transformer.

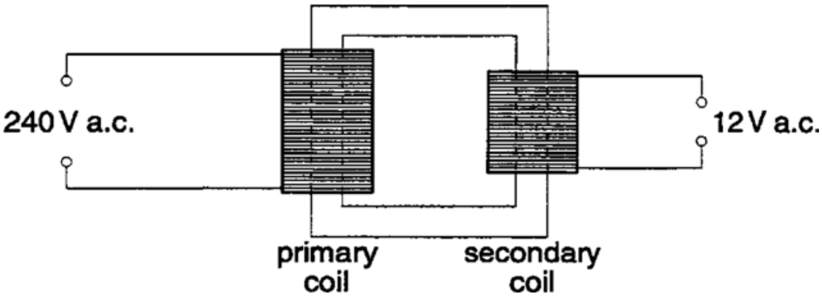


Fig. 4

(a) Explain why there is an e.m.f. across the secondary coil even though there is no electrical connection between the primary and secondary coils.

....

....

....

....[3]

(b) When the transformer is in use, the current in the secondary circuit is 3.2 A. The transformer may be considered 100% efficient.

Calculate the current in the primary coil.

current = ... [3]

Extension 2

A student is given a battery, a switch, two insulated thick copper leads and a coil of resistance wire. On Fig. 5 only the coil is drawn in.

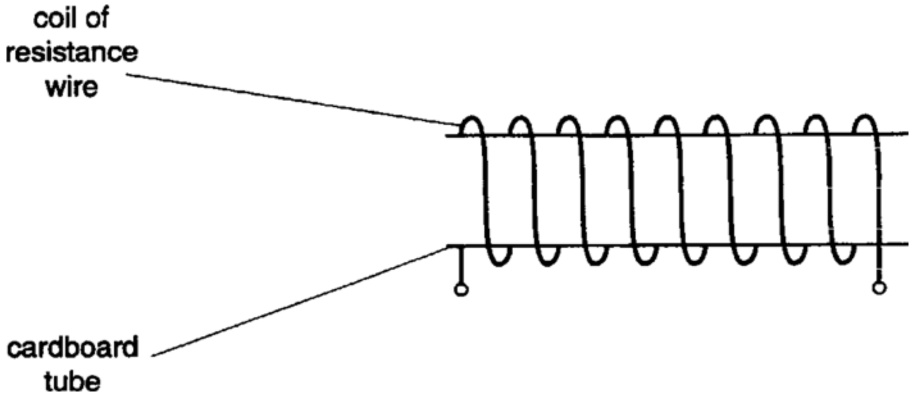


Fig. 5

(a) The student set up the apparatus to make a current flow through the coil.
Using standard symbols for components, complete a circuit diagram on Fig. 5 . Also on Fig. 5, draw the magnetic field lines in and around the coil, with arrows to indicate the direction of the lines. [4]

(b) A charge of 16 C flows through the coil in 40 s.
Calculate the current in the coil.

current = ... [2]

Extension 2

(c) The potential difference across the coil is 1.2 V.

(i) Calculate the energy released as heat in the coil in 40 s.

energy= ....

(ii) Calculate the resistance of the coil.

resistance = ... [4]

(d) The battery supplies 24 J of energy to drive 16 C of charge around the circuit.
Define the e.m.f. of this battery.

....

....[2]

Electromagnetism – answers

Core 1

(a) wind the wire round the iron bar
connect both ends of the coil to the battery
strip the ends of the wire
or these points shown in a diagram

(b) attracts / picks up iron filings, steel paper clips etc.
deflects a compass needle
repels another magnet
induces an e.m.f. if moves into a wire coil

Core 2

(a) **(i)** potential / position / gravitational

(ii) kinetic / motion / movement

(iii) turbine / coils / blades rotor
electrical

(b) any two from
waves
tides
steam
geothermal

Core 3

(a) the coil turns

(b) current carrying coil in magnetic field experiences turning effect

(c) electric motor
galvanometer

Alternative to Practical 1

(a) move the centre of the compass along the line from the magnet

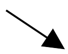
(i) judge that the small magnet is parallel using .g. lined paper, ruler and set square etc.

(ii) tap the compass to prevent sticking

(iii) mark either end of the needle as near as possible to the compass then mark A between

(iv) look directly down on to the compass so the centre is on the line

(b) **(i)** N pole should be marked at the right hand end

(ii) the needle moves gradually to a direction of approximately 

Extension 1

(a) any three from

- primary current creates magnetic field
- field is constantly changing
- the field in the core links into the secondary coil
- there is a changing field in or through the secondary coil
- a current is induced in the secondary coil

(b) $V_P I_P = V_S I_S$

$240 \times I_P = 12 \times 3.2$

$I_P = 0.16\ A$

Extension 2

(a) a circuit with a battery symbol and switch

straight lines of magnetic force inside the coil extending to loops either side showing arrows pointing in direction which is correct with current flow

(b) current = charge / time
= 16 / 40
= 0.4 A

(c) **(i)** energy released = V × I × t
= 1.2 × 0.4 × 40
= 19.2 J

(ii) resistance = 1.2 / 0.4
= 3 Ω

(d) e.m.f. = joules / coulombs
= 24 / 16
= 1.5 V

Electricity 2

CORE questions

Core 1

Fig. 1 shows a battery, a switch and a bell connected so that the bell rings when the switch is pushed.

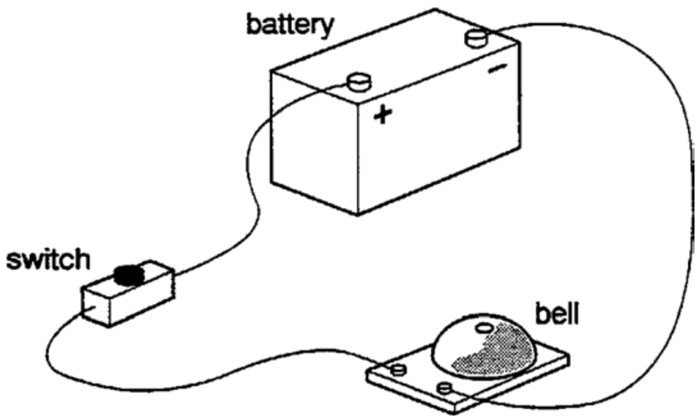


Fig. 1

(a) Draw the circuit diagram for this arrangement. Use standard circuit symbols.

[3]

(b) A second bell is now connected in parallel with the first bell.

(i) Copy your circuit diagram from **(a)** and add the second bell.

(ii) Why will the battery run out more quickly when the switch has been pushed?

....

.... [2]

Core 2

(a) (i) Copper is an electrical conductor. What is meant by a *conductor*?

....

(ii) Ebonite, glass and polythene are electrical insulators. What is meant by an *insulator*?

....
[2]

(b) Polythene is easily given a negative charge by rubbing it with a dry woollen cloth.

(i) Fig. 2 shows a charged polythene rod being held close to a suspended charged polythene rod.

Complete the phrase,

"like charges ....".

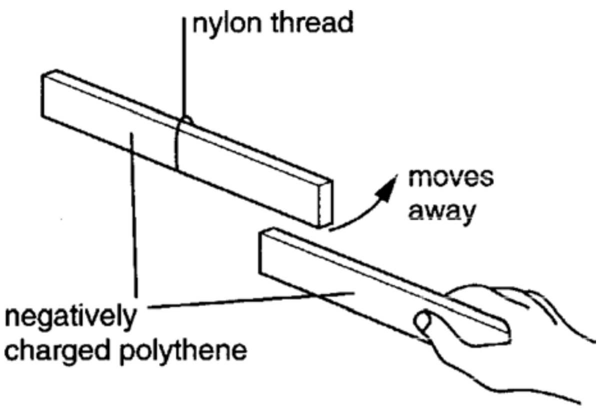


Fig. 2

(ii) Fig. 3 shows rod X being held near the suspended charged polythene rod.

Tick any of the following which might correctly describe rod X.

positively charged glass ☐

negatively charged ebonite ☐

uncharged copper ☐

negatively charged polythene ☐

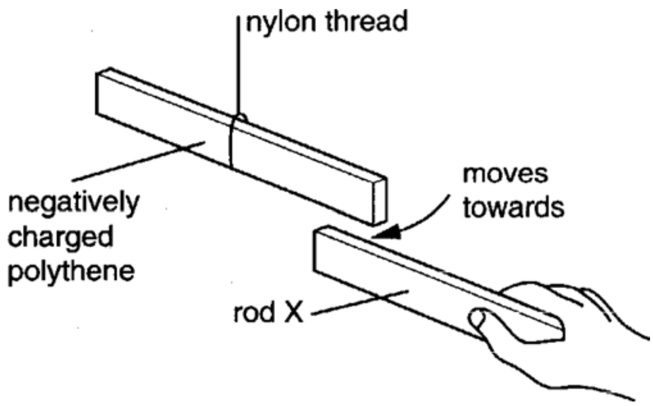


Fig. 3

[3]

Core 3

The circuit in Fig. 4 is connected up.

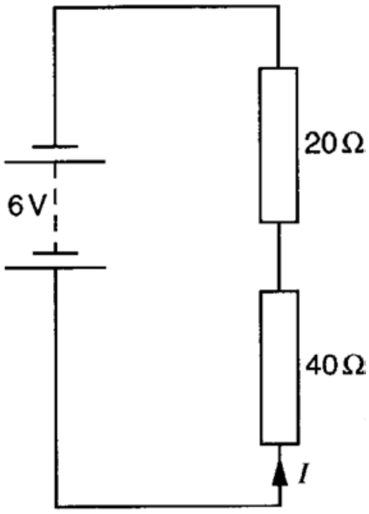


Fig. 4

(a) Calculate the combined resistance of the two resistors in Fig. 4

combined resistance = ... Ω [2]

(b) **(i)** State the relationship between resistance, p.d. and current by completing the following equation.

resistance = ______________________

(ii) Calculate the current, *I*, in Fig. 4 State the unit in your answer.

(c) Use your answer to **(b)(ii)** to calculate the p.d. across the 40 Ω resistor.
State the unit in your answer.

p.d. = ... [3]

(d) The circuit is now used as a potential divider, as shown in Fig. 5

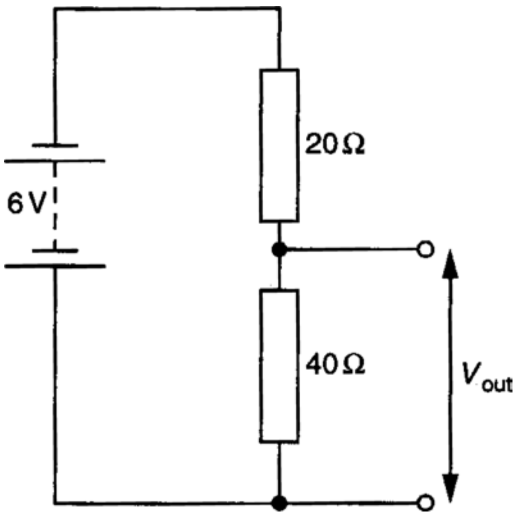


Fig. 5

Use your answer to **(c)** to state the value of V_{out} , the output voltage of the potential divider.

V_{out} = ... V [1]

EXTENSION questions

Extension 1

Fig. 6 shows an uncharged metal plate held in a wooden clamp and stand.

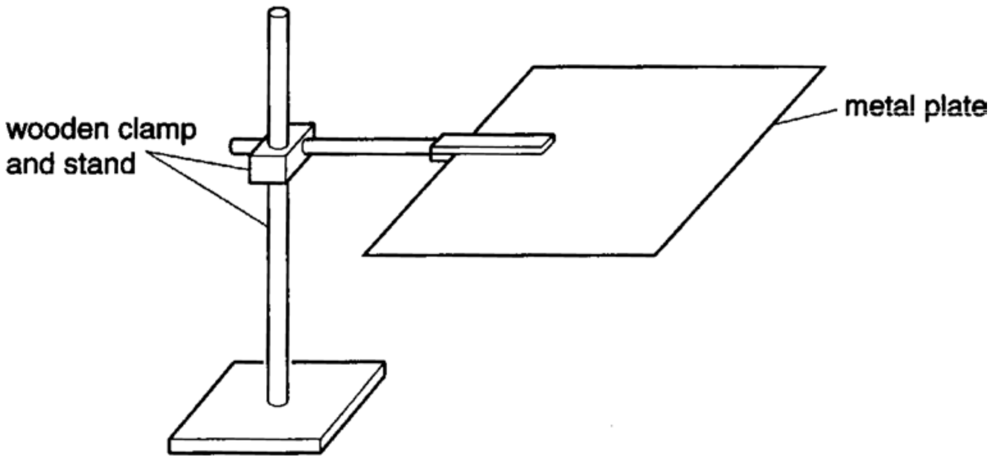


Fig. 6

(a) A polythene rod is charged negatively by rubbing it with a duster.

Suggest, in terms of the movement of electrons,

(i) how the polythene becomes negatively charged,

....

....

....

(ii) how the metal plate can be positively charged without the polythene touching the plate.

....

....

....

....[4]

(b) A strong α-particle emitting source is brought close to, but not touching, the positively charged metal plate.

Explain why the plate rapidly loses its charge.

....

....

....

....[2]

Extension 2

Fig. 7 is a block diagram of an electrical generating and distribution system.

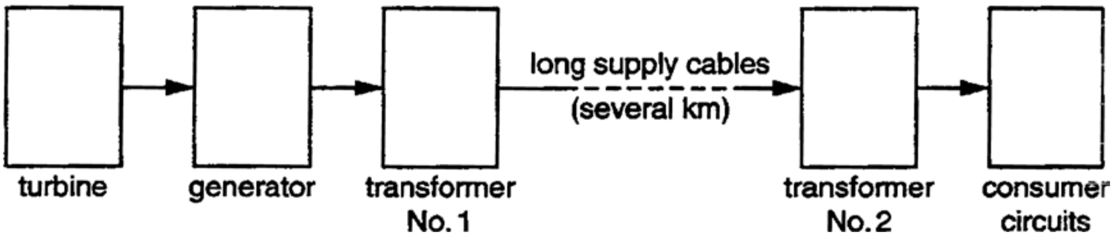


Fig. 7

(a) The generator produces an e.m.f. by a process called electromagnetic induction.

(i) Name two factors and state how they are changed in order to increase the output e.m.f. of the generator.

1. ....

....

2. ....

....

(ii) Explain what is meant by the statement 'the induced e.m.f. acts in such a direction as to produce effects to oppose the change causing it'.

....

....

....

....

[6]

Extension 2

(b) **(i)** Fig. 8 shows the basic parts of transformer No. 1 which is 100% efficient.

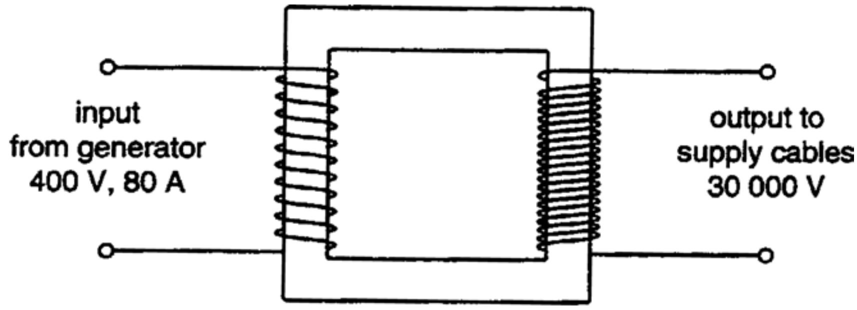


Fig. 8

Using the information on Fig. 8 calculate the current in the supply cables.

current = ...

(ii) Describe the function of transformer No. 2.

....

....

(iii) Explain why the use of the two transformers results in a big reduction in power loss in the supply cables

....

....

....

Extension 2

(c) Fig. 9 shows one of the consumer circuits with three electrical appliances R, S and T, connected into the circuit.

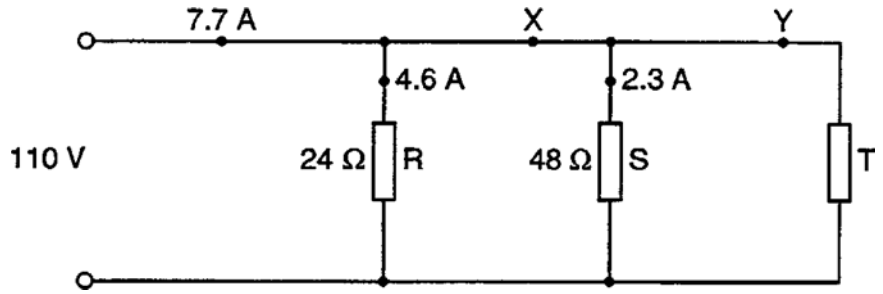


Fig. 9

Using the current, voltage and resistance values shown on Fig. 9, calculate

(i) the current at point X and at point Y,

current at X = ...

current at Y = ...

(ii) the resistance of appliance T,

resistance = ...

(iii) the combined resistance of appliances R and S,

resistance = ...

(iv) the power developed in appliance R,

power= ....

(v) the energy converted by the appliances in 2 minutes (120 s).

energy converted = ...
[10]

Electricity 2 – answers

Core 1

(a) a series circuit using symbols
correct symbols for switch and cell
correct symbol for battery (group of cells)

(b) **(i)** second bell in parallel with the first (any recognisable symbol may be used)

(ii) more current / amps / energy / charge / electricity from the battery

Core 2

(a) **(i)** passes a current / charge / electricity
some electrons are free to move about

(ii) does not pass a current or does not conduct electricity or all charge / electrons fixed or bad conductor

(b) **(i)** repel or move away

(ii) first and third boxes ticked

Core 3

(a) $R = R_1 + R_2$
$= 60\,\Omega$

(b) **(i)** P .D. / current or voltage / current or volts / amps or V / I or 6 / I

(ii) current = 6 / 60
= 0.1 A / amps

(c) $0.1 \times 40 = 4$ V / volts

(d) 4 V

Extension 1

(a) **(i)** electrons move from the duster to the rod

(ii) hold the rod close to the plate
touch the plate to earth it
remove the rod leaving the plate positively charged

(b) alpha particles ionise the air
electrons are conducted by the ionised air to the plate

Extension 2

(a) **(i)** any two from

speed of rotation of the coil / magnet	faster
number of turns of the coil on the generator	greater
strength of the magnet / magnetic field	stronger

(ii) induced e.m.f. / current produced by a conductor cutting a magnetic field
induced e.m.f. / current also interacts with the magnetic field
this produces a force which slows the moving conductor

(b) **(i)** power input = power output
$400 \times 80 = 30\,000 \times I$
$I = 1.1$ A

(ii) to reduce the voltage

(iii) current in the cables is much reduced
because the voltage is increased
heat = I^2Rt or power = I^2R or the heat in the cables is less

(c) **(i)** current at X = 3.1 A
current at Y = 0.8 A

(ii) resistance of T = 110 / 0.8
= 138 Ω

(iii) $\frac{1}{R} = \frac{1}{24} + \frac{1}{48}$
R = 16 Ω

(iv) power = 110×4.6 or $4.6^2 \times 24$
= 506 W

(v) energy converted = I^2RI or VIt
= 30 000 J

Thermal physics

CORE questions

Core 1

(a) Complete the following sentence.

"The temperature of a body rises when the .... energy of its molecules is increased." [1]

(b) Fig. 1 gives details about an empty beaker and the same beaker with different substances in it.

	empty beaker	beaker + water	beaker + sand
mass	250 g	500 g	500 g
energy needed to raise temperature by 1°C	125 J	1175 J	325 J

Fig. 1

(i) Which of the arrangements has the highest thermal capacity?

....

(ii) 1. What is the mass of the water? .... g

2. What is the mass of the sand? .... g

3. How much energy is needed to raise the temperature of the water by 1 °C?

.... J

4. How much energy is needed to raise the temperature of the sand by 1 °C?

.... J

5. Use your answers above to suggest why, on a sunny day, the temperature of the sand on a beach rises faster than the temperature of the sea.

....

....

....[6]

Core 2

(a) Some students are asked to write down what they know about evaporation of a liquid. Here are their statements, some of which are correct and some incorrect.

Put a tick alongside those statements which are correct.

A "Evaporation occurs at any temperature." ☐

B "Evaporation only occurs at the boiling point." ☐

C "Evaporation occurs where the liquid touches the bottom of the container." ☐

D "Evaporation occurs at the surface of the liquid." ☐

E "It is the higher energy molecules which escape" ☐

F "The molecules gain energy as they escape." ☐

G "The liquid temperature **always** rises when evaporation occurs." ☐

H "Rapid evaporation produces cooling." ☐

[4]

(b) Sometimes after shaving, men splash a liquid, called an aftershave, over their faces. This makes their faces feel fresher as the aftershave evaporates.

(i) Which of the statements in part **(a)** explains why the aftershave, even though it is at room temperature, cools the skin.

statement ....

(ii) Suggest why the aftershave cools the skin better than water at room temperature.

....

....
[2]

Core 3

Some smoke is mixed with the air in a glass box. The box is lit brightly from the side and its contents studied from above through a microscope.

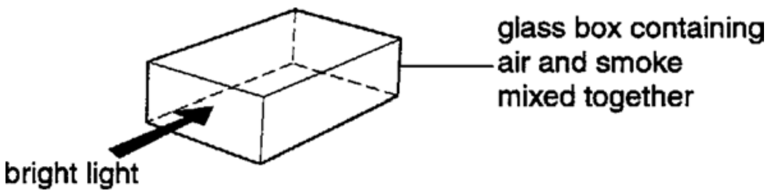


Fig. 2

(a) Bright specks are seen moving in continuous and jerky random movement.

(i) What are the bright specks? Tick **one** box.

air molecules ☐

smoke molecules ☐

smoke particles ☐

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ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

The apparatus shown in Fig. 3 is used in a heat experiment.

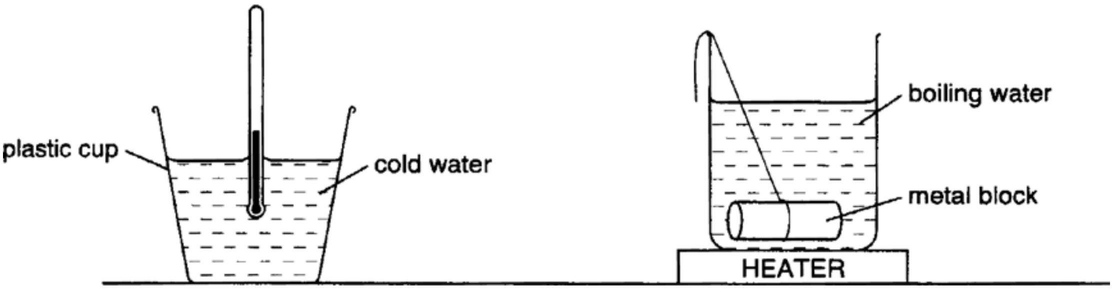

Fig. 3

A piece of metal at the boiling temperature of water is transferred to a mass of cold water. Initially, the cold water is at a temperature of T_C. The hot metal raises the temperature of this water to T_H. The rise in temperature, θ, is determined from the relation $\theta = T_H - T_C$. The experiment is repeated so as to obtain five sets of readings for different masses of cold water.

(a) Draw up a table, for use in your laboratory notebook, in which you can record

m, the mass of cold water used,

T_C, the temperature of the cold water,

T_H, the maximum temperature reached by the cold water,

θ, the rise in temperature of the cold water.

[3]

(b) Fig. 4 on page 6 is a graph showing how θ varies with *m*, the mass of cold water used.

(i) Why has a smooth line been drawn through the points?

....

....

....

Alternative to Practical 1

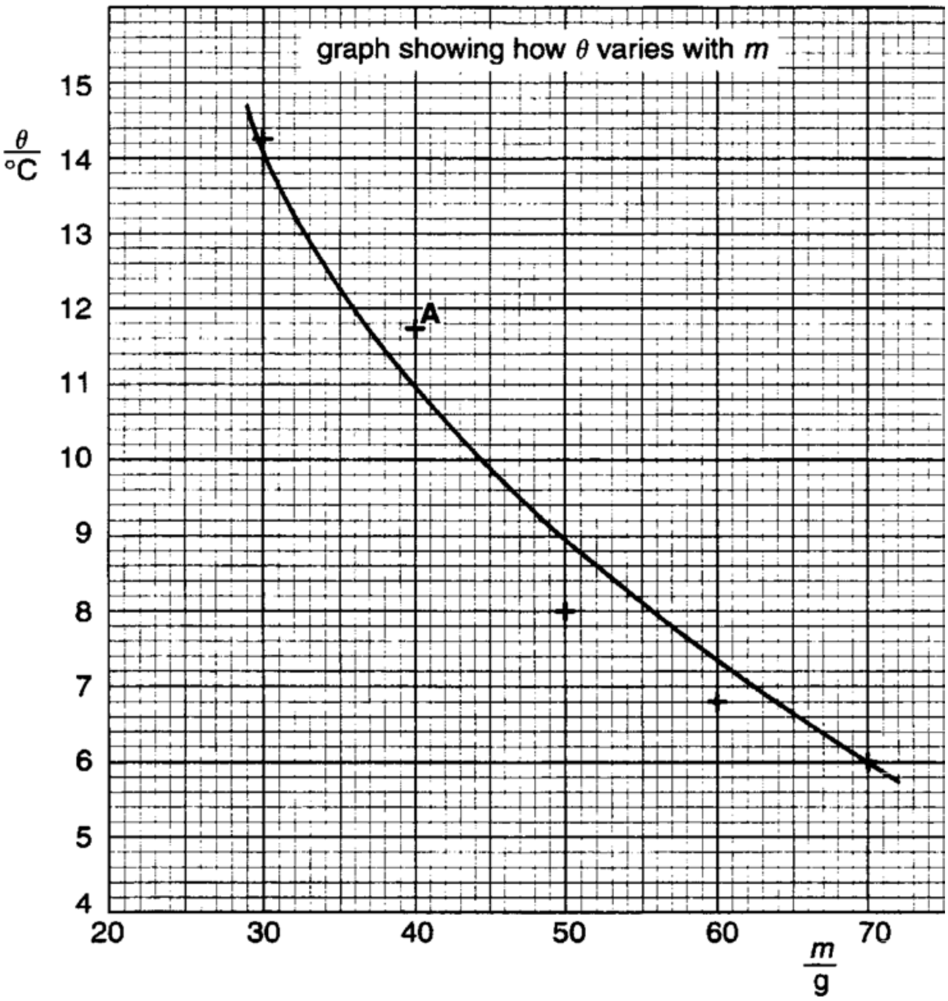

Fig. 4

(ii) The graph point that is labelled A does not lie on the graph line. (You can assume that the graph line is correctly drawn.) Complete the following statements about the value of θ and of m at the point A.

1. If the value of θ were .... °C smaller, the point A would lie on the line.

2. If the value of m were .... g smaller, the point A would lie on the line.

(iii) In **(ii)** above which is the most likely reason, 1 or 2, for the point A not being on the line? Give a reason for your choice.

choice: Tick **one** box.

☐ 1.

☐ 2.

reason:

....

....[4]

EXTENSION questions

Extension 1

Fig. 5 shows a student's design for a thermometer. The student stated that the material labelled M could be a copper rod, alcohol or nitrogen gas.

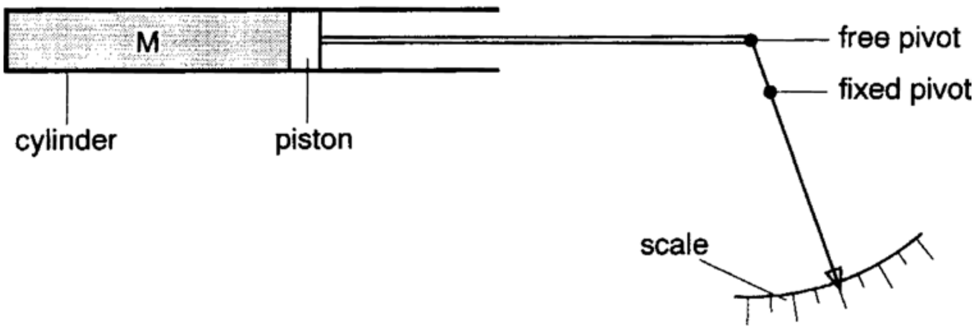

Fig. 5

(a) Explain what is meant by the term *sensitivity of the thermometer*.

....

....[1]

(b) **(i)** State which of the three suggested materials would give a thermometer of greatest sensitivity.

....

(ii) Explain your answer.

....

....

[2]

(c) **(i)** State which of the three materials would allow the thermometer to measure the largest range of temperature.

....

(ii) Explain your answer.

....

....

[2]

(d) The student found that the temperature scale of this thermometer was *non-linear*. Explain what this means.

....

....[2]

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Fig. 6 shows a sealed box containing only dry air. At a particular instant, one of the air molecules in the box is situated at P and it is moving towards face ABCD along the direction shown by the arrow.

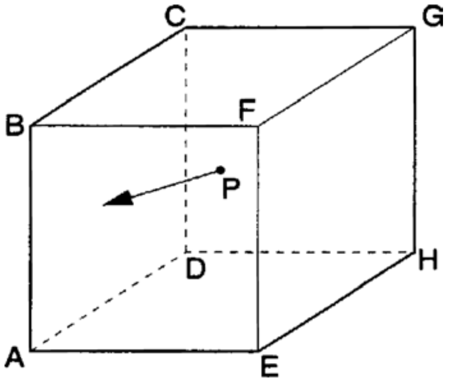

Fig. 6

(a) Describe and explain a possible path of the molecule within the box.

....

....

....

....

....[2]

(b) Explain how this molecule

(i) helps to cause a pressure on the side ABCD,

....

....

....

(ii) helps to cause an equal pressure on all the sides.

....

....

....[2]

Extension 2

(c) The box is squashed but no air leaks out. By calculation, complete the table below.

	volume of box / m^3	pressure / Pa	temperature / °C
before squashing	0.09	1.0×10^5	20
after squashing	0.04		20

[2]

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In an experiment to find the specific latent heat of fusion of ice, an electric heater, of power 200 W, is used.

The following readings are taken.

mass of ice at 0 °C, before heating started, 0.54 kg
mass of ice at 0 °C, after 300 s of heating, 0.36 kg

(a) Calculate a value of the specific latent heat of fusion of ice.

specific latent heat of fusion of ice = ... [4]

(b) Explain, in molecular terms, how heat is transferred from the surface of a block of ice to its centre.

....

....

....

....

....[2]

Thermal physics – answers

Core 1

(a) internal / thermal / kinetic / heat / motion / movement

b **(i)** the beaker and water

(ii) 1 250 g

2 250 g

3 1050 J

4 200 J

5 sand requires less energy to raise its temperature

or the temperature of sand rises more for the same energy input
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or water has a bigger specific heat capacity

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(a) correct answers A D E H

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(a) **(i)** correct answer smoke particles

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Alternative to Practical 1

(a) a suitable table showing units for both mass and temperature

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(a) specific latent heat of fusion of ice = heat supplied / mass melted
= 60 000 / 0.18 J / kg
= 330 000 J / kg

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molecules vibrate
pass energy from molecule to molecule
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Mechanics 2

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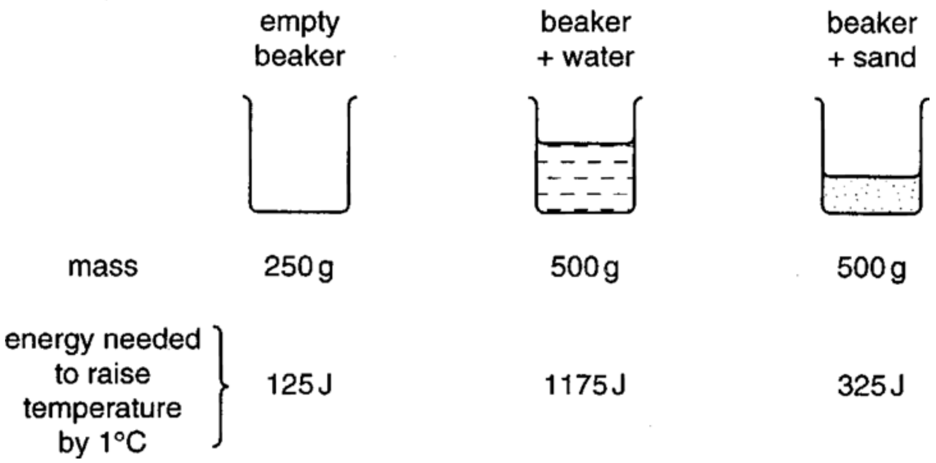

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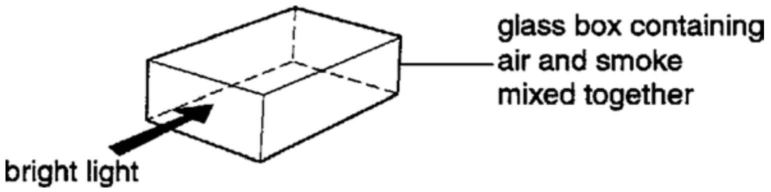

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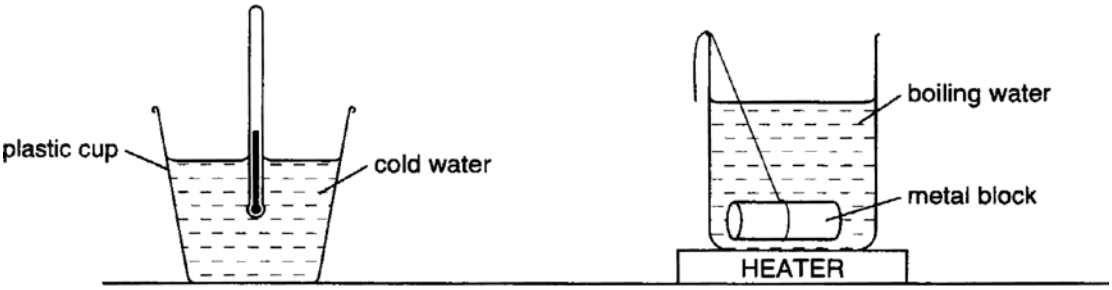

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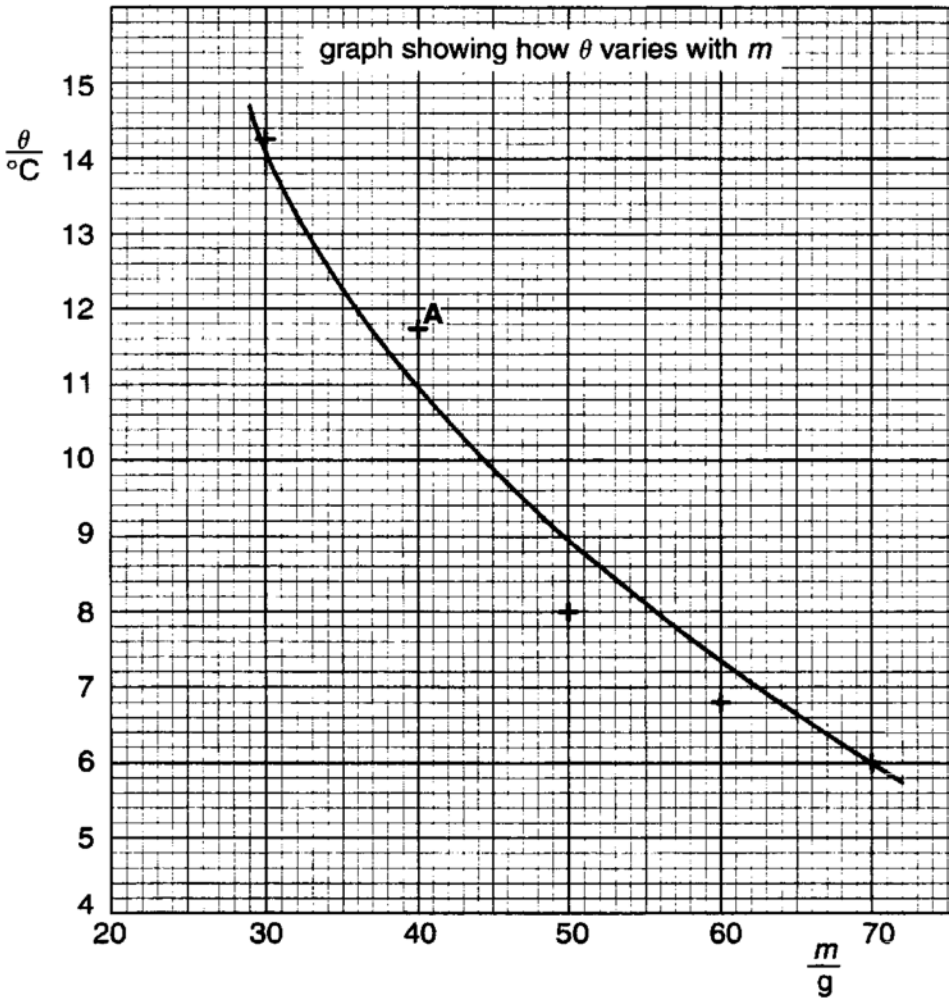

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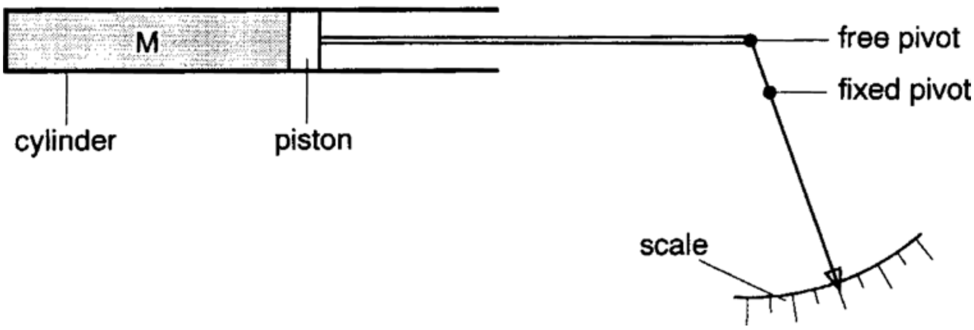

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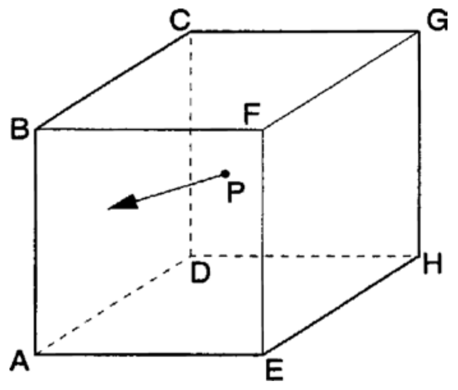

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= 60 000 / 0.18 J / kg
= 330 000 J / kg

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molecules vibrate
pass energy from molecule to molecule
process is conduction

Waves

CORE questions

Core 1

A man is watching a thunderstorm which is directly over a village. Some distance behind the village is a mountain.

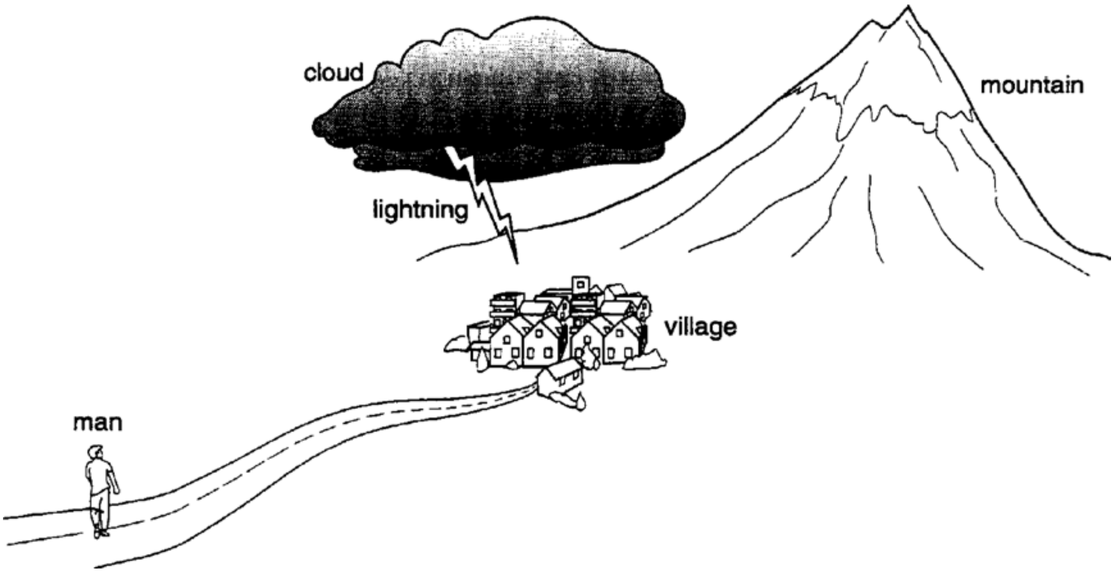


Fig. 1

(a) Thunder is created at the same time as the lightning flash but, after the man sees a lightning flash, he has to wait a short time before he hears the thunder.

Why is there this delay?

....

....

....

....[2]

(b) When he listens carefully, the man realises that, for each lightning flash, he can hear a loud sound of thunder followed by a quieter one.

(i) After studying Fig. 1, explain why he hears two sounds for each lightning flash.

....

....

(ii) Suggest why the second sound is quieter .

....

....[2]

Core 1

(c) The man measures the time between seeing a flash of lightning over the village, and hearing the first sound of thunder. The time is 4 s.

The speed of sound in air is 330 m / s.

How far away is the village?

ANSWER: .... m [3]

Core2

Here is a list of different types of waves.

gamma (γ)
infra-red
radio
sound
ultra-violet
visible
X-rays

(a) Which one of these is the only one which is **not** part of the electromagnetic spectrum?

....[1]

(b) Which one of these makes us feel warm when the Sun shines?

....[1]

(c) Which one of these do doctors use to detect broken bones?

....[1]

(d) **(i)**

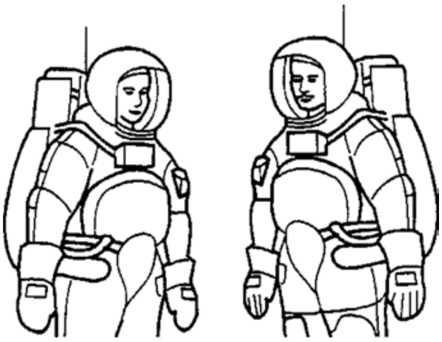


Fig. 2

On the moon, two astronauts cannot hear each other, even when they shout, unless they have their radios switched on.

1. Why cannot they hear each other even when they shout?

....

....

2. Why can they hear each other using their radios?

....

....

(ii) Which type of wave is used to carry messages from the astronauts to mission control on Earth?

....[4]

Core 3

(a) Fig. 3 shows a view from above of a person standing at the edge of a pond, dipping the end of a stick up and down in the water.
Some of the wavefronts that spread out are shown.

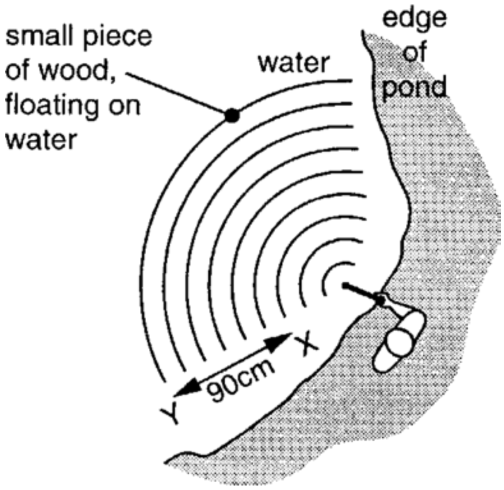


Fig. 3

(i) How many wavelengths are there between X and Y? ....[1]

(ii) The distance from X to Y is 90 cm. Calculate the wavelength of the waves.

wavelength = ... cm [2]

(iii) The speed of the waves is affected by the depth of the water.

1. Describe the shape of the wavefronts, as seen from above.

   ....

2. What does the shape of the wavefronts tell you about the depth of the pond?

   Give a reason for your answer.

   ....

   ....
   [3]

Core 3

(iv) Fig. 4 shows a sideways view of the water surface just before the first wave reaches the floating piece of wood.

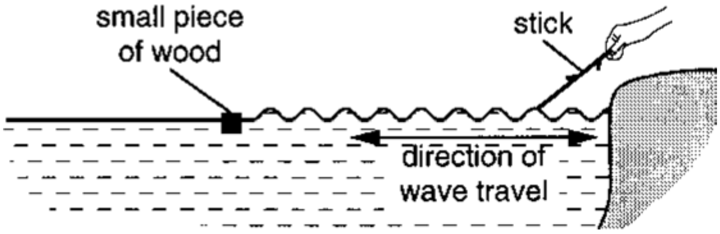


Fig. 4

Describe how the piece of wood moves after the waves reach it.
You may draw on Fig. 4 if it helps you to answer the question.

....

....[2]

(b) An underwater loudspeaker, placed in the pond in part **(a)**, sends out sound waves through the water, as shown in Fig. 5.

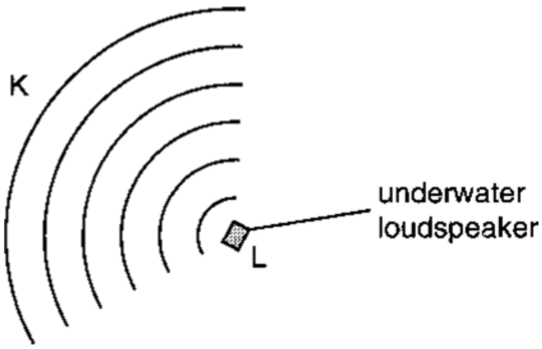


Fig. 5

(i) What is the difference between the nature of these sound waves and the water waves in (a)? Write the appropriate words in the gaps in the following sentences.

"Water waves are .... waves."

"Sound waves are .... waves." [2]

(ii) Fig. 6 shows a sideways view along the line KL.

Fig. 6

The dot labelled M represents a water molecule on the line KL.
Describe how the molecule moves when the loudspeaker is working.
You may draw on Fig. 6 if it helps you to answer the question.

....

....[2]

EXTENSION questions

Extension 1

(a) A sound wave in air is made up of compressions and rarefactions.

(i) State what is meant by a *compression*.

....

(ii) State what is meant by a *rarefaction*.

....
2]

(b) The distance between two consecutive rarefactions in a sound wave is 2.5 m. The speed of sound in air is 330 m / s.

Calculate the frequency of this sound wave.

frequency = ... [2]

(c) A person makes a loud sound and hears the echo of this sound 1.2 s later.

Calculate how far the person is from the object causing the echo. Assume that the speed of sound is 330 m / s.

distance =... [2]

Extension 2

Fig. 7 shows water wavefronts which are approaching a small gap in a wall which divides two stretches of water of the same depth. The diagram is drawn to scale.

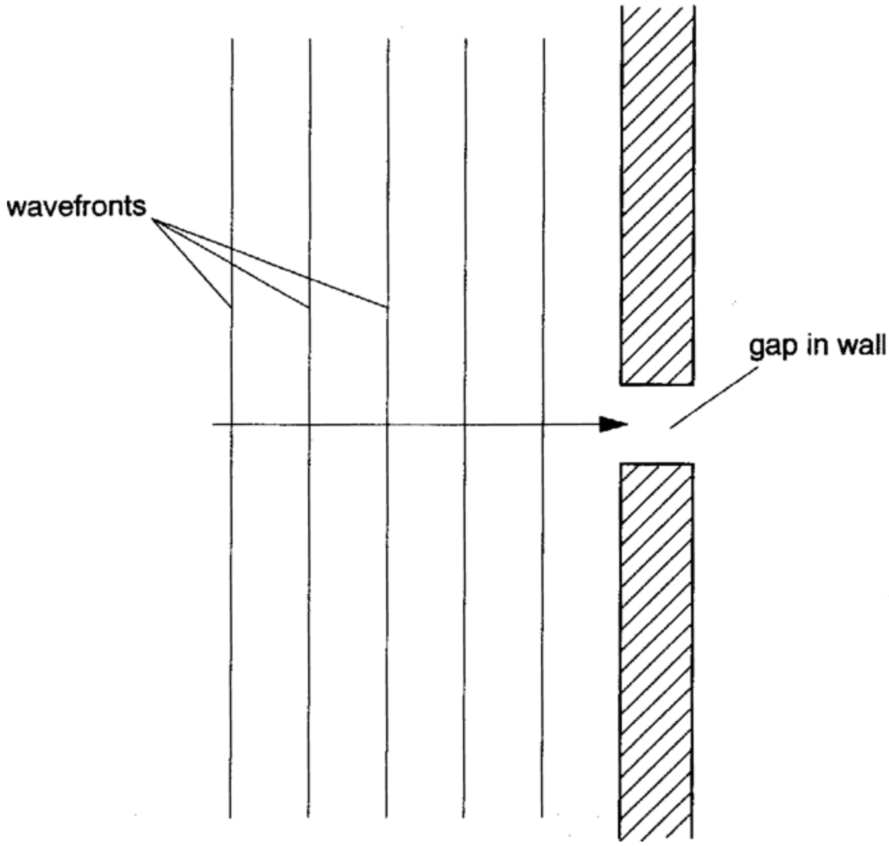


Fig. 7

(a) The waves moving towards the wall have a wavelength of 1.6 m and a frequency of 0.80 Hz.

Calculate the speed of these water waves.

speed of waves = ... [2]

(b) State the wavelength and frequency of the waves after they have passed through the gap in the wall.

wavelength = ...

frequency = ... [2]

(c) On Fig. 7, complete the pattern of wavefronts to the right of the wall. [3]

Waves – answers

Core 1

(a) light travels faster than sound
much faster / very fast so that it appears to arrive instantaneously

(b) **(i)** because of the echo

(ii) the absorption of sound / dispersion / diffraction

(c) speed = distance / time
distance = speed × time
= 330 × 4
= 1320 m

Core 2

(a) sound

(b) infra-red

(c) X-rays

(d) **(i)** 1 there is no air on the moon so air can not travel

2 radio waves do not need a medium to travel

(ii) radio / micro waves

Core 3

(a) **(i)** 6

(ii) wavelength = 90 / 6
= 15 cm

(iii) 1 arcs of circles

2 the pond has a constant depth
because it travels at the same speed in all directions

(ii) the motion may be described as up and down or in circles

(b) **(i)** transverse
longitudinal

(ii) the motion should be described as backwards and forwards / back and forth

Extension 1

(a) **(i)** a place of higher pressure / air molecules closer together

(ii) a place of lower pressure / air molecules further apart

(b) wavelength = 2.5 m speed = 330 m / s
frequency = 330 / 2.5
= 130 Hz

(c) distance travelled in 1.2 s = 330 × 1.2 = 396 m
distance to object = 396 / 2 = 198 m

Extension 2

(a) velocity = frequency × wavelength
= 0.8 × 1.6
= 1.3 m / s

(b) **(i)** 1.6 m / the same

(ii) 0.8 Hz / the same

(c) the diagram should show part circles (not semi-circles) centred on the middle of the gap

Atomic physics

CORE questions

Core 1

State one safety reason why

(a) radioactive sources should not be touched with bare hands,

....[1]

(b) radioactive sources emitting γ-rays should be stored in lead boxes with thick sides,

....[1]

(c) the radiation symbol should be displayed on the cupboard or drawer in which radioactive materials are kept.

....[1]

Core 2

(a) One nuclide is written as $^{210}_{84}Po$.

(i) Which figure is the proton number (atomic number)? ....

(ii) Which figure is the nucleon number (mass number)? ....

(iii) Which figure gives the number of protons in the nucleus? ....

(iv) How can you find the number of neutrons in the nucleus?

....
[4]

(b) An α-particle can be written as $^{4}_{2}\alpha$.

Polonium $^{210}_{84}Po$ decays into lead (Pb) by emitting an α-particle.

Complete the nuclear equation below, by writing the correct numbers in the boxes.

$$^{210}_{84}Po \rightarrow ^{\square}_{\square}Pb + ^{4}_{2}\alpha$$

[2]

Core 3

This question deals with the decay of a radioactive source.
The radioactive source has a count rate of 640 counts / minute at the start of an experiment.
This value has been plotted on Fig. 1

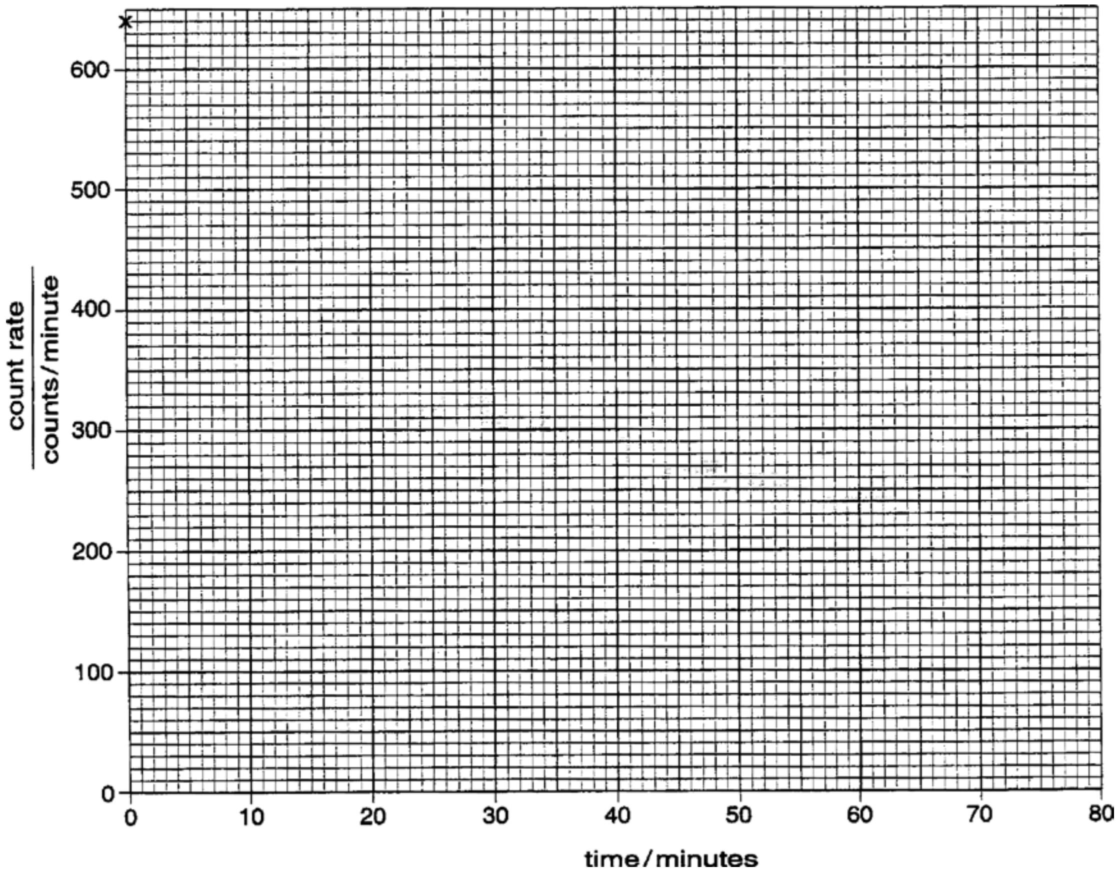


Fig. 1

The source has a half-life of 20 minutes.

(a) **(i)** What would you expect the count rate to be after 20 minutes?

.... counts / minute

(ii) Plot this value on the graph. [2]

(b) **(i)** What would you expect the count rate to be after a further 20 minutes (i.e. 40 minutes after the start of the experiment)?

.... counts / minute

(ii) Plot this value on the graph. [2]

(c) Plot two further points which might be expected if the decay curve were perfect. [1]

(d) Draw a smooth curve through all five points on your graph. [1]

Core 3

(e) If this perfect decay continued, how long would it take from the beginning of the experiment for the count rate to decrease to zero?

Tick **one** answer.

90 minutes ☐

100 minutes ☐

120 minutes ☐

a very long time ☐

an infinite time ☐ [1]

(f) In a real experiment, the values found for the count rates might not all lie exactly on a smooth curve. One reason for this might be experimental error. State one other reason.

....[1]

EXTENSION questions

Extension 1

(a) A radioactive source contains an isotope of thorium.

Thorium ($^{228}_{90}\text{Th}$) decays by α-particle emission to radium (Ra).

Write an equation to show this decay.

[2]

(b) The radium produced is also radioactive. Fig. 2 shows a laboratory experiment to test for the presence of the radioactive emissions from the thorium source, using a radiation detector.

In the laboratory there is a background count of 20 counts / minute.

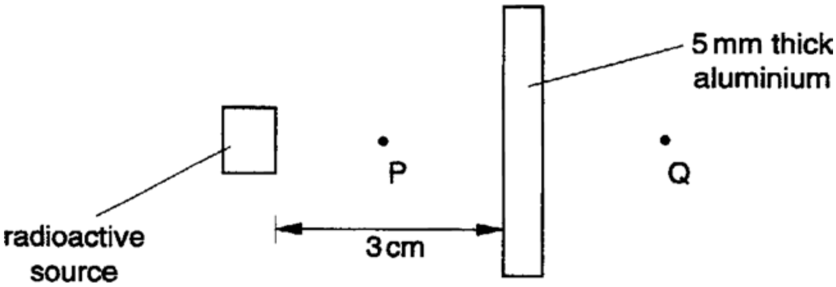


Fig. 2

The readings are given in the table.

position	reading in counts / minute
P	2372
Q	361

State and explain

(i) which radiation could be causing the count at a,

....

....

....

(ii) which radiations could be causing the count at P.

....

....

....

[4]

Extension 1

(c) All three types of radioactive emission cause some ionisation of gases.

(i) Explain what is meant by the term *ionisation of gases.*

....

....

....

(ii) Suggest a reason why γ-radiation produces very little ionisation.

....

....

....

[3]

Extension 2

(a) A nuclide, symbol $^{A}_{Z}X$, decays by β-particle emission to a nuclide, symbol Y.

A β-particle has the symbol $^{0}_{-1}e$.

Write an equation for this decay.

[2]

(b) Fig. 3 shows how a β-particle source may be used to measure the thickness of paper as it is being produced.

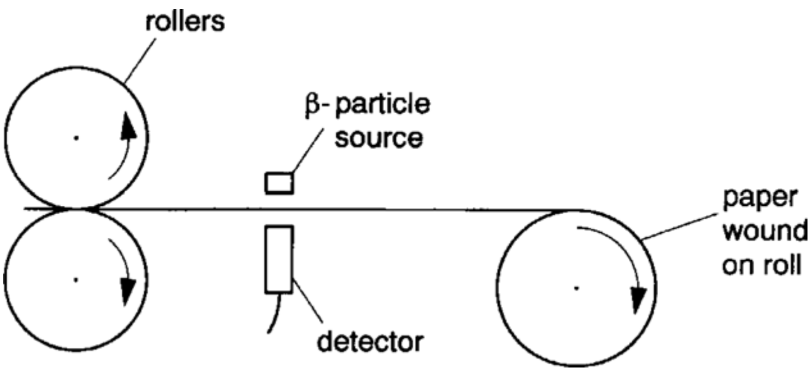


Fig. 3

(i) Explain why the reading of the detector changes with the thickness of the paper.

....

....

....

(ii) Write down two reasons why β-particles are more useful than γ-rays for this purpose.

reason 1. ....

....

....

reason 2. ....

....

....[4]

Extension 2

(c) Fig. 4 shows a beam of β-particles entering a magnetic field, the direction of which is into the paper.

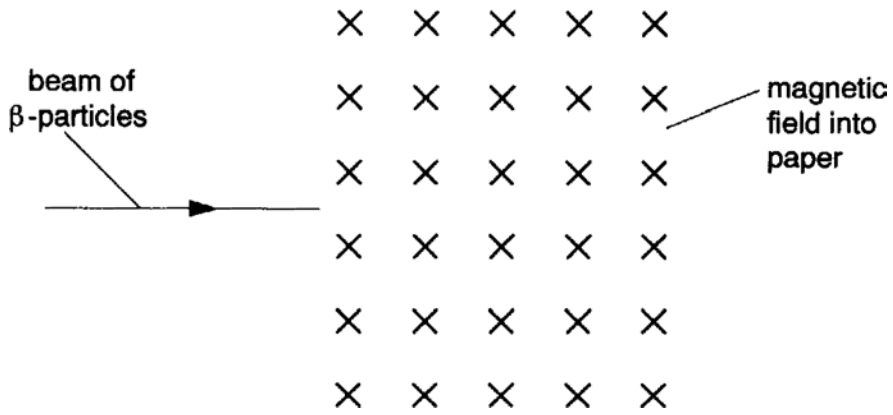


Fig. 4

On Fig. 4 continue the path of the beam of β-particles as they pass through the magnetic field [2]

Extension 3

Lengths of steel may be joined by welding them together, as illustrated in Fig. 5

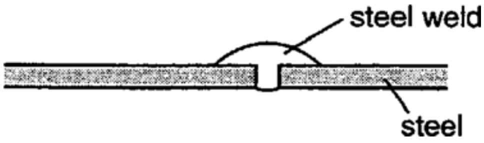


Fig. 5

A liquid radioactive source is to be used to test that the welds joining lengths of steel pipe are of equal thickness.

The diameter of the pipes is 120 mm and the pipe wall thickness is 5 mm.

The liquid runs through the pipes whilst a suitable detector moves around the outside of the joints.

(a) With the aid of a labelled diagram, explain how this method detects places where the welds are thinner than 5 mm.

....

....

....

....[3]

Extension 3

(b) In order to find out the most suitable type of isotope for this purpose, tests were carried out on the ability of the radiations from an α-emitter, a β-emitter and a γ-emitter to penetrate steel.

(i) Write down what you would expect to be the results of these tests.

α-emitter ....

....

β-emitter ....

....

γ-emitter ....

....

(ii) State and explain which type of emitter would be most useful for testing these welds

....

....

....
[4]

(c) Describe three precautions which should be taken to ensure the safety of the operator who is making these tests.

1. ....

....

2. ....

....

3. ....

....
[3]

Atomic physics – answers

Core 1

(a) to avoid contamination

(b) to prevent radiation getting out

(c) to warn of the presence of radioactive material

Core 2

(a) **(i)** 84 or bottom one

(ii) 210 or top one

(iii) 84 or bottom one

(iv) 210 – 84 or take bottom from top or take proton number from nucleon number

(b) 206
82

Core 3

(a) **(i)** 320

(ii) plot must be to within ± ½ small square

(b) **(i)** 160

(iii) plot must be to within ± ½ small square

(c) points plotted at (60, 80) and (80, 40) ± ½ small square

(d) smooth curve through points by eye

(e) either of last two boxes ticked

(f) randomness or background

Extension 1

(a) $^{228}_{90}\text{Th} \rightarrow {}^{4}_{2}\text{He} + {}^{224}_{88}\text{Ra}$

(b) **(i)** must be γ because α and β are absorbed by aluminium

(ii) α or β or γ

(c) **(i)** atoms of gas gain or lose electrons by colliding with particles

(ii) any three from
they are photons not particles
they have no mass
they have no charge
they do not have enough energy

Extension 2

(a) $^{A}_{Z}X \rightarrow \, ^{0}_{-1}e + \, ^{A}_{Z+1}Y$

(b) **(i)** some beta absorbed by paper
thicker paper, less pass through / lower reading

(ii) no gamma would be absorbed by the paper
gamma are less safe

(c) diagram should show a smooth curve
towards the bottom of the page

Extension 3

(a) the diagram should show the radioactive liquid on pipe, weld and detector in correct places
where the weld is thin the reading rises
radiation passes more easily through / is less absorbed by thinner metal

(b) **(i)** alpha – none passes through steel
beta – some passes through steel
gamma – most / all passes through steel

(ii) either beta or gamma with a clear reason (alpha absorbed completely)

(c) general shielding / absorbing
distance
monitoring radiation received

Electronics

CORE questions

Core 1

The circuit for adjusting the brightness of the lamp in the display panel of a car is shown in Fig.10.1.

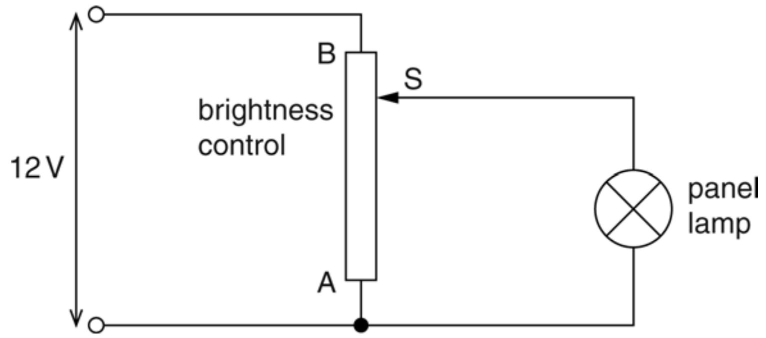


Fig. 10.1

The brightness control is uniformly wound with resistance wire and has a sliding contact S.

(a) State the name of the component used as the brightness control.

....[1]

(b) State the potential difference across the panel lamp when

(i) S is at end A, ... V

(ii) S is at end B. V

[2]

(c) Describe what happens to the brightness of the lamp as S is moved **from A to B**.

....

....[2]

[Total: 5]

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

(a) The circuit symbol for a diode is shown in Fig. 3. The diode conducts when the polarity is as shown.

Fig. 3

Draw a circuit diagram showing the following components, all connected in series:
a d.c. power supply, labelled to show its polarity,
a fixed resistor,
a diode,
a switch.

On your circuit diagram, the switch should be shown open and the diode should be able to conduct when the switch is closed.

[3]

(b) **(i)** Redraw your circuit diagram, adding an ammeter to measure the current in the diode. Label the polarity of the ammeter terminals.

(ii) Is there any other position in the circuit where you could put the ammeter to measure the current through the diode? Tick one box.

yes	
no	

Give one reason to support your answer.

....

....

....
[3]

Alternative to Practical 1

(c) **(i)** Assuming that the fixed resistor has a resistance of 100 Ω and that the potential difference of the power supply is 3.0 V, calculate the maximum current I_{max} in the circuit

I_{max} = ...

(ii) In order to calculate the value for I_{max} in **(i)** above, what assumption did you make about the resistance of the circuit?

....

....
[2]

EXTENSION questions

Extension 1

(a) Fig. 4 shows a beam of electrons about to enter the region between two charged metal plates.

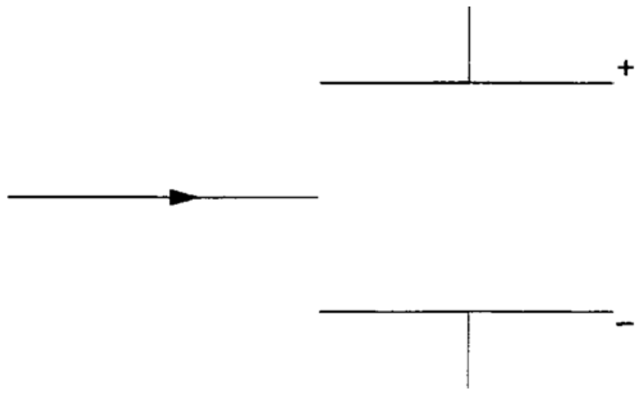


Fig. 4

On Fig. 9.1 continue the path of the electron beam between the plates

(i) for plates with a very small charge (label this path **P**),

(ii) for plates with the opposite charges to those shown on Fig. 4 (label this path **R**).

[3]

(b) Fig. 5 shows another arrangement, similar to the first, but in this case the electron beam continues in a straight line because a magnet (which is not shown) has been placed near the plates.

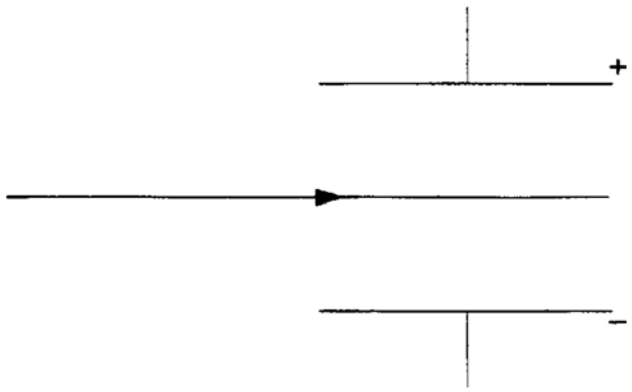


Fig. 5

Explain where you would place the N-pole of the magnet in order to achieve this effect. You may draw on the diagram if you feel that it will make your answer clearer.

....

....

....

....[3]

Extension 2

Fig. 6 shows part of a cathode-ray tube.
An electron beam PQ is entering the region between two horizontal, charged metal plates.

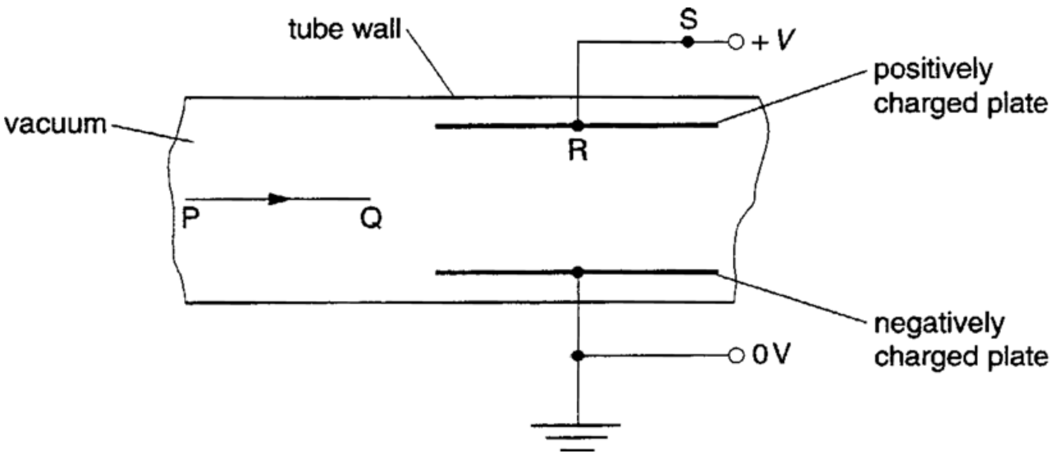


Fig. 6

(a) **(i)** On Fig. 6, draw the electron beam from Q to show its path between the charged plates.

(ii) Explain any change of direction of the electron beam when it is between the charged plates.

....

....

....

(iii) On Fig. 6, show the direction of the conventional current in the electron beam by drawing an arrow and labelling it D.

[5]

(b) The voltage across the plates is increased so that one of the plates collects 10^{14} electrons in 10 s. Each electron carries a charge of 1.6×10^{-19} C.

(i) Calculate the total charge collected by the plate in 1 0 s.

charge= ....

(ii) State an equation linking charge and current. Hence calculate the current in wire RS.

....

current= ....

[4]

Extension 2

(c) Air containing charged dust particles flows between two metal plates. A high potential difference is connected across the plates as illustrated in Fig. 7

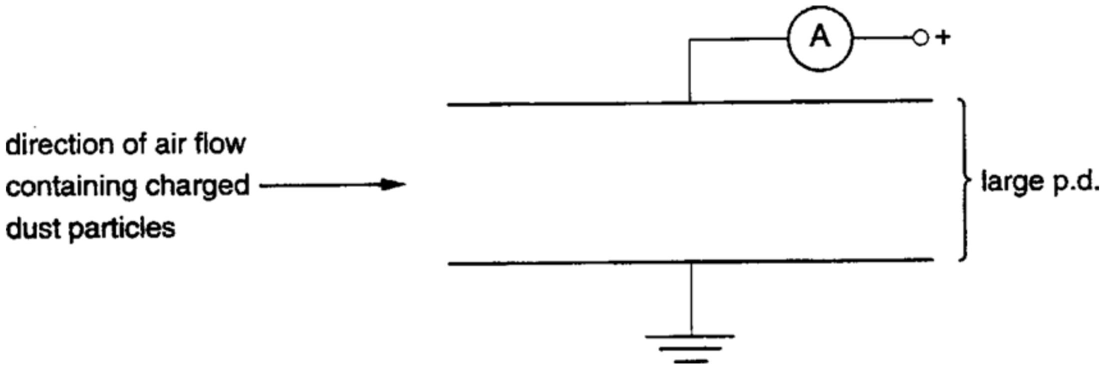


Fig. 7

The charged particles are attracted to the upper plate and move through a potential difference of 10 000 V. The ammeter records a current of 2.1×10^{-6} A.

Calculate

(i) the energy supplied by the voltage source in 10 minutes (600 s),

energy = ...

(ii) the power supplied.

power = ...
[6]

Extension 2

(d) Fig. 8 shows a beam of electrons entering the magnetic field of a coil. This magnetic field is directed into the paper.

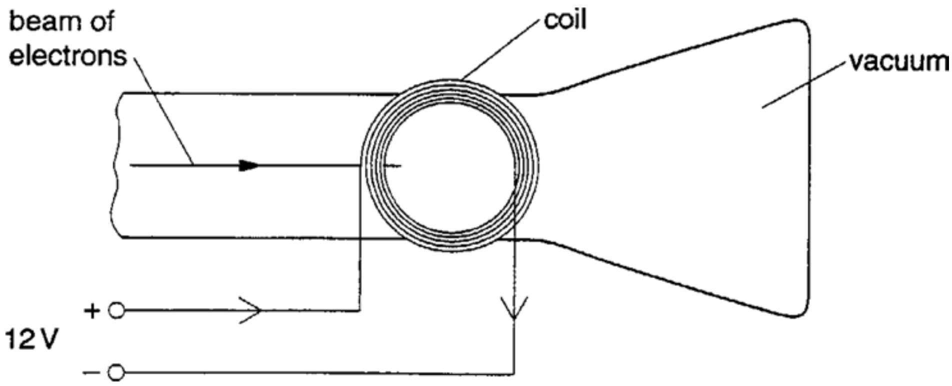


Fig. 8

(i) On Fig. 8, sketch the path of the electron beam until it hits the end of the tube. Explain your choice of path.

....

....

....

....

(ii) The resistance of the coil producing the magnetic field is 100 Ω. Calculate the current in the coil.

current= ....

(iii) State the effect on the electron deflection of increasing **and** reversing the potential difference connected across the coil.

....

....

[7]

Electronics – answers

Core 1

(a) rheostat / potential divider / variable resistor / potentiometer / dimmer

(b) **(i)** 0 (V) or zero or nothing

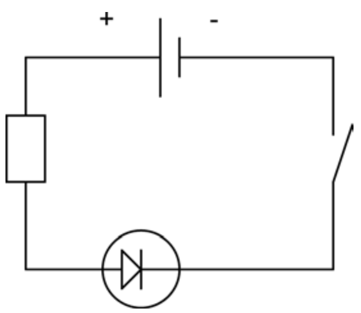
(ii) 12 (V)

(c) idea of increasing brightness as S moves from A to B
appropriate correct comment on resistance or voltage

Alternative to Practical 1

(a) four acceptable (textbook) symbols in series
power-supply polarity labelled and correct diode connection
open switch

e.g.



(b) **(i)** the ammeter should be placed anywhere in series with the other components and with its polarity compatible with the diode connections

(ii) Yes
the current is the same at every point in the circuit

(c) **(i)** I_{max} = 3 / 100 A or 30 mA

(ii) no other resistance in the circuit or 3 volt across 100 Ω or maximum resistance is 100 Ω

Extension 1

(a) **(i)** smooth curve P deviated upwards

(ii) smooth curve R deviated downwards

(b) in front or behind the paper or at right angles to the electric field
the N-pole should be "in front" of the paper to give field lines downwards in to the paper or an explanation in terms of Fleming's rule

Extension 2

(a) **(i)** a smooth curve upwards towards the positive plate

(ii) electrons are negatively charged
unlike charges attract
positive plate attracts electrons

(iii) an arrow pointing towards P anywhere on the line PQRS

(b) **(i)** total charge / s $= 1013 \times 1.6 \times 10^{-19}$
$= 1.6 \times 10^{-6}$ C

(ii) charge = current x time
current $= 1.6 \times 10^{-6} / 1$
$= 1.6 \times 10^{-6}$ A

(c) **(i)** Energy = V I t or V q
$= 10\,000 \times 2.1 \times 600$ J
$= 1.3 \times 10^{7}$ J

(ii) Power = E / t
$= 1.3 \times 10^{7} / 600$
$= 2.1 \times 10^{4}$ W

(d) **(i)** the path should be curved downwards while in the field of the coil in accordance with Fleming's left hand rule

(ii) current = 12 / 100
= 0.12 A

(iii) a bigger deflection in the opposite direction