Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS

0625/42

Paper 4 Theory (Extended)

October/November 2024

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

[Turn over

$W = (m) \times (g)$
weight = mass × Acceleration due to gravity

1 **(a)** A rocket has an initial mass of 7.4×10^6 kg.

(i) Calculate the initial weight of the rocket.

$W = m \times g$
$= 7.4 \times 10^6 \times 9.8$

Newton (unit of weight)

7.3×10^7 N

weight = ... [1]

(ii) Define, in words, the term weight.

Weight is a Gravitational force on an object with mass.

..... [1]

For Definition check syllabus : for this check 1.3 (mass & weight) = 2.

(b) Fig. 1.1 shows part of the speed-time graph for the rocket as it leaves the ground and travels into space.

Gradient of speed-time graph : Acceleration
Area under line : Distance travelled

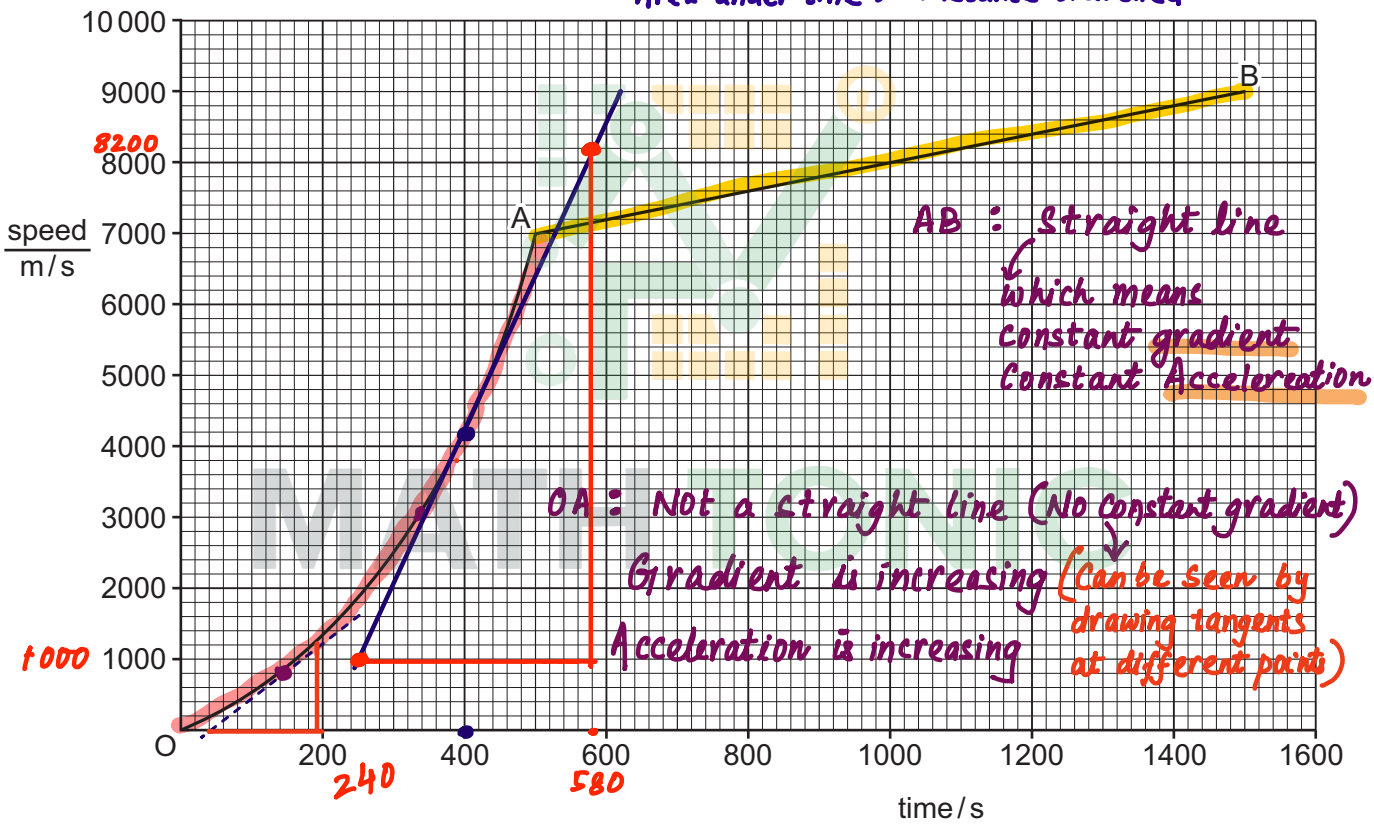


Fig. 1.1

(i) Describe the motion of the rocket:

From O to A ..... Increasing Acceleration .....

From A to B ..... Constant / uniform Acceleration .....

[2]

(ii) Draw a tangent to the graph at time = 400 s and use this to calculate the acceleration of the rocket at this time. Show your working.

gradient

$(x_1, y_1) = (240, 1000)$

$(x_2, y_2) = (580, 8200)$

Gradient = Acceleration

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{8200 - 1000}{580 - 240}$$

Any answer between (17 ~ 23)

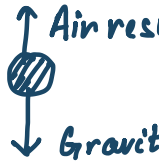
acceleration = 21.2 m/s^2 [2]

(c) Rockets are used to launch satellites into space. When the satellite is released, the rocket returns to the Earth.

Explain in terms of forces why the rocket reaches terminal velocity as it travels through the atmosphere back to the Earth.

forces are balanced

As it returns to earth, its velocity increases. The air resistance increases as well, to the point where the gravitational force and air resistance balances each other. [2]



[Total: 8]

Notes:

Terminal Velocity: It is the fastest speed that an object can reach when falling

: This velocity is reached when upward and downward acting forces are balanced.

: The resultant force on the object reaches zero

: The object no longer accelerates and constant terminal velocity reached.

Falling objects experience two forces: (a) weight (mg) (b) Air resistance

The force of Air resistance increases as the object's speed increases.
(Faster the object is travelling, the more collisions it has with air particles)

2 Fig. 2.1 shows a golfer about to hit a golf ball with a golf club. The initial momentum of the golf ball is zero.

$m \times u = 0$

$0.046 \times u = 0$

So, $u = 0$

initial velocity = zero

Fig. 2.1

(a) Define momentum.

.....mass of an object x velocity..... [1]

For definition check syllabus: 1.6 momentum - 1.

(b) The golf club is in contact with the ball for 5.0×10^{-4} s. The velocity of the golf ball as it leaves the golf club is 41 m/s. The golf ball has a mass of 0.046 kg.

Force is not given. So first Formula can't be used.

(i) Calculate the impulse on the golf ball.

$t = 5 \times 10^{-4} = 0.0005$ s

$v = 41$ m/s

$m = 0.046$ kg

$u = 0$ m/s

Impulse = force (f) x time (t)

or

Impulse = $\Delta(mv) = mv - mu$

check 1.6 momentum (2)

Impulse = $(0.046 \times 41) - (0.046 \times 0)$

For unit: m (kg) v (m/s)

impulse = ... 1.9 kg m/s or Ns ..... [2]

(ii) Calculate the force applied to the ball by the golf club.

Impulse = force x time

$\text{force} = \frac{\text{Impulse}}{\text{time}}$

$= \frac{1.9}{0.0005}$

force = ... 3800 N ..... [2]

[Total: 5]

3 **(a)** State **two** energy resources for which radiation from the Sun is the main source of energy.

1 Fossil Fuel 3. Biofuels 5. wind

2 Solar Panels 4. Hydroelectric

[2]

Check 1.7.3 = (1), (4)

(b) A wind turbine is used to generate electricity.
The useful output from the turbine in 1.0 s is 6000 J. The kinetic energy of the wind hitting the turbine in 1.0 s is 11 000 J. The velocity of the wind hitting the turbine is 6.3 m/s.

(i) Show that the mass of air hitting the turbine each second is approximately 550 kg.

Useful Output : 6000 J
t : 1 s
Kinetic energy : 11000 J
wind velocity : 6.3 m/s
m : ?

Kinetic energy $= \frac{1}{2} \times m \times v^2$

$11000 = \frac{1}{2} \times m \times 6.3^2$

$m = \frac{2 \times 11000}{6.3^2}$

$m = 554 \simeq 550\ kg$ [2]

(ii) Calculate the efficiency of the turbines. You may assume that all the kinetic energy stored in the wind is transferred to the turbine.

$\frac{\text{Total energy output}}{\text{Total energy input}} \times 100$

$\frac{6000\ J}{11000\ J} \times 100 = 54.65\%$

efficiency = 55 % [2]

Check 1.7.3 = 7(a)

(c) Tidal energy and wind energy are both renewable energy resources.
Suggest **one** reason why tidal energy is a more useful energy resource than wind energy.

Ignore the costs of construction and maintenance.

Tidal energy is more predictable and reliable

[1]

Tides follow a regular and predictable Pattern.

[Total: 7]

4 Fig. 4.1 shows a pressure cooker on an electric heating element. The cooker has a tight-fitting lid.

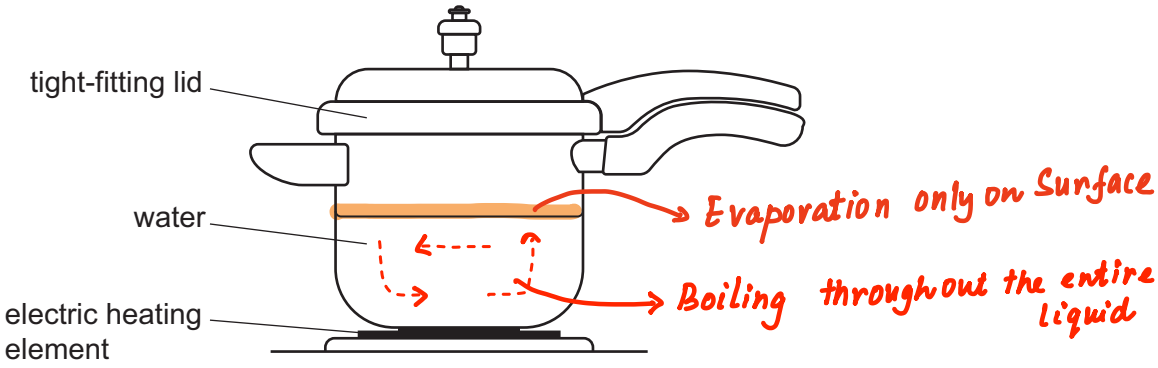


Fig. 4.1

(a) The pressure cooker is half-full of water. As the water is heated some water evaporates before the water boils.
Describe **two** differences between evaporation and boiling of the water in the cooker.

Boiling happens through out the water, but evaporation only takes place at the Surface. (for water → 100°C (liquid to gas))

Boiling takes place at a Specific temperature, but evaporation can happen at any temperature. [2]

(b) As the water is heated, the pressure of the gas inside the cooker increases.
Explain this increase in pressure in terms of particles.

As water is heated particles gain more Kinetic Energy. which leads up to more frequent Collisions Exert force on the inner wall of Cooker Pressure = $\frac{\text{force}}{\text{Area}}$, So, Higher the force, Higher the pressure [4]

[Total: 6]

Notes

water molecules will gain K.E.
Then they will collide with other molecules and inner surface of the pressure cooker more often.
More collision means more force is exerted on Surface.

$P = \frac{f}{A}$

↑ $P \propto F$ ↑

5 On a sunny day, the temperatures of a black tarmac road and the air above the road increase.

(a) Explain why the surface temperature of the tarmac increases.

It absorbs the radiation from the sun very well and emits the heat.

..... [2]

(b) State the method of thermal energy transfer from the tarmac (solid) to the air **immediately** above the road.

Conduction

..... [1]

(c) State the main method of thermal energy transfer from the air immediately above the road to the rest of the air.

Convection

..... [1]

(d) Explain why the surface temperature of the tarmac is higher than the surrounding air temperature.

Black color is a good absorber and emitter of heat Compared to surrounding air.

..... [2]

[Total: 6]

Properties of Colours:

	Matt black	White	Shiny Silver
Emitting	Best	Poor	Worst
Absorbing	Best	Poor	Worst
Reflecting	Worst	Good	Best

Types of thermal energy transfer:

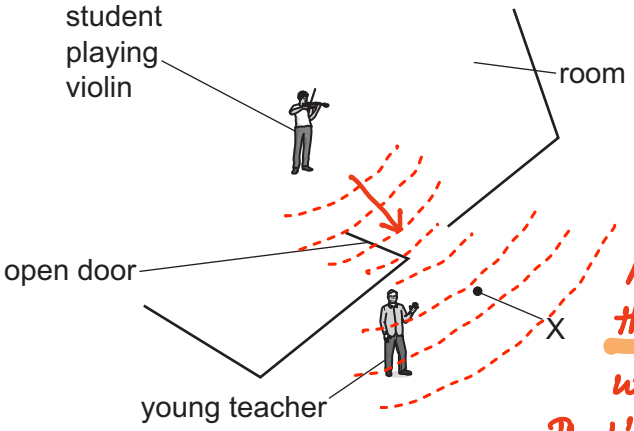
a. Conduction (by heating in Solids)

b. Convection (through liquid and gases)

c. radiation (Infra red)

6 A student plays the violin near the doorway to a large room. Fig. 6.1 shows a young teacher standing where he can hear the sound but cannot see the student.

Higher frequency means wave length are closer to each other.



Sound wave is a longitudinal wave. As it traves through the gap, the wave will diffract. That's how it reaches the teacher.

Fig. 6.1

(a) (i) State the wave effect that allows the young teacher to hear sounds from the violin at the position he is standing in Fig. 6.1.

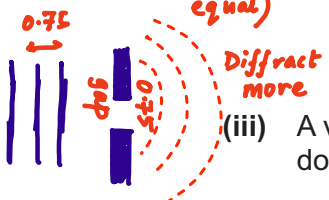
Diffraction ..... [1]

(ii) Calculate the frequency of sound with a wavelength of 0.75 m.
The speed of sound in air is 340 m/s.

Speed (v) = Frequency (f) x wavelength (λ)

$$f = \frac{v}{\lambda} = \frac{340\ m/s}{0.75\ m} = 453.33$$

wave length (larger or equal)



↑ F ↓ λ

frequency = 450 Hz ..... [2]

(iii) A violin produces sounds in the frequency range 200 Hz–3800 Hz. The width of the open doorway is 0.75 m.

Explain why the young teacher hears the frequency calculated in **(a)(ii)** clearly but finds a frequency of 3500 Hz much harder to hear.

Wave Length (lesser than gap) Diffract Less

High Frequency has shorter wavelength and this leads to less diffraction.

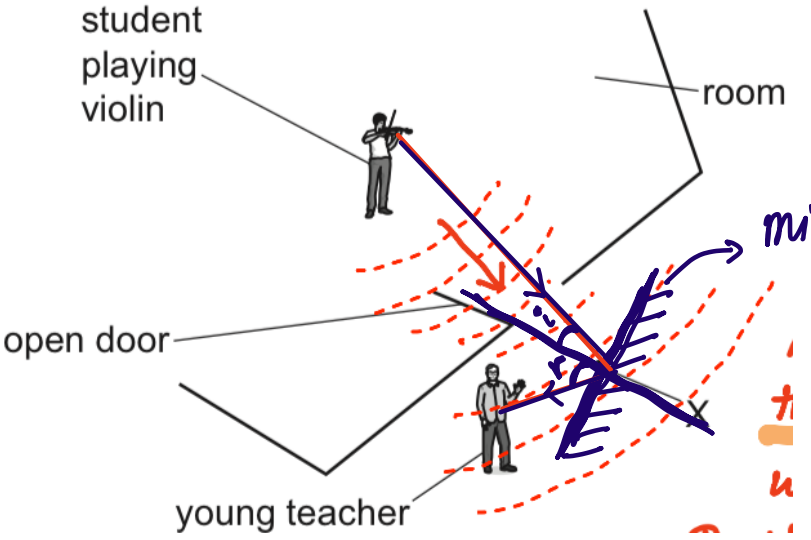
At frequency of 450 Hz, the wavelength was 0.75 m which is the width of the door way, so there is more diffraction. ..... [2]

(b) A plane mirror is placed at point X so that the teacher can see the student.
On Fig. 6.1:

- draw a light ray from the violin to point X and from point X to the teacher
- draw and label the mirror
- add an arrow to the ray to show how the teacher sees the student.

Use a ruler and sharp pencil for this drawing. [3]

[Total: 8]



$i = r$

Angle of incidence = Angle of reflection

7 A washing machine has an electric motor and an electric heater. Fig. 7.1 shows a simplified circuit diagram for the washing machine.

	Current (I)	Potential Difference (V)
Series	Same	Splits
Parallel	Splits	Same ✓

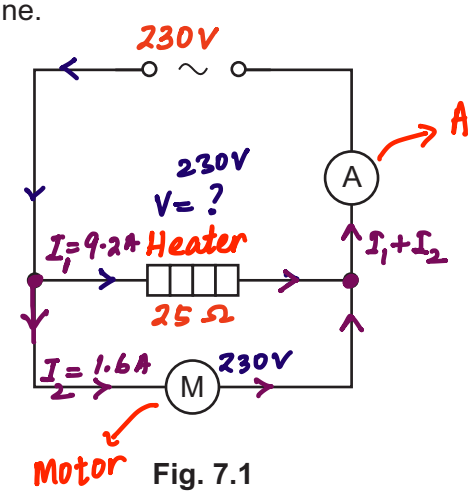
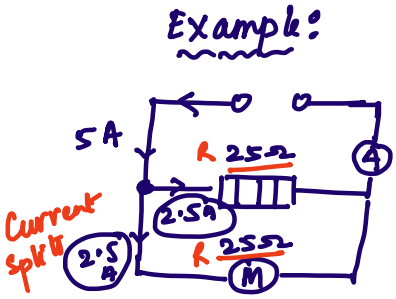


Fig. 7.1



The heater has a resistance of 25 Ω and the power supply has an electromotive force (e.m.f.) of 230 V.

(a) State the meaning of electromotive force.

Electromotive force (E.M.F) is the electrical work done by a source in moving a unit charge around a complete circuit. [2]

Check 4.2.3 Electrical Quantities Continued – (1)

(b) State the potential difference (p.d.) across the heater.

Since it is a parallel circuit P.d (V) is same.

p.d. = 230 V [1]

(c) Calculate the current in the heater.

V = 230 V R = 25 Ω

$V = I \times R$ (Ohm's law)

$I = \frac{V}{R} = \frac{230}{25}$

Current = 9.2 A [2]

(d) The current in the motor is 1.6A.
Determine the reading on the ammeter in Fig. 7.1. Explain your answer.

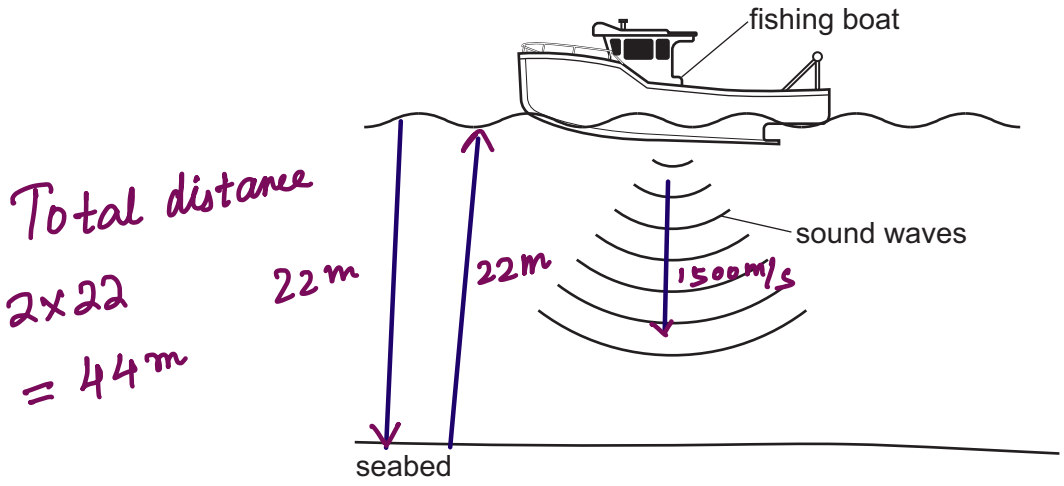
9.2A + 1.6A = 10.8 A

Ammeter reading 10.8 A

Explanation Current splits at the junction and joins back together out of junction. [2]

[Total: 7]

8 A fisherman uses high frequency sound waves to locate fish in the sea. Fig. 8.1 shows the sound waves emitted from the boat.



Total distance
2x22
= 44m

Fig. 8.1 (not to scale)

(a) State the name of sound waves which have a frequency greater than 20 kHz.

20000 Hz

Ultrasound ..... [1]

Check 3.4 Sound Continued (9)

(b) High frequency sound waves travel from the boat through the sea water.
The speed of sound in water is 1500 m/s. The seabed is 22 m below the boat.

Calculate the time taken for the boat to receive the reflected wave from the seabed after the sound is emitted.

$$t = \frac{d}{s} = \frac{44}{1500} = 0.029\ s$$

time = 0.029 Second ..... [3]

(c) Fig. 8.2 shows a fish below the boat.

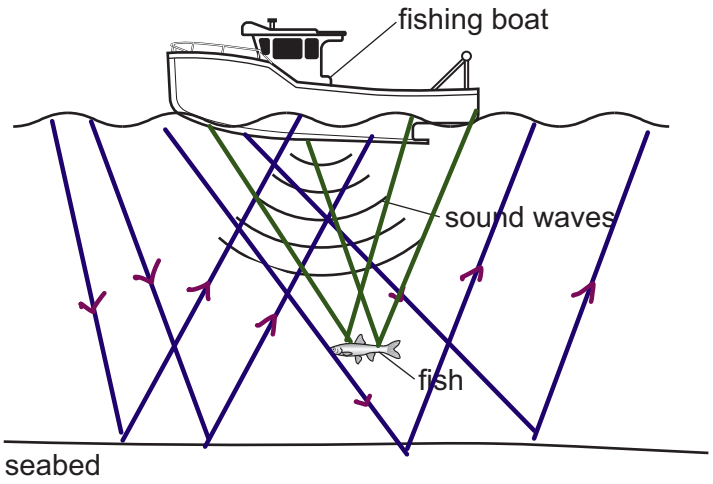


Fig. 8.2 (not to scale)

Describe and explain how the reflected sound wave received by the boat from the fish differs from the reflected sound wave received from the seabed.

Since the size of the fish is smaller, only small part of wave will be reflected back (most of sound goes to seabed) [2]

[Total: 6]

9 Fig. 9.1 shows a wireless charging plate used to charge the battery in a mobile phone (cell phone). The coil of wire is part of an electric circuit.

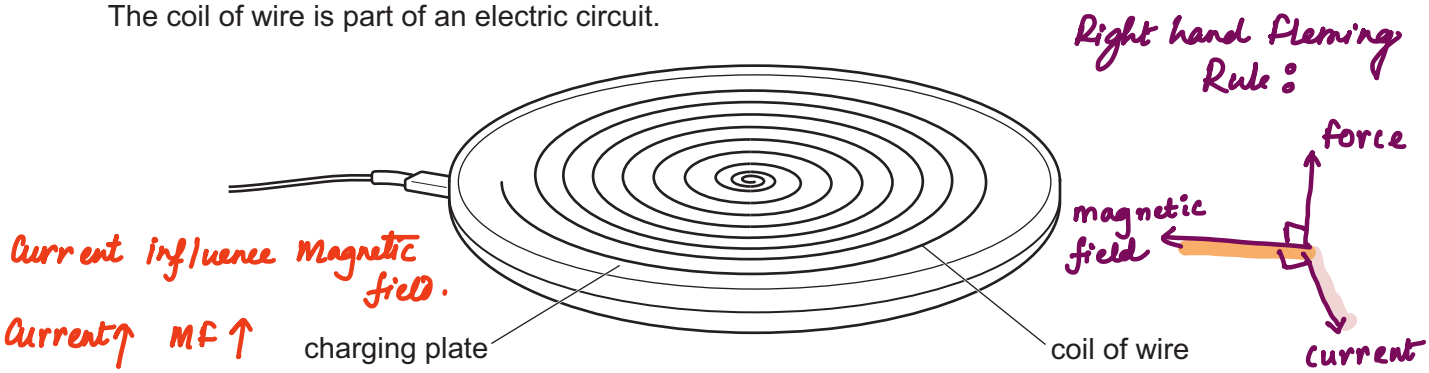


Fig. 9.1 Current flows in both directions.

The charging plate is connected to an a.c. power supply. The power supply is turned on.

(a) Describe the magnetic field around the charging plate in terms of its magnitude and direction.

Magnetic field around the charging plate Constantly changes. The direction of magnetic field will be perpendicular to the direction of Current. [2]

(b) A mobile phone is placed on the charging plate as shown in Fig. 9.2. The coil in the mobile phone is part of a separate circuit that charges the battery.

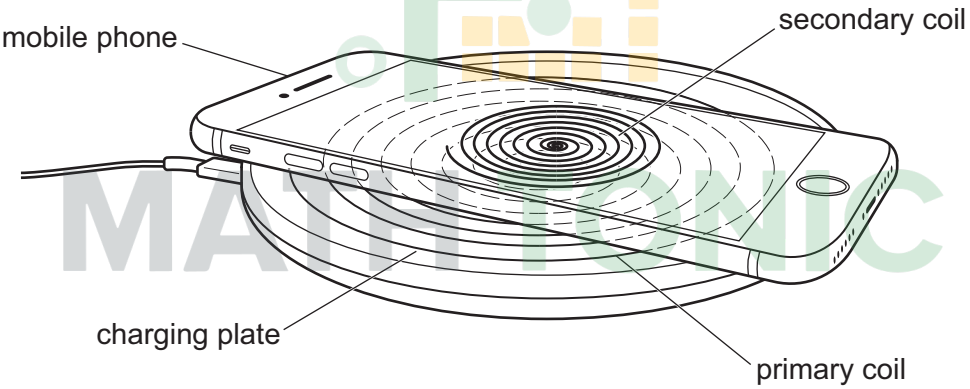


Fig. 9.2

The coil in the charging plate and the coil in the mobile phone act like a transformer.

(i) Explain why there is a current in the secondary coil shown in Fig. 9.2.

The Constant change in magnetic field through the primary coil changes the magnetic field in the Secondary Coil which induces voltage. [2]

(ii) Suggest why the transformer made from the charging plate and mobile phone is not 100% efficient.

The energy is lost to the Surrounding through thermal energy. [1]

(c) The mobile phone battery can be recharged using this charging plate and stores 4.5×10^4 J of energy when fully recharged. The current in the secondary coil is 0.63 A when the output voltage is 12 V.

(i) Calculate the time taken to fully recharge a completely uncharged battery.

$E = 4.5 \times 10^4 J$

$I_s = 0.63 A$

$V_s = 12 V$

$t = ?$

Energy (E) = V x I x t

$4.5 \times 10^4 = 12 \times 0.63 \times t$

$t = \frac{4.5 \times 10^4}{12 \times 0.63}$

time = ... 6000 s ..... [2]

(ii) Calculate the charge passing through the battery in 60 s.

$Q = I \times t$

$Q = 0.63 \times 60$

charge = ... 38 C ..... [2]

[Total: 9]

14 → Proton + Neutron
6 C
Protron

10 Carbon-14 ($^{14}_{6}C$) is a radioactive isotope of carbon. Carbon-12 ($^{12}_{6}C$) is not radioactive.

(a) Explain how an atom of carbon-14 ($^{14}_{6}C$) differs from an atom of carbon-12 ($^{12}_{6}C$).

$^{14}_{6}C$ has 2 more neutron than $^{12}_{6}C$

..... [2]

(b) All living organisms contain both carbon-12 atoms and carbon-14 atoms. The ratio of carbon-14 to carbon-12 is $1 : 1 \times 10^{12}$.

- what causes isotopes of an element to be radioactive
  → excess of neutrons in the nucleus
  → And/or the nucleus being too heavy.

Element reduced to become half → The time taken for this is called half-life.

Carbon-14 has a half-life of 5700 years.

(i) When an organism dies no new carbon is absorbed. The amount of carbon-12 in the dead organism remains fixed.

Describe how the amount of carbon-14 in the dead organism decreases with time.

Every 5700 years the numbers of atoms reduces by half. So the amount of Carbon-14 will reduce over time.

..... [2]

(ii) A sample of wood contains carbon-14 to carbon-12 atoms in the ratio $1 : 4 \times 10^{12}$.

Calculate how many years ago the tree died.

C-14 : C-12
1 : 4×10^{12}
↓ 5700 years (for reduced to half)
2×10^{12}
↓ 5700 years (for reduced to half)
1 : 1×10^{12}

5700 × 2 = 11400

11400 years ago [3]

(c) Other radioactive isotopes have different half-lives.

Suggest a use of a radioactive isotope with a half-life of one hour.

for instant medical tracers which is put in our body → Very short half life

Explain why a short half-life is suitable for this use.

use Medical tracers / medical imaging

explanation We donot want radioactive isotope to be present inside our body for long time, as it is unsafe for us.

[2]

[Total: 9]

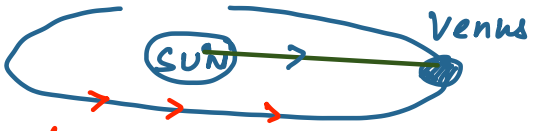
11 **(a)** **(i)** State the name of **one** planet that has an orbit further away from the Sun than Venus.

Earth, Mars, Jupiter, Saturn Uranus, Neptune [1]
(You can write any planet other after venus)

(ii) State the name of **one** planet that has an orbit closer to the Sun than Venus.

Mercury [1]

(b) Venus has an average radius of orbit of 1.1×10^{11} m and an orbital period of 220 Earth days. Calculate the average orbital speed of Venus. Give your answer in m/s.



$V = \frac{2\pi r}{T} = \frac{2 \times \pi \times 1.1 \times 10^{11}}{220 \times 24 \times 60 \times 60}$

take 220 days = (to Complete one Orbit)

average orbital speed = 3.6×10^4 m/s [3]

220 days x 24 hour x 60 m x 60 s (days to second)

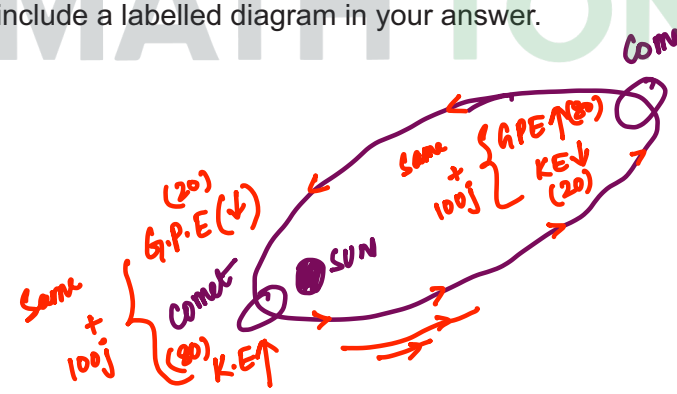
(c) State the relationship between the orbital speeds of the planets and their distances from the Sun.

The further the distance of planet with Sun, the slower the orbit Speed. [1]

(d) Comets are balls of ice and dust. Some comets orbit the Sun.

State how the speed of a comet changes as it orbits the Sun.
Explain your answer using ideas about the conservation of energy.

You may include a labelled diagram in your answer.



The Comet travels in an elliptical orbit. The speed is higher when it travels closer to Sun, hence the K.E is higher and G.P.E decreases. As it travels further G.P.E increases and K.E decreases. Therefore the total energy at all times remain unchanged. [3]

[Total: 9]

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