O Level Pure Physics Structured

Electromagnetic Induction Test 2.0

Q1

Fig. 8.1 shows an a.c. generator.

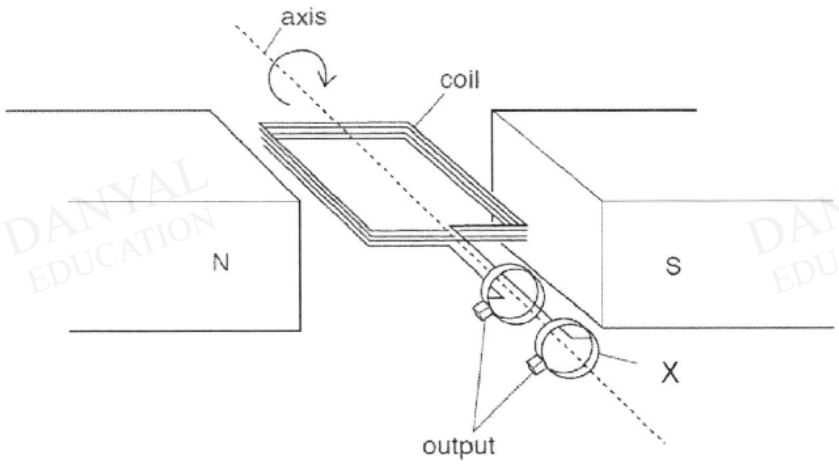

Fig 8.1

(a) The coil starts to rotate from the position shown in Fig. 8.1.

(i) Explain why the e.m.f. induced is a maximum at this instant.

.....

.....

.....[2]

(ii) The coil rotates 180° every 10 s and the maximum e.m.f. induced is 110 V.

On Fig. 8.2, sketch the voltage against time graph for the first 20 s, indicating your values clearly.

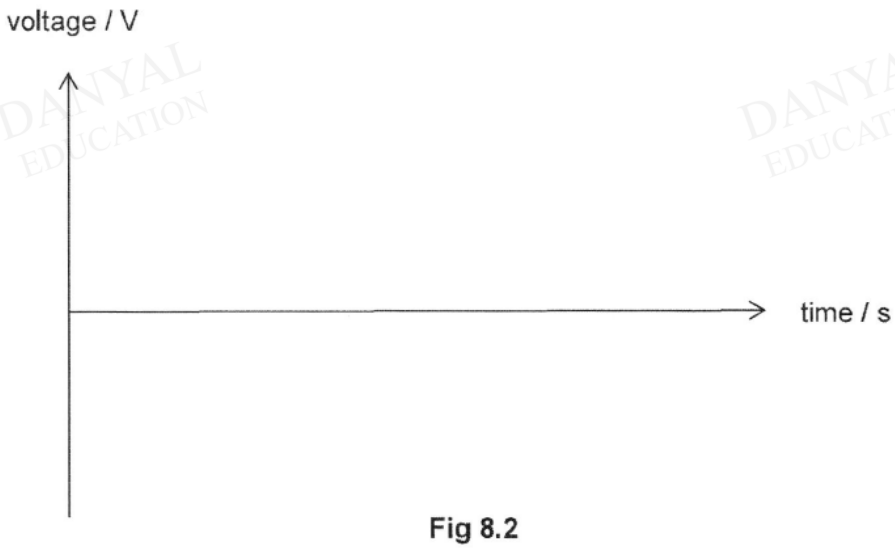

Fig 8.2

[2]

(b) State one way to increase the magnitude of the induced e.m.f.

.....[1]

(c) State component X and its function.

.....

.....[2]

Q2

Induction cookers work on the principle of electromagnetic induction. Fig 9.1 shows an induction cooker which consists of a copper coil connected to an alternating current (a.c.) supply and a ceramic plate. When a pot made of soft magnetic material is placed on top of the cooker and the a.c. supply is turned on, electromagnetic induction leads to the pot being heated. The ceramic plate remains relatively cool.

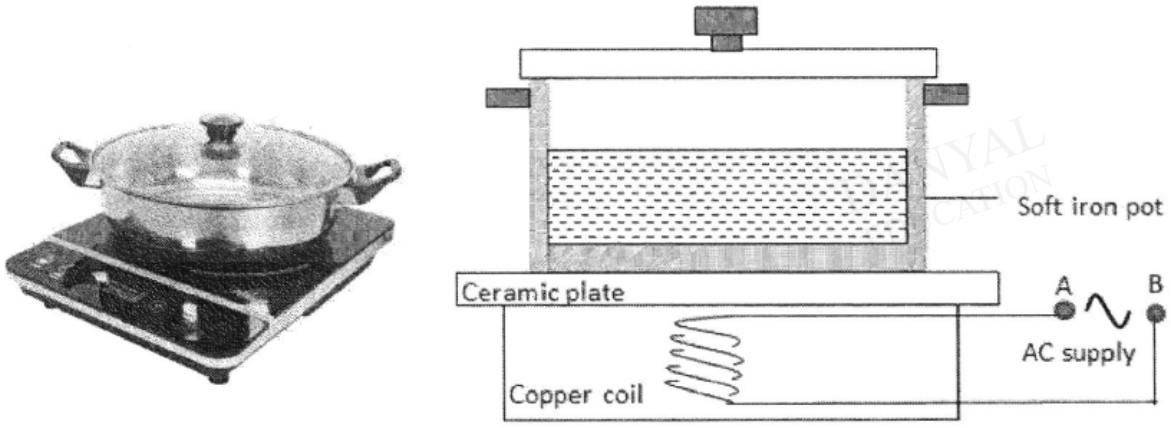

Fig. 9.1

(a) Explain how an alternating current causes a heating effect in the pot but not in the ceramic plate.

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.....[3]

Q3

(a) Fig. 11.1 shows an electric motor where a coil PQRS is connected to a battery and is placed between two solenoids AB and CD which are connected to a separate d.c. power supply.

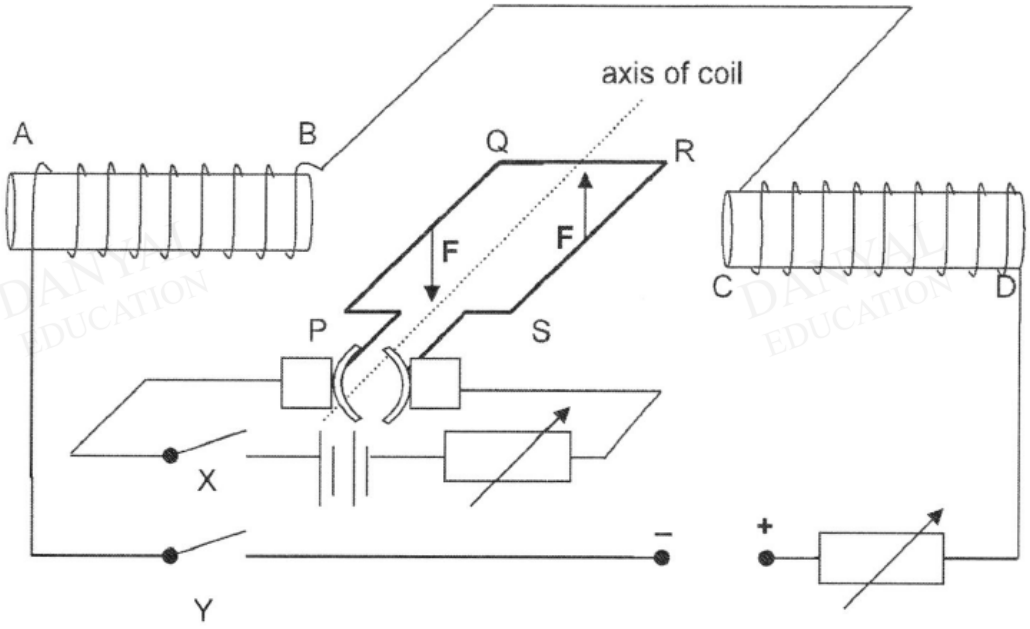

Fig 11.1

(i) On Fig. 11.1, **F** represents the force experienced by sides PQ and RS of the coil when both switches X and Y are closed.

Explain why a force is experienced by sides PQ and RS of the coil.

.....

.....[1]

(ii) The force experienced on each side of the coil is 8 N. The lengths of PQ and QR are 0.8 m and 0.5 m respectively.

Calculate the moment produced by the motor and state its direction of rotation.

moment =.....[2]

direction of rotation : .....[1]

(iii) Describe and explain the effect on the movement of coil PQRS when the d.c. power supply connected to solenoids AB and CD is replaced by an a.c. power supply.

.....

.....

.....[2]

(b) Fig. 11.2 shows a cathode-ray oscilloscope (c.r.o.) being used to measure the period and voltage of an a.c. supply.

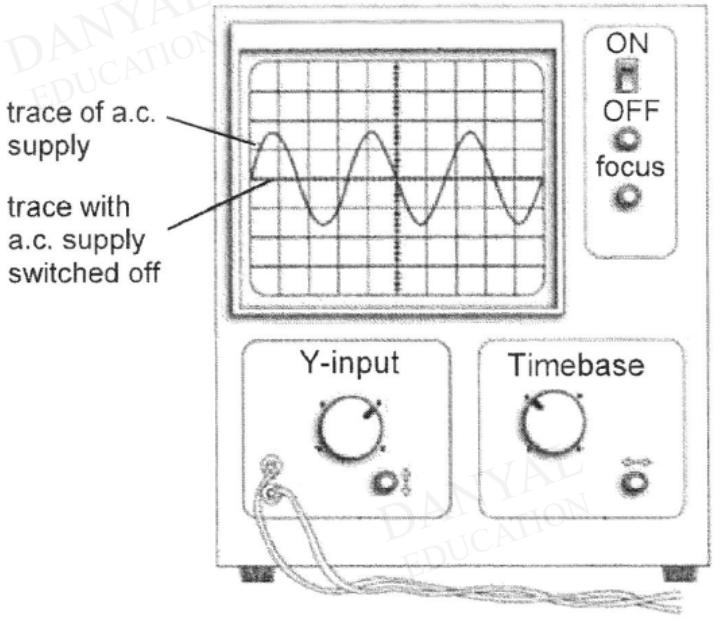

Fig 11.2

(i) The Y gain is 5 V / division and the timebase is 2 ms / division.

Using Fig. 11.2, determine the peak voltage and period of the a.c. supply.

peak voltage = ... [1]

period = ... [1]

(ii) Calculate the frequency of the a.c. supply.

frequency = ...[2]

Q4

An a.c. source is used to light up another lamp as shown in Fig. 11.4. A transformer with 500 turns in the primary coil is attached to a 240 V, 50 Hz a.c supply. The secondary coil is connected to a 20 V, 50 W lamp that is operating under normal working condition.

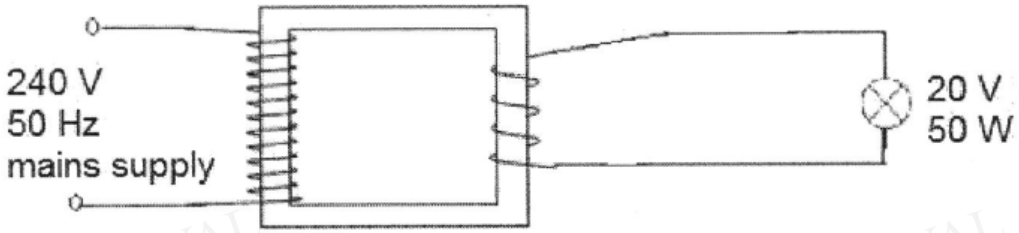

Fig. 11.4

(i) Calculate the number of turns in the secondary coil.

number of turns = ...[2]

(ii) Calculate the current flowing through the primary coil.

current = ...[1]

(iii) A thicker wire is used at the secondary coil instead of the primary coil.

Suggest a reason.

.....

.....

.....[1]

(iv) The core linking the two transformers is made of thin laminated sheets.

Explain how this improves the efficiency of the transformer.

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.....[1]

Q5

Fig 11.1 shows a torchlight that is lit when its handle is cranked by a hand

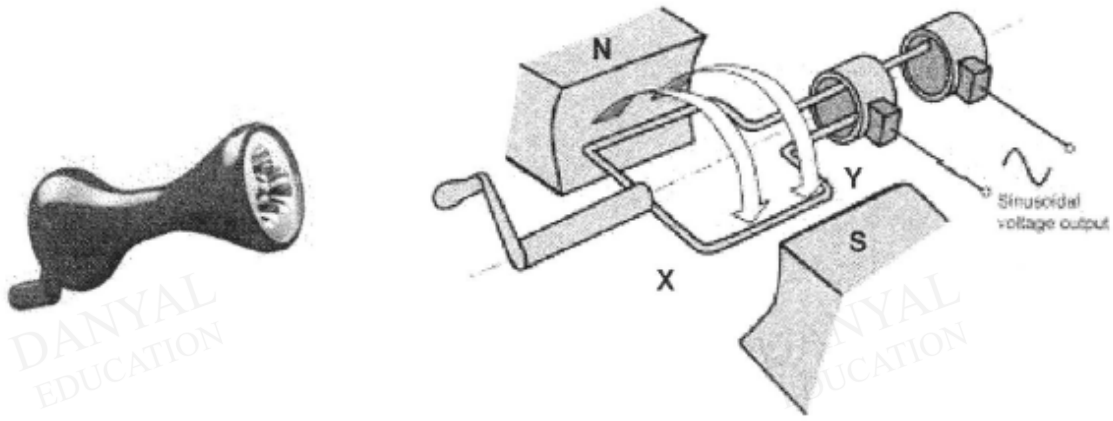

Fig 11.1

(a) State the direction of the current flow in branch XY at the instant shown in Fig 11.1.

.....

..... [1]

(b) The rotation of the coil when cranked by hand produces a sinusoidal voltage output as shown in Fig 11.2.

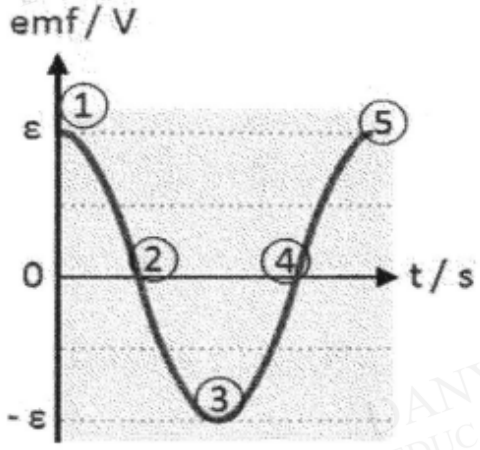

Fig. 11.2

Explain the change in voltage during each relevant stage (stages 1,2,3,4 and 5) of the coil rotation using Faraday's Law and Lenz's Law.

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.....

..... [3]

(c) Explain using Faraday's Law why the torch shines brighter when the hand cranks the coil at a faster speed.

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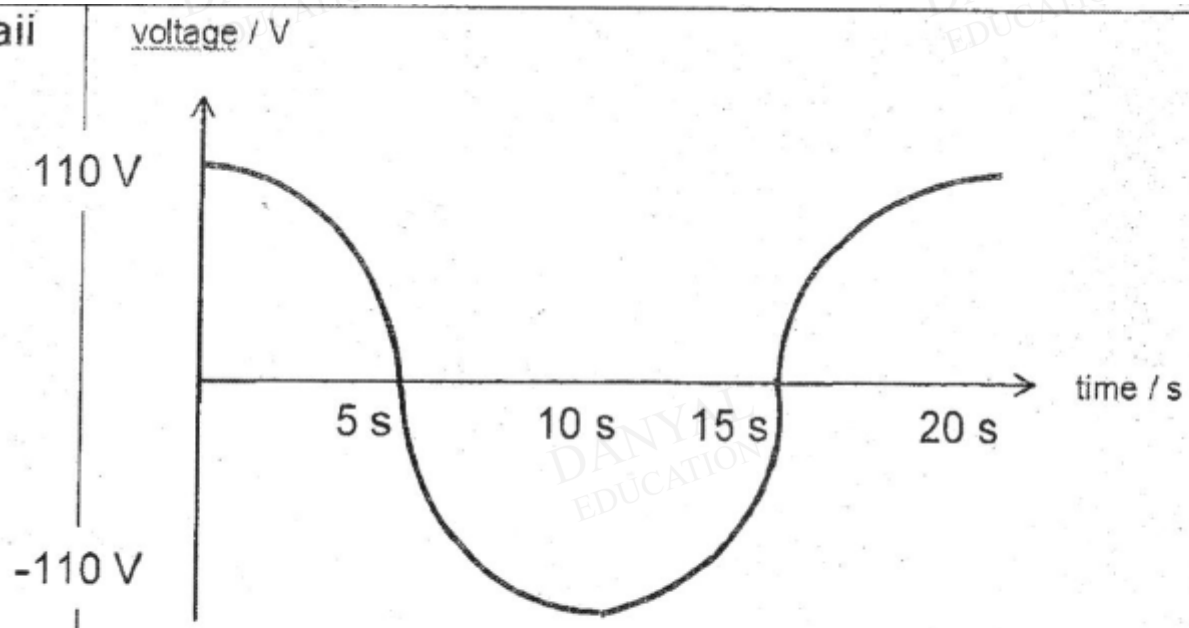
..... [1]

Answers

Electromagnetic Induction Test 2.0

Q1

ai	The magnetic field lines are being cut at the greatest rate / rate of change of magnetic flux is maximum. From Faraday's law, the magnitude of the induced current / e.m.f is directly proportional to the rate of change of magnetic flux and thus the e.m.f induced is maximum.	B1 B1
aii	 [1] – shape [1] - values	B1 B1
b	Increase speed of rotation / increase number of turns of coils / use stronger magnet / insert soft iron core (any one)	B1
c	Slip ring. To ensure the induced current in circuit / coil is transferred to the output.	B1 B1

Q2

a	An alternating current in the circuit creates a changing magnetic field/flux in the soft iron pot.	B1
	This induces a current in the soft iron pot which heats up the pot.	B1
	The ceramic plate does not heat up as it is an insulator of electricity (and no current flows through it). *Do not accept insulator of heat as question is not referring to transfer of heat between iron pot and ceramic plate	B1

Q3

ai	The magnetic field of the current and magnetic field of the magnet interact to give a resultant magnetic field producing a force.	B1
aii	M = F x d = 8 x 0.25 x 2 = 4 Nm	M1 A1
	anticlockwise	B1
aiii	The force acting on coils PQ and RS will change direction repeatedly.	B1
	This will cause the coil to rotate anticlockwise and then clockwise repeatedly.	B1

I aiii	The force acting on coils PQ and RS will change direction repeatedly. This will cause the coil to rotate anticlockwise and then clockwise repeatedly.	B1 B1
bi	Peak voltage = 5 V / div x 1.6 div = 8.0 V *accept 1.4 or 1.8 div (1.4 div x 5V / div = 7.0 V, 1.8 div x 5V / div = 9.0 V) 3 periods = 10 divisions 1 division = 2 ms 10 divisions = 20 ms 3 periods = 20 ms period = 20/3 = 6.67 ms *accept 3.2, 3.4 and 3.6 div (3.2 div x 2ms / div = 6.4 ms 3.4 div x 2 ms / div = 6.8 ms 3.6 div x 2 ms / div = 7.2 ms	B1 B1
bii	f = 1/T = 1 / 6.67 x 10^{-3} = 150 Hz *allow ecf from 11bi	M1 A1

Q4

bi	No. of turns in secondary/no. of turns in primary = voltage at secondary / voltage at primary No. of turns in secondary/500 = 20/240 No. of turns in secondary = 41.7	 M1 A1
bii	power at primary = power at secondary VI (pri) = P(sec) 240 x I = 50 I = 0.208 A	 B1
biii	Higher current at secondary which will leading to increased heating effect. Thicker wire is used as it has lower resistance which will reduce heating effect	B1
biv	The laminated sheets reduce eddy currents and reduce heating losses / energy lost as heat / joule heating effect	B1

Q5

a	Y to X (Use Fleming's Right Hand Rule)	1
b	emf is maximum at Stages 1, 3 and 5 as coil is horizontal and rate of change of magnetic flux is maximum (Faraday's Law)	1
	emf is zero at stages 2 and 4 as coil is vertical and rate of change of magnetic flux is minimum.	1
	emf changes direction as each branch is connected to the same slip ring and when each branch changes its direction of motion, the current will also change direction so as to produce an opposing magnetic field. (Lenz's Law)	1
c	The magnitude of emf increases as the coil experiences a greater rate of change of magnetic flux whe it rotates faster.	1