
PHYSICS VCE UNITS 3&4 DIAGNOSTIC TOPIC TESTS 2017

TEST 3: HOW ARE FIELDS USED TO MOVE ELECTRICAL ENERGY?

SUGGESTED SOLUTIONS AND MARKING SCHEME

Question 1 (16 marks)

a. $\Phi = BA \cos \theta$

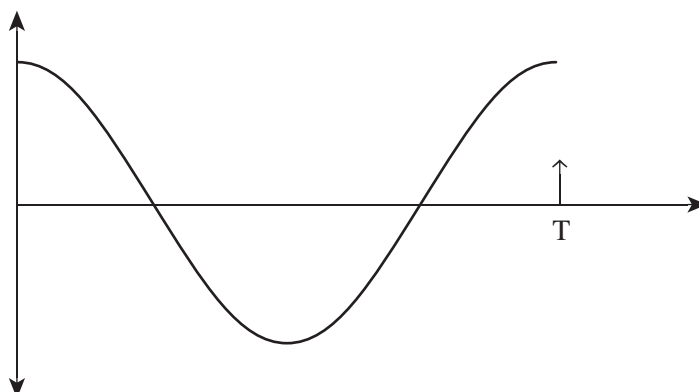
$$= 2.0 \times 0.30 \times 0.20 \times \cos 0^\circ$$

1 mark

$$= 0.12 \text{ Wb}$$

1 mark

b. magnetic flux



2 marks

1 mark for shape.

1 mark for starting and ending at maximum value.

c. As the coil moves out of the magnetic field, it experiences a decreasing external magnetic flux out of the page.

1 mark

The coil opposes this decrease in external flux by providing its own flux (induced) through its area and out of the page. This is according to Lenz' law.

1 mark

d. $\Delta t = \frac{d(ZY)}{3.0}$
 $= \frac{0.30}{3.0}$
 $= 0.10 \text{ sec}$

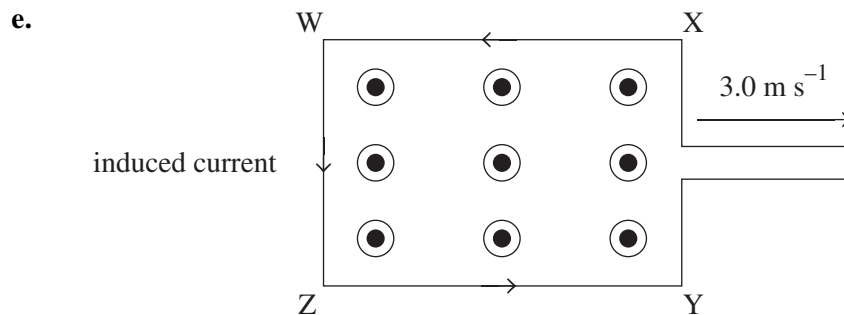
1 mark

$|\mathcal{E}| = N \left| \frac{\Delta \Phi}{\Delta t} \right|$
 $= 100 \left| \frac{0 - 0.12}{0.10} \right|$
 $= 120 \text{ V}$

1 mark

1 mark

Note: Consequential on answer to Question 1a.



1 mark

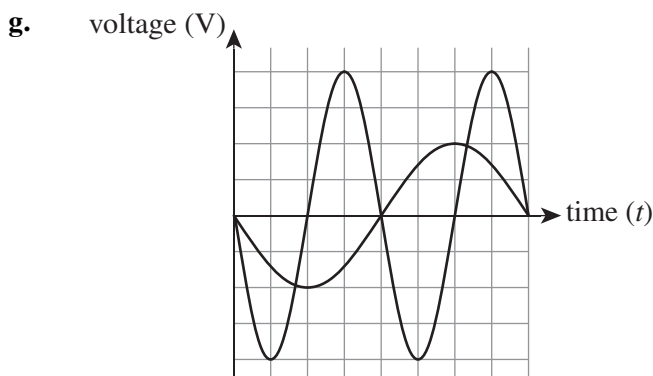
As the induced flux through the coil is out of the page, using the right-hand grip rule with the fingers as the induced field, the thumb shows the direction of the induced current to be anti-clockwise.

f. $\Delta t = \frac{1}{4}T$
 $= \frac{1}{4} \times \frac{1}{f}$
 $= \frac{1}{4} \times \frac{1}{10}$
 $= 0.025$

1 mark

$|\mathcal{E}| = N \left| \frac{\Delta \Phi}{\Delta t} \right|$
 $= 100 \left| \frac{0 - 0.12}{0.025} \right|$
 $= 480 \text{ V}$

1 mark



2 marks

1 mark for half the amplitude.

1 mark for double the period.

- h. The voltage amplitude is proportional to the frequency (rate of rotation) and is therefore halved.

1 mark

The period = $\frac{1}{\text{rotation rate}}$ ($T = \frac{1}{f}$) and so is doubled.

1 mark

Question 2 (10 marks)

- a. Assembly A shows the coil connected to two slip rings.

1 mark

This serves to maintain voltage output polarity so that the output is AC.

1 mark

Assembly B shows the coil connected to a split ring commutator.

1 mark

This serves to reverse the voltage output polarity every half-cycle so that the output is DC.

1 mark

- b. The coils rotate and experience a change in external magnetic flux.

1 mark

The coils have an induced voltage as a result of opposing the change in external flux by creating their own induced flux.

1 mark

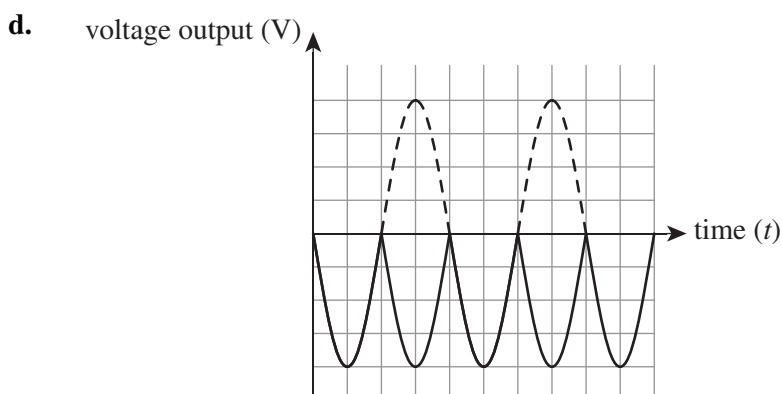
Accompanying the induced flux is an electromotive force (voltage).

This is according to Faraday's law $|\mathcal{E}| = N \left| \frac{\Delta \Phi}{\Delta t} \right|$.

1 mark

- c. assembly A

1 mark



2 marks

1 mark for DC.

1 mark for same period.

Note: Either positive or negative amplitude outputs are acceptable.

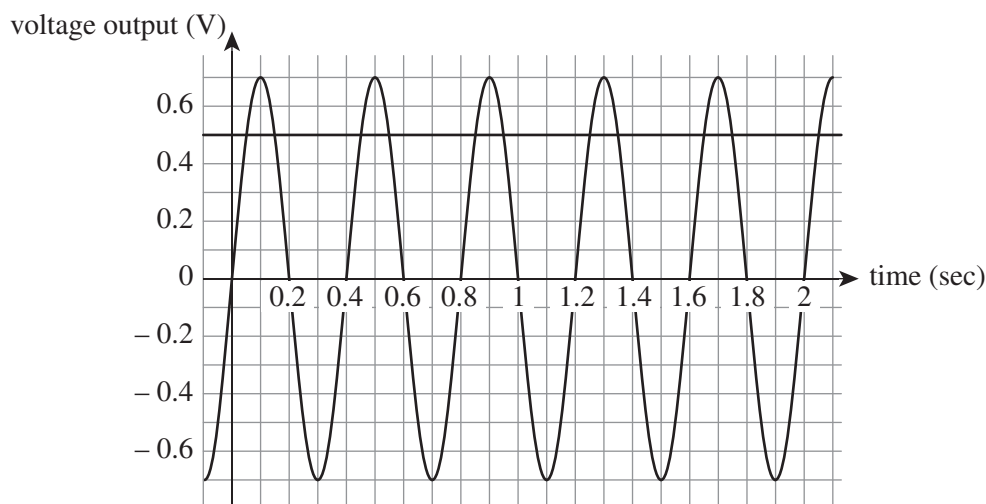
Question 3 (7 marks)

a. $V_{\text{peak}} = 0.7 \text{ V}$ (maximum voltage value) – read from graph 1 mark

b.
$$V_{\text{RMS}} = \frac{V_{\text{peak}}}{\sqrt{2}}$$

$$= \frac{0.7}{\sqrt{2}}$$
 1 mark

$$= 0.50 \text{ V}$$
 1 mark



c.
$$V_{\text{peak-peak}} = 2V_{\text{peak}}$$

$$= 2 \times 0.7$$

$$= 1.4 \text{ V}$$
 1 mark

Note: Consequential on answer to Question 3a.

d. $T = \text{time of 1 cycle}$

$$= 0.4 \text{ sec}$$
 1 mark

$$f = \frac{1}{T}$$

$$= \frac{1}{0.4}$$

$$= 2.5 \text{ Hz}$$
 1 mark

e.
$$I_{\text{peak-peak}} = \frac{V_{\text{peak-peak}}}{R}$$

$$= \frac{1.4}{2.0}$$

$$= 0.7 \text{ A}$$
 1 mark

Note: Consequential on answer to Question 3c.

Question 4 (6 marks)

- a.
$$\frac{N_{\text{primary}}}{N_{\text{secondary}}} = \frac{V_{\text{primary}}}{V_{\text{secondary}}}$$

$$= \frac{240}{18}$$
 1 mark

$$= 13.3$$
 1 mark
- b.
$$P_{\text{primary}} = P_{\text{secondary}}$$

$$V_{\text{primary}} \times I_{\text{primary}} = V_{\text{secondary}} \times I_{\text{secondary}}$$

$$240 \times I_{\text{primary}} = 18 \times 4.2$$
 1 mark

$$I_{\text{primary}} = \frac{18 \times 4.2}{240}$$

$$= 0.32 \text{ A}$$
 1 mark
- c. Different voltages can only be supplied from a power supply of 240 V connected to a transformer to step-up or step-down voltage to the desired values. 1 mark
 The transformer can only operate by a changing magnetic flux which is supplied by AC current, but not by DC current. 1 mark

Question 5 (6 marks)

- a.
$$I_{\text{line}} = \frac{P_{\text{transmission}}}{V_{\text{transmission}}}$$

$$= \frac{1.0 \times 10^9}{500 \times 10^3}$$
 1 mark

$$= 2000 \text{ A}$$
 1 mark
- b.
$$P_{\text{loss}} = I_{\text{line}}^2 \times R_{\text{line}}$$

$$= 2000^2 \times 2.0$$
 1 mark

$$= 8.0 \times 10^6 \text{ W}$$
 1 mark
- Note: Consequential on answer to Question 6a.*
- c. At a higher transmission voltage for constant power transmission, 1 mark
 a lower line current is produced $I_{\text{line}} = \frac{P_{\text{transmission}}}{V_{\text{transmission}}}$.
 A lower line current results in a smaller power loss since $P_{\text{loss}} = I_{\text{line}}^2 R_{\text{line}}$. 1 mark