Neap:

PHYSICS VCE UNITS 3&4
DIAGNOSTIC TOPIC TESTS 2017

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

SUGGESTED SOLUTIONS AND MARKING SCHEME

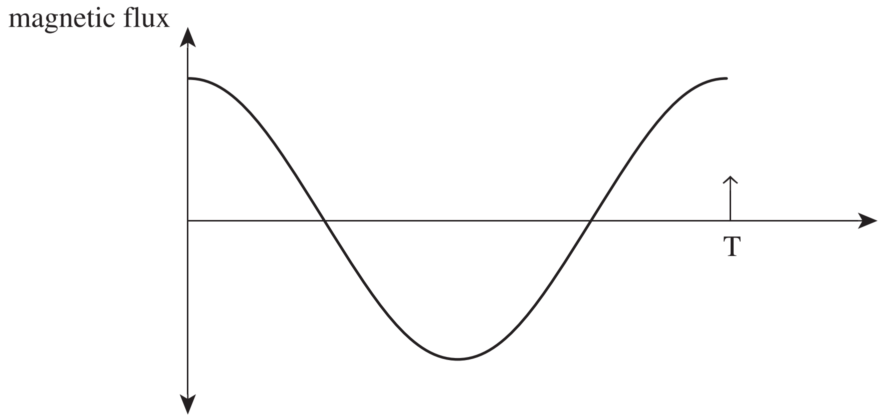
Question 1 (16 marks)

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

$= 2.0 \times 0.30 \times 0.20 \times \cos 0°$ 1 mark

$= 0.12$ Wb 1 mark

b.



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. $\Delta t = \frac{d(ZY)}{3.0}$

$= \frac{0.30}{3.0}$

$= 0.10$ sec — 1 mark

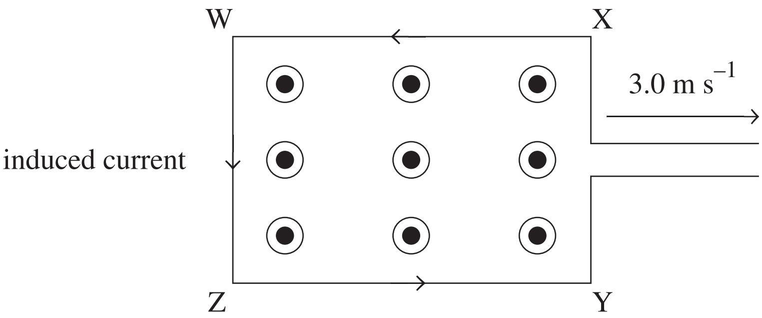
$|\varepsilon| = N\left|\frac{\Delta\Phi}{\Delta t}\right|$

$= 100\left|\frac{0 - 0.12}{0.10}\right|$ — 1 mark

$= 120$ V — 1 mark

Note: Consequential on answer to ***Question 1a.***

e.



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 currant to be anti-clockwise.

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

$= \frac{1}{4} \times \frac{1}{f}$

$= \frac{1}{4} \times \frac{1}{10}$

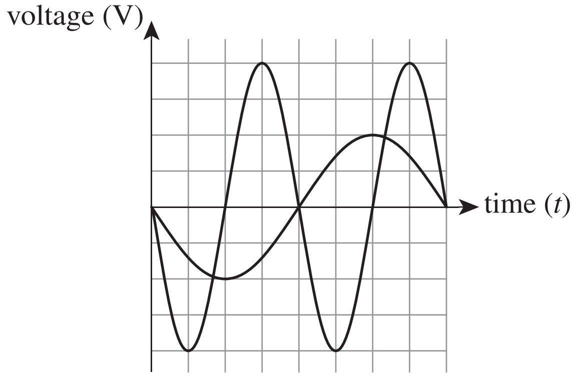
$= 0.025$ — 1 mark

$|\varepsilon| = N\left|\frac{\Delta\Phi}{\Delta t}\right|$

$= 100\left|\frac{0 - 0.12}{0.025}\right|$

$= 480$ V — 1 mark

g.



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 $= \frac{1}{\text{rotation rate}} \left(T = \frac{1}{f}\right)$ 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

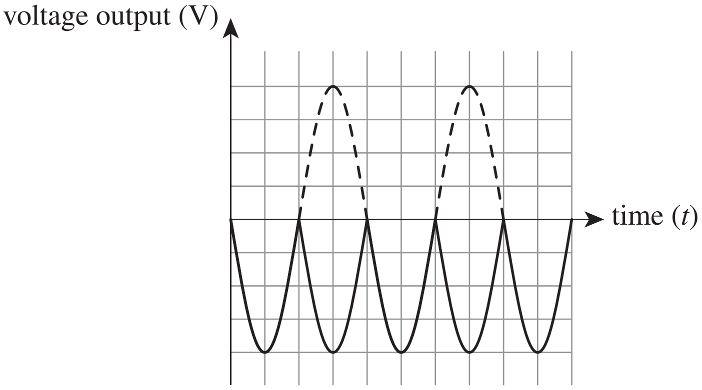
The coils have an induced voltage as a result of opposing the charge in external flux by creating their own induced flux. 1 mark

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

This is according to Faraday's law $|\varepsilon| = N\left|\frac{\Delta \Phi}{\Delta t}\right|$. 1 mark

c. assembly A 1 mark

d.



2 marks
1 mark for DC.
1 mark for same period.
Note: Either positive or negative amplitude outputs are acceptable.

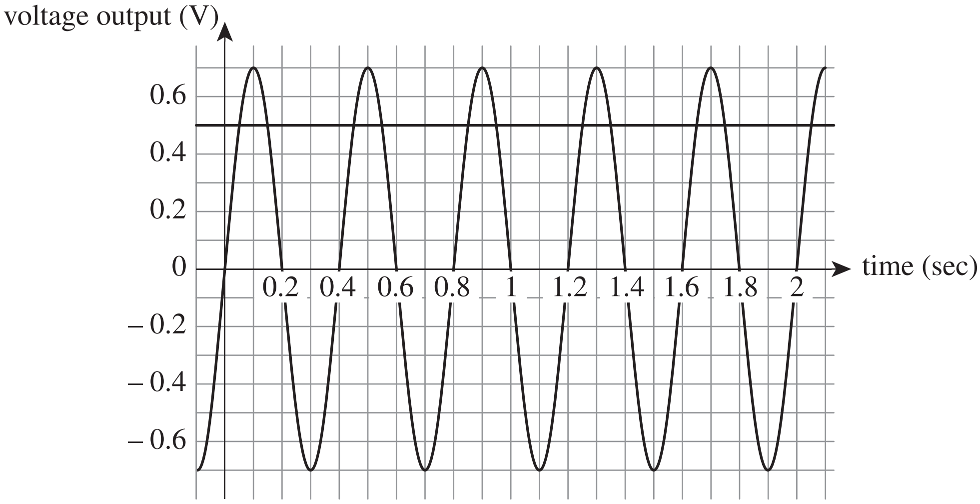
Question 3 (7 marks)

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

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

$= \dfrac{0.7}{\sqrt{2}}$ — 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 = time of 1 cycle

$= 0.4\text{ sec}$ — 1 mark

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

$= \dfrac{1}{0.4}$

$= 2.5\text{ Hz}$ — 1 mark

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

$= \dfrac{1.4}{2.0}$

$= 0.7\text{ A}$ — 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. $P_{\text{loss}} = I^2_{\text{line}} \times R_{\text{line}}$

$= 2000^2 \times 2.0$ 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 $P_{\text{loss}} = I^2_{\text{line}} R_{\text{line}}$. 1 mark