Neap:

PHYSICS VCE UNITS 3&4
DIAGNOSTIC TOPIC TESTS 2017

TEST 3: HOW ARE FIELDS USED TO MOVE ELECTRICAL ENERGY?
TOTAL 45 MARKS (45 MINUTES)

Student's Name: ____________________ Teacher's Name: ____________________

Directions to students

Write your name and your teacher's name in the spaces provided above.
Answer all questions in the spaces provided.

Question 1 (16 marks)

An electromagnetic induction experiment is conducted by some senior Physics students. They use a rectangular coil of wire, WXYZ, in a magnetic field of strength 2.0 T as shown in Figure 1. The length of side WX is 0.30 m and the length of the side WZ is 0.20 m.

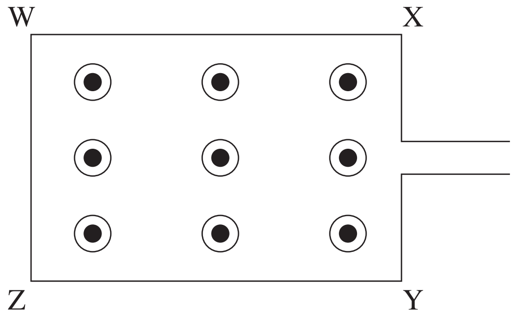

Figure 1

a. Calculate the magnetic flux threading the coil. 2 marks

Wb

The coil is now rotated about the dashed line as shown in Figure 2.

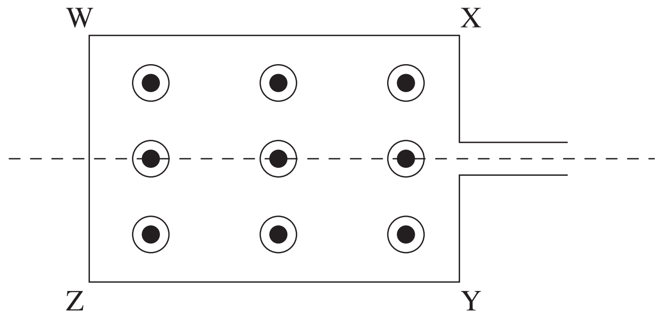

Figure 2

b. From its starting position shown in Figure 2, sketch the magnetic flux passing through the coil for one revolution of its rotation on the graph axes in Figure 3. Consider out of the page as positive for magnetic flux. (T denotes the time of one rotation on the horizontal axis.) 2 marks

Figure 3

The coil from Figure 1 is now replaced by a coil of the same physical dimensions, but the new coil has 100 turns of wire. The coil is now moved to the right out of the magnetic field at a speed of 3.0 m s^{-1}, as shown in Figure 4.

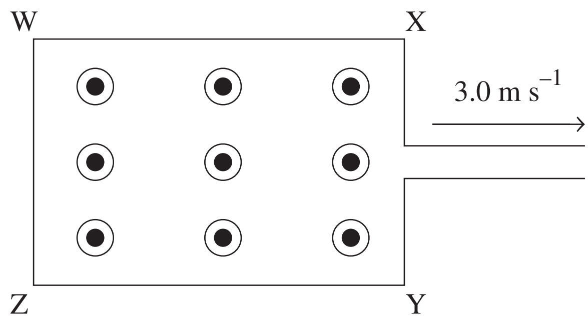

Figure 4

c. Explain, using principles of physics, the direction of the induced magnetic flux acting through the coil area as it moves out of the external magnetic field. 2 marks

d. Determine the magnitude of the induced electromotive force across the ends of the coil. 3 marks

V

e. Indicate on Figure 4 the direction of the induced current in the coil. 1 mark

The coil of 100 turns is placed back in the same magnetic field, except this time the students rotate the coil at a constant frequency of 10 Hz about the axis, which is shown as a dashed arrow in Figure 5.

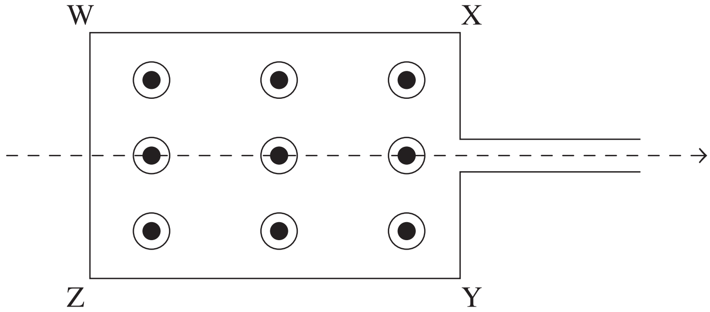

Figure 5

f. Calculate the magnitude of the average induced voltage created in one quarter of a revolution of the coil starting from the position shown in Figure 5. 2 marks

V

The induced voltage versus time graph for two revolutions of the coil is shown in Figure 6.

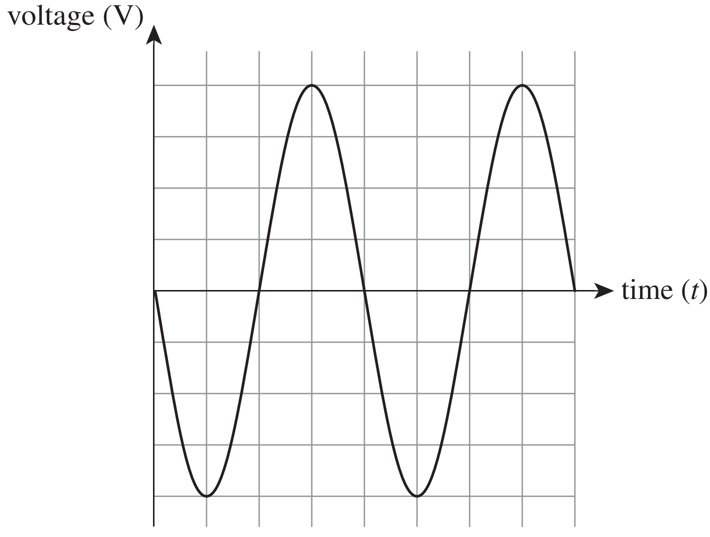

Figure 6

The students now halve the rate of rotation of the coil.

g. Draw the voltage versus time graph for this new rate of rotation on Figure 6. 2 marks

h. Explain how you arrived at your answer to part **e.** 2 marks

Question 2 (10 marks)

Figure 7 shows two generator assemblies, A and B.

Both assemblies have the following common components:

- identical external magnetic field strengths
- the same coil dimensions with an equal number of turns
- assemblies are rotated with the same frequency

The two assemblies also have some different components.

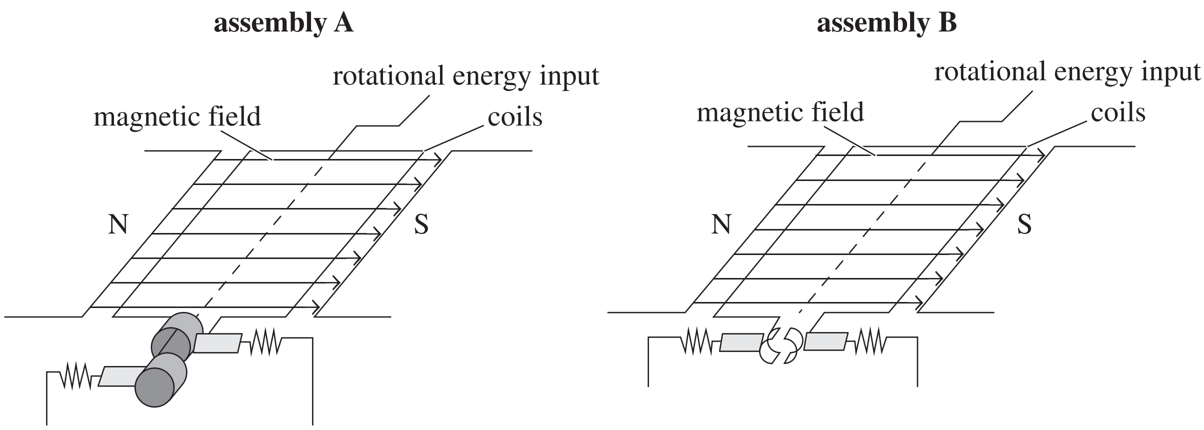

Figure 7

a. State the components and explain their purposes which make the two generators operate differently to each other. 4 marks

b. Explain the physics principles that leads to both assemblies operating as voltage generators. 3 marks

One of the assemblies produces the following voltage output shown in Figure 8.

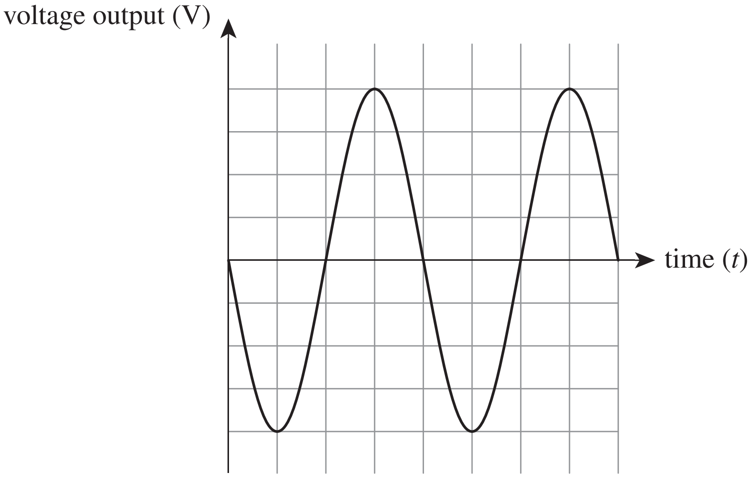

Figure 8

c. Indicate which assembly, A or B, produces the voltage output shown in Figure 8. 1 mark

d. Figure 8 is reproduced below as Figure 9.

On Figure 9, sketch the voltage output for the other generator. 2 marks

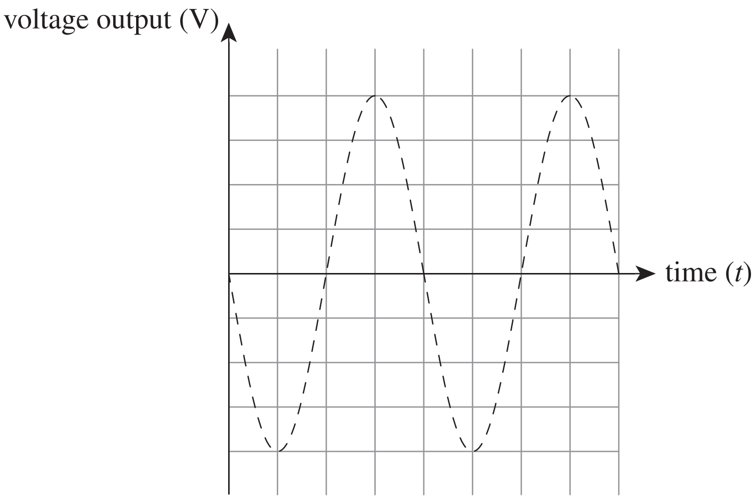

Figure 9

Question 3 (7 marks)

A simple generator is turned by hand and the voltage output from it is shown in Figure 10.

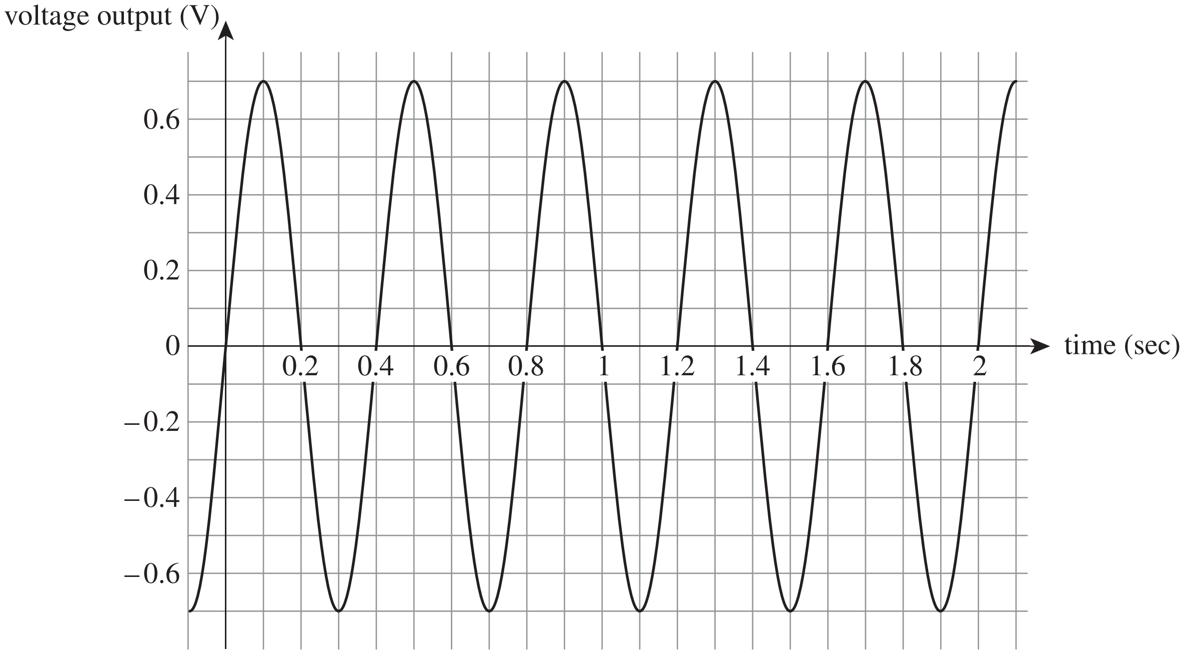

Figure 10

The generator is connected to a globe whose resistance is 2.0 Ω.

a. Determine the peak voltage output of the generator. 1 mark

V

b. Determine the RMS voltage output of the generator and show this as a function of time on the graph in Figure 10. 2 marks

V

c. Determine the peak-to-peak voltage output from the generator. 1 mark

V

d. Determine the frequency of rotation and the period of rotation of the generator. 2 marks

Hz	sec

e. Determine the peak-to-peak current provided to the globe by the generator. 1 mark

A

Question 4 (6 marks)

A transformer is used in an AC adaptor for a laptop computer. The input voltage is 240 V RMS AC at 50 Hz. The required output voltage is 18 V RMS AC with a maximum current of 4.2 A RMS AC.

a. Calculate the ratio of the number of turns of the primary coil to the number of turns of the secondary coil for this transformer. (Assume the transformer is ideal.) 2 marks

b. Determine the RMS current at the primary coil of the transformer if maximum power is being drawn by the laptop. (Assume the transformer is ideal.) 2 marks

A

c. Explain why AC electricity is used instead of DC electricity in the supply of power to electrical appliances in houses which use various voltage inputs for various different appliances. 2 marks

Question 5 (6 marks)

Power stations generate electrical power which is then transmitted to consumers. One electrical power station generates 1.0 GW of power at 20 kV. This is then transformed using a transformer T_1 to 500 kV for transmission through transmission wires that have a total resistance of 2.0 Ω. The power is then transformed again using another transformer T_2 to 50 kV at the substation. Assume the transformers are 100 per cent efficient. This is shown in Figure 11.

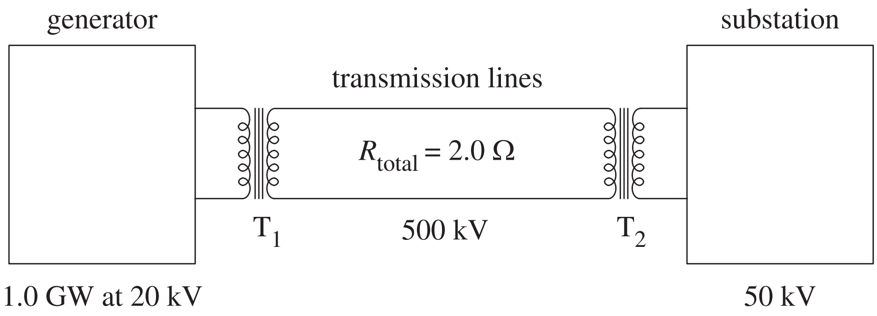

Figure 11

a. Calculate the RMS current in the secondary windings of transformer T_1. 2 marks

A

b. Calculate the total electrical power loss in the transmission wires when the electricity is transmitted at 500 kV. 2 marks

W

c. Explain why the power is distributed at a high transmission voltage over long distances. 2 marks