



VCE PHYSICS UNITS 3&4 [2020]

Unit 3 AOS 2 - How are fields used to move electrical energy? - Topic Exam 2

YOUR NAME: Vishnu Prasad Sivakumar

STRUCTURE OF EXAM

Section A - Short Answer

10 questions

44 marks

44 marks

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SECTION A – SHORT ANSWER

Question 1 (4 marks)

Emily and Gerry are studying generators and alternators. They have constructed the device shown in Figure 1.

The coil is a single rectangular loop of effective area $9.0 \times 10^{-4} \text{ m}^2$. The coil can be rotated about an axis as shown, in a uniform magnetic field, B , larger in area than the coil.

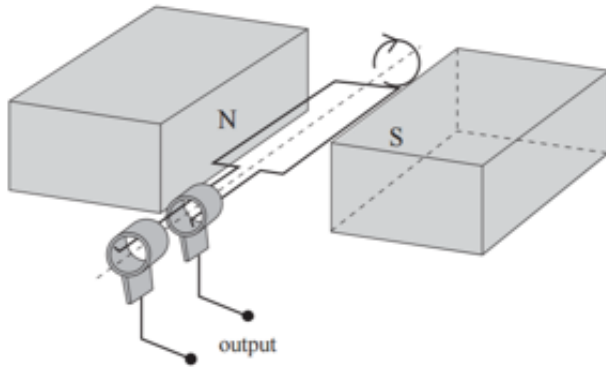


Figure 1

Question 1.a

2 marks

The maximum magnetic flux that passes through the coil is $7.2 \times 10^{-6} \text{ Wb}$.

What is the magnitude of the uniform magnetic field?

Question 1.b

2 marks

In the experimental setup shown, how would the coil be orientated at the point when there is maximum flux in the coil? Give a reason for your answer.

Question 2 (2 marks)

Emily and Gerry have been studying generators and alternators. They have constructed the device shown in Figure 3.

The rectangular coil, which is a single loop of area of $9.0 \times 10^{-4} \text{ m}^2$, is rotated in the direction shown, in a uniform magnetic field with a direction indicated by B.

The coil is completely contained in the magnetic field.

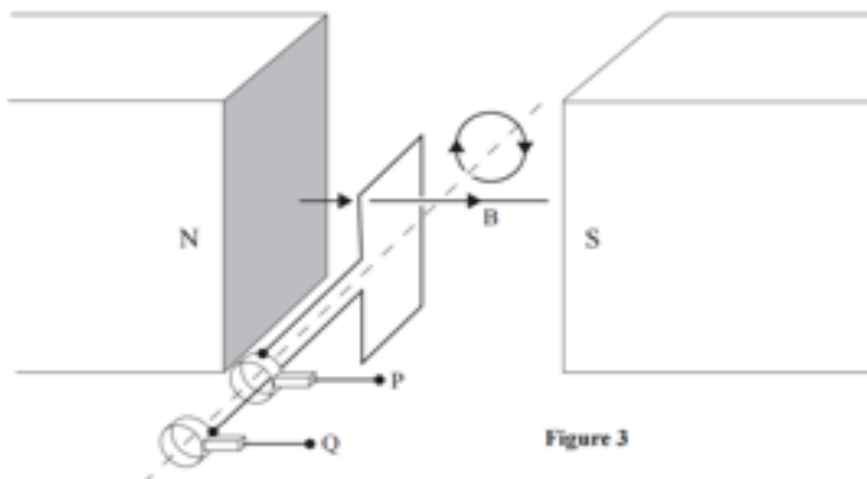
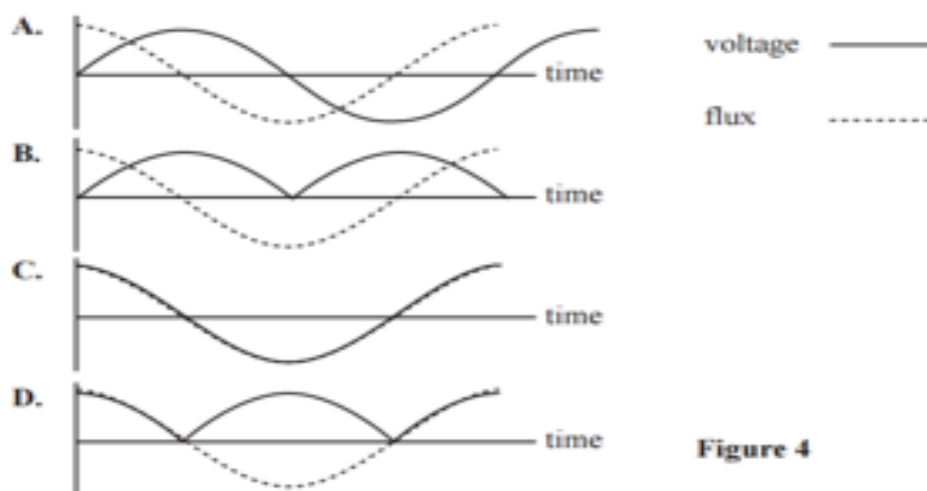


Figure 3



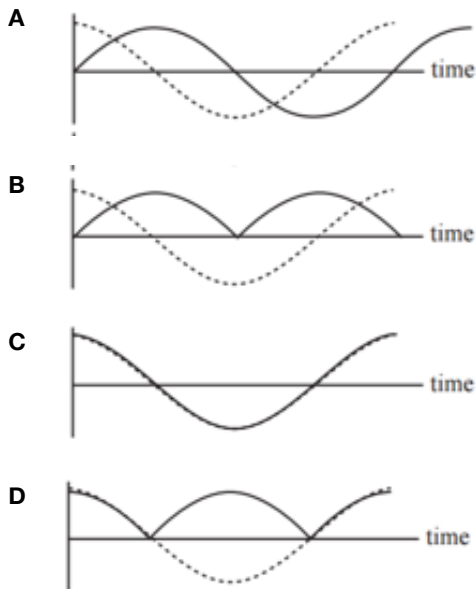
They tested the device by firstly connecting an oscilloscope between the terminals P and Q, and then rotating the coil at a constant rate, in the uniform field B, in the direction shown. Figure 4 shows graphs of the magnetic flux through the coil and of the voltage measured between the terminals.

Question 2.a (2 marks)

Which one of the graphs in Figure 4 best represents the voltage observed on the oscilloscope?

voltage ———

flux

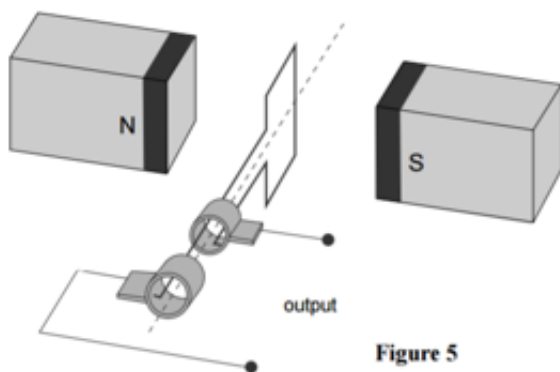
**Question 3**

3 marks

Explain the difference in function between a split-ring commutator and slip rings. Describe the situations in which a split-ring commutator and slip rings are used.

Question 4 (6 marks)

Figure 5 shows an alternator consisting of a rectangular coil with sides of $0.20\text{ m} \times 0.30\text{ m}$, and 1000 turns rotating in a uniform magnetic field. The magnetic flux through the coil in the position shown is $3.0 \times 10^{-4}\text{ Wb}$.

**Figure 5**

Question 4.a

3 marks

What is the magnitude of the magnetic field? Include a unit.

Question 4.b

3 marks

The coil rotates a quarter of a revolution in 0.01 s from the starting position shown in Figure 5.

Calculate the magnitude of the average induced emf in the coil in this time. You must show your working.

Question 5 (8 marks)

At a particular speed of rotation, the output of another alternator is as shown in Figure 6 below

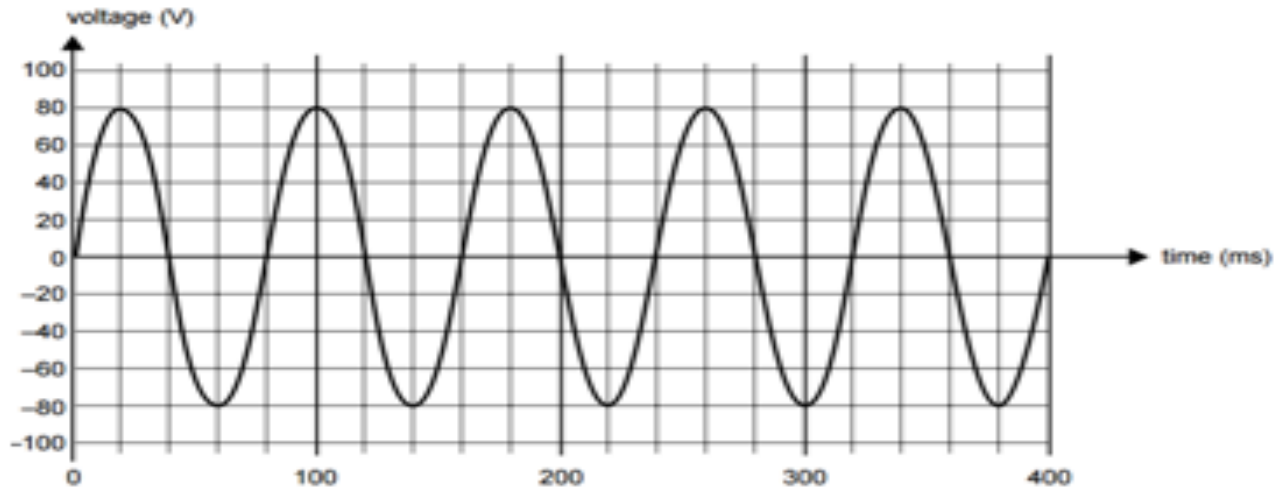


Figure 6

Question 5.a

3 marks

What is the frequency of rotation of the alternator?

Question 5.b

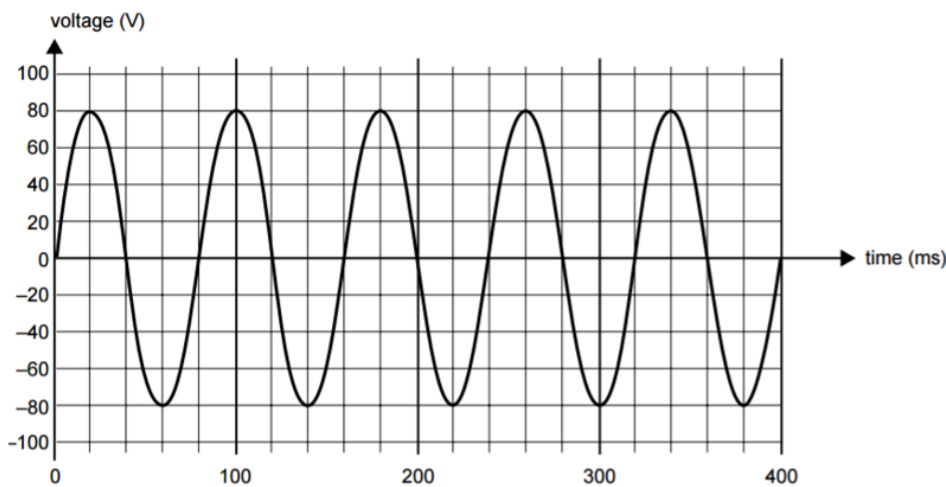
2 marks

What is the RMS value of the output voltage?

Question 5.c

3 marks

The experimenters make 2 changes to the generator. They replace the slip rings with a split ring commutator and rotate the coil at a quarter of the original speed. The graph shows the original voltage produced. On this diagram add a second trace to represent the new voltage produced.

**Figure 6**

Question 6

2 marks

A camping store has started to sell some low voltage TV systems that operate on a constant 12 Volt supply. These devices have been precisely constructed and tested to withstand voltages as high as 14 Volts. The store advertises that these units can be used with DC generators that supply $12 V_{\text{RMS}}$.

They find that many of these devices are being returned as faulty, explain why so many of these devices are failing when used under the conditions advertised.

Question 7 (3 marks)

An ideal transformer has 130 turns in the primary coil and 5200 turns in the secondary coil.

Question 7.a

1 mark

A DC voltage signal of 12 V is connected to the primary coil. State the value of the steady voltage at the output of the secondary coil.

Question 7.b

2 marks

An AC voltage signal is then connected to the primary coil and an AC RMS voltage of 400 V appears at the output of the secondary coil.

Calculate the peak value of the voltage at the input of the primary coil.

Question 8

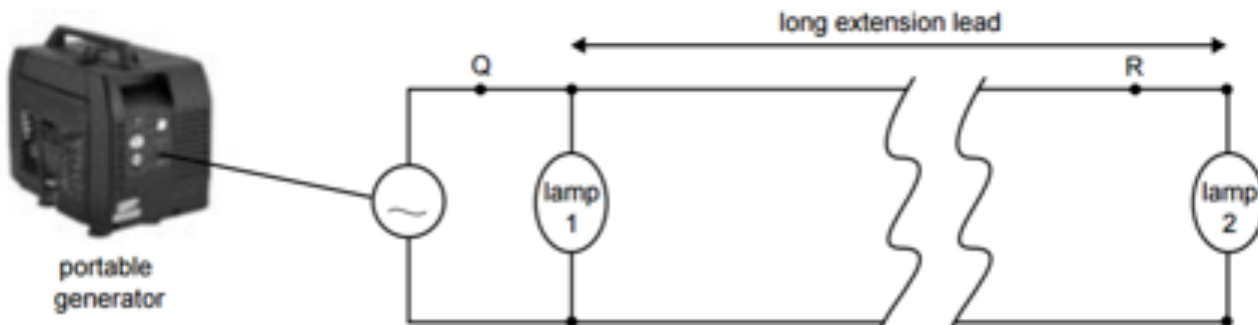
3 marks

A student has designed and is testing an AC generator as part of their practical investigation. When they place this in a heating circuit they measure the average power delivered to be 36 Watts. If the peak current was measured to be 3.8 A, calculate the size of the peak to peak voltage being supplied by the generator.

Question 9 (9 marks)

John is using a small portable generator which has both a $240\text{ V}_{\text{RMS}}$ and 12 V_{RMS} output. He wants to power two identical 12 V lamps as shown in Figure 5.

The first lamp is connected directly to the low voltage output of the generator. The second lamp is some distance away and requires a 75 m extension lead. The total resistance of the extension lead is $1.0\ \Omega$. When the generator is started, both lamps glow, but lamp 1 is considerably brighter than lamp 2. John measures the current at R to be 4.0 A . Assume both lamps have constant resistance and obey Ohm's law.

**Figure 5****Question 9.a**

3 marks

Why is lamp 1 brighter than lamp 2? Justify your answer.

Question 9.b

4 marks

Calculate the power dissipated in lamp 2.

Question 9.c (2 marks)

Which one of the following statements is true?

- A** the current at Q is less than 4 A
- B** the current at Q is 4 A
- C** the current at Q is 8 A
- D** the current at Q is greater than 8 A

Question 10

4 marks

Efficient transmission of electric power over long distances often involves the use of step-up and step-down transformers.

Outline how the use of these transformers reduces transmission losses. Include relevant physics formulas.