



VCE PHYSICS UNITS 3&4 [2020]

Unit 3 AOS 2 - How are fields used to move electrical energy? - Topic Exam 1

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STRUCTURE OF EXAM

Section A - Short Answer

9 questions

39 marks

39 marks

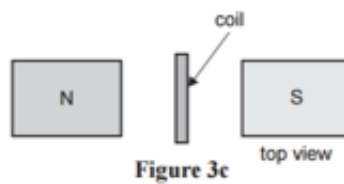
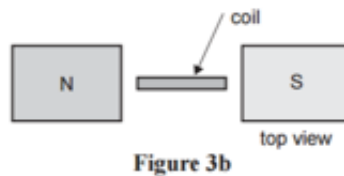
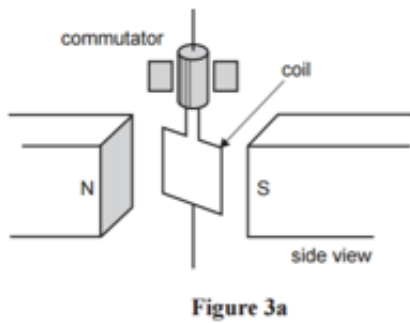
WHEN YOU FINISH

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SECTION A – SHORT ANSWER**Question 1** (4 marks)

Jo and Effie have found a design for a small electric motor, shown in Figure 3a below. It consists of two large permanent magnets, a coil of wire and a commutator. They plan to build the motor as part of their Physics experiment. The area of the coil is 5.0 cm^2 and the magnetic field strength (which can be assumed to be uniform) between the poles is $2.0 \times 10^{-4} \text{ T}$ (Wb m^{-2}).

**Question 1.a**

2 marks

What is the magnetic flux, Φ_B , threading the loop when the face of the coil is aligned as shown in Figure 3b? Include the unit.

Question 1.b

2 marks

What is the magnetic flux, Φ_B , threading the loop when the face of the coil is aligned as shown in Figure 3c?

Include the unit.

Question 2 (6 marks)

Students are using an AC generator with a coil that rotates at a steady speed in a uniform magnetic field. The generator is producing a sinusoidal voltage signal that varies with time, as shown in Figure 5.

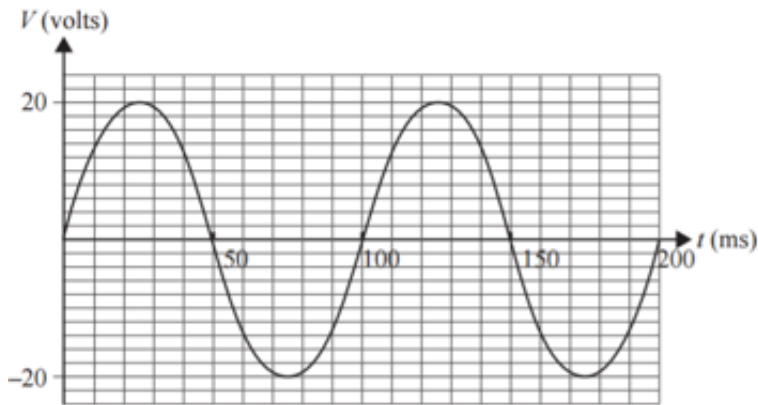


Figure 5

Question 2.a

2 marks

Calculate the frequency of the AC signal shown in Figure 5.

Question 2.b

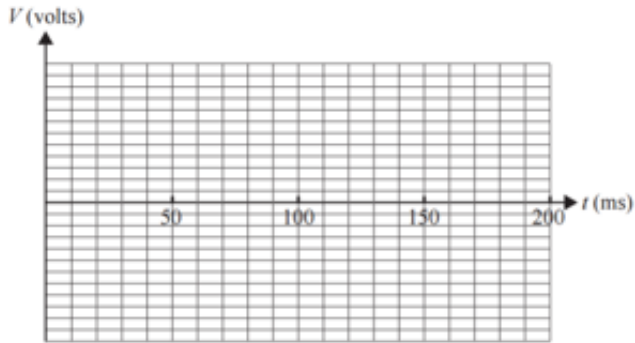
1 mark

Calculate the RMS voltage of the signal shown in Figure 5.

Question 2.c

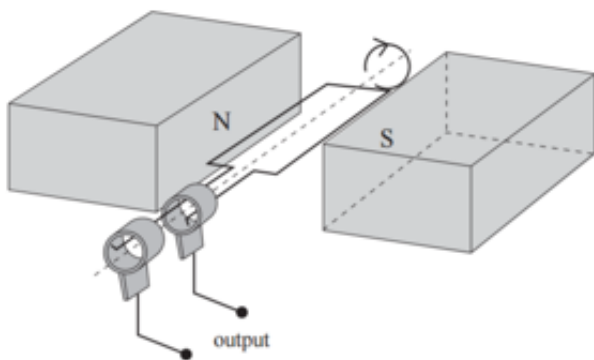
3 marks

The students halve the speed of rotation of the generator. On the axes below, sketch the voltage signal that the AC generator will now produce. Label the voltage axis carefully with the correct numbers.



Question 3 (6 marks)

The experimental apparatus shown was used to generate a voltage when the coil was rotated at a constant rate. The coil is shown as horizontal in the figure.



Question 3.a

3 marks

Identify which of the following statements are true or false.

Statement**True or False**

The output voltage is DC

The maximum voltage is produced when the coil is vertical

There is a constant voltage produced if the coil is rotated at a constant rate

Question 3.b

3 marks

State 3 ways that the RMS voltage output could be increased in the experiment described.

Question 4 (2 marks)

A local resident (Jamie) is concerned about media reports of increases in burglaries in his local area. He has purchased a very sensitive security system that requires a constant DC power supply between 16 and 20 Volts to operate. Usually the power supply included with the system works well, but during power outages the system goes off line. Jamie decides to install a simple gas powered DC generator that provides an RMS output of 18 Volts, which can be used when the power is cut.

Question 4.a

2 marks

Explain why Jamie's solution to this problem will not work.

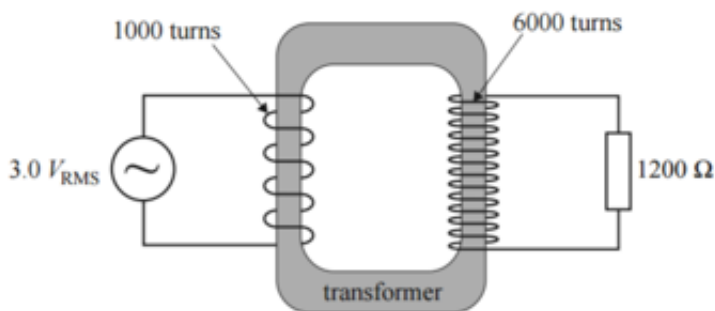
Question 5

2 marks

A power supply is designed to produce an output voltage of 50 V_{RMS} . What would the corresponding size of the peak to peak voltage?

Question 6 (7 marks)

Students are experimenting with an ideal transformer. The circuit is shown in Figure 19.

**Figure 19**

The primary coil has 1000 turns; the secondary coil has 6000 turns. There is a $1200\ \Omega$ resistor in the secondary circuit. A $3.0\text{ V}_{\text{RMS}}$ AC power supply is connected across the primary coil.

Question 6.a

1 mark

Calculate the RMS voltage across the resistor.

Question 6.b

1 mark

Calculate the peak voltage across the resistor.

Question 6.c

2 marks

Calculate the power dissipated in the resistor.

Question 6.d

3 marks

The students now modify the circuit, and connect a 3.0 V DC battery and a switch in the primary circuit, as shown in Figure 20.

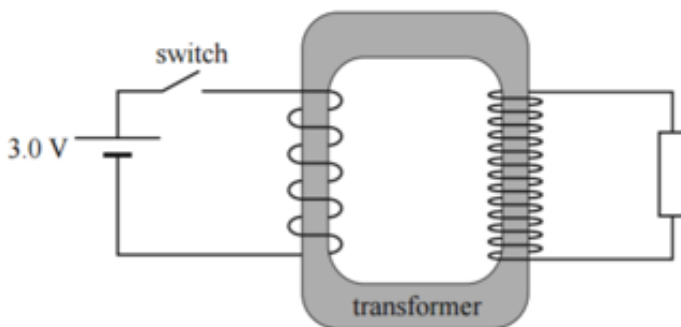


Figure 20

The students have been asked to observe the current in the resistor as the switch is closed. Before the switch is closed, there is no current in the resistor. This does not surprise them. When the switch is closed, there is a very short pulse of current in the resistor. When the switch remains closed, there is no current in the resistor.

Explain why there is a short pulse of current as the switch is closed and why there is no current in the resistor as the switch remains closed. No numbers are required in your answer, but you should refer to the relevant law of physics.

Question 7

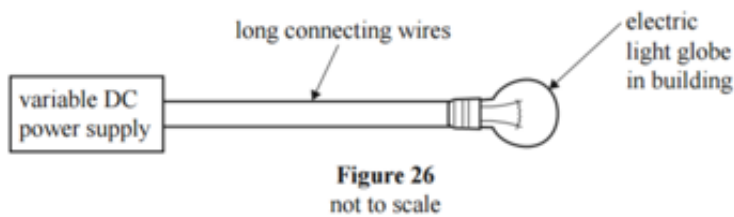
3 marks

A circuit is set up to power a simple lighting display in a well-known department store. The store electrician measures the voltage and current using a multi-meter and records these as 62 VRMS and 15 ARMS. To ensure that safety documentation is completed she needs to calculate the maximum power delivered in the circuit at any one time.

Calculate the maximum power delivered when the lights are in operation.

Question 8 (6 marks)

Jemima is planning to operate an electric light globe in a building some distance from her house. To do this, she connects two long wires from a variable voltage DC power supply in house to an electric light globe in the building.



The wires have a total resistance of $5.0\ \Omega$. The DC power supply produces a constant output voltage of 13 V. The light globe in the building is designed to operate at 6.0 V. Assume that its resistance is a constant $1.5\ \Omega$. When Jemima switches on the circuit, she measures the voltage at the light globe to be only 3.0 V.

Question 8.a

1 mark

Calculate the voltage loss in the long connecting wires.

Question 8.b

1 mark

Calculate the power output of the light globe at this voltage.

Question 8.c

1 mark

Calculate the current flowing in the long connecting wires.

Question 8.d

3 marks

Calculate the greatest voltage that Jemima can set the DC power supply at, without exceeding 6.0 V across the light globe in the building. Show your working.

Question 9

3 marks

Explain why AC is used rather than DC for the transmission of electrical power over large distances. You should include references to correct formulae to support your answer, although no numerical analysis is required.
