VICTORIAN CERTIFICATE OF EDUCATION

STUDENT NAME	MARK
	……../50 **……...%**
TEACHER CODE:	

PHYSICS

SAC 2: How are fields used to move electric energy?
Reading time: 5 minutes
Writing time: 55 minutes

QUESTION AND ANSWER BOOK

Section	*Number of questions*	*Number of marks*
Part A - Multiple choice	10	20
Part B - Short answer	12	30
Total	**22**	**50**

- Students are permitted to bring into the examination room: one single sided A4 sheet of notes, pens, pencils, highlighters, erasers, sharpeners, rulers, and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper, white out liquid/tape or a CAS calculator.

Materials supplied

- Question and answer book, MC answer sheet and a formula sheet.

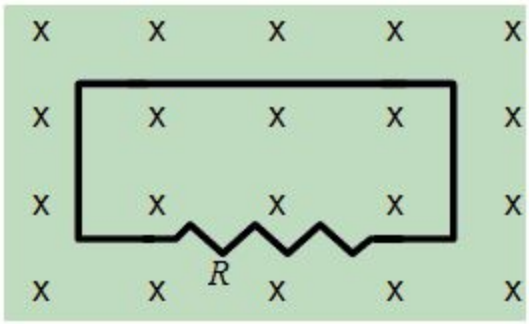
Instructions

- Write your **name** in the space provided above on this page.
- Unless otherwise indicated, the diagrams in this paper are **not** drawn to scale.
- All written responses must be in English and in **blue or black pen.** Diagrams and graphs may be drawn in pencil.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices (watches) into the test room.

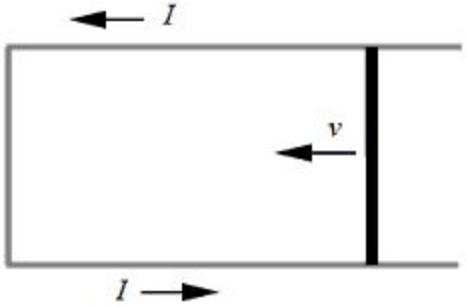
Part A - Multiple choice (20 marks)

1. The figure shows a uniform magnetic field that is perpendicular to the plane of a conducting loop with resistance *R*. Which one of the following changes will cause an induced current to flow through the resistor?



A) decreasing the area of the loop
B) decreasing the magnitude of the magnetic field
C) increasing the magnitude of the magnetic field
D) rotating the loop through 90° about an axis in the plane of the paper
E) all of the above

2. A conducting bar moves to the left at a constant speed *v* on two conducting rails joined at the left as shown. As a result of the bar moving through a constant magnetic field, a current *I* is induced in the indicated direction. Which one of the following directions is that of the magnetic field?

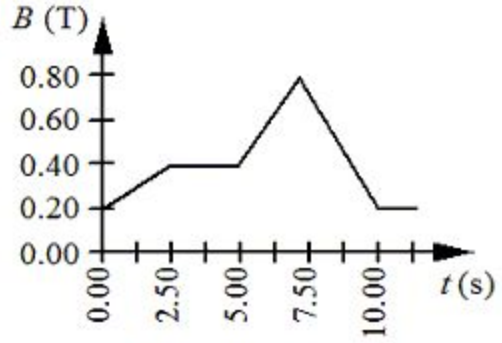


A) toward the right
B) toward the left
C) parallel to the long axis of the bar
D) into the page
E) out of the page

3. A conducting loop has an area of 0.065 m^2 and is positioned such that a uniform magnetic field is perpendicular to the plane of the loop. When the magnitude of the magnetic field *decreases* to 0.30 T in 0.087 s, the average induced emf in the loop is 1.2 V. What is the initial value of the magnetic field?

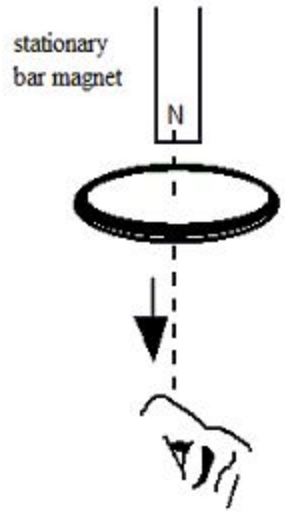
A) 0.42 T
B) 0.75 T
C) 0.87 T
D) 1.31 T
E) 1.9 T

4. A circular coil of wire has 25 turns and has a radius of 0.075 m. The coil is located in a variable magnetic field whose behavior is shown on the graph. At all times, the magnetic field is directed perpendicular to the plane of a loop. What is the average emf induced in the coil in the time interval from t = 5.00 s to 7.50 s?



A) –18 mV
B) –71 mV
C) –92 mV
D) –140 mV
E) –180 mV

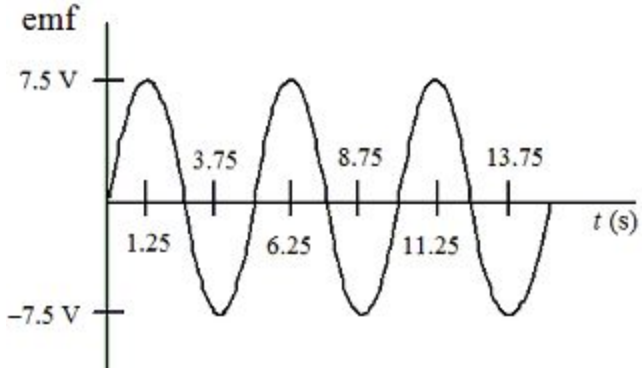
5. A metal ring is dropped from rest below a bar magnet that is fixed in position as suggested in the figure. An observer views the ring from below. Which one of the following statements concerning this situation is true?



A) As the ring falls, an induced current will flow *counterclockwise* as viewed by the observer.
B) As the ring falls, an induced current will flow *clockwise* as viewed by the observer.
C) As the ring falls, there will be an induced magnetic field around the ring that appears *counterclockwise* as viewed by the observer.
D) As the ring falls, there will be an induced magnetic field around the ring that appears *clockwise* as viewed by the observer.
E) Since the magnet is stationary, there will be no induced current in the ring.

Use the following information to answer question 6:

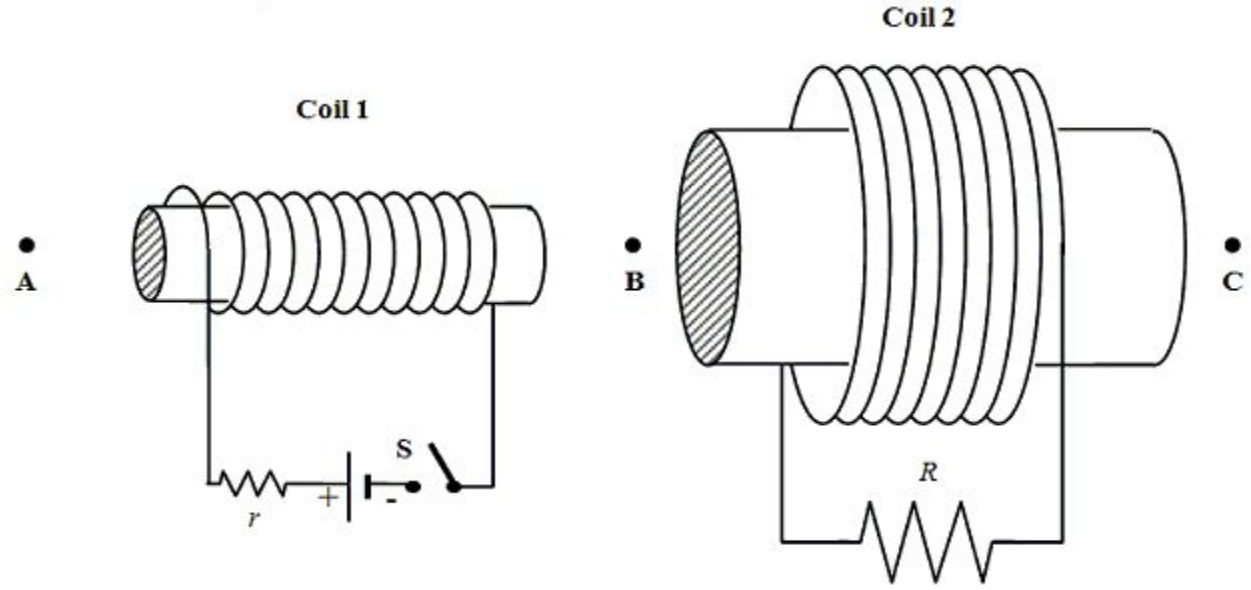
A single conducting loop with an area of 2.0 m^2 rotates in a uniform magnetic field so that the induced emf has a sinusoidal time dependence as shown.



6. With what frequency does the loop rotate?
   A) 0.15 Hz
   B) 0.20 Hz
   C) 0.50 Hz
   D) 0.80 Hz
   E) 1.25 Hz

Use the following information to answer questions 7:

Two coils, **1** and **2**, with iron cores are positioned as shown in the figure. Coil **1** is part of a circuit with a battery and a switch.



7. Immediately after the switch **S** is closed, which one of the following statements is true?
   A) An induced current will flow from right to left in *R* (resistor in the coil 2 circuit).
   B) An induced current will flow from left to right in *r* (resistor in the coil 1 circuit).
   C) A magnetic field that points toward **B** appears inside coil **1.**
   D) An induced magnetic field that points toward **B** appears inside coil **2**.
   E) A current will pass through *r*, but there will be no current through *R*.

8. An ideal transformer has 450 turns in its primary coil and 30 turns in its secondary coil. Which one of the following statements concerning this transformer is true?
   A) This is a *step-up* transformer.
   B) The secondary to primary *turns ratio* is 15 for this transformer.
   C) The ratio of the voltages $V_{\text{Secondary}} / V_{\text{Primary}}$ is 15 for this transformer.
   D) The ratio of the currents $I_{\text{Primary}} / I_{\text{Secondary}}$ is 0.067 for this transformer.
   E) The power delivered to the secondary is larger than the power delivered to the primary.

Use the following information to answer questions 9-10:

A small power plant produces a voltage of 6.0 kV and 150 A. The voltage is stepped up to 240 kV by a transformer before it is transmitted to a substation. The resistance of the transmission line between the power plant and the substation is 75 Ω.

9. What is the current in the transmission line from the plant to the substation?
   A) 3.8 A
   B) 5.2 A
   C) 6.4 A
   D) 7.0 A
   E) 7.5 A

10. What percentage of the power produced at the power plant is lost in transmission to the substation?
   A) 0.47 %
   B) 0.41 %
   C) 0.34 %
   D) 0.23 %
   E) 0.12 %

Short answer questions (30 marks)

1. A circular coil has 275 turns and a radius of 0.045 m. The coil is used as an ac generator by rotating it in a 0.500 T magnetic field, as shown in Figure 1. At what frequency should the coil be rotated so that the average emf during a quarter of a period is 175 V?

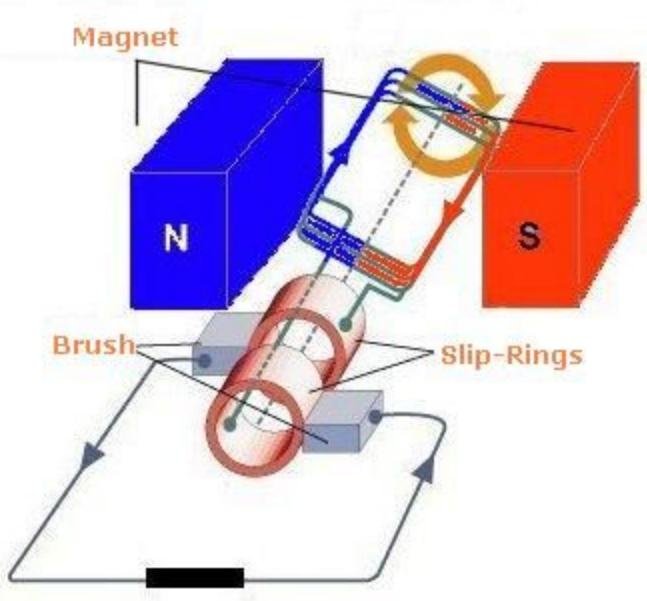


Figure 1

3 marks

The information and diagram in question 2 is to be used in questions 3, 4, 5 and 6:

2. In order to satisfy the electrical power needs of a village, an electrical company builds a 100 KW wind generator, 20 km away from the community. The power is supplied by an alternator, which generates electricity at 250 V_{RMS} at a frequency of 50 Hz. This is converted by a step-up transformer (T_1) to 22 000 VRMS, transmitted to the edge of the village by power lines with a total resistance of 8.0 Ω (4.0 Ω each wire), and converted back to 250 V_{RMS} by a step-down transformer (T2) near the village. A diagram of the system is shown in Figure 2 below.

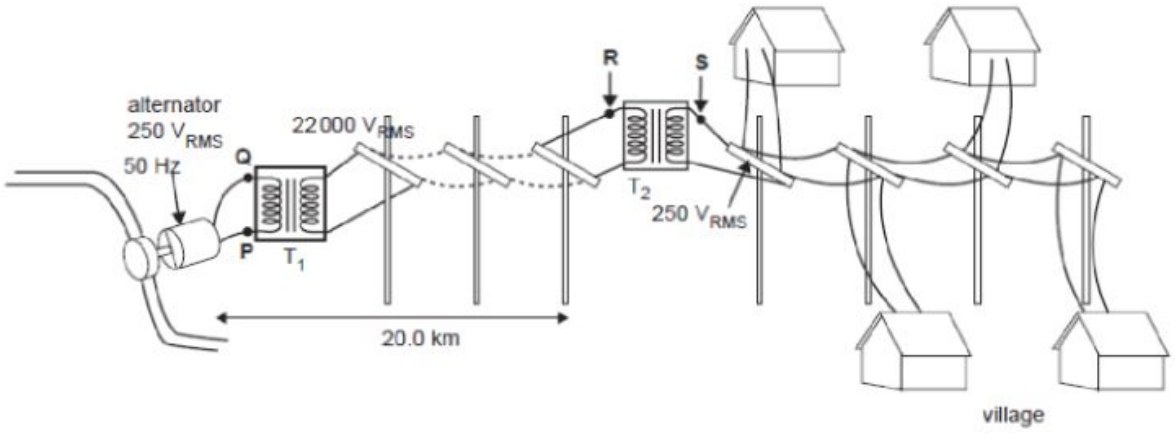


Figure 2

What is the current at point Q?

2 marks

3. What is the current in the transmission lines in Figure 2?

2 marks

4. What is the power loss in the transmission lines in Figure 2?

2 marks

5. What is the voltage in the primary of the T2 transformer?

2 marks

6. Briefly explain how the 22000 V high-voltage transmission system leads to lower power losses in the wind generator - village system.

3 marks

7. At a particular speed of rotation, the output of another alternator is as shown in Figure 3 below.

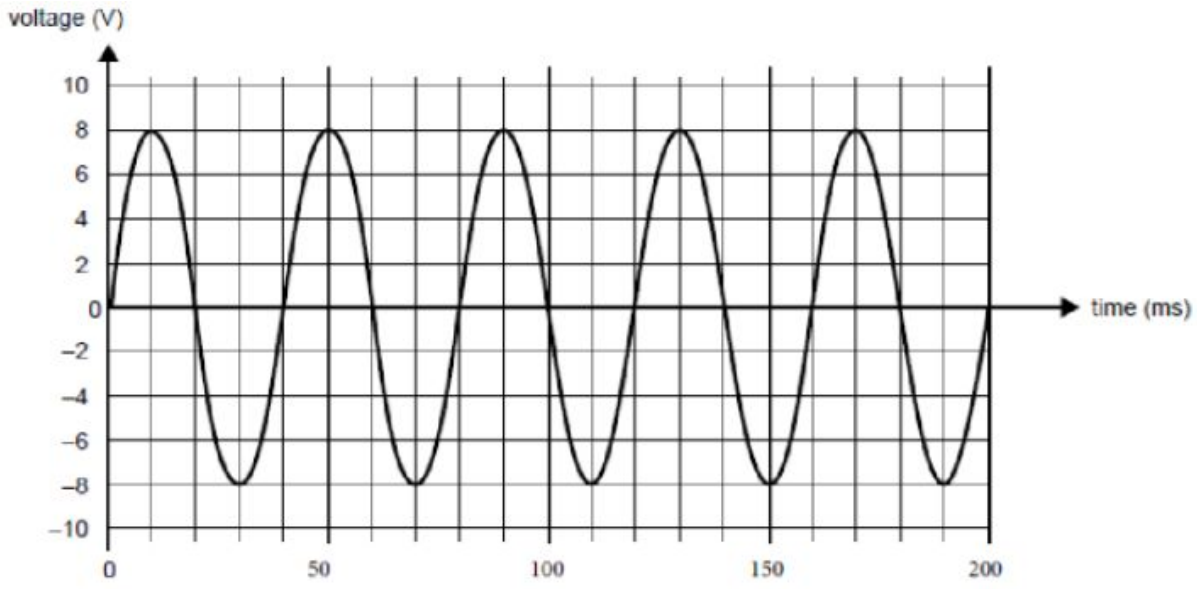


Figure 3

What is the frequency of rotation of the alternator?

2 marks

8. What are the RMS , peak and peak to peak values of the output voltage?

3 marks

9. An AC alternator is rotating at a steady 50 revolutions per second. The output voltage, as measured on an oscilloscope, is shown below in Figure 4.

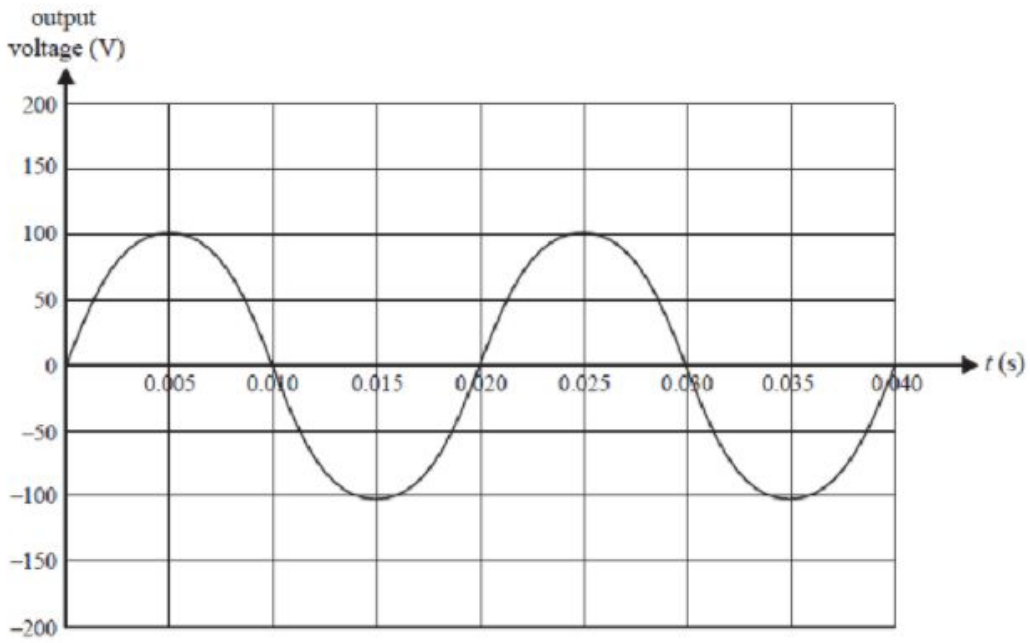
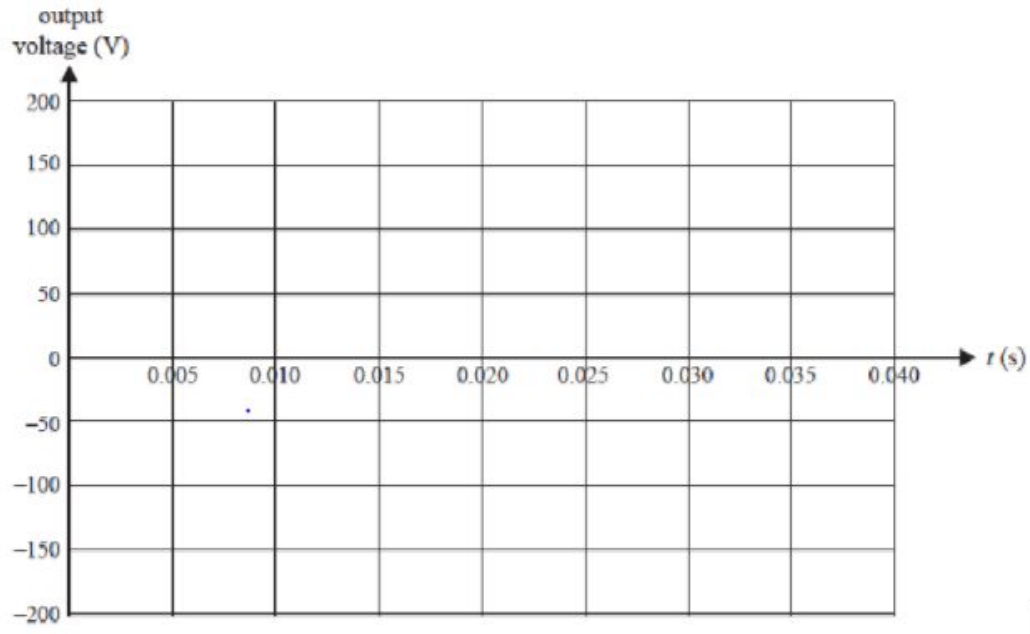


Figure 4

The rate of rotation is then increased to 100 revolutions per second. On the axes provided below sketch how the output will now appear. 2 marks



10. Figure 5 shows a schematic diagram of a DC electric generator.

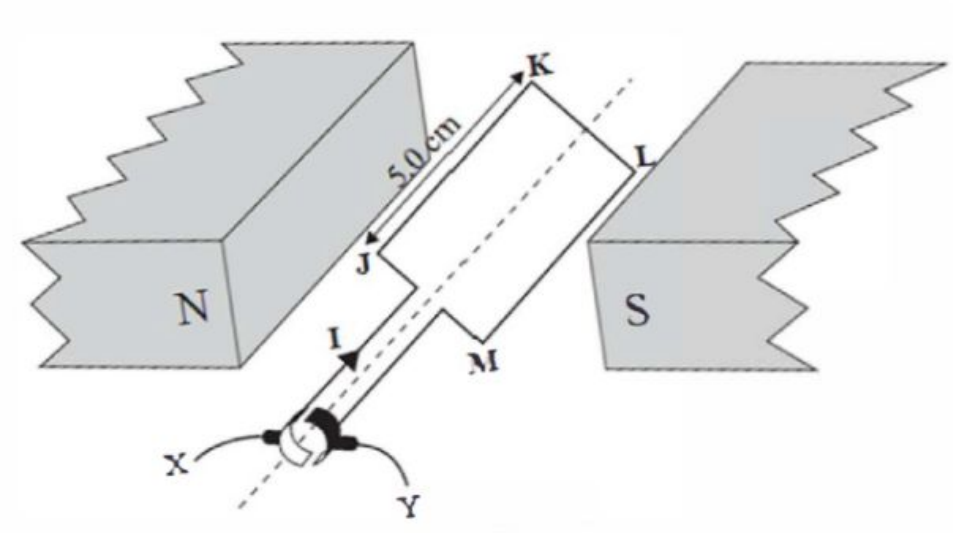


Figure 5

Explain the role of the split ring commutator in the operation of a DC electric generator.

3 marks

11. Students are testing a transformer. The transformer is working correctly. The transformer has 600 turns in the primary coil and 150 turns in the secondary coil. The students connect the transformer to a 20 V battery and they measure the output voltage in the secondary circuit. What is the value that they measure? Explain your answer in terms of electromagnetic induction.

3 marks

12. Figures 6A and 6B show a square loop being moved between the poles of a magnet. In the space between the poles there is a uniform magnetic field. The loop moves at a steady speed from position 1 to position 3. The loop is connected to a sensitive microammeter. The area of the loop is much less than the area of the magnetic field. You may assume that the only magnetic field present is located directly between the north and south poles.

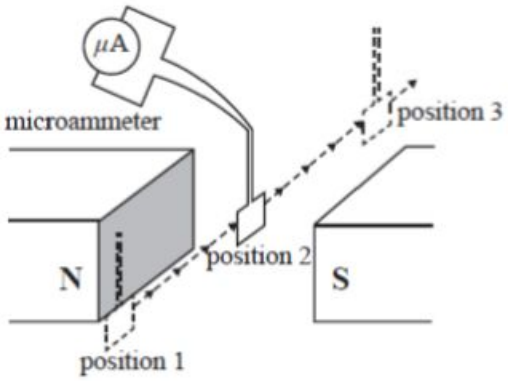


Figure 6A

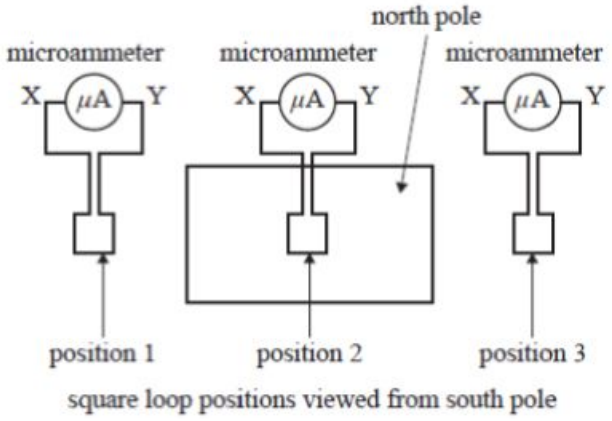


Figure 6B

Describe the direction of the current in the square loop as it moves **from position 2 to position 3**, as viewed from the south pole (see Figure 6B). You may use a sketch in your answer. Explain the reasons for your answer.

3 marks

Multiple Choice Answer Sheet

1. A B C D E

2. A B C D E

3. A B C D E

4. A B C D E

5. A B C D E

6. A B C D E

7. A B C D E

8. A B C D E

9. A B C D E

10. A B C D E