



Perth College

Anglican School for girls

Year 12 Physics ATAR

## Electromagnetism 2 Practice Test

Student Name:

Teacher:

\_\_\_\_\_

Total: \_\_\_\_\_ /62

Time allowed for this paper: 55 minutes

This test contains three parts:

Section A: Short Answer                      20 marks

Section B: Problem-Solving                32 marks

Section C: Comprehension                10 marks

Note: Some extra practice questions have been added to Sections A and B.

Answers are to be written in the space below or next to each question.

When calculating numerical answers, show your working or reasoning clearly. Give final answers to three significant figures and include appropriate units where applicable.

When estimating numerical answers, show your working or reasoning clearly. Give final answers to a maximum of two significant figures and include appropriate units where applicable.

---

You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

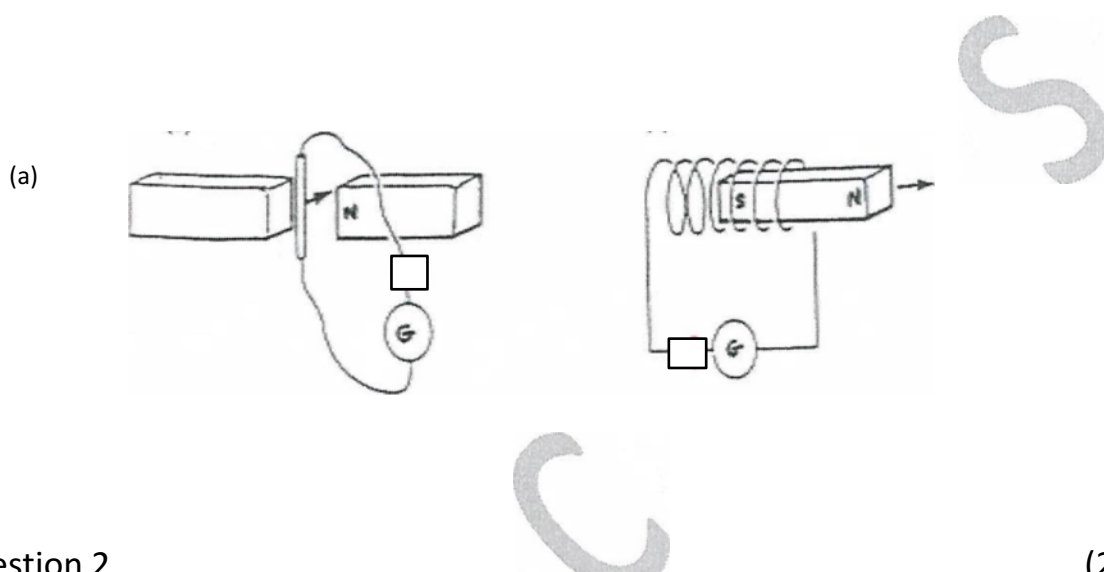
**Section One: Short Response** **(20 marks)**

This section has six (6) questions. Answer all questions. Write your answers in the spaces provided.

---

**Question 1** **(2 marks)**

In each case below, an external force is applied in the direction of the arrow inducing an emf in the external circuit, and current flow is detected by the galvanometer. Indicate the direction of induced current in each of these cases. Draw an arrow on the wire next to the galvanometer.



**Question 2** **(2 marks)**

Calculate the magnetic flux threading a single loop of wire shaped into a rectangle of length 5.00 cm and width 4.00 cm and held perpendicular to a uniform field of 0.300 T.

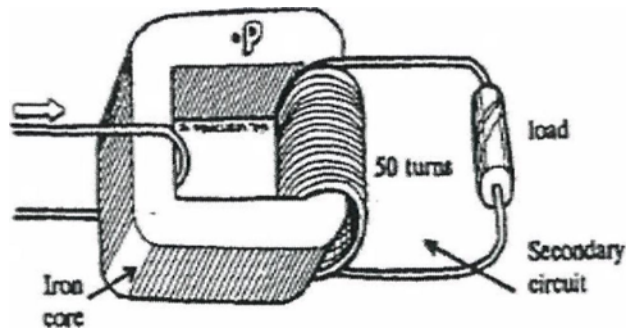
## Question

(4 marks)

3

A single loop of wire is passed through the iron core of a transformer as shown in the diagram below. This loop forms the primary circuit. The secondary winding has 50 turns.

A steady current of 10.0 mA DC is flowing in the primary circuit in the direction shown by the arrow.



- (a) Draw, on the diagram, an arrow to indicate the direction of the magnetic field at P, created by the current in the primary circuit. (1 mark)
- (b) The current in the primary circuit is steadily increased over 0.0500 seconds, causing the magnetic flux threading the loops to increase by 0.00500 Wb.

(3 marks)

## Question

(4 marks)

4

A set of door chimes is activated from the 6.00 V output of a step-down transformer. The transformer primary input is at 240 V and has a current of  $1.00 \times 10^{-1}$  A. The primary coil has 120 turns. Calculate the current flowing through the door chimes from the transformer if the transformer is 90% efficient.

## Question 5(4 marks)

The 'black box' on the power lead that connects a standard school laptop computer to the domestic power supply for recharging batteries is marked

TOSHIBA AC ADAPTOR

INPUT: 240V, 0.550 A, 50 Hz OUTPUT:

15.0V, 3.00 A

(a) What type of device is this adaptor? Be specific. (1 mark)

\_\_\_\_\_

(b) Calculate the efficiency of the power lead. (3 marks)

\_\_\_\_\_

Question

(4 marks)

6

(a) Explain the difference between an AC and a DC generator. (2 marks)

---

---

(b) Name two physical quantities that determine the magnitude of the induced emf from a generator and explain the effect on the induced emf if these quantities are increased

End of Section A

Question

(4 marks)

## Section Two: Problem-Solving

(32 marks)

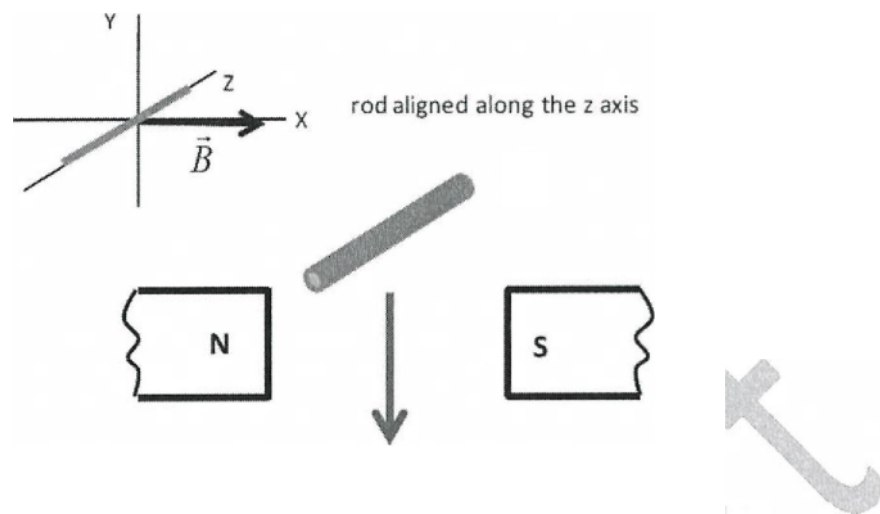
This section has two (2) questions. Answer all questions. Write your answers in the spaces provided.

---

Question 7

(7 marks)

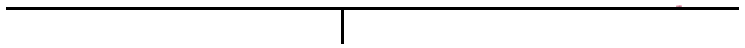
A copper rod is held in a horizontal position just above the poles of a permanent magnet. It then is released and falls through the magnetic field of the magnet.



(a) Describe how an induced emf is created in the rod, (2 marks)

(b) State and explain how the motion of the rod differ from its free fall motion. (3 marks)

---





- (c) Indicate with the letter N on the diagram end of the rod that becomes negatively charged. (1 mark)
- (d) Explain why is no induced current in the rod. (1 mark)

Question 8

(6 marks)

An aeroplane with a wingspan of 10.0 m is flying horizontally at a velocity of 200 m s<sup>-1</sup>. In the region the plane is flying, the Earth's magnetic field is  $2.0 \times 10^{-4}$  T at an angle of 60.0° to the horizontal.

- (a) Calculate the vertical component of the Earth's magnetic field.

(2 marks)

- (b) Calculate the emf induced across the wingtips of the plane.

(2 marks)

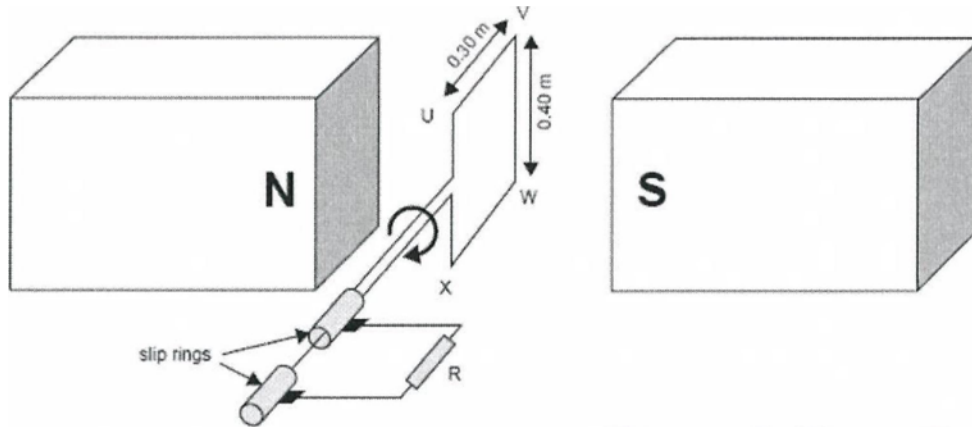
- (c) Could this emf be used to power the cabin lights? Explain.

(2 marks)

## Question 9

(12 marks)

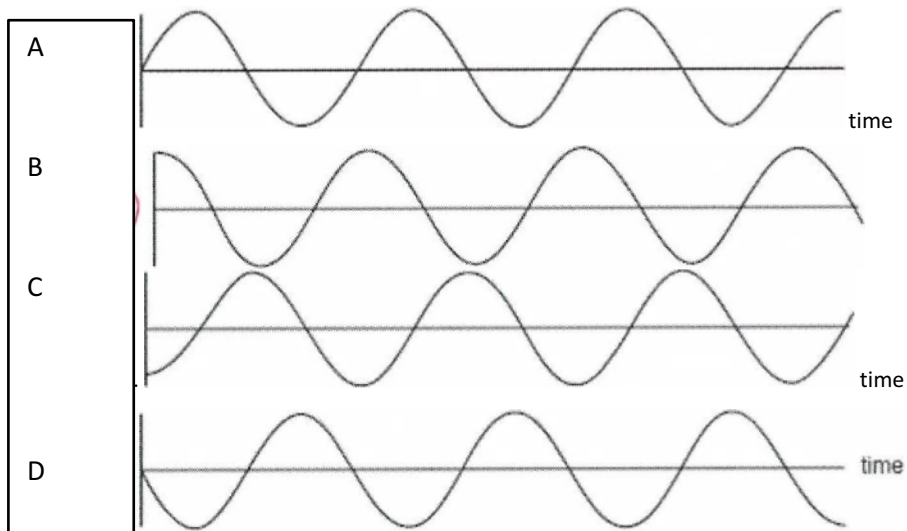
The figure below is a diagram of a simple alternator. A coil  $0.300\text{ m}$  by  $0.400\text{ m}$ , consists of 20 turns of wire. It is in a uniform magnetic field of strength  $0.250\text{ T}$ , and can rotate as shown.



- (a) Calculate the magnitude of the magnetic flux through each turn of the coil when the coil is oriented as above. (3 marks)
- (b) The coil is rotated at a constant rate of 50 revolutions per second in the direction shown. Calculate the average voltage developed across the resistor  $R$  when the coil rotates through  $90$  degrees from the orientation shown in the figure above. (3 marks)

(c) The graphs below show possible variations of the magnetic flux through the coil as a function of time as it rotates. They all begin at time  $t = 0$ , when the coil is oriented as in the diagram above.

(i) Indicate which of these graphs (A — D) best shows the variation of the magnetic flux through the coil as a function of time. Take the direction from N to S in the figure as positive. (1 mark)



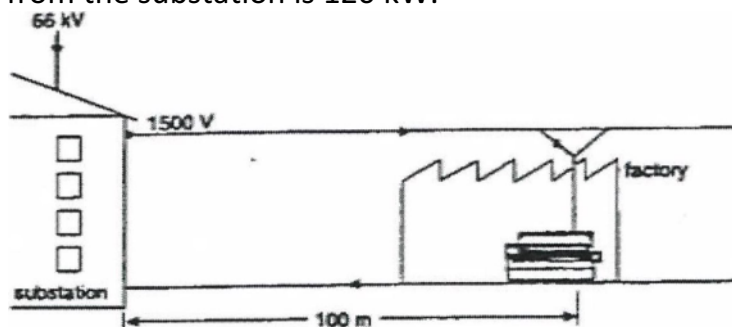
D.

(ii) Assuming the same conditions, indicate which of the graphs (A — D) best shows the variation of the current flowing from U to V in the coil, as a function of time?

## Question 10

(7 marks)

An electrical power grid supplies 66.0 kV to a substation which uses a transformer to provide power at 1500 V to a line to operate a machine in a factory as shown below. The power output from the substation is 120 kW.



The machine is located 100 m from the substation and the average resistance of the circuit wires are  $4.00 \times 10^{-3} \Omega/\text{m}$  (a circuit return wire is also used).

(a) Calculate the current that flows in the factory circuit when the machine is operating.  
(3 marks)

(b) What is the total power lost in the circuit wires when the machine is operating?

(2 marks)

(c) What is the actual operating voltage of the machine? (2 marks)

---

---

End of Section B

## Section Three: Comprehension

(10 marks)

This section has one (1) question. Answer all questions. Write your answers in the spaces provided.

Read the article below and answer the questions that follow.

Power stations burn coal to heat water to produce steam, This steam turns the turbine which spins a massive magnet inside a very large coil of wire. As the magnet spins, electricity is induced in the coil of wire.

### Inside the generator

A generator turns mechanical energy into electrical energy. The turbine turns a rotor which consists of coils of wire wound on a steel core (see Figure 3 below) an electric current supplied to the rotor produces a magnetic field so that it behaves like a magnet. This is an electromagnet. The rotor turns inside another set of windings called the stator. As the rotor turns its magnetic field induces an electric current in the coils of the stator. Because first the north pole and then the south pole cuts the stator windings, the current that flows continually reverses its direction. This is an alternating current (AC) generator, sometimes called an alternator. In Australia, there is a cycle of flow and reversal 50 times a second, making the supply frequency 50 Hertz.

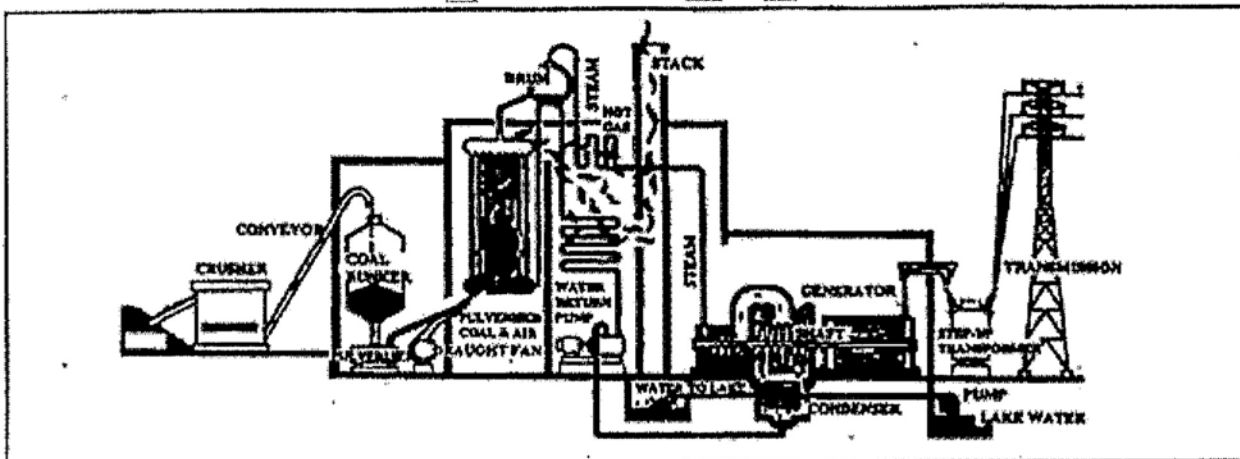


Figure 2: Inside a coal-fired power station

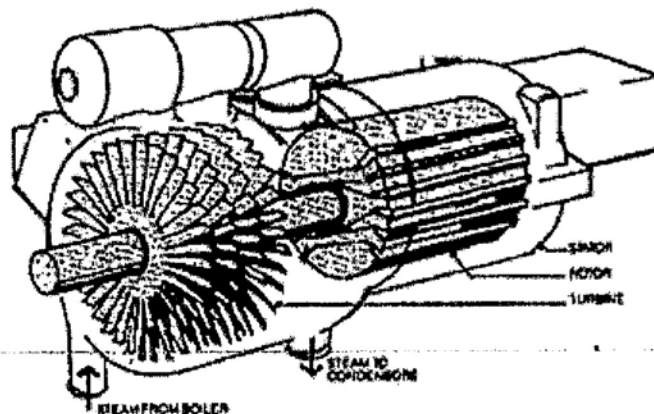


Figure 3: Inside the generator

(a) Calculate the period of the AC cycle due to the rotational speed of the turbine. (2 marks)

b) Figure 2 shows a Step-up Transformer between the generator and transmission lines. (i)

State the purpose of this device? (2 marks)

(ii) Describe the relationship between the number of windings in the primary and secondary coils that would exist in this device. (1 mark)

(iii) These devices require some sort of heat dissipation (i.e. cooling) design. Explain: (1 mark)

- e) Explain why the coils of the rotor are wound on a steel core. (2 marks)

12

- f) The induced emf is produced in the coils of the stator. Western Australia power grid generators have three stators placed around the rotor. Each produces an emf as the rotor spins but the resulting electrical cycles are out of phase. A basic law would suggest you could not continually add more stators to induce a greater number of separate emf supplies from the same rotor without affecting its rotation.

Name this law.

(1 mark)

Test



Practice

---

End of Test