Christ Church Grammar School

Science Department
Year 12 2021

ATAR PHYSICS
UNIT 3: ELECTROMAGNETISM
TEST 1 2021

Student Name:

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Teacher: CJO JRM PCW
(Please circle)

Time allowed for this paper
Working time for paper: 50 minutes.

Instructions to candidates:

- You must include **all** working to be awarded full marks for a question. Answers should be expressed to 3 significant figures unless otherwise indicated.
- Marks may be deducted if diagrams are not drawn neatly with a ruler and to scale (if specified).
- Marks will be deducted for incorrect or absent units.
- **No** graphics calculators are permitted – scientific calculators only.

Mark:	/ 53
=	%

Question 1 **(3 marks)**

Calculate the magnitude and direction of the electric field 12.5 cm East of a negative point charge of magnitude 5.30 μC.

Question 2 **(5 marks)**

A student finds a piece of soft iron. Using a compass needle he is able to determine that the iron has no net external magnetic field.

(a) Describe two ways he could turn this piece of iron into a permanent magnet.

(2 marks)

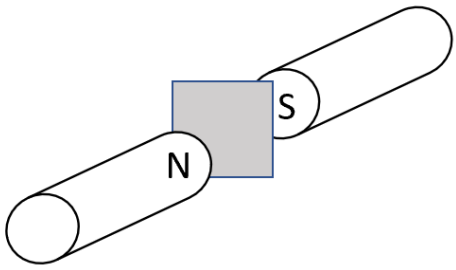
The student is successful in magnetising the iron, much to the dismay of the laboratory technician.

(b) Explain, with reference to domain theory, two ways that the technician could return the iron to a demagnetised state.

(3 marks)

Question 3 **(6 marks)**

A sheet of copper is placed between the opposite poles of a strong magnet with the magnetic field perpendicular to the sheet, as shown in the diagram below. A large force is required to pull the copper sheet out.



(a) Will the force required (circle your chosen response):

(1 mark)

A. Decrease when the speed of the pull is increased?

B. Increase when the speed of the pull is increased?

C. Not be affected by the speed of the pull?

(b) Explain the reasoning for your answer to (a) below

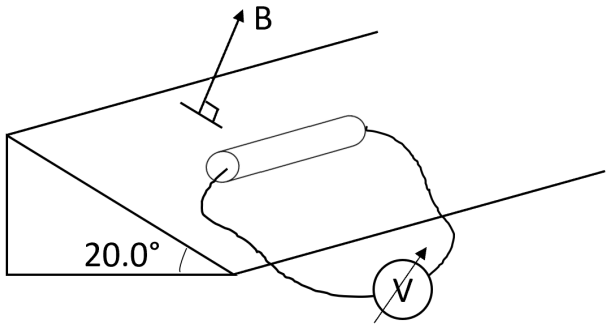
(4 marks)

(c) Indicate on the diagram the direction of rotation of the induced eddy currents when the copper sheet is pulled to the right.

(1 mark)

Question 4 **(8 marks)**

A straight piece of conducting metal of mass 100.0 g and length 20.0 cm is placed on a frictionless incline tilted at an angle of 20.0° to the horizontal. There is a uniform, 0.500 T magnetic field, B, perpendicular to the incline and directed out of the incline at all points, as shown in the diagram below.



To keep the metal from rolling down the incline, an adjustable voltage source is attached to the ends of the wire. When the correct amount of current flows through the metal it remains at rest.

(a) On the diagram above indicate the direction of the current required to keep the metal at rest.
(1 marks)

(b) Determine the magnitude of the current required to keep the metal at rest.
(4 marks)

(c) If the magnetic field is now altered to point upwards in a vertical direction, would the amount of current required to keep the wire at rest, increase, decrease or stay the same? Explain your reasoning.
(3 marks)

Question 5 **(3 marks)**

Draw the resultant magnetic field when a wire carrying current into the page is placed between two permanent magnets as shown.

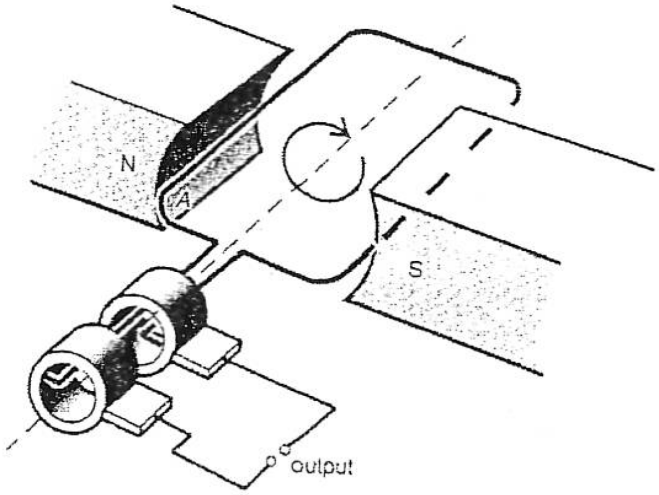
Question 6 **(4 marks)**

A generator at a power station produces electricity with a current of 1.10×10^2 A at 4.35×10^3 V. The voltage is stepped up to 2.55×10^4 V by a transformer before being sent across a high voltage transmission line across a rural area to a town. Assume the total resistance of the transmission lines are 32.0 Ω and that the transformers are ideal.

Calculate the power lost in the transmission lines.

Question 7 **(13 marks)**

A simple single phase AC generator has a coil of 200 turns. The coil is 14.0 cm long and 9.00 cm wide. The magnetic field in the generator has a strength of 0.150 T. The generator coil is turned at a rate of 3000 rpm.



(a) Explain the purpose of the slip rings in the generator

(2 marks)

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(b) On the following axes, draw a graph of the emf produced by the generator for two complete rotations from a starting position as shown in the diagram. Show the scales on the time axis and label all intercepts. You do not need to label the magnitudes on the vertical axis. (Working space for calculations is provided underneath)

(2 marks)

Working space:

(c) Calculate the emf produced by this generator and state whether your calculated value is a maximum or average.

(3 marks)

(d) On the following axis, draw a graph of the emf produced if the generator were turned at 6000 rpm instead of 3000 rpm. Using your answer to part (c) provide an approximate scale on the vertical axis.

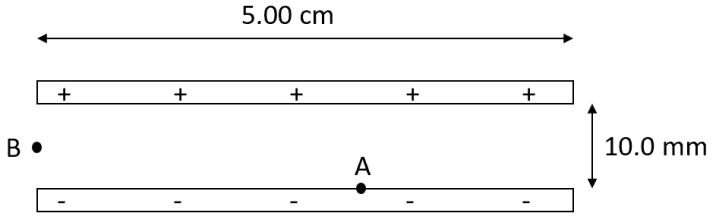
(2 marks)

(e) State and explain two ways (other than frequency) in which the construction of the generator could be modified to increase the emf generated.

(4 marks)

Question 8 **(11 marks)**

Two parallel metal plates are separated by a distance of 10.0 mm with a potential difference of 9.00 V across them as shown. An electron is placed at Point A and released from rest.



(a) Using concepts of work and energy, calculate its velocity as it passes through the half way distance between the plates.

(3 marks)

Another electron is fired horizontally from point B (the midway point between the plates) with an initial velocity of 8.60×10^6 m s^{-1}.

(b) Calculate the electron's acceleration as it passes through the plates. Assume any effects of gravity are negligible.

(4 marks)

(c) Calculate the electron's displacement from the positive plate as it leaves the field. (If you could not solve part (b) use $a = 9.60 \times 10^{13}$ m s $^{-2}$)

(4 marks)

END OF TEST