Perth College
Anglican School for Girls

Year 12 Physics ATAR

Electromagnetism 1 Practice Test

Student Name: ANSWERS

Teacher: ______________________________

Total: _______ / 50

Time allowed for this paper:
Reading time: 5 minutes
Working time: 50 minutes

This test contains two parts:

Section A: Short Answer

Section B: Problem-Solving

Section C: Comprehension

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 **30% (15 marks)**

This section has **five (5)** questions. Answer **all** questions. Write your answers in the spaces provided.

Question 1 **(2 marks)**

The Earth's North pole is a magnetic South pole. Explain the meaning of this apparent contradiction.

Magnetic north of compass needle points to geographic north pole *(1)*

As unlike poles attract, the Noerth pole of the compass needle must be attracted to the south magnetic pole *(1)*

Question 2 **(2 marks)**

An electric cable carrying direct current passes along a conduit, which lies within a factory wall running north - south. It is found that a horizontal compass needle on the east side of the wall points south instead of north.

(a) Within the wall, is the conduit and cable running horizontally or vertically? (1 mark)

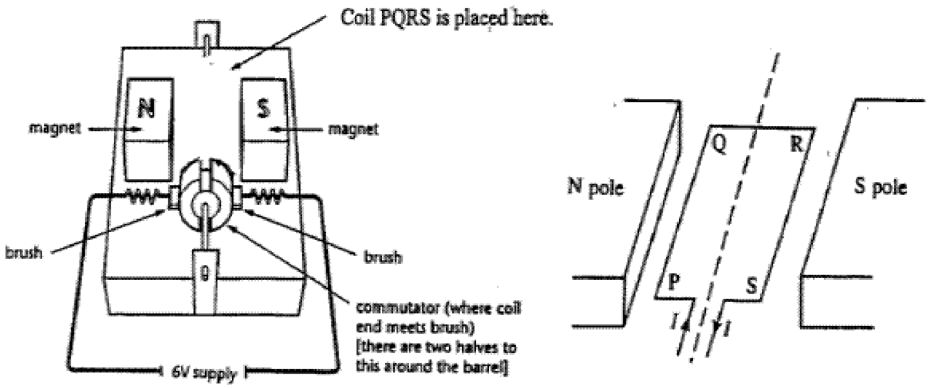
vertically

(b) What is the direction of the current in the cable? (1 mark)

down

Question 3 **(4 marks)**

A group of four students decided to make an electric motor for an assignment in which a device was to be made, its design and theory explained and the forces developed by the device calculated. The second diagram shows a rectangular coil PQRS, which can rotate about an axis, which is perpendicular to the magnetic field between two magnetic poles.



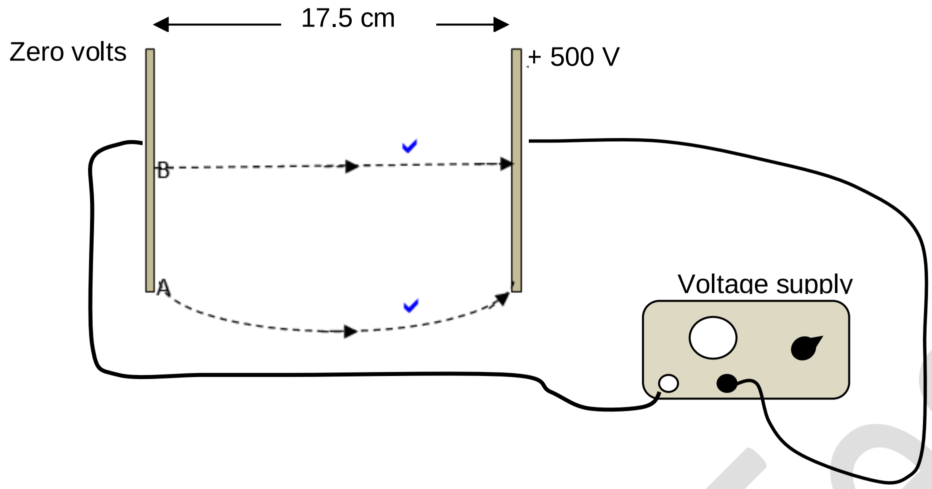
Front

Consider the information above (text, diagrams & labelling) carefully and complete the table below with T (true) or F (false) for each statement.

Statement	T or F
The 'split' ring assembly requires a DC power supply to operate this motor.	*T*
As viewed from the front, the left-hand brush will require a negative electrical polarity to drive current direction PQRS in the coil.	*F*
As viewed from the front, a current direction PQRS in the coil would cause the coil to rotate in a 'clockwise' direction.	*F*
If the external field magnets (N and S poles) were shifted closer to the coil PQRS the motor would develop greater torque.	*T*

Question 4 **(4 marks)**

In an experiment two metal plates are attached to a 500 V power supply to produce an electric field E between the plates.



(a) Determine the a value for E when the plates are placed 17.5 cm apart. (2 marks)

$E = \frac{V}{d}$ $E = \frac{500}{0.175}$

E = 2.86 X 10³ V m⁻¹

(b) Two electrons are released at points A and B on the left-hand plate which are attracted towards the right-hand plate. Draw on the diagram the paths of each of these electrons as they move from left to right. *Refer to diagram above* (2 marks)

Question 5 **(3 marks)**

Explain, with reference to the domain theory of magnetism, why a permanent magnet can pick up a steel paper-clip, even though the paper-clip is not a permanent magnet.

Without the presence of a permanent magnetic the ferromagnetic domains in the paper clip are randomly arranged *(1)*

As the magnet approaches the paper clip the domains are induced to align with the magnet's field lines *(1)*

Now the paper clip is a temporary magnet that is attracted to the permanent magnet *(1)*

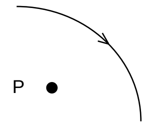
End of Section A

Section Two: Problem-Solving — 50% (25 marks)

This section has **four (4)** questions. Answer **all** questions. Write your answers in the spaces provided.

Question 6 (3 marks)

The diagram below shows a conductor carrying a 234 mA current in the direction shown. Point P is 23.5 cm from the conductor and on the same plane.



(a) State the direction of the magnetic field at P. (1 mark)

Into the page

(b) Calculate the magnetic field strength at this point. (2 marks)

$B = \frac{\mu_o I}{2\pi r}$ (1)

$B = \frac{2\times10^{-7}\times0.234}{2\pi\times0.235}$ (1) for conversions

$B = 1.99 \times 10^{-7}\ T$ (1)

Question 7 (3 marks)

Two point charges produce and electric force of 6.20 x 10^{-2} N on each other. Calculate the resulting electric force if the distance between the two point charges triples and one of the charges is doubled.

$F_1 = \frac{kq_1q_2}{r^2} = 6.20 \times 10^{-2}$

$F_2 = \frac{kq_1\times2q_2}{(3r^2)}$ (1)

$F_2 = \frac{2\times kq_1q_2}{9r^2}$

$F_2 = \frac{2}{9}\times\frac{kq_1q_2}{r^2}$ (1)

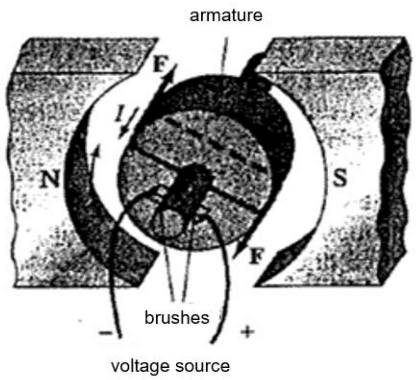
$F_2 = \frac{2}{9}\times F_1 = 6.20 \times 10^{-2}$

$F_2 = 1.38 \times 10^{-2} N$ (1)

Question 8 **(7 marks)**

The simple motor shown has windings of 3.50 cm length and 2.40 cm width and rotates in a uniform magnetic field of 7.50 x 10^{-3} T.

When 200 mA of current passes through the coil it develops a maximum torque of 1.89 x 10^{-4} Nm.



(a) Calculate the number of windings on the armature. (4 marks)

$\tau = 2 \times BIl \times r \times n$ (1)

$n = \frac{\tau}{2BIlr} = \frac{1.89 \times 10^{-4}}{2 \times 7.5 \times 10^{-3} \times 0.2 \times 0.035 \times 0.012}$ (2)

$n = 150$ (1)

(b) If a greater torque were required, state three ways this could be achieved in the design of the motor. (3 marks)

More windings on the armature	*(1)*
Stronger magnetic field	*(1)*
Larger current used	*(1)*

Question 9 **(12 marks)**

An electron is accelerated from rest in the electron gun of a cathode ray oscilloscope by a potential of 1.80 x 10^3 V. The electron then enters the region between two parallel and horizontal deflecting plates which are 4.00 cm apart and across which is applied a potential of 420 V. The electric field between the plates deflects the electron from its straight line path down the axis of the tube into a parabolic path.

(a) Calculate the horizontal velocity of the electron when it enters the deflecting plates. (4 marks)

gain in E_k = work done

$\frac{1}{2}mv^2 = qV$ ①

$v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{2 \times 1.6\times10^{-19} \times 1.8\times10^3}{9.11\times10^{-31}}}$ ①

$v = 2.51 \times 10^7\ ms^{-1}$ ①

(b) Calculate how long does the electron spends travelling between the plates if they are 6.60 cm long. (2 marks)

$v = \frac{s}{t}$ $t = \frac{s}{v} = \frac{6.6\times10^{-2}}{2.51\times10^7}$ ①

$= 2.63\times10^{-9}\ s$ ①

(c) If the electric field accelerates the electron vertically downwards, calculate its vertical displacement as a result of travelling between the plates. (6 marks)

$F = Eq = \frac{V}{d}\times q$ $F = \frac{420\times1.6\times10^{-19}}{4\times10^{-2}}$ ①

$= 1.68\times10^{-15}\ N$ ①

$\therefore a = \frac{F}{m} = \frac{1.68\times10^{-15}}{9.11\times10^{-31}} = 1.84\times10^{15}\ ms^{-2}$ ①

$s = ut + \frac{1}{2}at^2 = 0 \times \frac{1}{2} \times 1.84\times10^{15} \times (2.63\times10^{-9})^2$ ①

$s = 6.38\times10^{-3}\ m$ ①

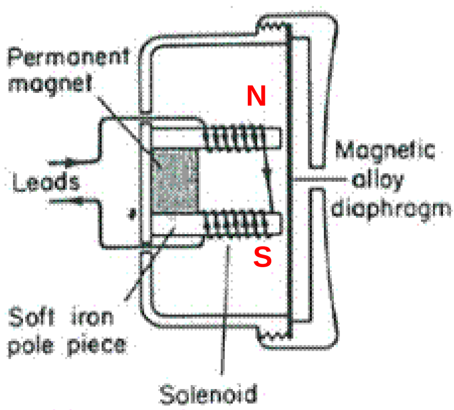
End of Section B

Section Three: Comprehension **20% (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.

The telephone receiver (earpiece)



The telephone receiver contains a U-shaped magnet formed by placing a short permanent bar magnet across the ends of two soft-iron bars (Fig. 36.14). This is placed so that it exerts a pull on a springy magnetic alloy diaphragm. Two solenoids are wound in opposite directions on the soft-iron bars.

When a person speaks into the microphone at the other end of the line a varying electric current is set up having the same frequency as the sound waves. A similar electric current is caused to pass through the solenoids in the earpiece. This alters the strength of the magnetic flux in the U-shaped magnet and produces a corresponding variation in the pull of the diaphragm. The latter therefore vibrates and reproduces a copy of the sound waves which entered the microphone.

(a) Mark the polarity of the two solenoids by placing an N or S at the ends of the solenoids nearest to the Magnetic alloy diaphragm. Refer to diagram (2 marks)

(b) Explain why "soft iron" is a suitable core material for the solenoid windings. (2 marks)

Soft iron undergoes rapid domain alignment *(1)*

so the magnetic strength of the fields in the solenoid is very responsive to changing currents *(1)*

(c) The microphone and earpiece are functionally similar to motors and generators. Complete the statements.

(i) The microphone is most similar to a _______generator_______ (1 mark)

(ii) The earpiece is most similar to a _______motor_______ (1 mark)

(d) The *frequency* of variation in the electric current controls the *pitch* of the resulting sound. State what the *magnitude* of the electric current controls in the resulting sound. (1 mark)

loudness

(e) The alloy diaphragm is a magnetic material, but not a magnet. Describe how it can be attracted to the" V-shaped magnet" and name this property of the magnetic alloy material.

(3 marks)

Solenoid fields include magnetism *(1)*

in the diaphragm by causing domain alignment in the material *(1)*

with opposite polarity to the solenoids, resulting in attraction. *(1)*

End of Test