O Level Combined Physics Structured

Electromagnetism Test 1.0

Q1

A simple electromagnet is shown in Fig. 9.1.

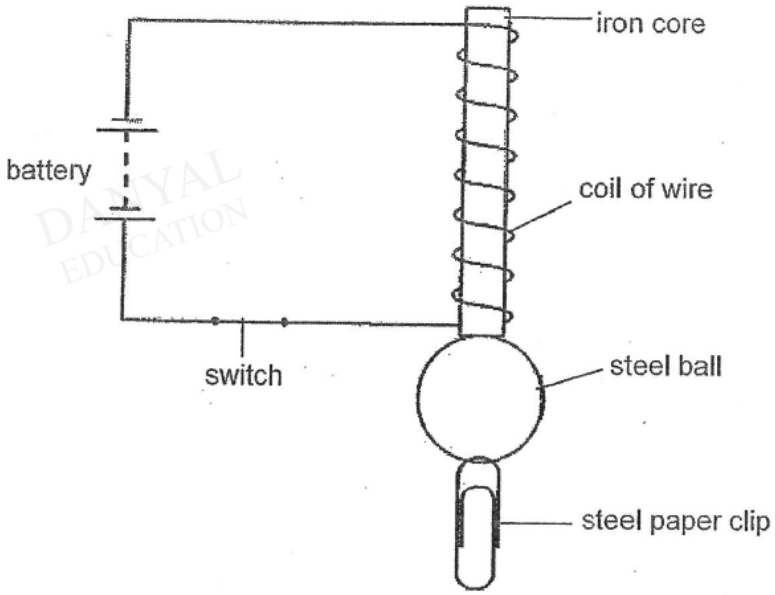

Fig. 9.1

(a) When the switch is closed, a steel ball is attracted to the iron core. The steel paper clip is attracted to the steel ball.

(i) State the magnetic pole that is formed at the end of the iron core closest to the steel ball.

.....[1]

(ii) Explain why there is an attractive force between the steel ball and the paper clip.

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.....[2]

(b) The switch is now open. Explain why the steel ball and the paper clip remain attracted to the iron core before they eventually fall off.

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.....[2]

Q2

The voltage of a power supply P varies with time as shown in **Fig. 13.1**

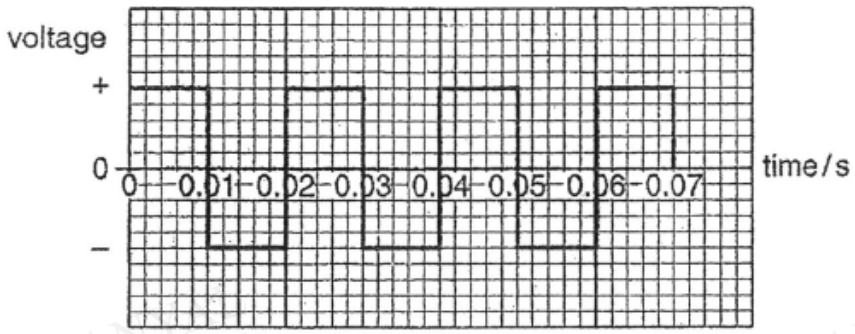

Fig. 13.1

The direction of the voltage changes with 0.01 s.

A coil of wire is wrapped around an iron core and connected to power supply P.
An iron rod is suspended close to one end of the core and a small bar magnet is suspended close to the other end as shown in **Fig. 13.2**

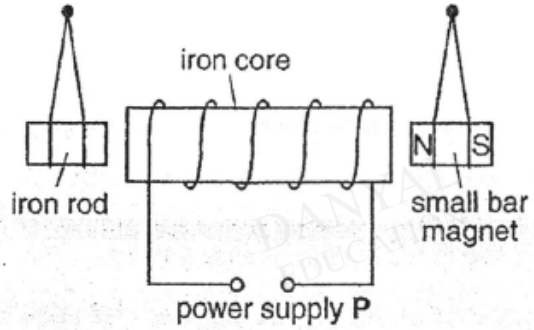

Fig. 13.2

(a) Power supply **P** is switched on. Explain why the iron rod is always attracted to the iron core but the force on the bar magnet varies. [4]

(b) The iron rod is removed and the bar magnet is attached to a cone of paper to make a simple loudspeaker, as shown in **Fig. 13.3**

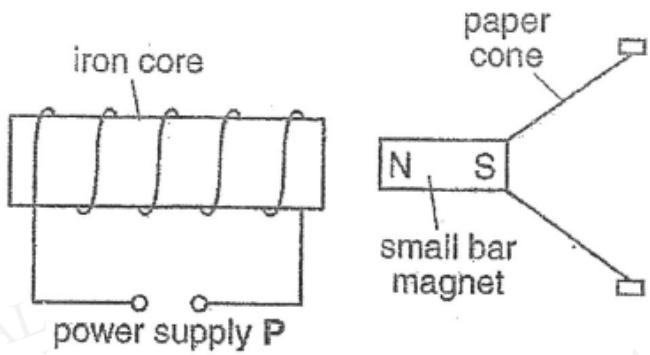

Fig. 13.3

The magnet causes the paper cone to vibrate, producing a sound wave in the air. Use **Fig. 13.1** on pg 14 to calculate the frequency of the sound wave.

frequency = _____ [1]

(c) Power supply **P** is now replaced with a second power supply that causes the speaker to produce a sound wave of frequency 240 Hz.

(i) The speed of sound in air is 330 m/s. Calculate the wavelength of this new sound wave.

wavelength = _____ [3]

(ii) The new current in the coil is smaller than when power supply **P** was used and is of a different frequency.

Describe and explain how the sound produced with the second power supply is different from that produced by power supply **P**. [2]

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Q3

Fig 12.1 shows an electric bell. When the switch is pushed down, the striker will hit the bell repeatedly.

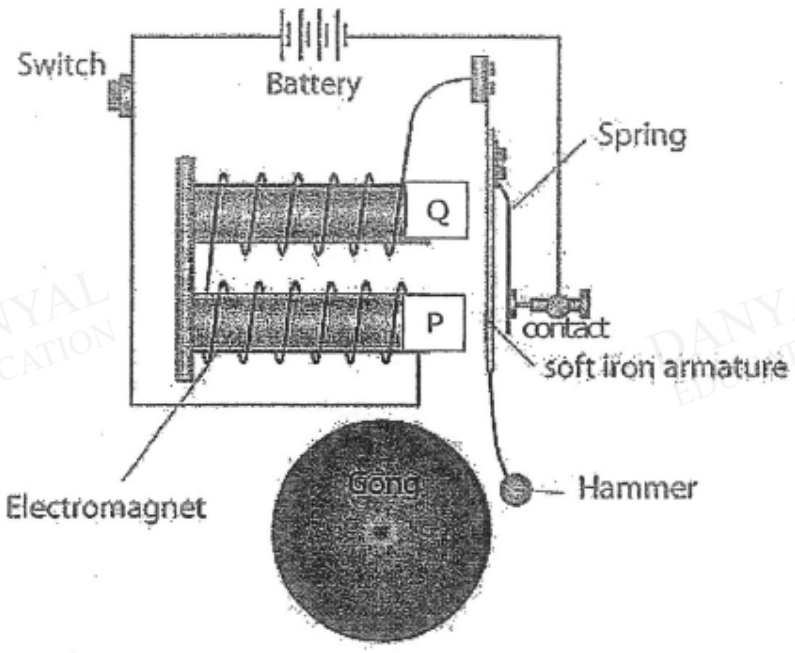

Fig 12.1

(a) Identify poles P and Q.

P: ..... Q: ..... [1]

(b) Explain how the bell will ring repeatedly when the push switch is closed.

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..... [3]

(d) Fig 12.2 shows the soft iron armature and the two magnets. Draw the magnetic field between them when the push switch is closed.

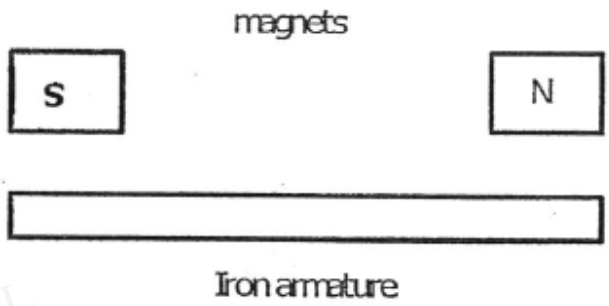

Fig 12.2

[2]

(e) Fig 12.3 shows a current-carrying wire between two permanent magnets. When the switch is closed, the wire XY moves.

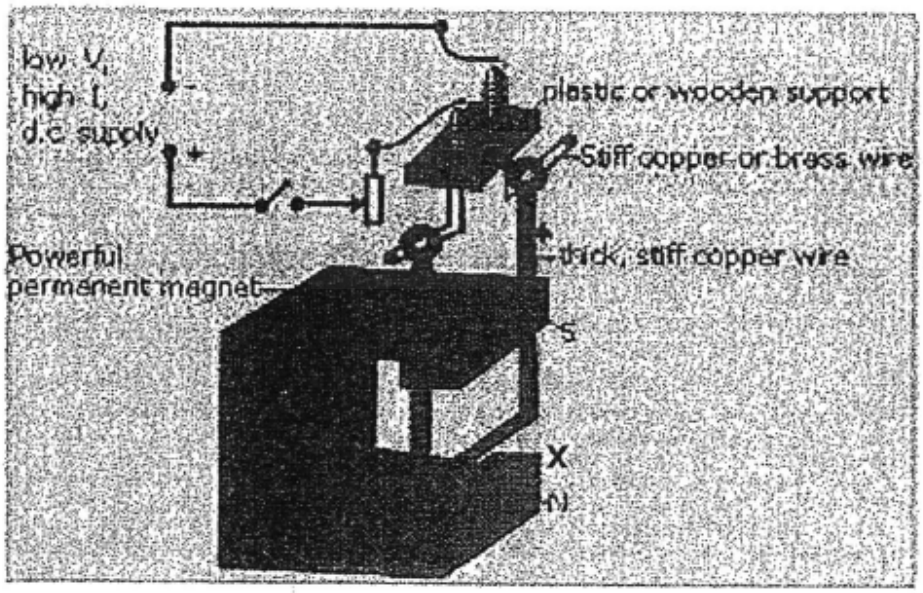

Fig 12.3

Describe and explain the motion of the wire XY.

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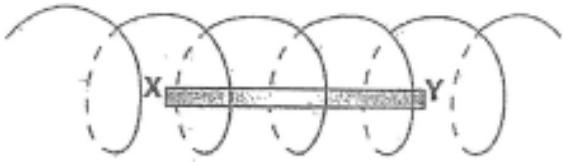
..... [2]

Q4

(a) Fig. 13.1 shows a steel rod XY placed inside a solenoid. In order to magnetise the steel rod, the solenoid needs to be connected to a circuit.

Fig. 13.1



(i) On Fig. 13.1,

1. draw the circuit diagram needed to magnetise the steel rod. Include a power supply and any other apparatus needed. [2]

2. mark the direction of the current flow **on the circuit** and state clearly the corresponding magnetic pole at the end labelled Y. [2]

(ii) State one factor in this method that will affect the strength of the magnet produced.

.....[1]

(b) Fig. 13.2 and Fig. 13.3 show a small bar magnet hanging on a thread **near** the end of a solenoid (coil) carrying a steady current.

Fig 13.2

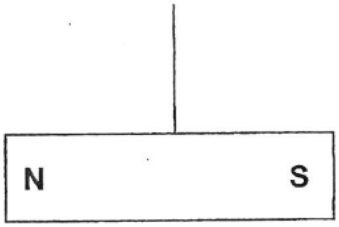
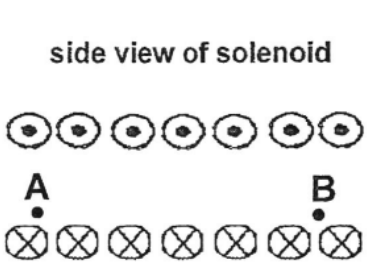
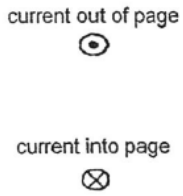


Fig. 13.3



key



The current in the solenoid creates a magnetic field.

(i) A magnetic field line passes through **A** and **B**.
On Fig 13.3, draw this magnetic field line both **inside and outside** the solenoid that passes through **A** and **B.** Indicate the **direction** of the magnetic field on the line you have drawn with an arrow. [2]

(ii) An iron core is inserted into the solenoid in Fig. 13.3.
State and explain what will happen to the solenoid and the bar magnet.

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.....[3]

Q5

Fig. 9 shows a coil wound around an iron core. It is placed near an iron nail.

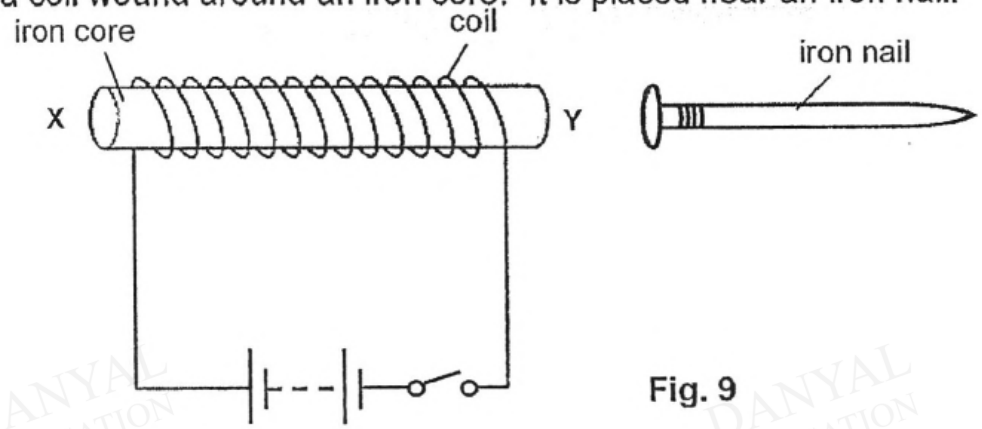

Fig. 9

a) Explain why the iron nail moves towards the coil when the circuit is switched on.[3]

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b) Suggest a modification to the setup that may allow the iron nail to be attracted to the iron core if it is now placed further away. [1]

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Answers

Electromagnetism Test 1.0

Q1

(a) (i) North pole B1

(ii) The iron core is magnetized and causes both the steel ball and paper clips to become induced magnets. B1

The bottom of the steel ball and the top of the paper clip have unlike poles and unlike poles attract. B1

(b) Steel is a hard magnetic material [B1] that retains magnetism for a long time [B1]

Q2

The voltage of a power supply P varies with time as shown in **Fig. 13.1**

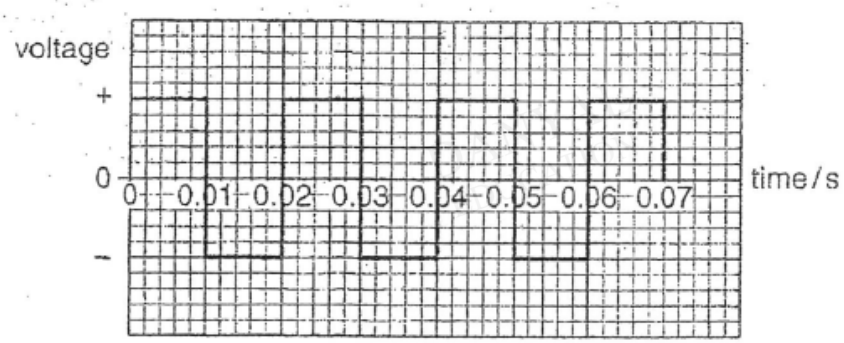

Fig. 13.1

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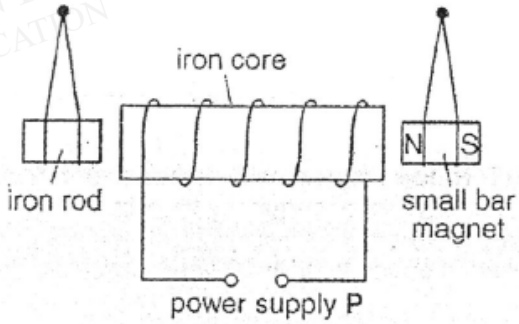


Fig. 13.2

(a) Power supply **P** is switched on. Explain why the iron rod is always attracted to the iron core but the force on the bar magnet varies. [4]

The power supply P is switched on, the iron core will be magnetized. As the power supply is an alternating current supply, the **iron core will be magnetized with poles** [B1] alternating every 0.1 s.

The iron rod is always attracted to the iron core by **magnetic induction,** [B1] when the poles of the iron core changes, the **surface of the iron rod nearest to the iron core will be induced with an opposite polarity, unlike poles attract** [B1] and the iron rod will be attracted to the iron core.

The force on the bar magnet varies as the small bar magnet will alternate between being **attracted and repelled** by the iron core depending on the pole formed at the end of the iron core closer to it as the direction of the current changes. [B1]

(b) The iron rod is removed and the bar magnet is attached to a cone of paper to make a simple loudspeaker, as shown in **Fig. 13.3**

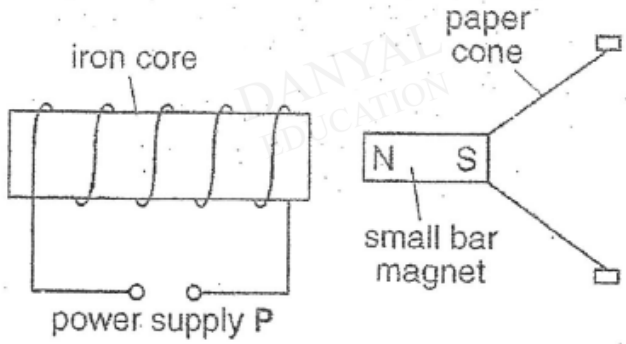


Fig. 13.3

The magnet causes the paper cone to vibrate, producing a sound wave in the air. Use **Fig. 13.1** on pg 14 to calculate the frequency of the sound wave.

frequency = 1 / T
= 1 / 0.02
= 50 Hz [A1: minus 1 mark for wrong or missing unit]

frequency = _____ [1]

(c) Power supply P is now replaced with a second power supply that causes the speaker to produce a sound wave of frequency 240 Hz.

(i) The speed of sound in air is 330 m/s. Calculate the wavelength of this new sound wave.

$v = f\lambda$

$330 = 240\,\lambda$ [C1]

$\lambda = 330 / 240$

$\lambda = 1.375$ [C1]

$\lambda \approx$ **1.38 m or 1.4 m** [A1: minus 1 mark for wrong or missing unit]

wavelength = _____ [3]

(ii) The new current in the coil is smaller than when power supply P was used and is of a different frequency.

Describe and explain how the sound produced with the second power supply is different from that produced by power supply **P**. [2]

As the new current in the coil is smaller, the attractive and repulsive force is lesser, the paper cone will vibrate with a lower amplitude and the sound produced will be softer. [B1]

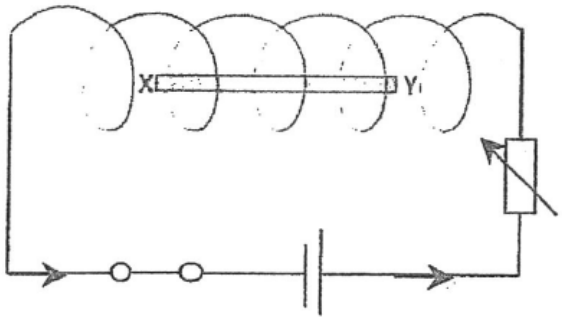
The increase in frequency will cause the paper cone to vibrate with a higher frequency and the sound produced will be higher in pitch. [B1]

Q3

2a)	P – N, Q - S	1
b)	Current flow magnetizes two iron core The iron arm becomes an induced magnet and is attracted. Striker hits gong. Contact is broken, spring pulls arm back to close circuit to start current. Cycle repeats.	1 1 1
d)	See diagram	1 pattern 1 arrow
e)	Wire XY deflects to the right The magnetic field of the permanent magnet interacts with the magnetic field of of the current to produce a force	1 1

Q4

ai



Part 2
Correct current direction and corresponding magnetic pole at end Y or next to right end of solenoid, in symbol or spelt

aii - (Magnitude) of current flowing in the solenoid or
- Number of turns (per unit length) of the solenoid

bi One closed loop passing through A and B enclosing all "X"
Direction of magnetic field is clockwise

bii The solenoid becomes a stronger electromagnet with a South pole/ S pole on the left / facing the bar magnet.

Explanation: When iron core is inserted the magnetic field strength of the electromagnet is greatly increased.

Since like poles repel, the bar magnet will be repelled more strongly by the solenoid / move away more from the solenoid.

Q5

a) When current flows through the coil, the iron core is induced to become a temporary magnet with north pole at the right. [1] Since the iron nail is a magnetic material, it will be induced to become a temporary magnet with south pole nearer the iron core[1]. Since unlike poles attract [1], the iron nail will be attracted and move towards the coil.

b) Increase the number of turns of the coil around the iron core or increase the voltage of the battery [1]