AQA A-LEVEL PHYSICS · 7408

PHYSICS



EXAM QUESTION PACK

3.7.5 MAGNETIC FIELDS

SCORE	PERCENTAGE
/135	%

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Q1.

(a) State Lenz's law.

_____

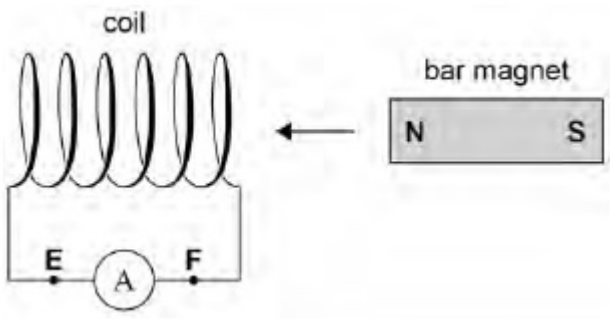
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_____

(1)

(b) Lenz's law can be demonstrated using a bar magnet and a coil of wire connected to a sensitive ammeter as shown in **Figure 1**.

Figure 1



The bar magnet is moved towards the coil and is then brought to a halt.

State how the reading on the ammeter changes during this process.

_____

_____

_____

(1)

(c) During the demonstration an induced current is detected by the ammeter. The induced current is in the direction **E** to **F**.
Explain how this demonstrates Lenz's law.

_____

_____

_____

_____

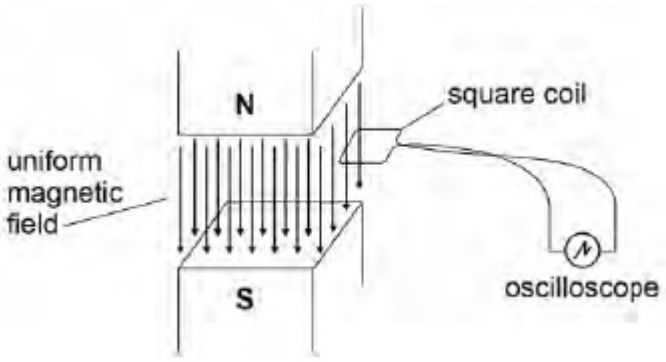
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(2)

(d) **Figure 2** shows an arrangement for investigating induced emf.

Figure 2

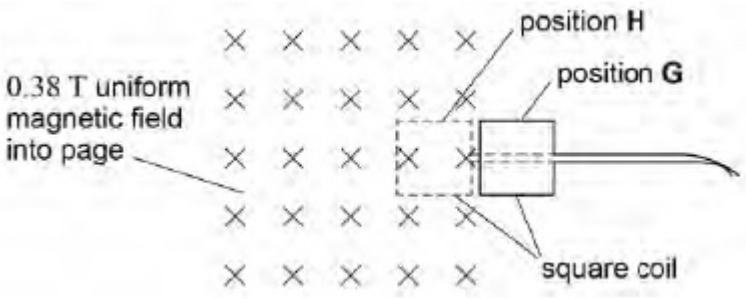
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As shown, the uniform vertical magnetic field is confined to the gap between the poles of the magnet. The plane of the square coil is horizontal and is made of conducting wire. The coil consists of a single turn and is attached by flexible wire to an oscilloscope.

The oscilloscope gives a reading of 2.9×10^{-4} V when the coil is moved at uniform speed from position **G** outside the field to position **H** inside the field, as shown in **Figure 3**.

Figure 3



Length of side of square coil = 32 mm

Magnetic flux density of uniform magnetic field = 0.38 T

Calculate the time taken to move the coil from position **G** to position **H**.

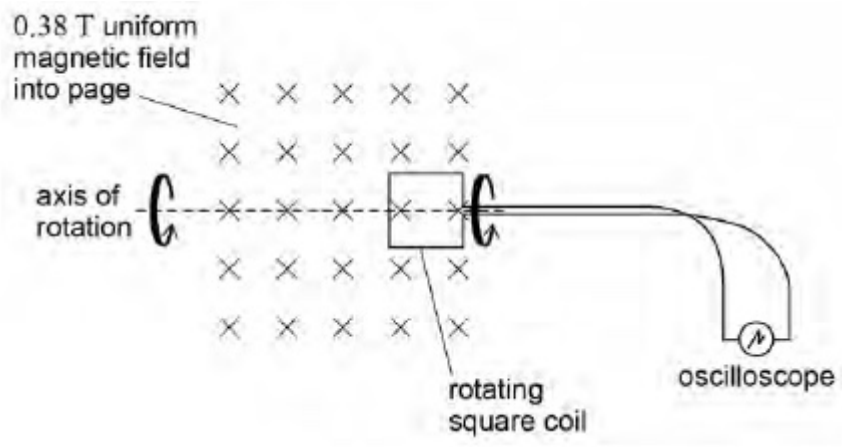
time = _____ s

(2)

(e) The square coil is rotated through 360° at a constant angular speed about the horizontal axis shown in **Figure 4**.

Figure 4

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Calculate the angular speed of the coil when the maximum reading on the oscilloscope is 5.1 mV

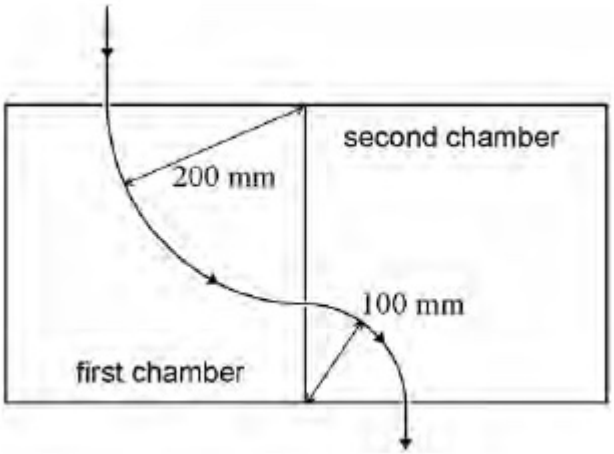
angular speed = _____ rad s^{-1}

(2)

(Total 8 marks)

Q2.

Different magnetic fields are present in the two chambers shown. A particle enters the first chamber at a velocity of 80 m s^{-1} and is deflected into a circular path of radius 200 mm
In the second chamber it follows a circular path of radius 100 mm



The particle leaves the second chamber at a speed of

A 20 m s^{-1} ⬭

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B 40 m s^{-1} ⬭

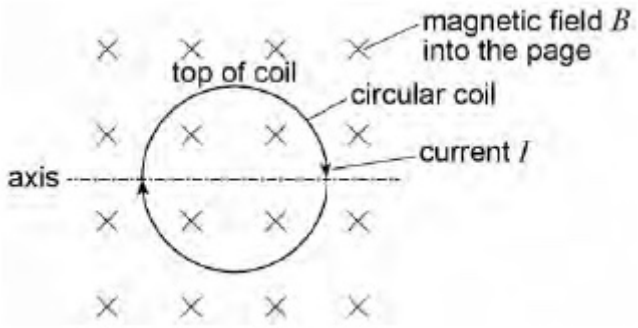
C 80 m s^{-1} ⬭

D 160 m s^{-1} ⬭

(Total 1 mark)

Q3.

The diagram shows a clockwise current I in a circular coil placed in a uniform magnetic field B with the plane of the coil perpendicular to the magnetic field.



What is the effect on the coil of the interaction between the current and the magnetic field?

A It rotates about the axis with the top moving out of the page. ⬭

B It rotates about the axis with the top moving into the page. ⬭

C It causes an increase in the diameter of the coil. ⬭

D It causes a decrease in the diameter of the coil. ⬭

(Total 1 mark)

Q4.

A transformer has an efficiency of 80%
It has 7000 turns on its primary coil and 175 turns on its secondary coil. When the primary of the transformer is connected to a 240 V ac supply, the secondary current is 8.0 A

What are the primary current and secondary voltage?

	Primary current / mA	Secondary voltage / V	
A	250	6.0	⬭
B	160	6.0	⬭
C	250	9600	⬭

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D	160	9600	⬭

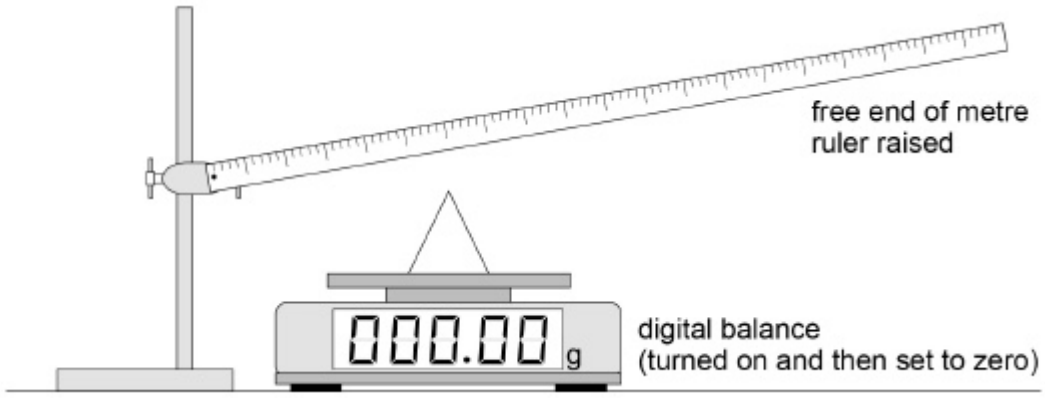
(Total 1 mark)

Q5.

This question is about using a digital balance to investigate the force on a wire placed in a magnetic field when there is an electric current in the wire.

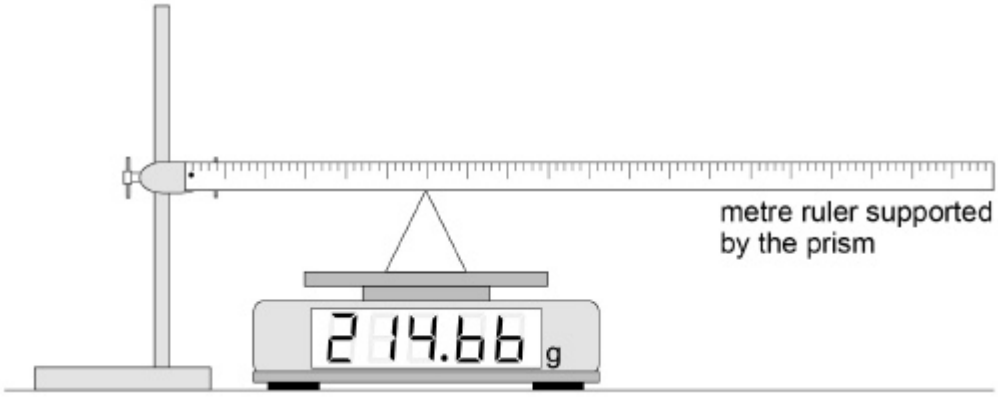
A student carries out the procedure shown in **Figure 1** and **Figure 2**.
A metre ruler is pivoted at the 1.0 cm mark and a prism is placed on a digital balance. The free end of the ruler is raised and the balance is turned on and then set to zero, as shown in **Figure 1**.

Figure 1



The ruler is then supported by the prism with the apex of the prism at the 30.0 cm mark as shown in **Figure 2**. The height of the pivot is adjusted so that the ruler is horizontal.

Figure 2



(a) Deduce the mass of the ruler.
State **one** assumption you make.

mass of ruler = _____ g

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assumption _____

_____

(3)

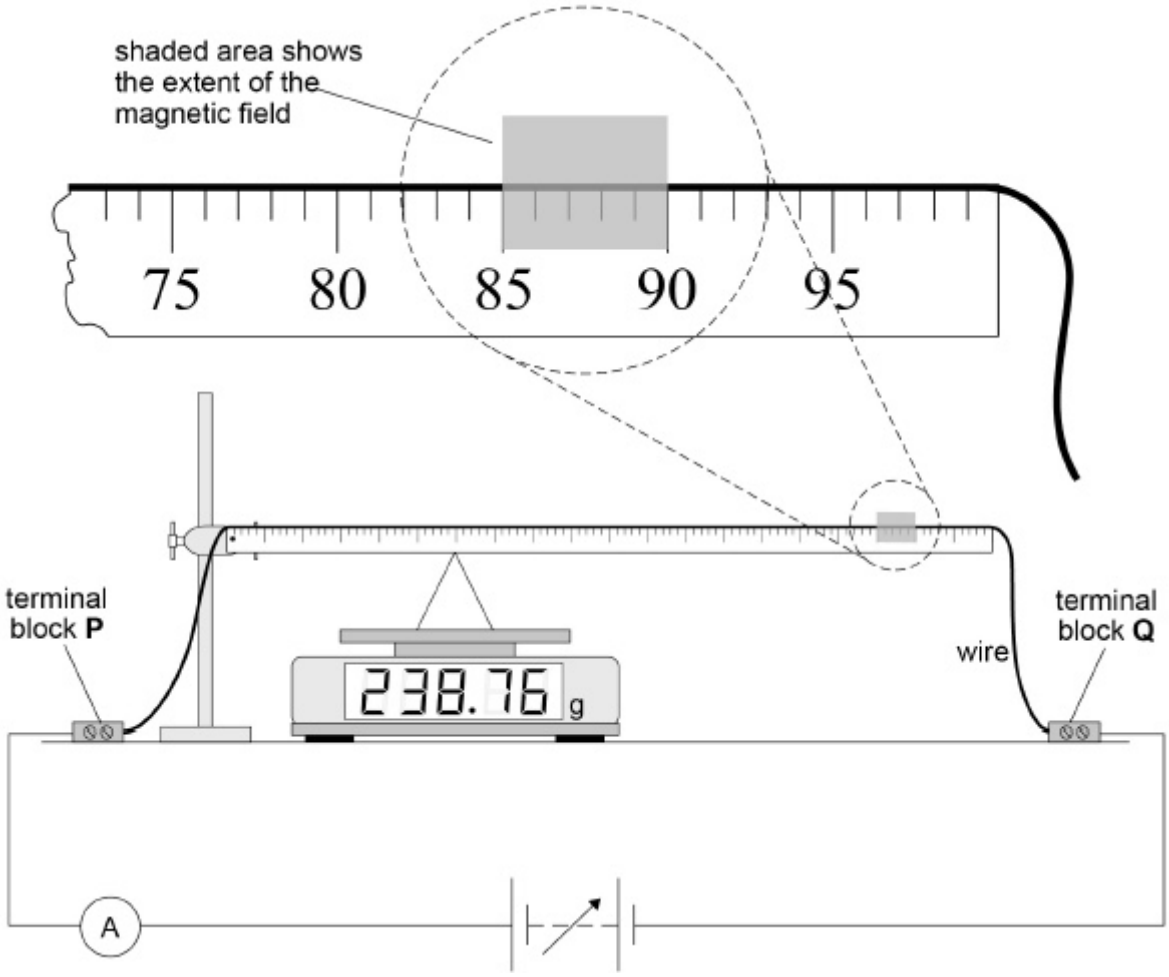
(b) The student attaches a uniform wire to the upper edge of the ruler, as shown in **Figure 3**.

The ends of the wire are connected to terminal blocks **P** and **Q** which are fixed firmly to the bench. A power supply and an ammeter are connected between **P** and **Q**.

These modifications cause the balance reading to increase slightly.

A horizontal uniform magnetic field is applied, perpendicular to the wire, between the 85 cm and 90 cm marks, as shown in the close-up diagram in **Figure 3**.

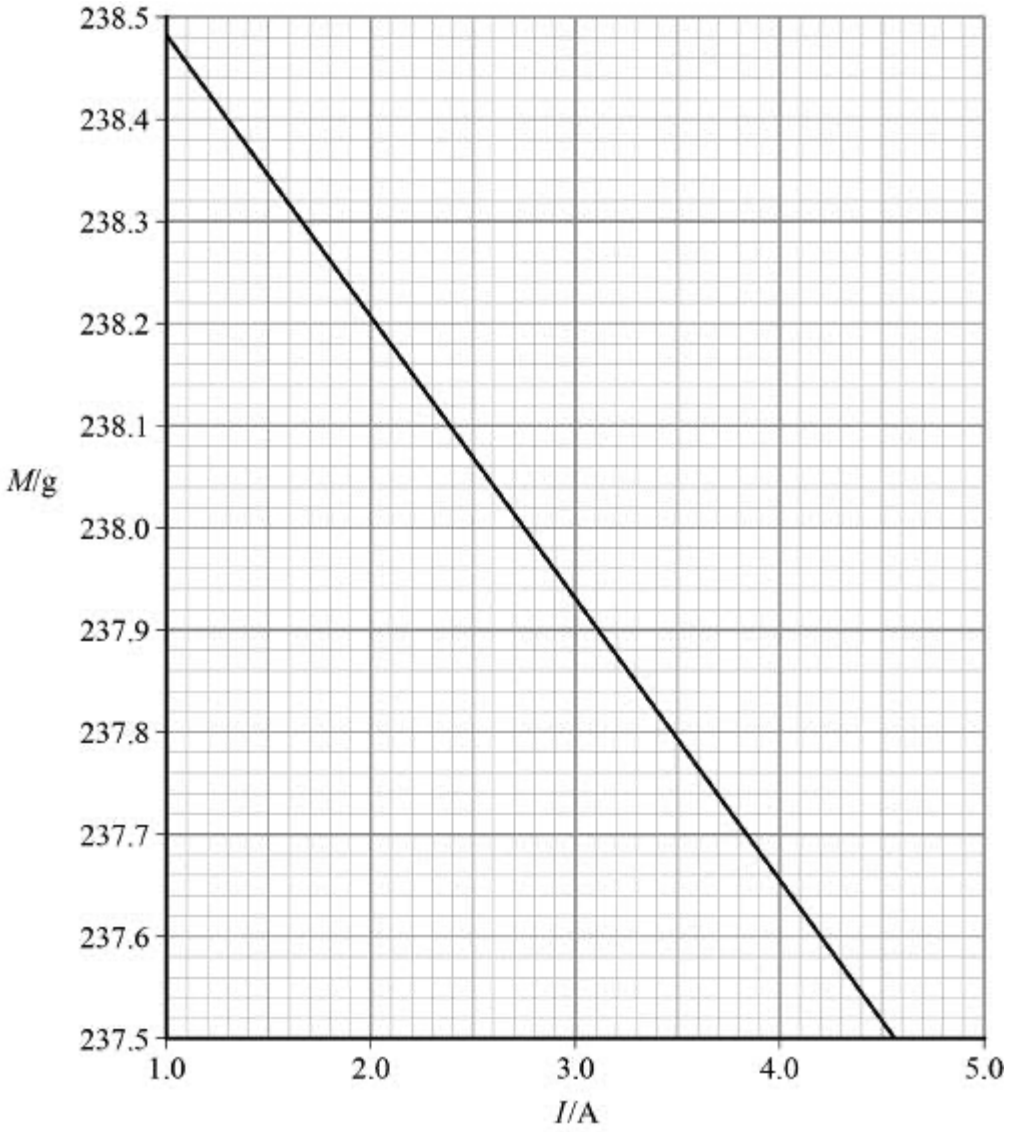
Figure 3



The balance reading M is recorded for increasing values of current I.
A graph of these data is shown in **Figure 4**.

Figure 4

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State and explain the direction of the horizontal uniform magnetic field.

(3)

(c) It can be shown that B, the magnitude of the magnetic flux density of the horizontal uniform magnetic field, is given by

$$B = \frac{\sigma}{3L}$$

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where

σ = change in force acting on the prism per unit current in the wire
L = length of the region where the magnetic field cuts through the wire.

Determine B.

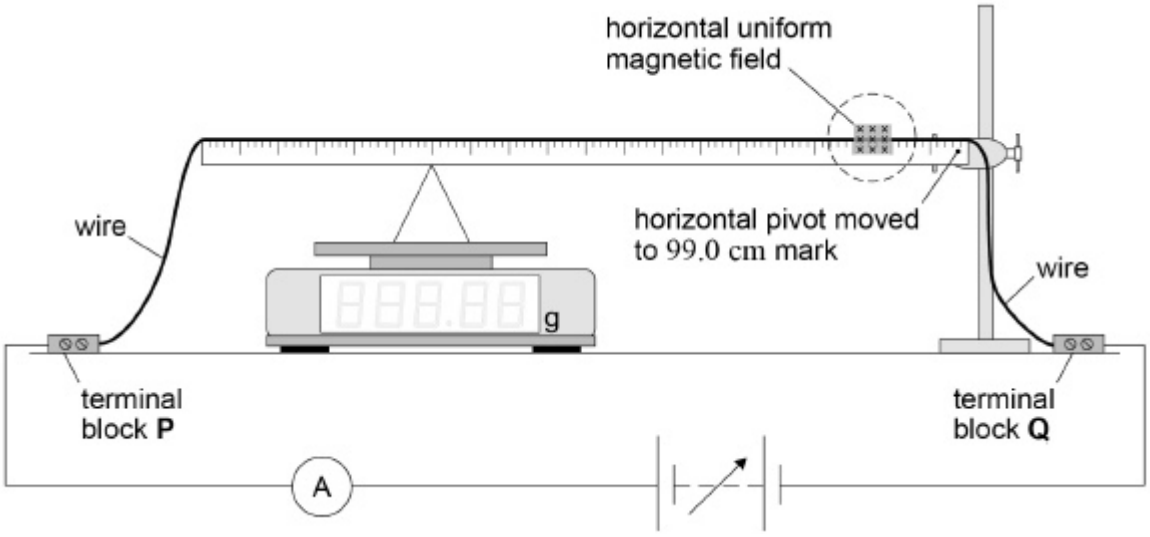
B = _____ T

(3)

(d) The experiment is repeated with the ruler pivoted at the 99.0 cm mark. Nothing else is changed from **Figure 3**.

This arrangement is shown in **Figure 5**.

Figure 5



Tick (✓) **one** box in row 1 and **one** box in row 2 of the table to identify the effect, if any, on the magnitude of the forces acting on the apparatus as a certain current is passed through the wire.

Tick (✓) **one** box in row 3 and **one** box in row 4 of the table to identify the effect, if any, on the graph produced for this modified experiment compared with the graph in **Figure 4**.

		Reduced	**No effect**	**Increased**
1	Force acting on the current-carrying wire due to the horizontal uniform magnetic field			
2	Force acting on the prism due to the pivoted ruler			

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3	Gradient of the graph			
4	Vertical intercept of the graph			

(3)

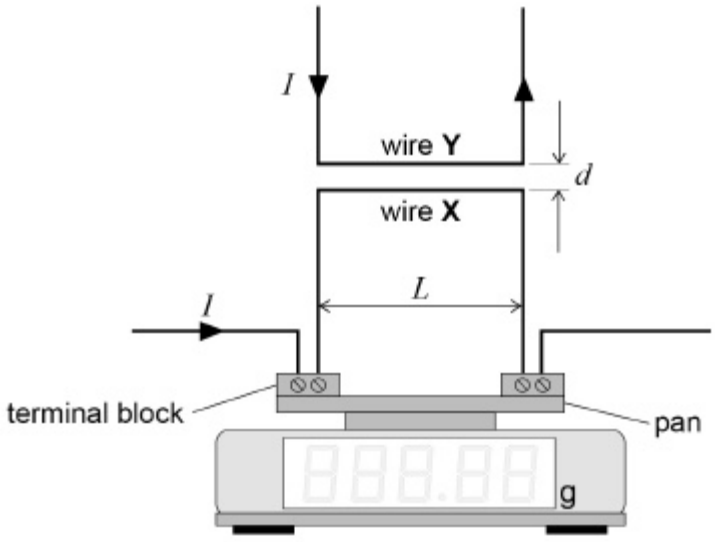
(e) **Figure 6** shows the balance being used to measure the forces between two wires. The connections joining these wires to the power supply are not shown.

The pan of the balance moves a negligible amount during use and it supports a straight conducting wire **X** of horizontal length L.
Terminal blocks are used to connect **X** into the circuit. The weight of these does not affect the balance reading.
A second conducting wire **Y** is firmly supported a distance d above **X**.

Show, by adding detail to **Figure 6**, the wire connections that complete the circuit. The currents in **X** and **Y** must have the same magnitude and be in the directions indicated.

Figure 6





(2)

(f) The vertical force F on wire **X** due to the magnetic field produced by wire **Y** is given by

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$$F = \frac{kI^2L}{d}$$

where

k is a constant
d is the perpendicular distance between **X** and **Y**
I is the current in the wires

and
L is the horizontal length of wire **X**.

A student wants to measure k using the arrangement in **Figure 6**.

The student is told that the following restrictions must apply:

- L is fixed
- I must not exceed 5.0 A
- the result for k must be obtained using a **graphical method**
- the experimental procedure must involve **only one** independent variable.

Explain what the student could do to find k.

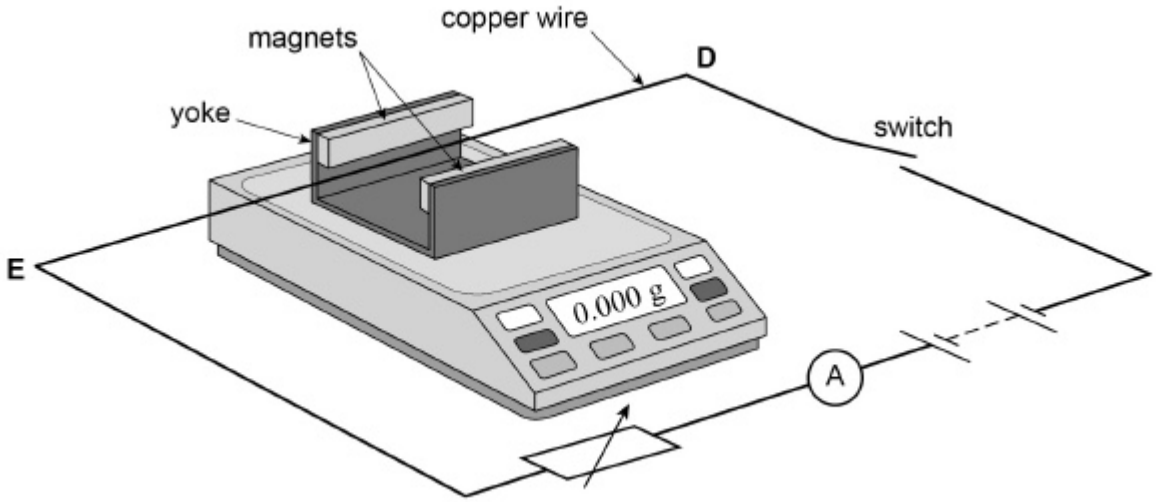
(5)
(Total 19 marks)

Q6.

Figure 1 shows two magnets, supported on a yoke, placed on an electronic balance.

Figure 1

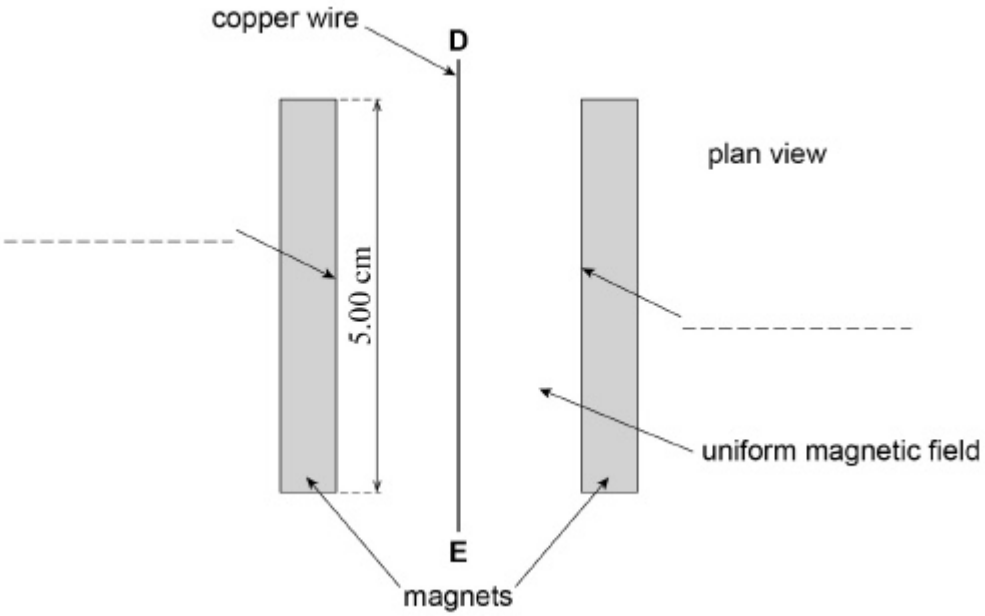
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The magnets produce a uniform horizontal magnetic field in the region between them. A copper wire **DE** is connected in the circuit shown in **Figure 1** and is clamped horizontally at right angles to the magnetic field.

Figure 2 shows a simplified plan view of the copper wire and magnets.

Figure 2



When the apparatus is assembled with the switch open, the reading on the electronic balance is set to 0.000 g. This reading changes to a positive value when the switch is closed.

(a) Which of the following correctly describes the direction of the force acting on the wire **DE** due to the magnetic field when the switch is closed?

Tick (✓) the correct box.

towards the left magnet in **Figure 2** ☐

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towards the right magnet in **Figure 2** ☐

vertically up ☐

vertically down ☐

(1)

(b) Label the poles of the magnets by putting **N** or **S** on each of the two dashed lines in **Figure 2**.

(1)

(c) Define the tesla.

_____

_____

_____

(1)

(d) The magnets are 5.00 cm long. When the current in the wire is 3.43 A the reading on the electronic balance is 0.620 g.

Assume the field is uniform and is zero beyond the length of the magnets.

Calculate the magnetic flux density between the magnets.

magnetic flux density = _____ T

(2)

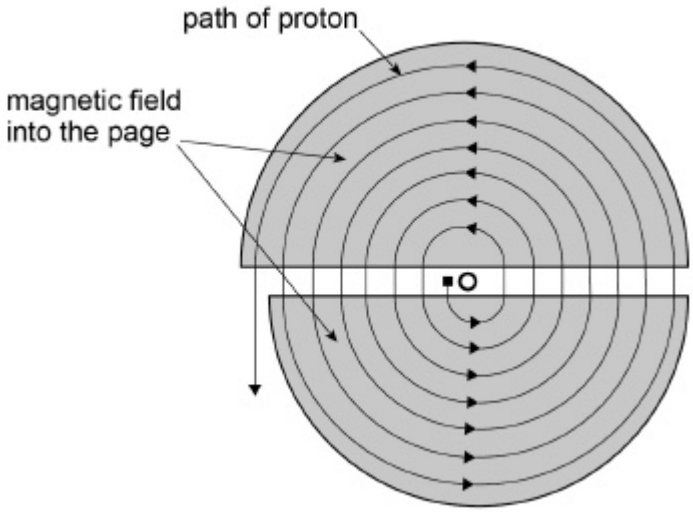
(Total 5 marks)

Q7.

A cyclotron has two D-shaped regions where the magnetic flux density is constant.
The D-shaped regions are separated by a small gap.
An alternating electric field between the D-shaped regions accelerates charged particles.
The magnetic field causes the charged particles to follow a circular path.

The diagram shows the path followed by a proton that starts from **O**.

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(a) Explain why it is **not** possible for the magnetic field to alter the speed of a proton while it is in one of the D-shaped regions.

_____

_____

_____

_____

_____

(1)

(b) Derive an expression to show that the time taken by a proton to travel round one semi-circular path is independent of the radius of the path.

(3)

(c) The maximum radius of the path followed by the proton is 0.55 m and the magnetic flux density of the uniform field is 0.44 T.

Ignore any relativistic effects.

Calculate the maximum speed of a proton when it leaves the cyclotron.

maximum speed = _____ m s^{-1}

(2)

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(Total 6 marks)

Q8.

A coil with 20 circular turns each of diameter 60 mm is placed in a uniform magnetic field of flux density 90 mT.

Initially the plane of the coil is perpendicular to the magnetic field lines as shown in **Figure X**.

Figure X

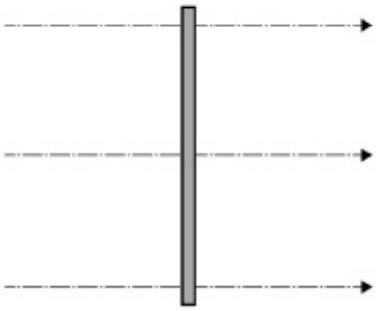
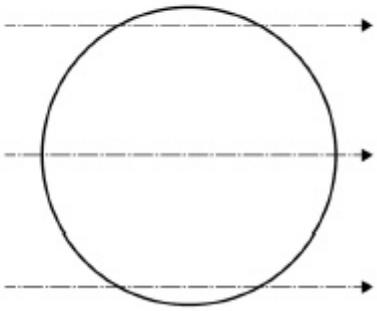


Figure Y



The coil is rotated about a vertical axis by 90° in a time of 0.20 s so that its plane becomes parallel to the field lines as shown in **Figure Y**.
Assume that the rate of change of flux linkage remains constant.

What is the emf induced in the coil?

A zero ⬭

B 1.3 mV ⬭

C 25 mV ⬭

D 100 mV ⬭

(Total 1 mark)

Q9.

Read the following passage and answer the questions that follow.

A mass spectrometer is an instrument for measuring the masses of isotopes. The main working parts of the instrument are shown in **Figure 1**.

Figure 1

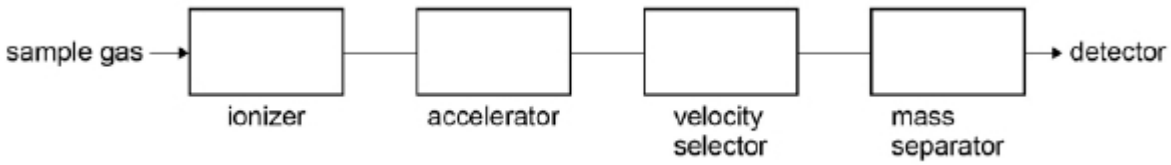


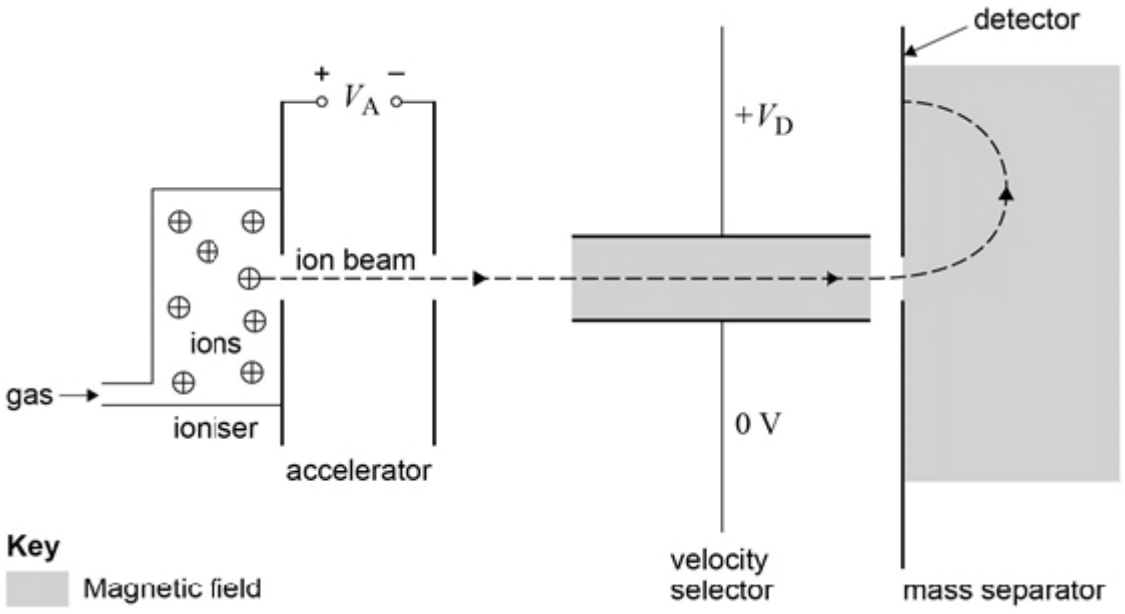
Figure 2 shows the components in more detail. Positive ions are created in the ionizer. Some of these ions enter the accelerator where they are accelerated by a potential

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difference V_A. The ions emerge from the accelerator with different speeds and enter the velocity selector.

The velocity selector contains a region where there is a uniform magnetic field at right angles to an electric field. This electric field is formed between two parallel plates held at a potential difference V_D. This combination of fields only allows ions of a particular velocity to enter the mass separator. Here ions of different mass are separated by a uniform magnetic field. Finally the ions are detected.

Figure 2



(a) Explain what is meant by ionisation.

_____

_____

(1)

(b) Discuss the energy transfers that take place in the accelerator as the ion passes through it. Assume the ions are in a perfect vacuum.

_____

_____

_____

_____

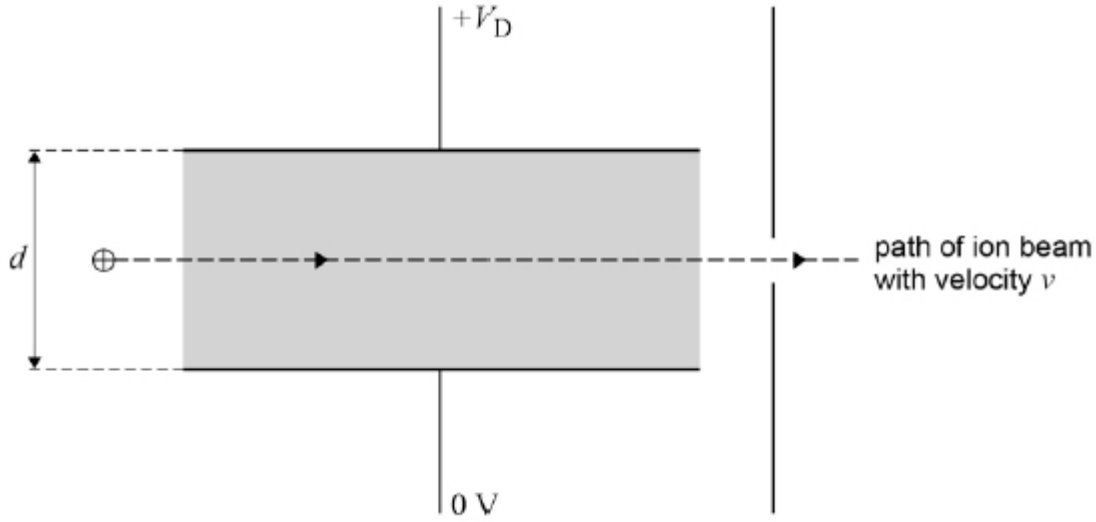
_____

(3)

(c) **Figure 3** shows the path taken by an ion that moves through the velocity selector at a velocity v.

Figure 3

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Discuss how the path changes when an ion enters the velocity selector with a velocity greater than v.

(3)

(d) Draw, on **Figure 3**, the path of the ion that is suggested by your answer to part **(c)**.

(1)

(e) Ions created in the ioniser may have the same charge but a different number of nucleons.

Discuss how the path of an ion in the mass separator is affected when it has more nucleons.

(2)

(f) Some ions are created with the same mass but a double charge. The path of the ions shown in **Figure 2** is that of a singly charged ion.

Compare, with justification, the path of a doubly charged ion through the mass spectrometer with that of a singly charged ion of the same mass.

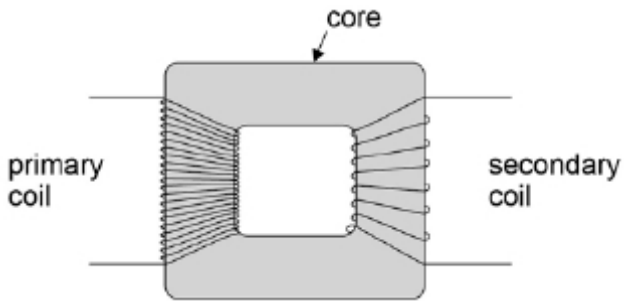
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(3)
(Total 13 marks)

Q10.

Figure 1 shows a step−down transformer used in a laptop power supply.

Figure 1



(a) Explain the purpose of the core in the transformer.

(1)

(b) Describe and explain **two** features of the core that improve the efficiency of the transformer.

1.

2.

(2)

(c) Explain why transformers only work continuously when supplied with an alternating current.

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_____

_____

(1)

(d) The primary coil of the transformer is connected to a 230 V_{rms} ac supply. The current in the primary coil is 0.30 A_{rms}. The secondary coil has 300 turns and provides an output of 20 V_{rms} and a power of 65 W.

Calculate the number of turns on the primary coil.

number of turns on primary =_____

(1)

(e) Calculate the efficiency of the transformer.

efficiency _____

(2)

(Total 7 marks)

Q11.

A horizontal copper wire of mass 4.0×10^{-3} kg and length 80 mm is placed perpendicular to a horizontal magnetic field of flux density 0.16 T. The magnetic force acting on the wire supports the weight of the wire.

How many electrons are passing a point in the wire in each second?

A 1.9×10^{18} ⬭

B 1.9×10^{19} ⬭

C 1.9×10^{20} ⬭

D 1.9×10^{21} ⬭

(Total 1 mark)

Q12.

Two charged particles, $\mathbf{P}_1$ and $\mathbf{P}_2$, follow circular paths as they move at right angles to the

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same uniform magnetic field. Both particles are travelling at the same speed.

The radius of the path travelled by $\mathbf{P}_1$ is twice the radius of the path travelled by $\mathbf{P}_2$.

The mass of $\mathbf{P}_1$ is m and its charge is q.

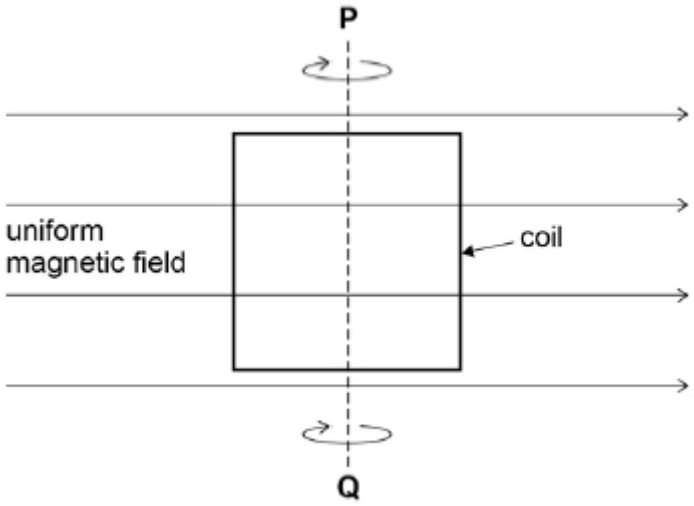
What is the mass of $\mathbf{P}_2$ and the charge of $\mathbf{P}_2$?

	Mass of P_2	Charge of P_2	
A	$2m$	q	⬭
B	$2m$	$2q$	⬭
C	$\sqrt{2}\,m$	$\sqrt{2}\,q$	⬭
D	m	$2q$	⬭

(Total 1 mark)

Q13.

A rectangular coil of area A has N turns of wire. The coil is in a uniform magnetic field of flux density B with its plane parallel to the field lines.



The coil is then rotated through an angle of 30° about axis **PQ**.

What are the correct initial value and correct final value of the magnetic flux linkage?

	Initial magnetic flux linkage	Final magnetic flux linkage	
A	0	$\frac{1}{2}BAN$	⬭
B	0	BAN	⬭

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C	BAN	$\frac{1}{2}BAN$	⬭
D	BAN	BAN	⬭

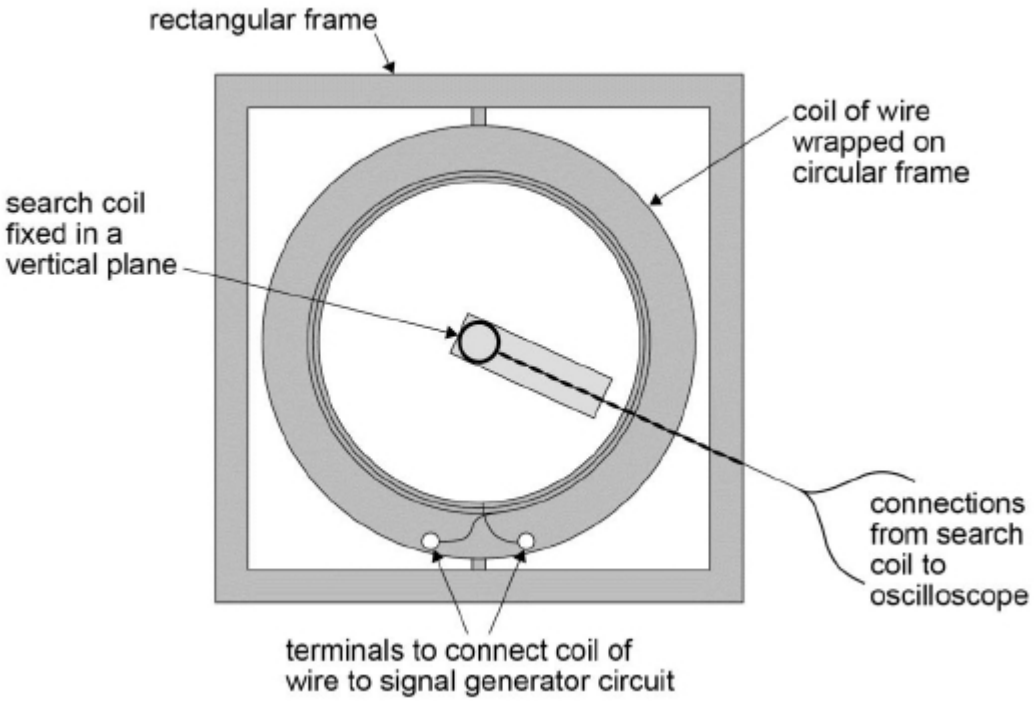
(Total 1 mark)

Q14.

This question is about experiments to investigate the magnetic flux density around a current−carrying conductor.

A student is provided with apparatus shown in **Figure 1**.

Figure 1



The apparatus consists of a circular frame on which is wound a coil of wire. This arrangement is mounted inside a rectangular frame.

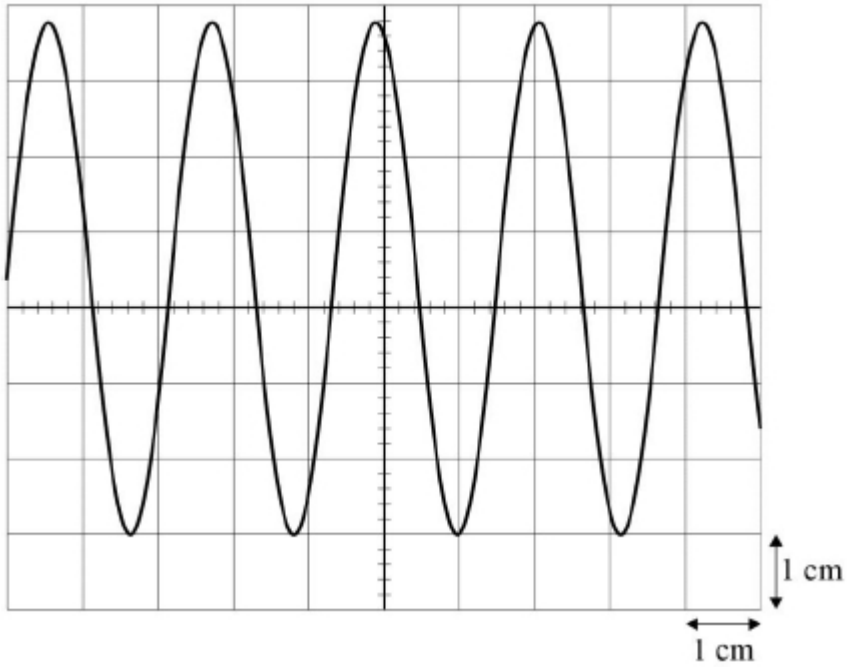
The student clamps a search coil so it is co−axial with the circular coil then arranges the apparatus so that both frames and the search coil lie in the same vertical plane.

The coil of wire is connected to a signal generator and the search coil is connected to an oscilloscope. When a sinusoidal alternating current is passed through the coil an alternating emf is induced in the search coil.

The induced emf displayed on the oscilloscope is shown in **Figure 2**.

Figure 2

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(a) Determine, using **Figure 2**, the frequency of the current in the coil.

Time−base setting of the oscilloscope is 0.2 ms cm^{-1}.

frequency = _____ Hz

(2)

(b) Determine, using **Figure 2**, the root mean square (rms) voltage of the emf induced in the search coil.

y−voltage gain of the oscilloscope = 10 mV cm^{-1}

rms voltage = _____ V

(2)

(c) **Figure 3** and **Figure 4** show the search coil and B_{peak}, the peak magnetic flux density produced by the current in the circular coil, when the apparatus is viewed from above.

Figure 3 shows the direction of B_{peak} when the search coil is arranged as in **Figure**

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1.

Figure 4 shows the direction of B_{peak} when the circular frame is rotated through an angle θ.

The shaded area in these diagrams shows how the flux linked with the search coil changes as the circular coil is rotated.

Figure 3

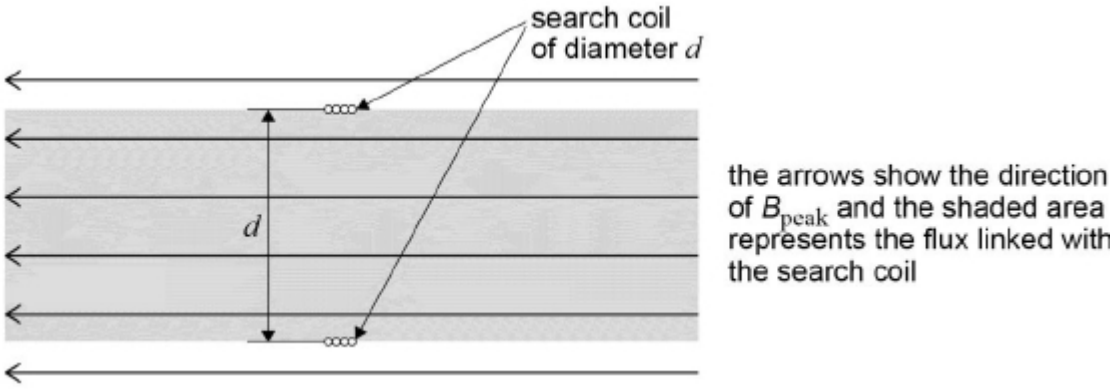
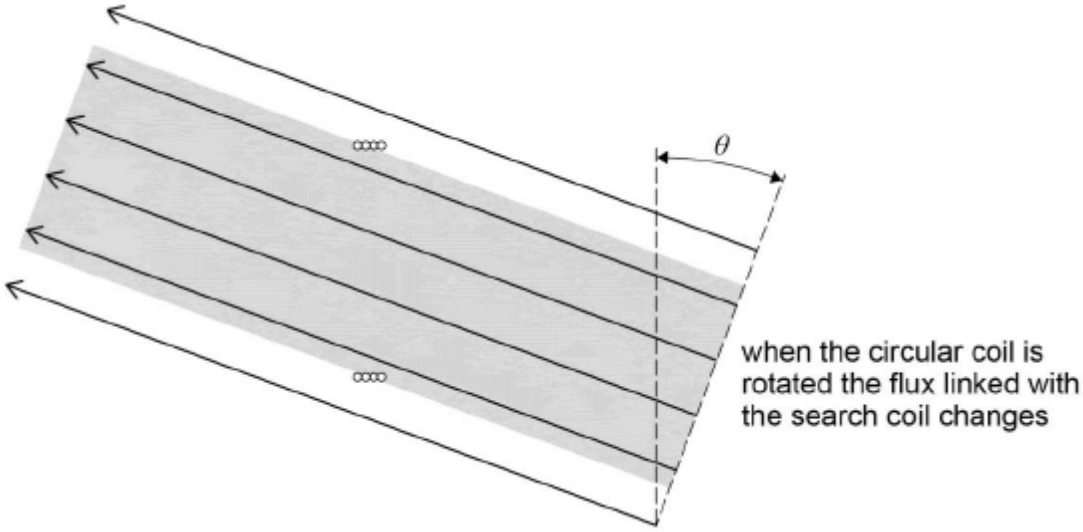


Figure 4



Explain why the flux linked with the coil is directly proportional to cosθ.

_____

_____

_____

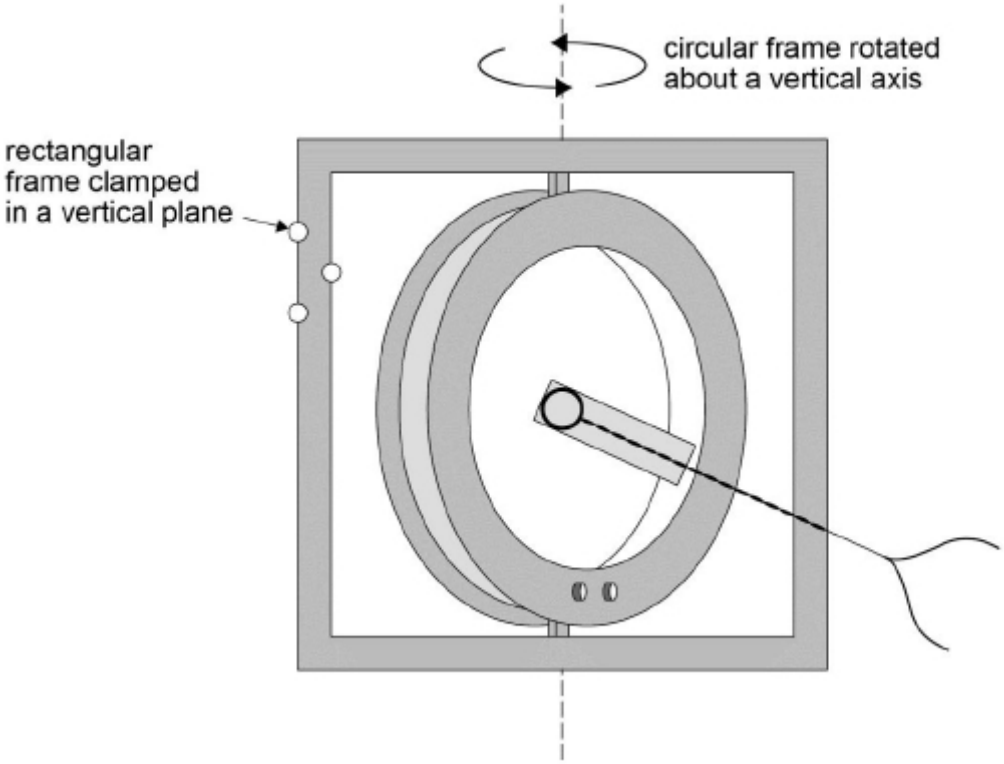
_____

(2)

(d) The student clamps the rectangular frame so that it remains in a vertical plane. Without changing the position of the search coil she rotates the circular frame about a vertical axis so that it is turned through an angle, as shown in **Figure 5**.

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Figure 5



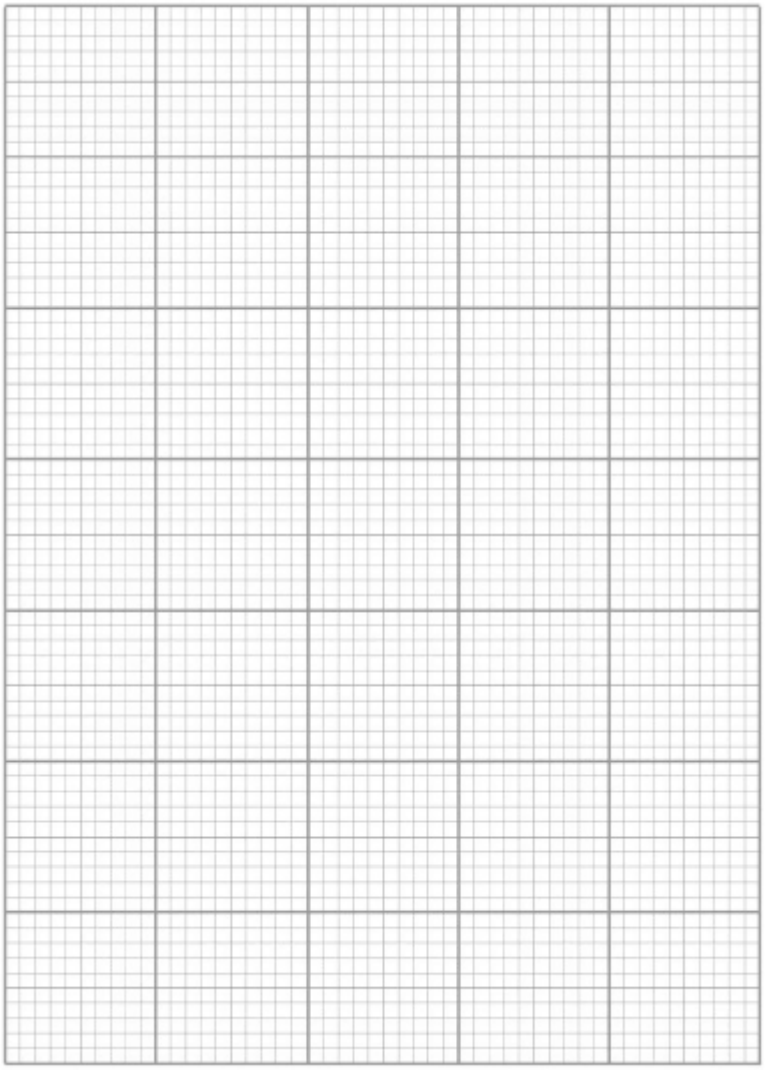
She turns off the time−base on the oscilloscope so that a vertical line is displayed on the screen. Keeping the y−voltage gain at 10 mV cm^{-1} she records the length l of the vertical line and the angle θ through which the circular frame has been rotated. She measures further results for l as θ is increased as shown in the table below.

θ/degree	l/cm	cosθ
10	6.7	
34	5.6	
50	4.4	
60	3.4	
72	2.1	
81	1.1	

Plot on **Figure 6** a graph to test if these data confirm that l is directly proportional to cosθ. Use the additional column in **Table 1** to record any derived data you use.

Figure 6

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(4)

(e) State and explain whether the graph you have drawn confirms the suggestion that l is directly proportional to $\cos\theta$.

_____

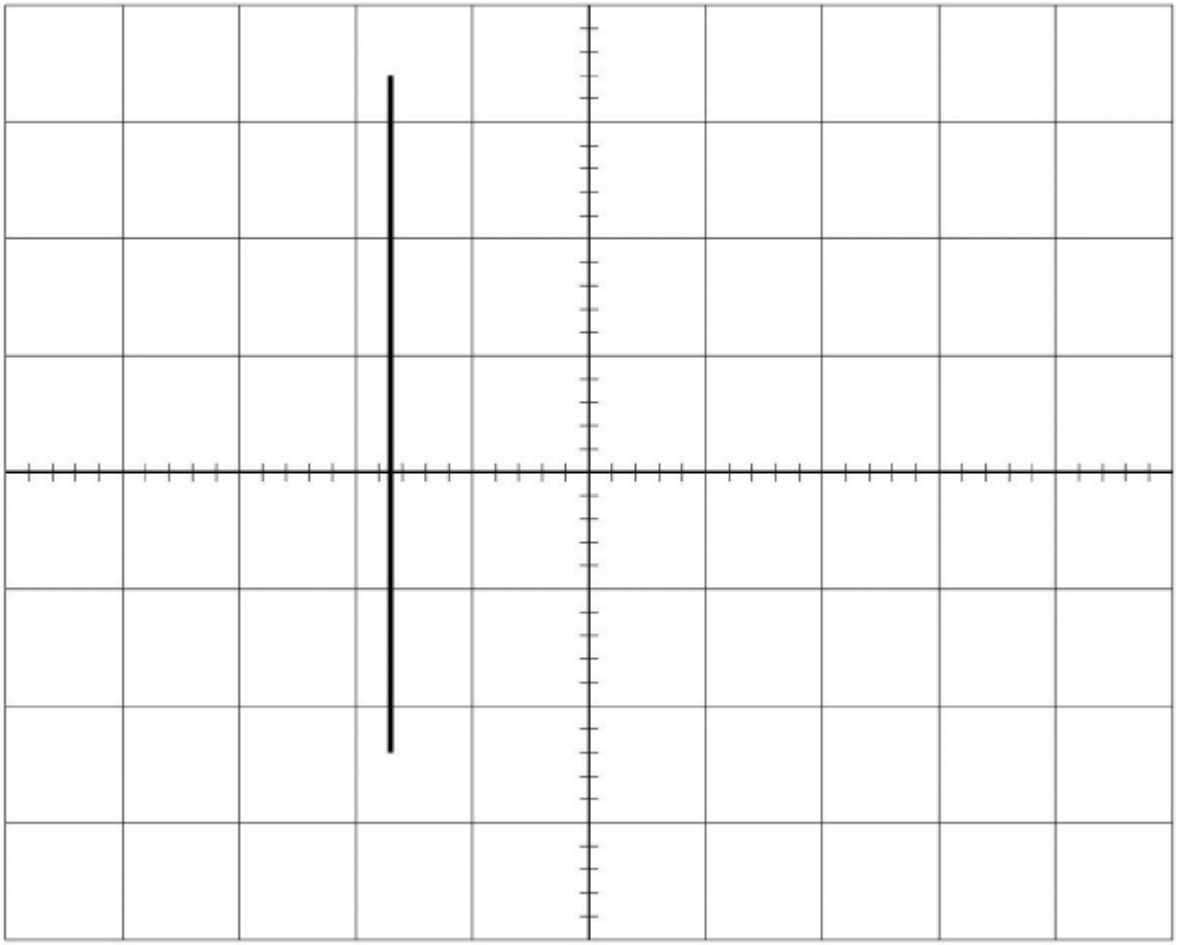
_____

(1)

(f) When the time−base is switched off, the trace on the oscilloscope appears as shown in **Figure 7**.

Figure 7

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Describe **two** adjustments the student should make to the trace to reduce the uncertainty in l.

You should refer to specific controls on the oscilloscope. You may use **Figure 7** to illustrate your answer.

(4)

(g) The student adjusts the signal generator so that the frequency of the current in the circular coil is doubled.

State and explain any changes she should make to the settings of the oscilloscope in part **(f)** so that she can repeat the experiment.

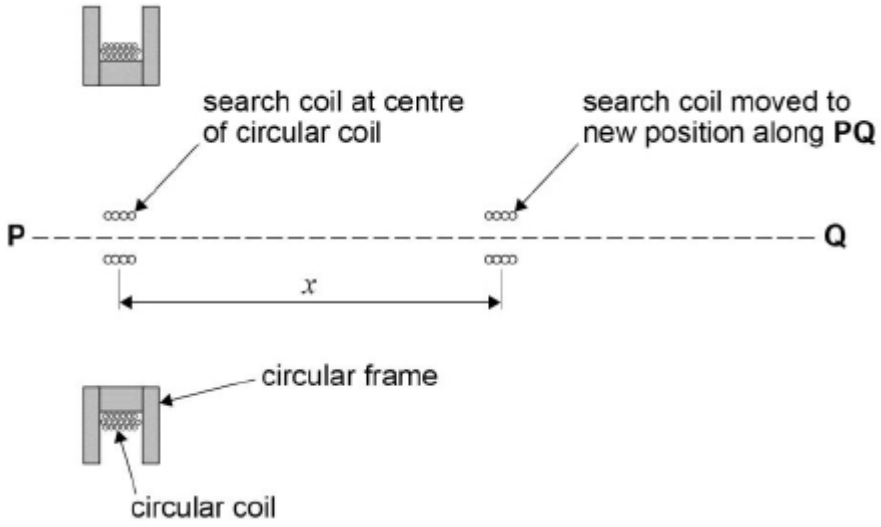
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(3)

(h) The apparatus is re−arranged as in **Figure 1** so that both coils lie in the same vertical plane and are co-axial along a line **PQ**.

The search coil is then moved a distance x along **PQ**, as shown in **Figure 8**.

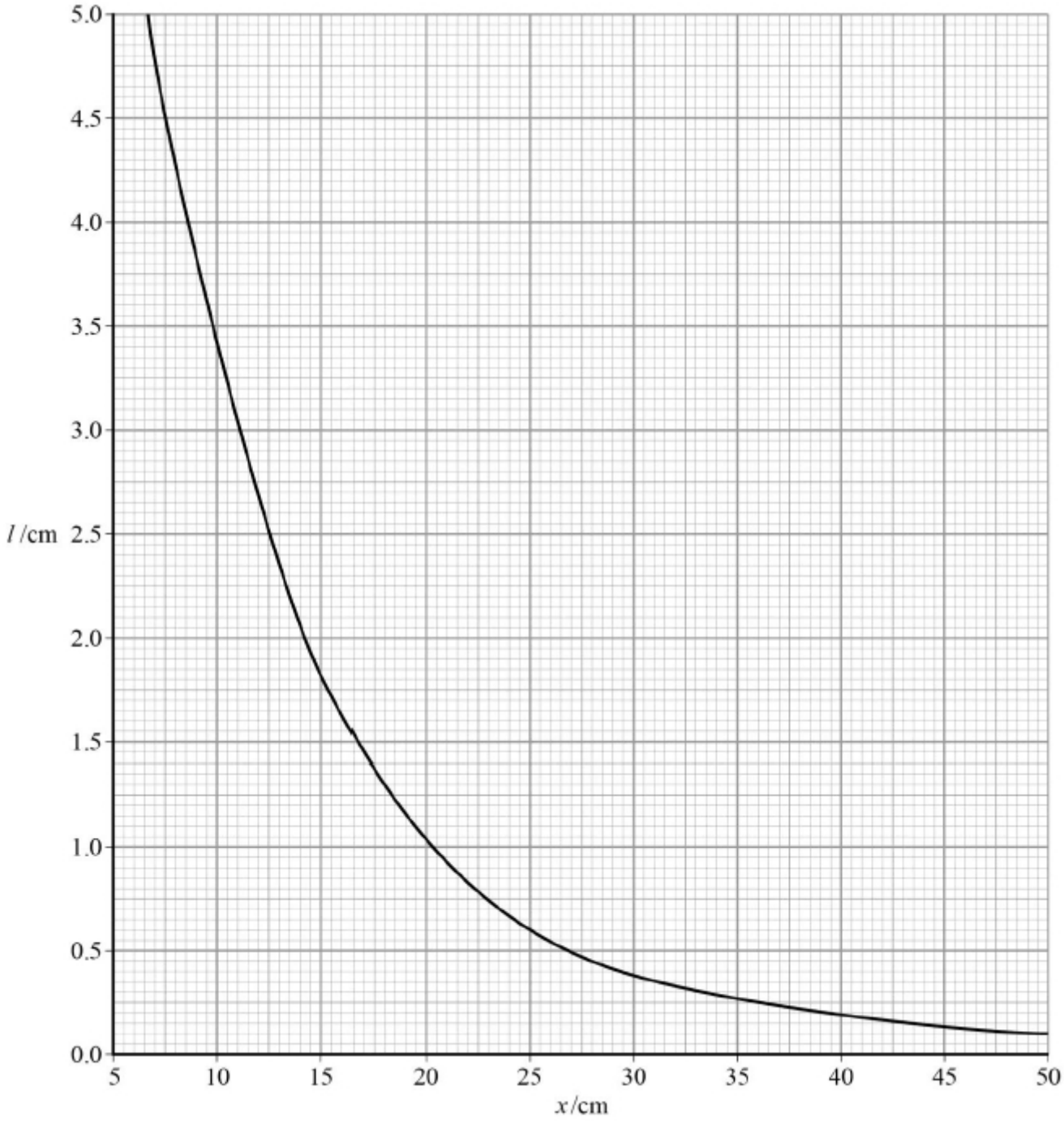
Figure 8



The values of l corresponding to different values of x are recorded. A graph of these data is shown in **Figure 9**.

Figure 9

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It is suggested that l decreases exponentially as x increases.

Explain whether **Figure 9** supports this suggestion.

_____

_____

_____

_____

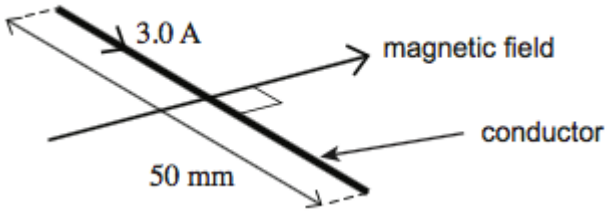
(2)

(Total 20 marks)

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Q20.

The diagram shows a horizontal conductor of length 50 mm carrying a current of 3.0 A at right angles to a uniform horizontal magnetic field of flux density 0.50 T.



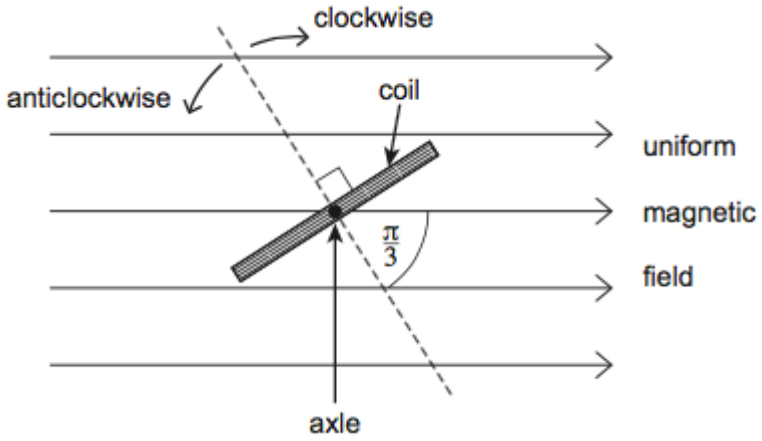
What is the magnitude and direction of the magnetic force on the conductor ?

A 0.075 N vertically upwards
B 0.075 N vertically downwards
C 75 N vertically upwards
D 75 N vertically downwards

(Total 1 mark)

Q21.

The diagram shows a coil placed in a uniform magnetic field. In the position shown, the angle between the normal to the plane of the coil and the magnetic field is $\frac{\pi}{3}$ is rad.



Which line, **A** to **D**, in the table shows the angles through which the coil should be rotated, and the direction of rotation, so that the flux linkage becomes (i) a maximum, and (ii) a minimum?

	Angle of rotation / rad	
	(i) for maximum flux linkage	**(ii) for minimum flux linkage**
A	$\frac{\pi}{6}$ clockwise	$\frac{\pi}{3}$ anticlockwise
B	$\frac{\pi}{6}$ anticlockwise	$\frac{\pi}{3}$ clockwise
C	$\frac{\pi}{3}$ clockwise	$\frac{\pi}{6}$ anticlockwise

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D	$\frac{\pi}{3}$ anticlockwise	$\frac{\pi}{6}$ clockwise

(Total 1 mark)

Q22.

A train is travelling at 20 m s^{-1} along a horizontal track through a uniform magnetic field of flux density 4.0×10^{-5} T acting vertically downwards.

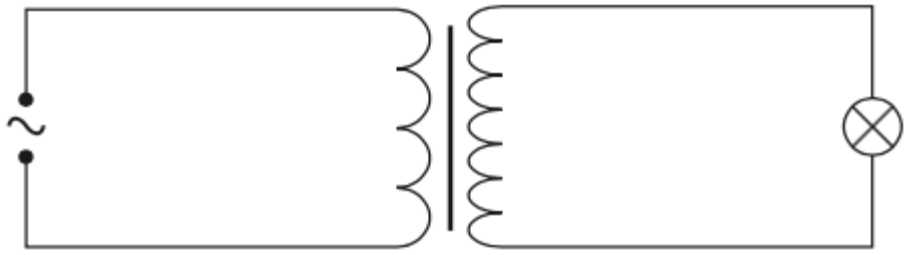
What is the emf induced between the ends of an axle 1.5 m long?

A 3.0×10^{-6}V
B 5.3×10^{-4}V
C 1.2×10^{-3}V
D 7.5×10^{5}V

(Total 1 mark)

Q23.

The primary coil of a step-up transformer is connected to a source of alternating pd.
The secondary coil is connected to a lamp.



Which line, **A** to **D**, in the table correctly describes the ratios of flux linkages and currents through the secondary coil in relation to the primary coil?

	Secondary magnetic flux linkage / Primary magnetic flux linkage	**Secondary current / Primary current**
A	< 1	< 1
B	> 1	< 1
C	> 1	> 1
D	< 1	> 1

(Total 1 mark)

Q24.

Which one of the following statements is the main reason for operating power lines at high voltage?

A Transformers are never perfectly efficient.
B High voltages are required by many industrial users of electricity.
C Electrical generators produce alternating current.

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D For a given amount of transmitted power, increasing the voltage decreases the current.

(Total 1 mark)

Q25.

(a) State, in words, the two laws of electromagnetic induction.

Law 1 _____

_____

_____

_____

Law 2 _____

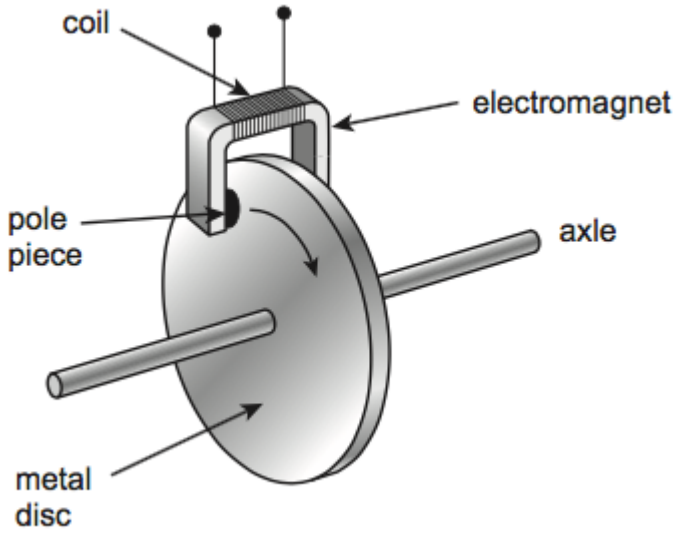
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_____

(3)

(b) The diagram below illustrates the main components of one type of electromagnetic braking system. A metal disc is attached to the rotating axle of a vehicle. An electromagnet is mounted with its pole pieces placed either side of the rotating disc, but not touching it. When the brakes are applied, a direct current is passed through the coil of the electromagnet and the disc slows down.



(i) Explain, using the laws of electromagnetic induction, how the device in the diagram acts as an electromagnetic brake.

_____

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(3)

(ii) A conventional braking system has friction pads that are brought into contact with a moving metal surface when the vehicle is to be slowed down. State **one** advantage and **one** disadvantage of an electromagnetic brake compared to a conventional brake.

Advantage _____

Disadvantage _____

(2)

(Total 8 marks)

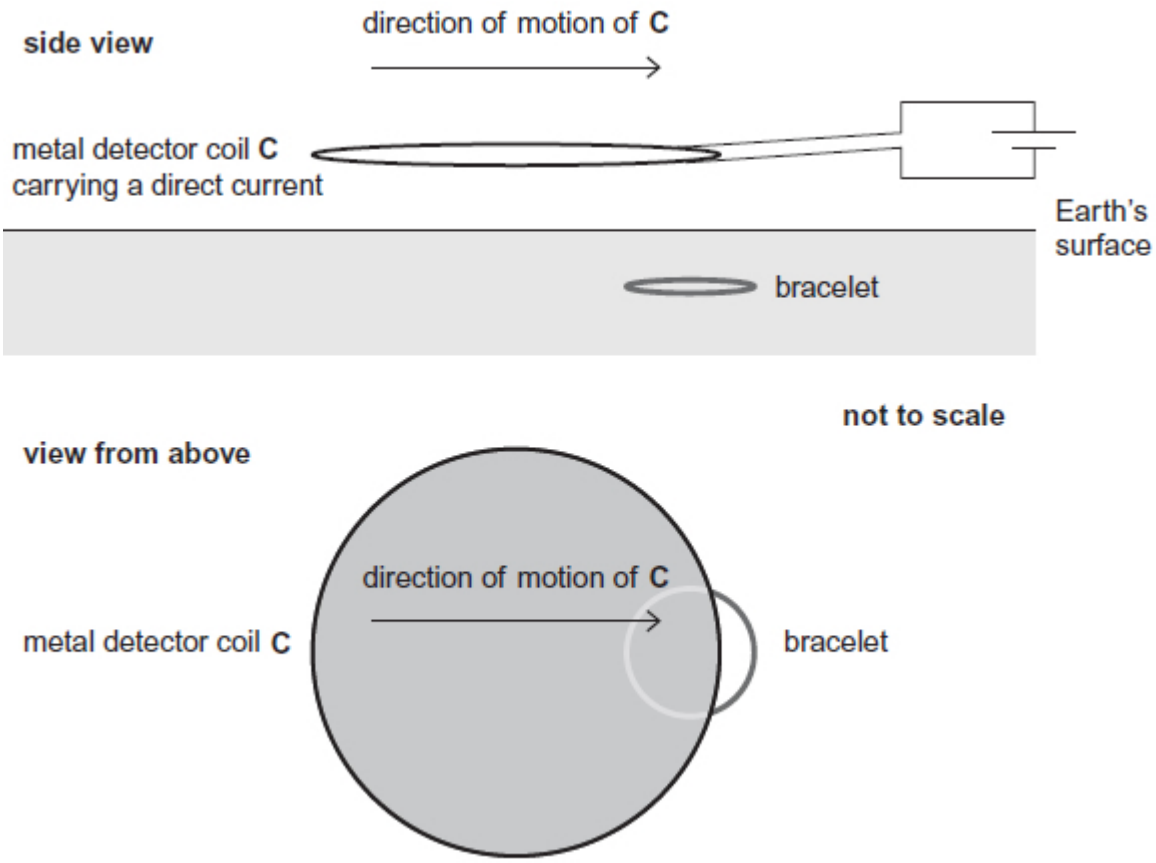
Q26.

A metal detector is moved horizontally at a constant speed just above the Earth's surface to search for buried metal objects

Figure 1 shows the coil **C** of a metal detector moving over a circular bracelet made from a single band of metal. The planes of the coil and the bracelet are both horizontal.

Figure 1

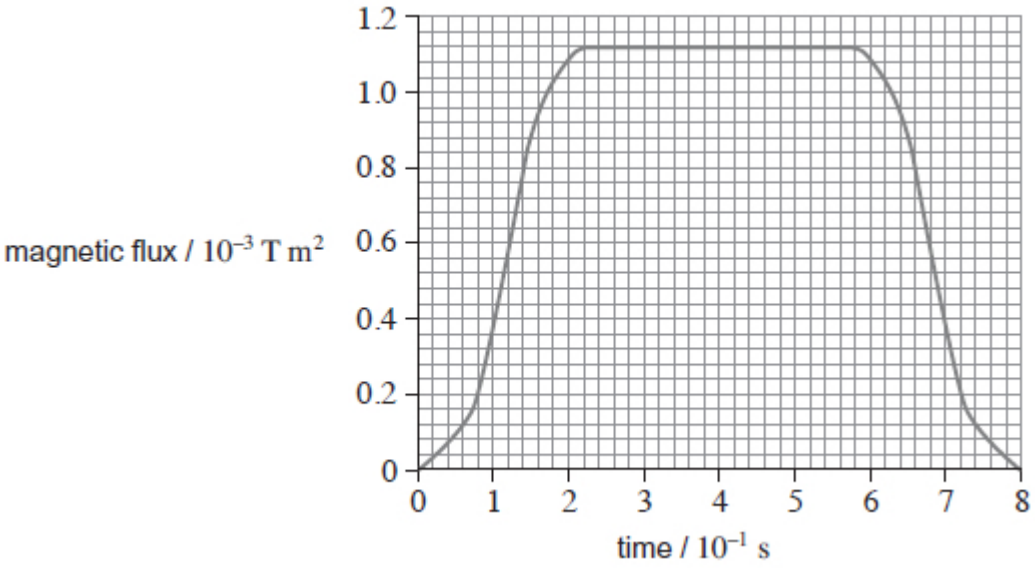
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In this metal detector, **C** carries a direct current so that the magnetic flux produced by **C** does not vary. The bracelet is just below the surface, so the flux is perpendicular to the plane of the bracelet. The field is negligible outside the shaded region of **C**.

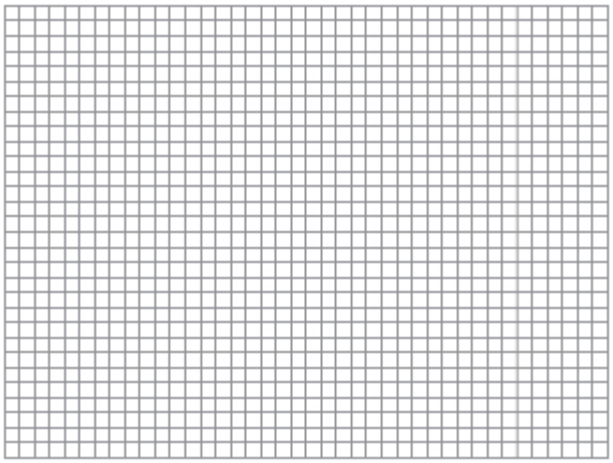
Figure 2 shows how the magnetic flux through the bracelet varies with time when **C** is moving at a constant velocity.

Figure 2



(a) (i) Sketch a graph on the grid to show how the emf induced in the bracelet varies with time as **C** moves across the bracelet. Use the same scale on the time axis as in **Figure 2**.

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(3)

(ii) Use the laws of Faraday and Lenz to explain the shape of your graph.

(4)

(b) The velocity at which **C** is moved is 0.28 m s^{-1}.

Show that the diameter of the bracelet is about 6 cm.

(1)

(c) Determine the magnetic flux density of the field produced by **C** at the position of the bracelet.

magnetic flux density _____ T

(2)

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(d) Determine the maximum emf induced in the bracelet.

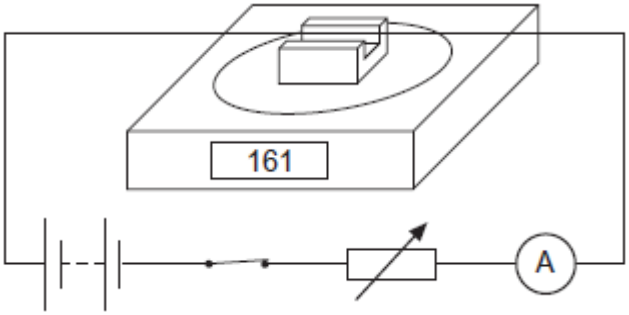
maximum emf _____ V

(3)

(Total 13 marks)

Q27.

The diagram shows a rigidly-clamped straight horizontal current-carrying wire held mid-way between the poles of a magnet on a top-pan balance. The wire is perpendicular to the magnetic field direction.



The balance, which was zeroed before the switch was closed, read 161 g after the switch was closed. When the current is reversed and doubled, what would be the new reading on the balance?

A −322 g

B −161 g

C zero

D 322 g

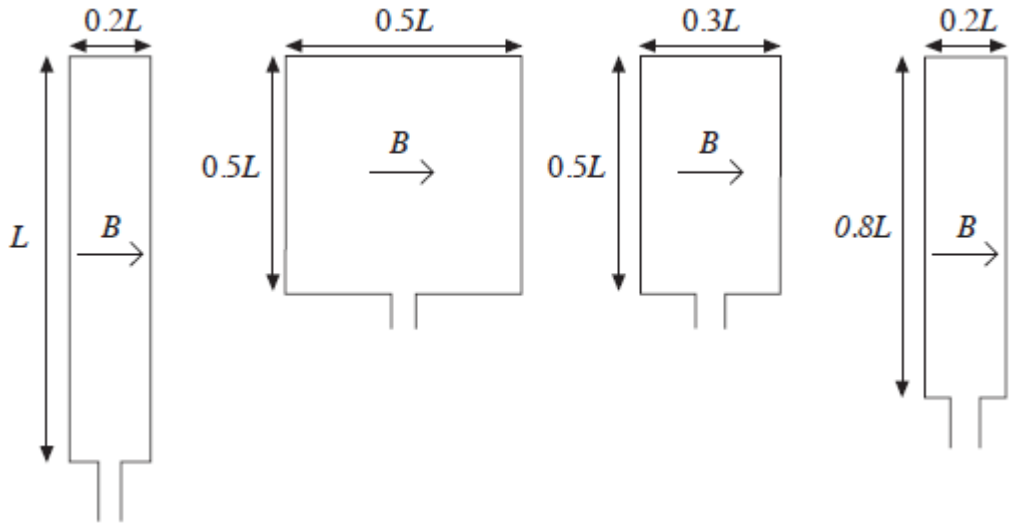
(Total 1 mark)

Q28.

Four rectangular loops of wire **A**, **B**, **C** and **D** are each placed in a uniform magnetic field of the same flux density B. The direction of the magnetic field is parallel to the plane of the loops as shown.

When a current of 1 A is passed through each of the loops, magnetic forces act on them. The lengths of the sides of the loops are as shown.
Which loop experiences the largest couple?

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A **B** **C** **D**

(Total 1 mark)

Q29.

Which one of the following statements is correct?

An electron follows a circular path when it is moving at right angles to

A a uniform magnetic field.

B a uniform electric field.

C uniform electric and magnetic fields which are perpendicular.

D uniform electric and magnetic fields which are in opposite directions.

(Total 1 mark)

Q30.

Two electrons, X and Y, travel at right angles to a uniform magnetic field.
X experiences a magnetic force, F_{X}, and Y experiences a magnetic force, F_{Y}.

What is the ratio $\frac{F_X}{F_Y}$ if the kinetic energy of X is half that of Y?

A $\frac{1}{4}$

B $\frac{1}{2}$

C $\frac{1}{\sqrt{2}}$

D 1

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(Total 1 mark)

Q31.

A lamp rated at 12 V 60 W is connected to the secondary coil of a step-down transformer and is at full brightness. The primary coil is connected to a supply of 230 V. The transformer is 75% efficient.
What is the current in the primary coil?

A 0.25 A

B 0.35 A

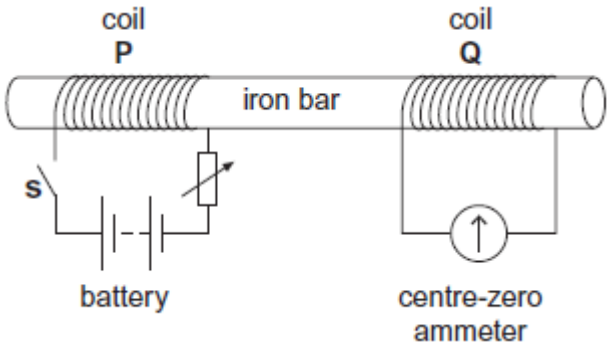
C 3.75 A

D 5.0 A

Q32.

(a) **Figure 1** shows two coils, **P** and **Q**, linked by an iron bar. Coil **P** is connected to a battery through a variable resistor and a switch **S**. Coil **Q** is connected to a centre-zero ammeter.

Figure 1



(i) Initially the variable resistor is set to its minimum resistance and **S** is open. Describe and explain what is observed on the ammeter when **S** is closed.

(3)

(ii) With **S** still closed, the resistance of the variable resistor is suddenly increased.
Compare what is now observed on the ammeter with what was observed in part (i).
Explain why this differs from what was observed in part (i).

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_____

_____

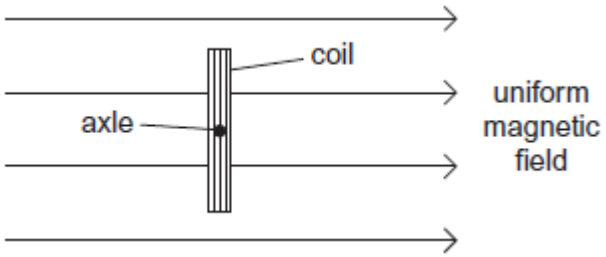
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_____

(2)

(b) **Figure 2** shows a 40-turn coil of cross-sectional area 3.6×10^{-3} m^2 with its plane set at right angles to a uniform magnetic field of flux density 0.42 T.

Figure 2



(i) Calculate the magnitude of the magnetic flux linkage for the coil.
State an appropriate unit for your answer.

flux linkage _____ unit _____

(2)

(ii) The coil is rotated through 90° in a time of 0.50 s.
Determine the mean emf in the coil.

mean emf _____ V

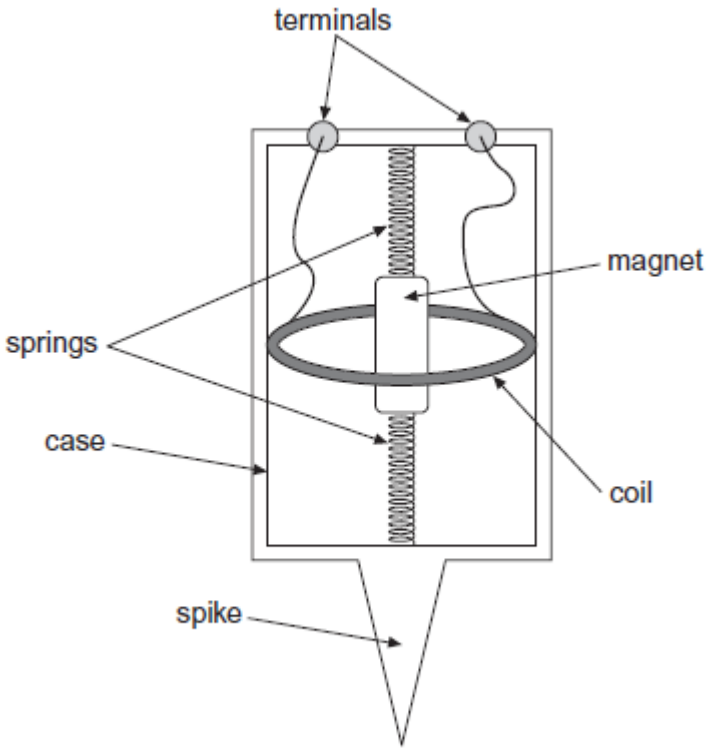
(2)

(Total 9 marks)

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Q33.

The diagram below shows the main parts of a geophone.



The spike attaches the geophone firmly to the ground. At the instant an earthquake occurs, the case and coil move upwards due to the Earth's movement. The magnet remains stationary due to its inertia. In 3.5 ms, the coil moves from a position where the flux density is 9.0 mT to a position where the flux density is 23.0 mT.

(a) The geophone coil has 250 turns and an area of 12 cm^2.

Calculate the average emf induced in the coil during the first 3.5 ms after the start of the earthquake.

emf _____ V

(3)

(b) Explain how the initial emf induced in the coil of the geophone would be affected:

if the stiffness of the springs were to be increased

_____

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if the number of turns on the coil were to be increased.

(2)

(c) (i) The geophone's magnet has a mass of 8.0×10^{-3} kg and the spring stiffness of the system is 2.6 N m^{-1}.

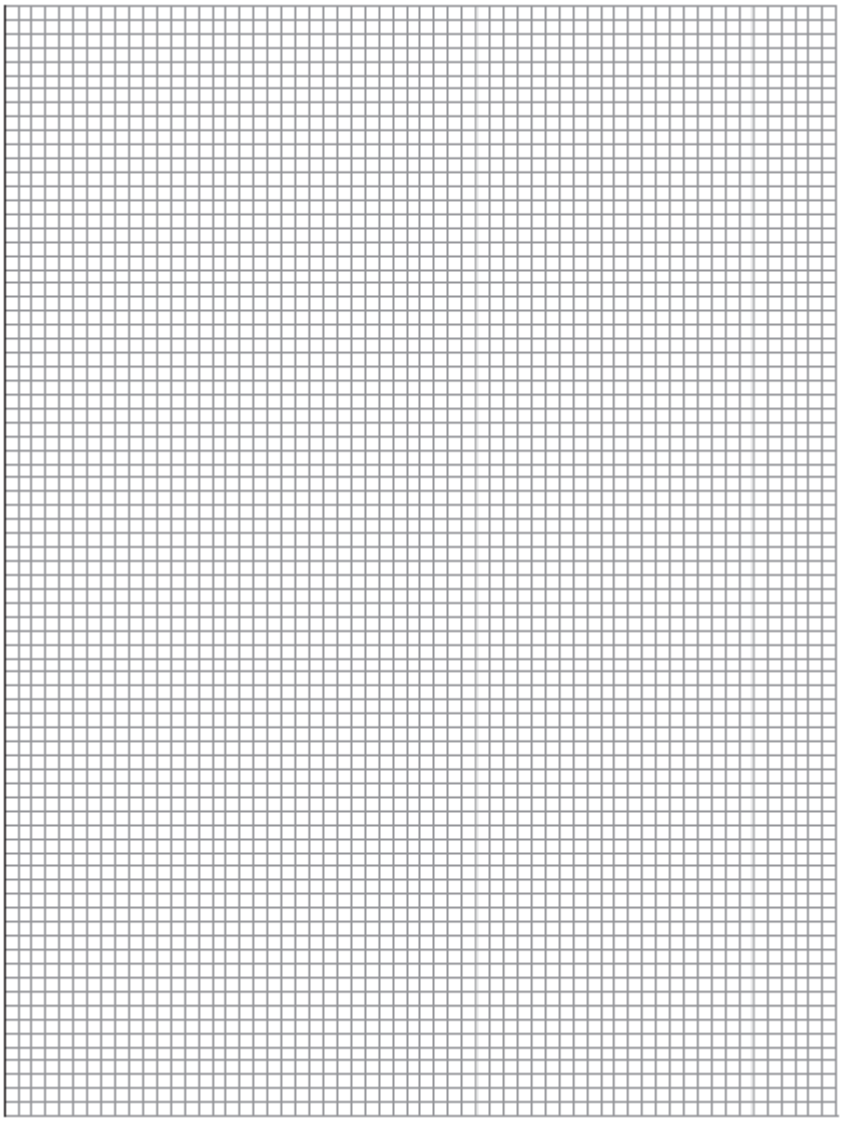
Show that the natural period of oscillation of the mass−spring system is approximately 0.35 s.

(2)

(ii) At the instant that the Earth stops moving after one earthquake, the emf in the coil is at its maximum value of +8 V. The magnet continues to oscillate.

On the grid below, sketch a graph showing the variation of emf with time as the magnet's oscillation decays.
Show at least **three** oscillations.

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(3)
(Total 10 marks)

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