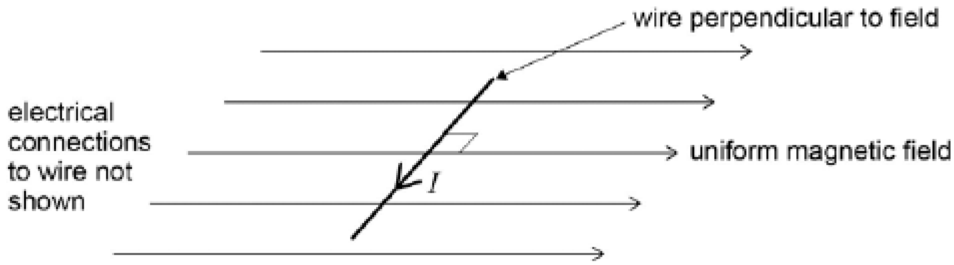
1 A horizontal straight wire of length 0.30 m carries a current of 2.0 A perpendicular to a horizontal uniform magnetic field of flux density 5.0×10^{-2} T. The wire 'floats' in equilibrium in the field.



What is the mass of the wire?

A 8.0×10^{-4} kg

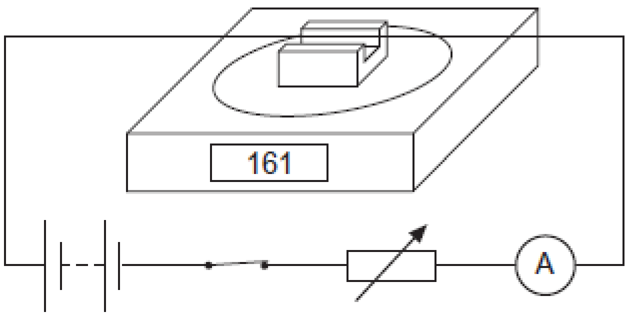
B 3.1×10^{-3} kg

C 3.0×10^{-2} kg

D 8.2×10^{-1} kg

(Total 1 mark)

2 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

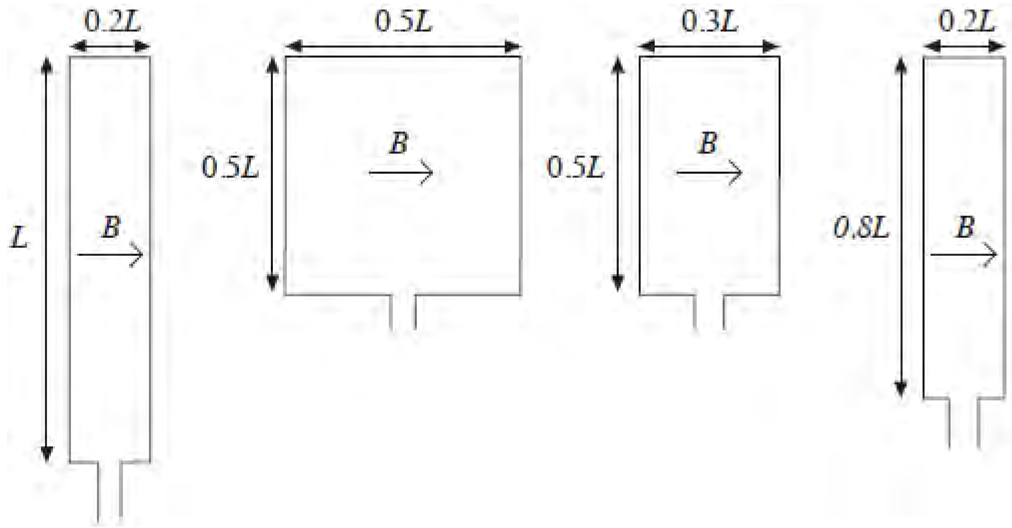
C zero

D 322 g

(Total 1 mark)

3 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.

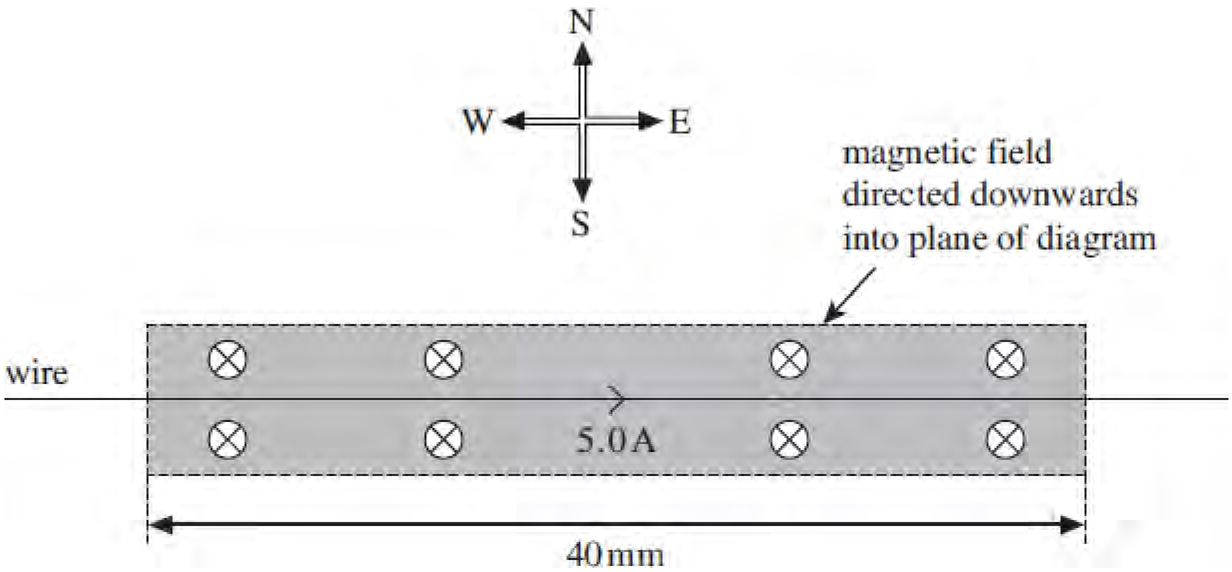
When a current of 1 A is passed through each of the loops, magnetic forces act on them. The lengths of the sides of the loops are as shown.
Which loop experiences the largest couple?



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

(Total 1 mark)

4 A horizontal straight wire of length 40 mm is in an east-west direction as shown in the diagram. A uniform magnetic field of flux density 50 mT is directed downwards into the plane of the diagram.



When a current of 5.0 A passes through the wire from west to east, a horizontal force acts on the wire. Which line, **A** to **D**, in the table gives the magnitude and direction of this force?

	magnitude / mN	direction
A	2.0	north
B	10.0	north
C	2.0	south
D	10.0	south

(Total 1 mark)

5 Which one of the following could **not** be used as a unit of force?

A A T m

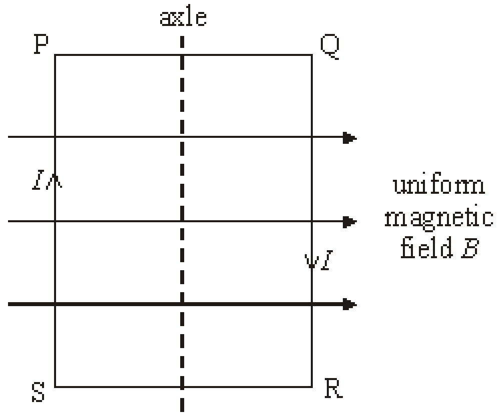
B W s^{-2}

C kg m s^{-2}

D J m^{-1}

(Total 1 mark)

6



A coil, mounted on an axle, has its plane parallel to the flux lines of a uniform magnetic field *B*, as shown. When a current I is switched on, and before the coil is allowed to move,

A there are no forces due to *B* on the sides PQ and RS.

B there are no forces due to *B* on the sides SP and QR.

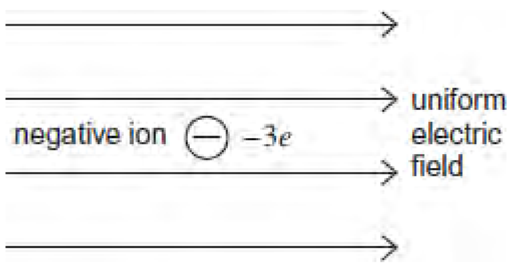
C sides SP and QR attract each other.

D sides PQ and RS attract each other.

(Total 1 mark)

7 (a) **Figure 1** shows a negative ion which has a charge of –3*e* and is free to move in a uniform electric field. When the ion is accelerated by the field through a distance of 63 mm parallel to the field lines its kinetic energy increases by 4.0 × 10sup class="xsmall">–16 J.

Figure 1



(i) State and explain the direction of the electrostatic force on the ion.

....

....

....

....

(2)

(ii) Calculate the magnitude of the electrostatic force acting on the ion.

magnitude of electrostatic force .... N

(2)

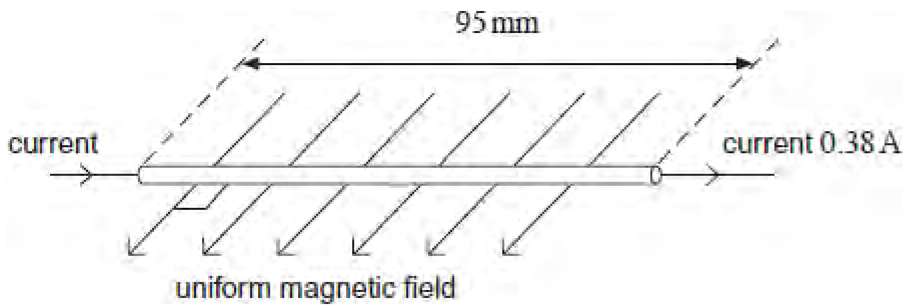
(iii) Calculate the electric field strength.

electric field strength .... NC^{-1}

(1)

(b) **Figure 2** shows a section of a horizontal copper wire carrying a current of 0.38 A.
A horizontal uniform magnetic field of flux density B is applied at right angles to the wire in the direction shown in the figure.

Figure 2



(i) State the direction of the magnetic force that acts on the moving electrons in the wire as a consequence of the current and explain how you arrive at your answer.

....

....

....

....

....

(2)

(ii) Copper contains 8.4×10^{28} free electrons per cubic metre. The section of wire in **Figure 2** is 95 mm long and its cross-sectional area is 5.1×10^{-6} m^2.
Show that there are about 4×10^{22} free electrons in this section of wire.

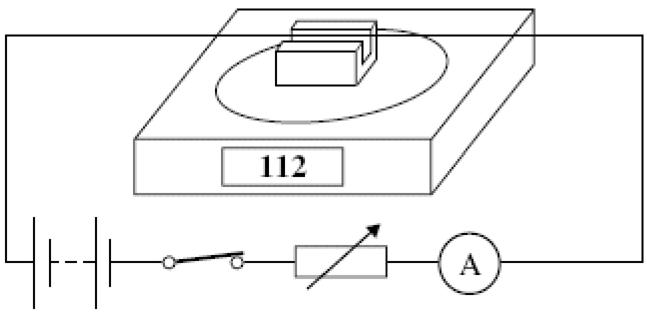
(1)

(iii) With a current of 0.38 A, the average velocity of an electron in the wire is 5.5×10^{-6} m s^{-1} and the average magnetic force on one electron is 1.4×10^{-25} N.
Calculate the flux density B of the magnetic field.

flux density .... T

(2)
(Total 10 marks)

8 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, reads 112 g after the switch is closed. If the current is reversed and doubled, what will be the new reading on the balance?

A –224 g

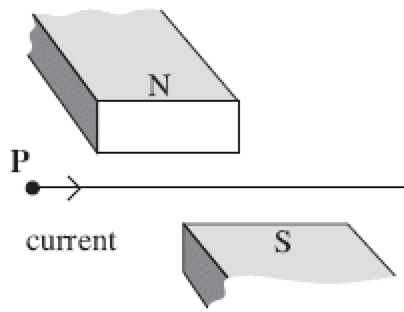
B –112 g

C zero

D 224 g

(Total 1 mark)

9 The figure below shows a horizontal wire, held in tension between fixed points at **P** and **Q**. A short section of the wire is positioned between the pole pieces of a permanent magnet, which applies a uniform horizontal magnetic field at right angles to the wire. Wires connected to a circuit at **P** and **Q** allow an electric current to be passed through the wire.



(a) (i) State the direction of the force on the wire when there is a direct current from **P** to **Q**, as shown in the figure above.

....

(1)

(ii) In a second experiment, an alternating current is passed through the wire. Explain why the wire will vibrate vertically.

....

....

....

....

....

....

(3)

(b) The permanent magnet produces a uniform magnetic field of flux density 220 mT over a 55 mm length of the wire. Show that the maximum force on the wire is about 40 mN when there is an alternating current of rms value 2.4 A in it.

(3)

(c) The length of **PQ** is 0.40 m. When the wire is vibrating, transverse waves are propagated along the wire at a speed of 64 m s^{-1}. Explain why the wire is set into large amplitude vibration when the frequency of the a.c. supply is 80 Hz.

....

....

....

....

....

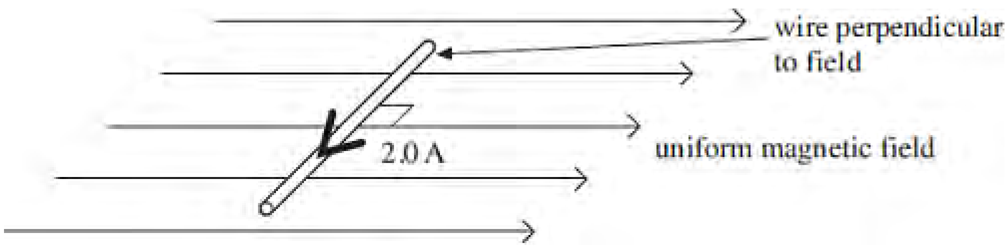
....

....

....

(3)
(Total 10 marks)

10 A horizontal straight wire of length 0.30 m carries a current of 2.0 A perpendicular to a horizontal uniform magnetic field of flux density 5.0 × 10^{-2} T. The wire 'floats' in equilibrium in the field.



What is the mass of the wire?

A 8.0 × 10^{-4} kg

B 3.1 × 10^{-3} kg

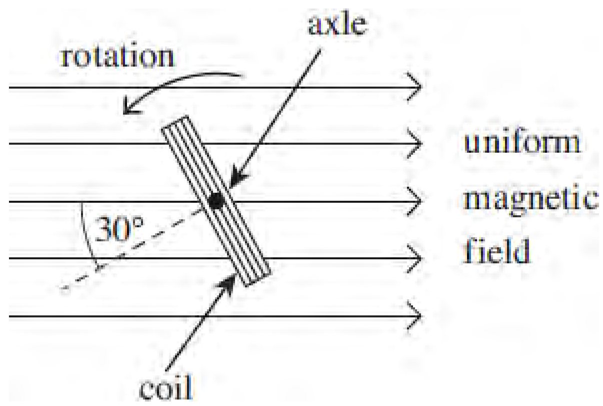
C 3.0 × 10^{-2} kg

D 8.2 × 10^{-1} kg

(Total 1 mark)

11 A rectangular coil is rotating anticlockwise at constant angular speed with its axle at right angles to a uniform magnetic field. **Figure 1** shows an end-on view of the coil at a particular instant.

Figure 1



(a) At the instant shown in **Figure 1**, the angle between the normal to the plane of the coil and the direction of the magnetic field is 30°.

(i) State the minimum angle, in degrees, through which the coil must rotate from its position in **Figure 1** for the emf to reach its maximum value.

angle .... degrees

(1)

(ii) Calculate the minimum angle, in radians, through which the coil must rotate from its position in **Figure 1** for the flux linkage to reach its maximum value.

angle .... radians

(2)

(b) **Figure 2** shows how, starting in a different position, the flux linkage through the coil varies with time.

(i) What physical quantity is represented by the gradient of the graph shown in **Figure 2**?

....

(1)

(ii) Calculate the number of revolutions per minute made by the coil.

revolutions per minute ....

(2)

Figure 2

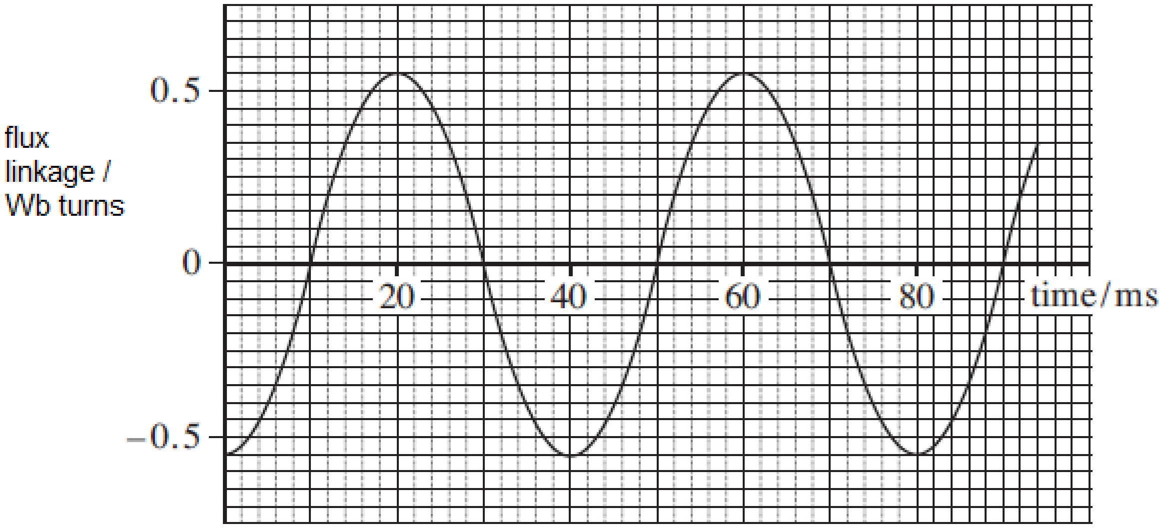
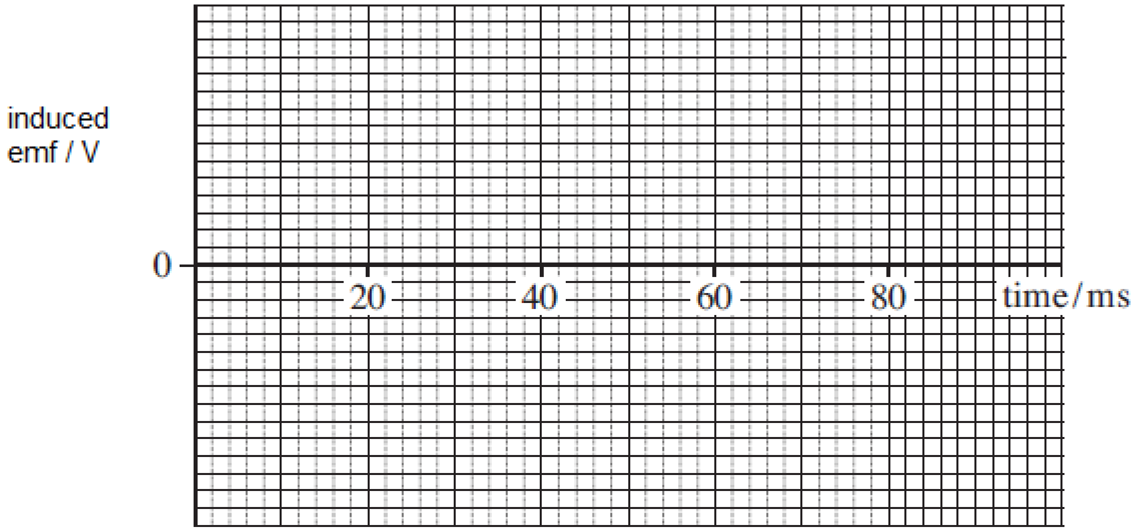


Figure 3



(iii) Calculate the peak value of the emf generated.

peak emf V

(3)

(c) Sketch a graph on the axes shown in **Figure 3** above to show how the induced emf varies with time over the time interval shown in **Figure 2**.

(2)

(d) The coil has 550 turns and a cross-sectional area of $4.0 \times 10^{-3} m^2$.

Calculate the flux density of the uniform magnetic field.

flux density .... T

(2)

(Total 13 marks)

12 A section of current-carrying wire is placed at right angles to a uniform magnetic field of flux density *B*. When the current in the wire is I, the magnetic force that acts on this section is *F*.

What force acts when the same section of wire is placed at right angles to a uniform magnetic field of flux density 2*B* when the current is 0.25 I?

A $\frac{F}{4}$

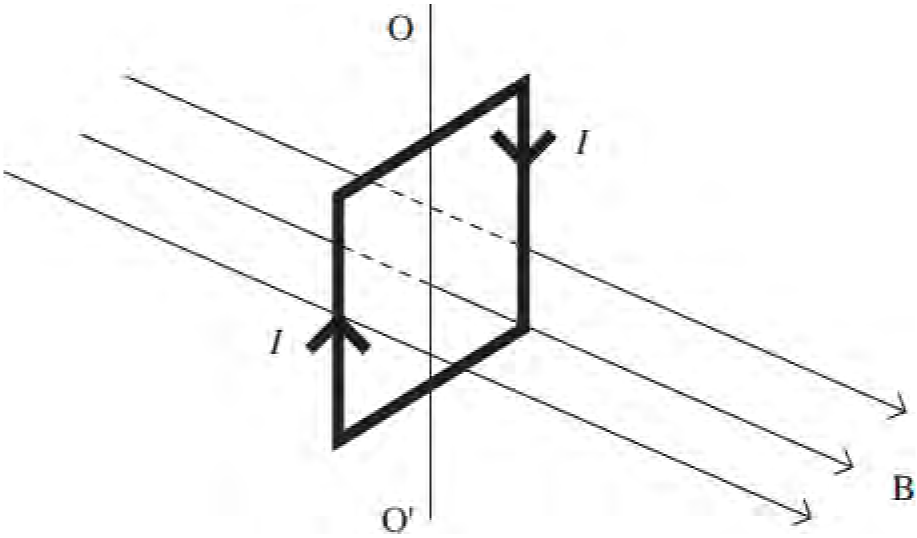
B $\frac{F}{2}$

C *F*

D *2F*

(Total 1 mark)

13 The diagram shows a vertical square coil whose plane is at right angles to a horizontal uniform magnetic field B. A current, I, is passed through the coil, which is free to rotate about a vertical axis OO'.



Which one of the following statements is correct?

A The forces on the two vertical sides of the coil are equal and opposite.

B A couple acts on the coil.

C No forces act on the horizontal sides of the coil.

D If the coil is turned through a small angle about OO' and released, it will remain in position.

(Total 1 mark)