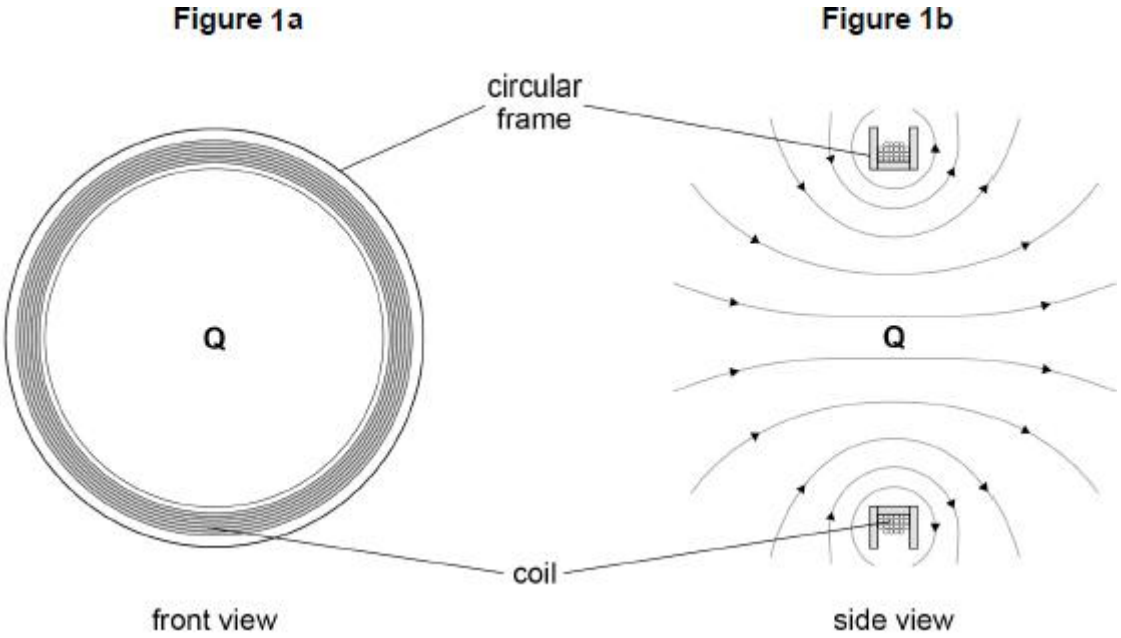
Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

Figure 1 shows the front view of a vertical coil mounted on a circular frame.

Figure 1 is a side view showing a section through the frame and coil.
A constant direct current in the coil produces magnetic flux represented by the magnetic field lines on this diagram.



Point **Q** is at the centre of the coil.

A sensor placed at **Q** detects B_H, the horizontal component of the magnetic flux density.

The effect of the Earth's magnetic field at **Q** is negligible.

(a) Discuss whether a search coil is a suitable sensor to detect B_H.

_____

_____

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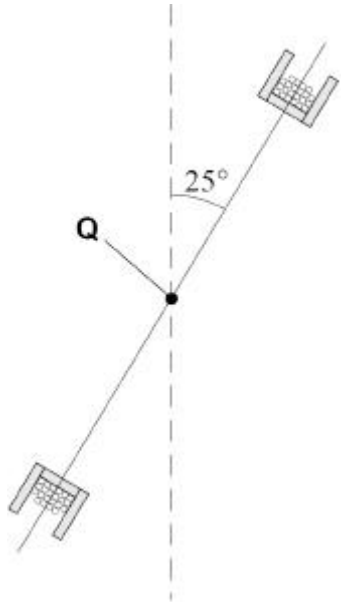
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(2)

B_H is measured at **Q** with the coil vertical.

The coil is now rotated about **Q** through 25° as shown in **Figure 2**.
The current in the coil does not change.

Figure 2



A new measurement of B_H is made with the coil fixed in this new position.

(b) Determine the percentage change in B_H produced by this rotation of the coil.
Show your working.

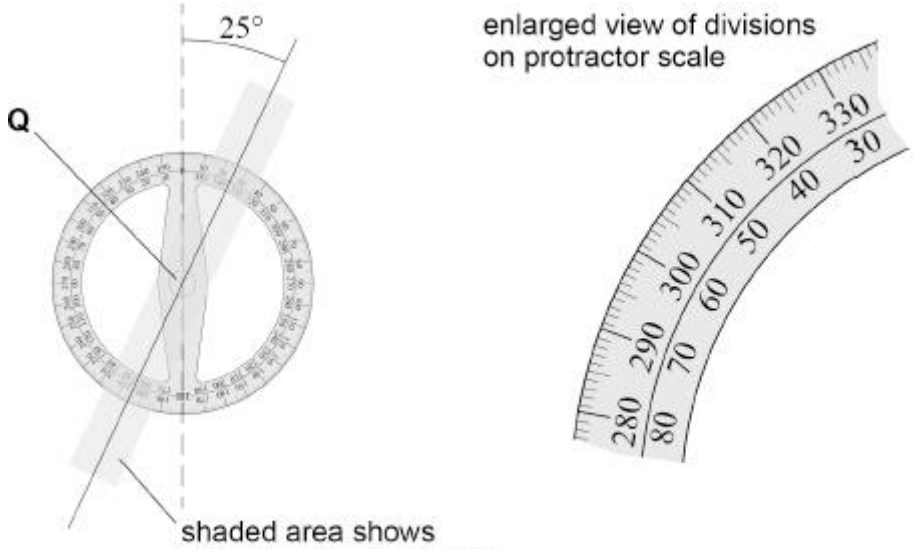
percentage change = _____ %

(2)

(c) **Figure 3** shows a protractor being used to measure the angle through which the coil is rotated.

Figure 3

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Estimate the percentage uncertainty in this result.
Justify your answer.

_____

_____

_____

_____

_____

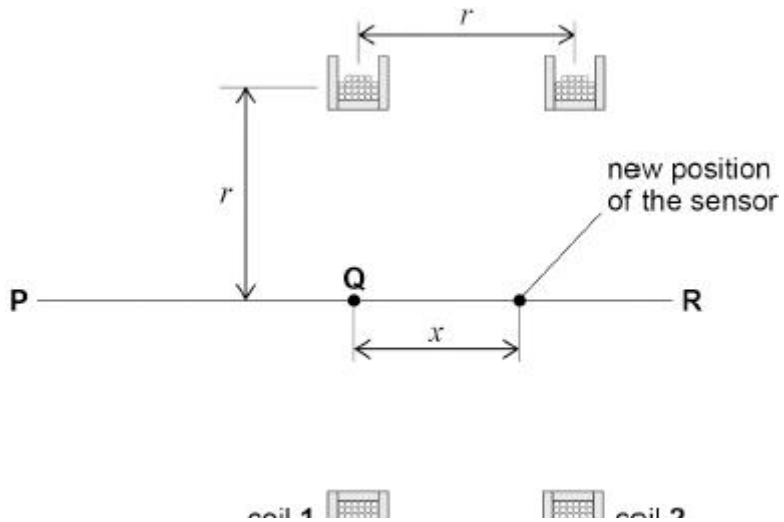
percentage uncertainty = _____ %

(3)

Figure 4 shows an arrangement of two vertical coils.
Four experiments are done using this arrangement.

Figure 4

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Coil **1** and coil **2** are identical and have a radius r.
The coils are separated by a distance r and have a common axis **PR**.
Q is at the centre of coil **1**.

The four different experiments investigate how B_H varies with x, the displacement of the sensor from **Q** along **PR**.

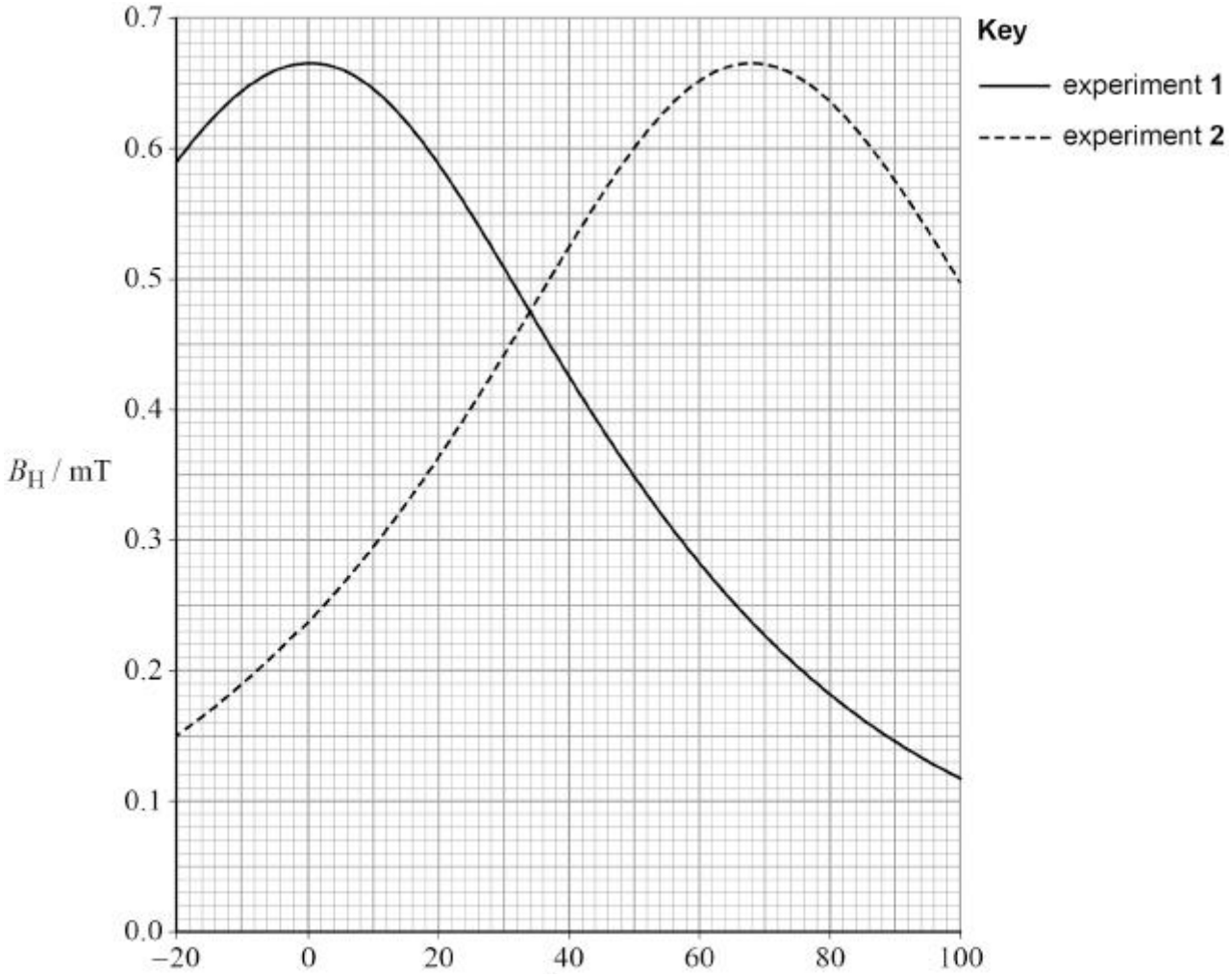
In experiment **1**, the current in coil **1** is 225 mA and the current in coil **2** is zero.

In experiment **2**, the current in coil **1** is zero and the current in coil **2** is 225 mA.

Figure 5 shows the results of experiment **1** and experiment **2**.

Figure 5

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(d) During experiment **1**, B_H is measured with the sensor at **Q**.
The sensor is then moved along **PR** until the value of B_H is halved.
The distance from **Q** to the sensor is $x_{0.5}$

Determine $\frac{x_{0.5}}{r}$

$\frac{x_{0.5}}{r}$ = _____

(2)

In experiment **3**, the current in both coils is 225 mA so that the magnetic fields produced by coil **1** and coil **2** are combined.

The resultant B_H has a constant maximum value in the region between $x = \frac{r}{4}$ and $x = \frac{3r}{4}$

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(e) Deduce, in mT, the value of B_H in this region.

B_H = _____ mT

(2)

(f) State **two** characteristics of the magnetic field lines in this region.

1 _____

_____

_____

2 _____

_____

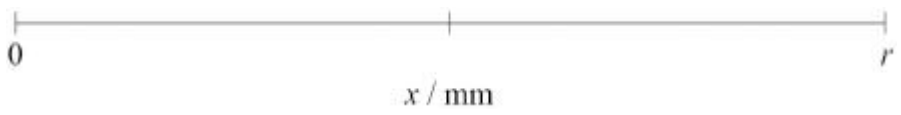
_____

(2)

(g) In experiment **4**, the current in coil **2** is reversed so that the direction of the magnetic field produced by coil **2** is also reversed.
The magnitudes of the currents in coil **1** and coil **2** are still 225 mA.

Sketch a graph to show how B_H varies between $x = 0$ and $x = r$.
The x-axis has been provided for you.

Your graph should include numerical values on your B_H axis that correspond to $x = 0$ and $x = r$.



(3)

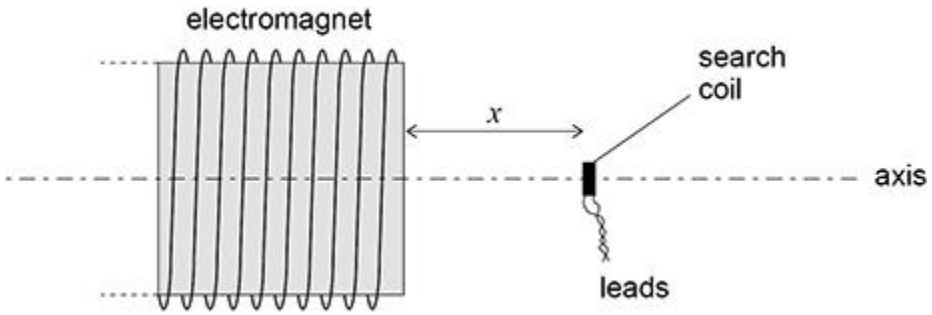
(Total 16 marks)

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Q2.

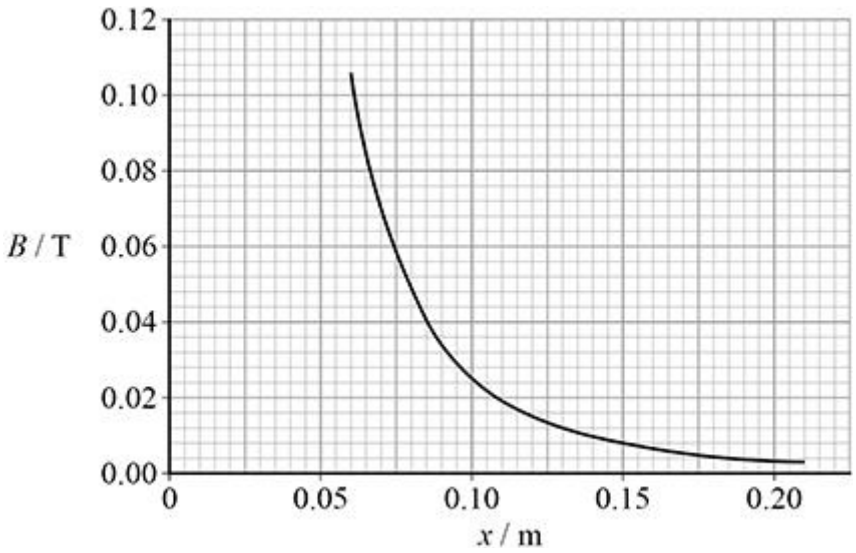
Figure 1 shows a search coil positioned on the axis of an electromagnet, with the plane of the search coil perpendicular to the axis. A magnetic field is produced by a constant current in the electromagnet.
Assume that the magnetic flux density inside the search coil is uniform.

Figure 1



The distance between the search coil and the end of the electromagnet is x. **Figure 2** shows how the magnetic flux density B of the field varies with x.

Figure 2



The search coil has 200 turns and a cross-sectional area of 3.5×10^{-5} m^2.

(a) The search coil is placed at $x = 0.070$ m.

Show that the magnetic flux linkage through the search coil is about 5×10^{-4} Wb.

(2)

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The search coil is now moved at a constant speed of 0.80 m s^{-1} along the axis so that x is increasing. An emf is induced across the terminals of the search coil.

(b) Explain what happens to the value of the emf as the search coil moves.

_____

_____

_____

_____

_____

_____

(2)

(c) The search coil passes through the position where x = 0.10 m.

Deduce whether the emf can exceed 5 mV for values of x greater than 0.10 m.

(4)

(Total 8 marks)

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