

Name of the Student: _____

Max. Marks : 19 Marks

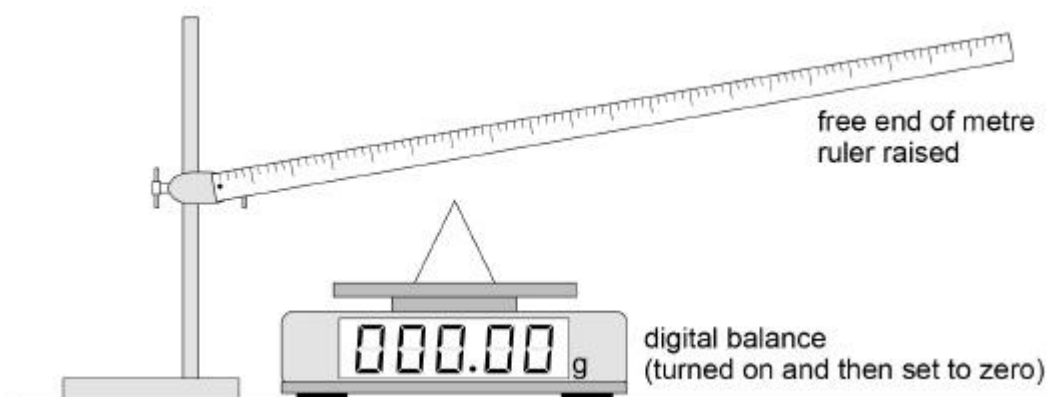
Time : 19 Minutes

Q1.

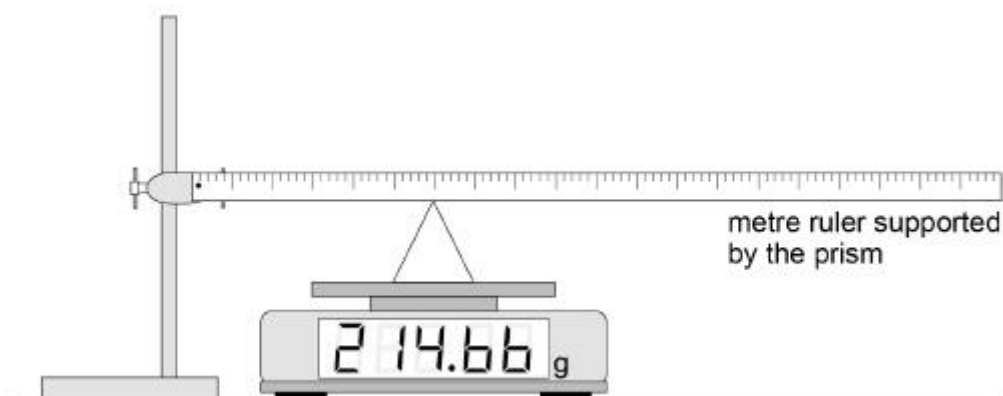
This question is about using a digital balance to investigate the force on a wire placed in a magnetic field when there is an electric current in the wire.

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

assumption _____

(3)

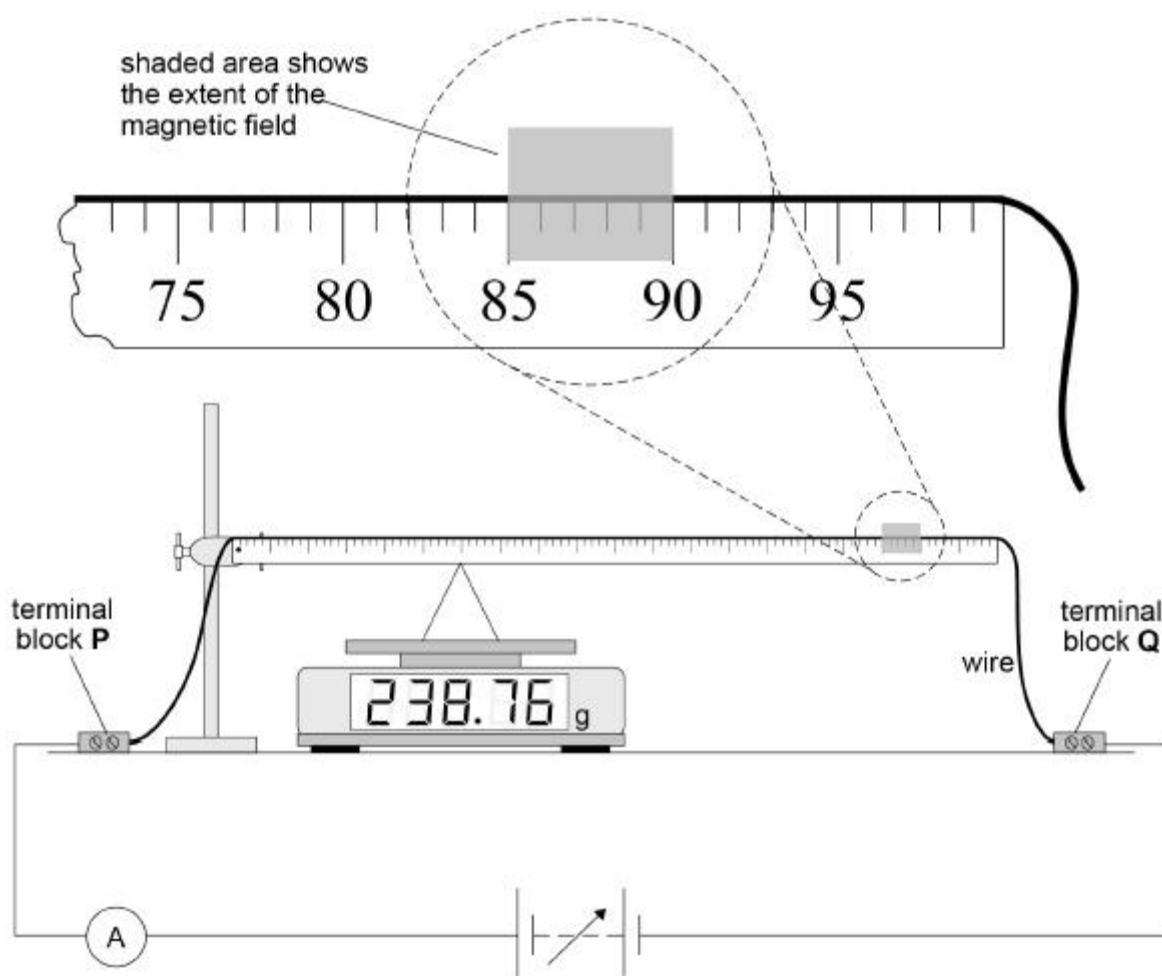
- (b) The student attaches a uniform wire to the upper edge of the ruler, as shown in **Figure 3**.

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.

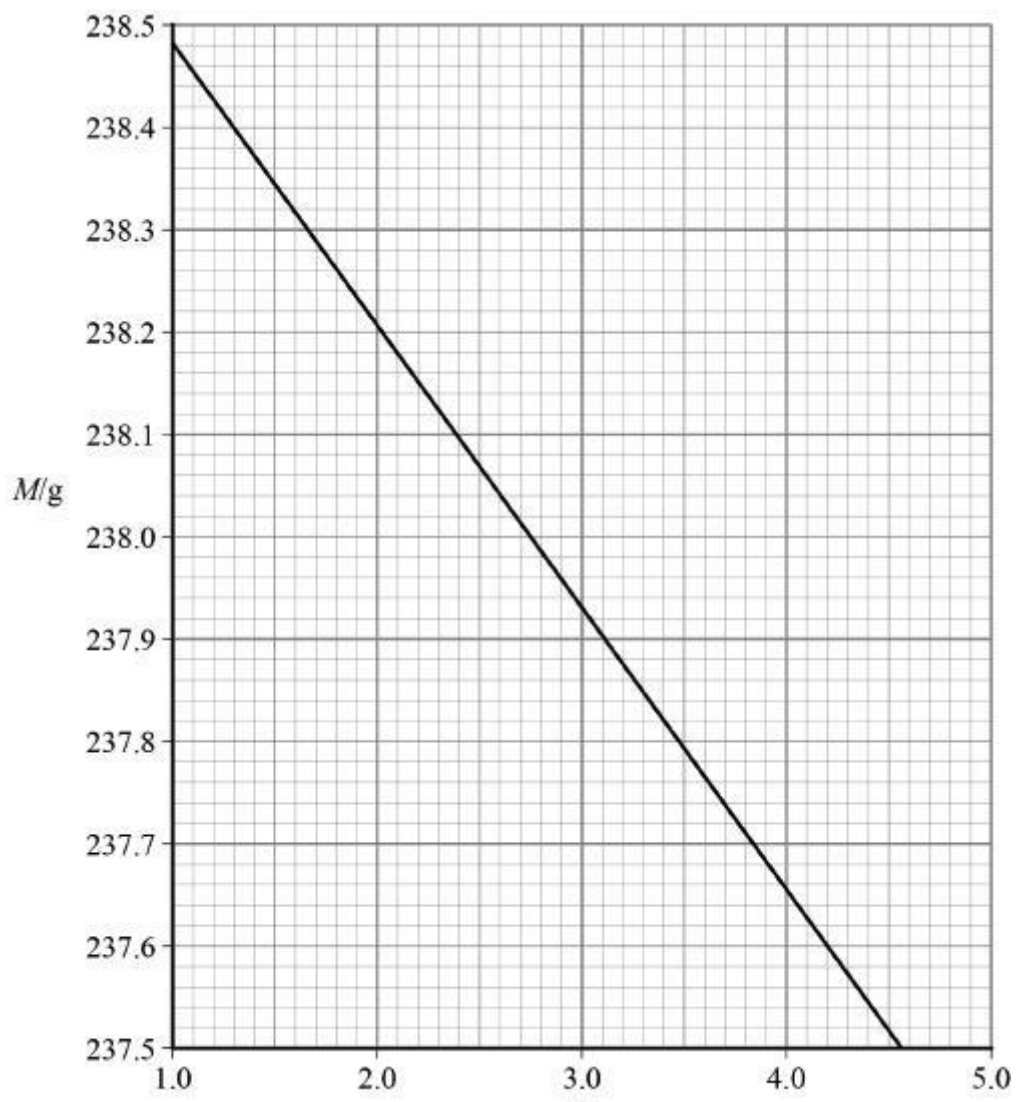
A horizontal uniform magnetic field is applied, perpendicular to the wire, between the 85 cm and 90 cm marks, as shown in the close-up diagram in **Figure 3**.

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



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

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

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 .

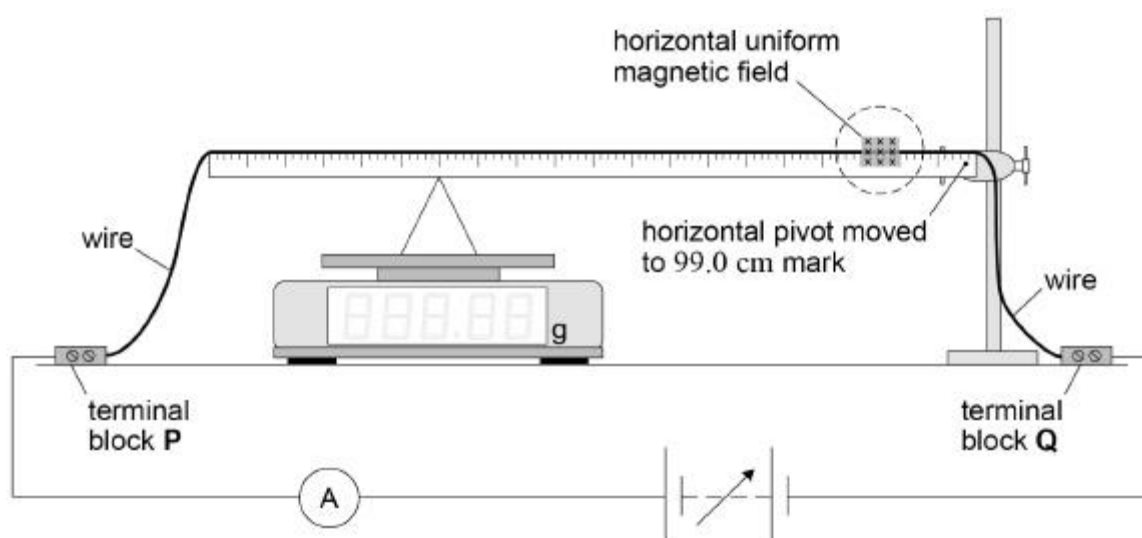
$$B = \text{_____ T}$$

(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			
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 .

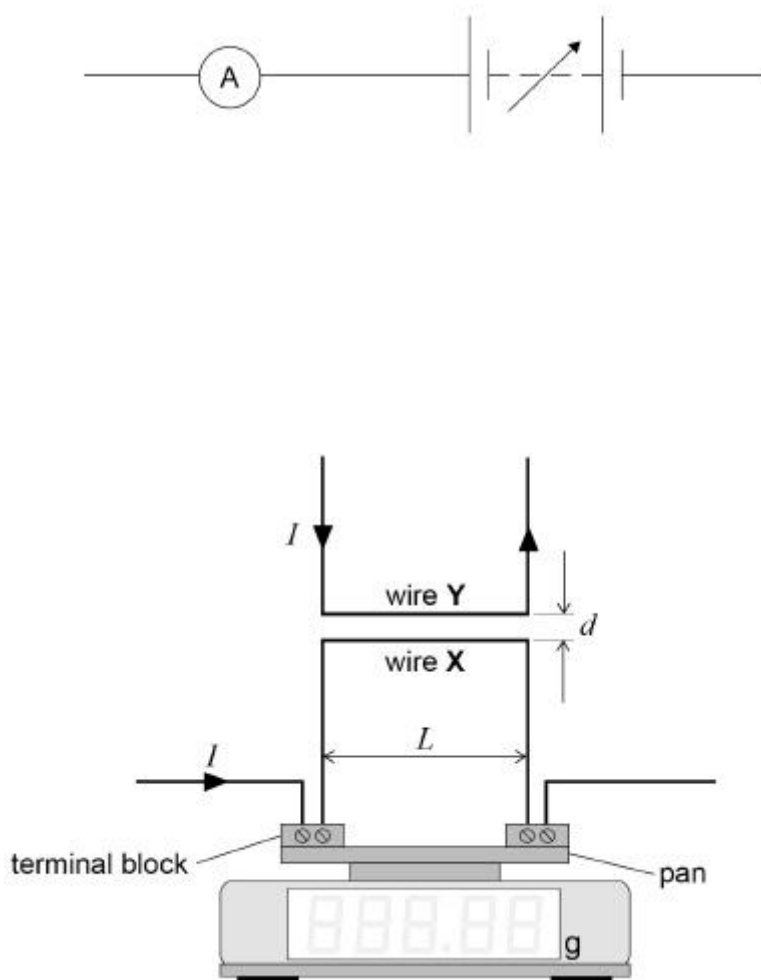
Terminal blocks are used to connect **X** into the circuit. The weight of these does not affect the balance reading.

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

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

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)