Force on a current-carrying wire

Worked solutions

GCSE science calculations

This topic online

1 **Higher tier**

A straight wire carries a current of 3.0 A. A 0.50 m length of the wire is at right angles to a magnetic field of flux density 0.20 T.

Calculate the force on the wire. (2 marks)

Force = magnetic flux density x current x length

$F = BIL$

$F = 0.20 \times 3.0 \times 0.50$

$F = 0.3\ N$

2 **Higher tier**

One side of the coil in a model electric motor is 0.25 m long. It carries a current of 4.0 A at right angles to a magnetic field of flux density 0.15 T.

Calculate the force on this side of the coil. (2 marks)

Force = magnetic flux density x current x length

$F = 0.15 \times 4.0 \times 0.25$

$F = 0.15\ N$

3 **Higher tier**

In a loudspeaker, 0.20 m of wire sits at right angles to a magnetic field of flux density 0.50 T. The current in the wire is 2.4 A.

Calculate the force on the wire. (2 marks)

Force = magnetic flux density x current x length

$F = 0.50 \times 2.4 \times 0.20$

$F = 0.24\ N$

4 **Higher tier**

A wire carries a current of 5.0 A. A 0.40 m length of the wire is at right angles to a magnetic field of flux density 60 mT.

Calculate the force on the wire. (2 marks)

Force = magnetic flux density x current x length

60 mT = 0.060 T

$F = 0.060 \times 5.0 \times 0.40$

$F = 0.12\ N$

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

5 **Higher tier**

Rhys places a wire between the poles of a magnet. 8.0 cm of the wire is at right angles to the magnetic field. The magnetic flux density is 0.25 T and the current is 1.6 A.

Calculate the force on the wire. (2 marks)

Force = magnetic flux density × current × length

8.0 cm = 0.080 m

$F = 0.25 \times 1.6 \times 0.080$

$F = 0.032$ N

6 **Higher tier**

A wire carries a current of 750 mA. 5.0 cm of the wire is at right angles to a magnetic field of flux density 0.40 T.

Calculate the force on the wire. (3 marks)

Force = magnetic flux density × current × length

750 mA = 0.75 A

5.0 cm = 0.050 m

$F = 0.40 \times 0.75 \times 0.050$

$F = 0.015$ N

7 **Higher tier**

A force of 0.18 N acts on a wire carrying a current of 3.0 A. 0.20 m of the wire is at right angles to the magnetic field.

Calculate the magnetic flux density. (2 marks)

Force = magnetic flux density × current × length

$0.18 = B \times 3.0 \times 0.20$

$0.18 = B \times 0.60$

$B = 0.18 \div 0.60$

$B = 0.3$ T

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

8 **Higher tier**

0.40 m of a wire is at right angles to a magnetic field of flux density 0.12 T. The force on the wire is 0.096 N.

Calculate the current in the wire. (3 marks)

Force = magnetic flux density x current x length

$0.096 = 0.12 \times I \times 0.40$

$0.096 = 0.048 \times I$

$I = 0.096 \div 0.048$

$I = 2$ A

9 **Higher tier**

A wire carries a current of 1.5 A at right angles to a magnetic field of flux density 90 mT. The force on the wire is 0.054 N.

Calculate the length of wire in the magnetic field. Give your answer in centimetres. (3 marks)

Force = magnetic flux density x current x length

90 mT = 0.090 T

$0.054 = 0.090 \times 1.5 \times l$

$0.054 = 0.135 \times l$

$l = 0.054 \div 0.135$

$l = 0.40$ m

$l = 40$ cm

10 **Higher tier**

A force of 0.021 N acts on a wire carrying a current of 3.5 A. 4.0 cm of the wire is at right angles to the magnetic field.

Calculate the magnetic flux density. Give your answer in millitesla (mT). Show your working. (3 marks)

Force = magnetic flux density x current x length

4.0 cm = 0.040 m

$0.021 = B \times 3.5 \times 0.040$

$0.021 = B \times 0.14$

$B = 0.021 \div 0.14$

$B = 0.15$ T

1 T = 1000 mT

$B = 150$ mT

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

11 **Higher tier**

A wire with a resistance of 4.0 Ω is connected to a 6.0 V supply. 25 cm of the wire is at right angles to a magnetic field of flux density 0.080 T.

Calculate the force on the wire. Show your working.

(4 marks)

Potential difference = current × resistance

$6.0 = I \times 4.0$

$I = 6.0 \div 4.0$

$I = 1.5\ A$

Force = magnetic flux density × current × length

25 cm = 0.25 m

$F = 0.080 \times 1.5 \times 0.25$

$\boxed{F = 0.03\ N}$

12 **Higher tier**

In a Year 11 practical, Mei puts a magnet on a top-pan balance. A horizontal wire passes between the poles of the magnet, at right angles to the magnetic field. 5.0 cm of the wire is in the field.

When a current of 2.5 A flows in the wire, the reading on the balance increases by 1.20 g. The force on the magnet is equal in size to the force on the wire.

Gravitational field strength = 9.8 N/kg.

Calculate the magnetic flux density between the poles. Give your answer to 2 significant figures. Show your working.

(5 marks)

1.20 g = 0.00120 kg

Weight = mass × gravitational field strength

$F = 0.00120 \times 9.8$

$F = 0.01176\ N$

Force = magnetic flux density × current × length

5.0 cm = 0.050 m

$0.01176 = B \times 2.5 \times 0.050$

$0.01176 = B \times 0.125$

$B = 0.01176 \div 0.125$

$B = 0.09408\ T$

$\boxed{B = 0.094\ T\ (2\ s.f.)}$

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

13 **Higher tier**

A wire 1.2 m long carries a current of 2.5 A. Only 0.30 m of the wire is between the poles of a magnet, at right angles to a magnetic field of flux density 0.40 T.

Calculate the force on the wire. (2 marks)

Use the length in the field (0.30 m), not the whole wire (1.2 m)

Force = magnetic flux density × current × length

$F = 0.40 \times 2.5 \times 0.30$

0.3 N

14 **Higher tier**

A horizontal copper wire 30 cm long hangs between the poles of a U-shaped magnet. The poles are 5.0 cm wide, so 5.0 cm of the wire is in the magnetic field, at right angles to it.

The current in the wire is 3.2 A. The force on the wire is 4.8 mN.

Calculate the magnetic flux density between the poles. Show your working. (3 marks)

Use the length in the field (5.0 cm), not the whole wire (30 cm)

1 N = 1000 mN

$4.8 \text{ mN} = 4.8 \div 1000 = 0.0048 \text{ N}$

1 m = 100 cm

$5.0 \text{ cm} = 5.0 \div 100 = 0.050 \text{ m}$

Force = magnetic flux density × current × length

$0.0048 = B \times 3.2 \times 0.050$

$0.0048 = B \times 0.16$

$B = 0.0048 \div 0.16$

0.03 T

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.