Combined science - Physics

Key stage 4 - Magnetism

$F = B \times I \times L$ (HT only)

Mr van Hoek

The strength of the force

force on a conductor = magnetic flux density × current × length of conductor

$$F = B \times I \times L$$

- F force on a conductor, Newton (N)
- B magnetic flux density, Teslas (T)
- I current, Amperes (A)
- L length of conductor, metres (m)

I do

A wire measuring 1 m long was suspended in a magnetic field of flux density 21 T. The current flowing was 3 Amps. Calculate the force on the wire.

Values

Equation

Substitute

Rearrange

Answer

Units

We do A current of 1.5 A flows through a wire. 0.5 m of the wire passes through a magnetic field with a strength of 0.75 T. The field and wire are at right angles.
What is the force exerted on the wire?

Values

Equation

Substitute

Rearrange

Answer

Units

You do

An electricity cable has 0.4 A of current flowing in it as it passes at right angles through a magnetic field with magnetic flux density of 1.2 T. The wire's length is 0.25 m. What is size of the force exerted on the wire?

Values

Equation

Substitute

Rearrange

Answer

Units

You do

To get a maglev train to float, a large magnetic field of magnetic flux density 32 T is used.
A current of 20 A is passed along a conductor underneath the train of length 25m.
What is the force produced to lift the train?

The cables suspended from large pylons in the National Grid carry around 250A each. The magnetic flux density of the earth's magnetic field is about 0.000 045 T. Over 15,000 m of cable, what force is applied to the cable?

Converting units

Giga, G	= × 1,000,000,000
Mega, M	= × 1,000,000
kilo, k	= × 1,000
milli, m	= ÷ 1,000
micro, μ	= ÷ 1,000,000
nano, n	= ÷ 1,000,000,000

Converting units

Giga, G = × 1,000,000,000
Mega, M = × 1,000,000
kilo, k = × 1,000
milli, m = ÷ 1,000
micro, μ = ÷ 1,000,000
nano, n = ÷ 1,000,000,000

I Do

Magnetic flux density = 450 mT

Converting units

I Do

Giga, G	= × 1,000,000,000
Mega, M	= × 1,000,000
kilo, k	= × 1,000
milli, m	= ÷ 1,000
micro, μ	= ÷ 1,000,000
nano, n	= ÷ 1,000,000,000

Distance = 450 km

Converting units

Giga, G	= × 1,000,000,000
Mega, M	= × 1,000,000
kilo, k	= × 1,000
milli, m	= ÷ 1,000
micro, μ	= ÷ 1,000,000
nano, n	= ÷ 1,000,000,000

We Do

Current = 16 GA

Converting units

Giga, G	= × 1,000,000,000
Mega, M	= × 1,000,000
kilo, k	= × 1,000
milli, m	= ÷ 1,000
micro, μ	= ÷ 1,000,000
nano, n	= ÷ 1,000,000,000

We Do

Force = 32 μN

Converting units

Giga, G	= × 1,000,000,000
Mega, M	= × 1,000,000
kilo, k	= × 1,000
milli, m	= ÷ 1,000
micro, μ	= ÷ 1,000,000
nano, n	= ÷ 1,000,000,000

You Do

Magnetic Flux Density = 890 nT

Current = 56 μA

Further practice

Giga, G	= × 1,000,000,000
Mega, M	= × 1,000,000
kilo, k	= × 1,000
milli, m	= ÷ 1,000
micro, μ	= ÷ 1,000,000
nano, n	= ÷ 1,000,000,000

1. Magnetic flux density = 45 μT
2. Current = 775 mA
3. Length = 120 mm
4. Magnetic flux density = 620 mT
5. Current = 6,700 μT
6. Length = 25.3 km

Further practice - answers

1. Magnetic flux density = 45 μT
2. Current = 775 mA
3. Length = 120 mm
4. Magnetic flux density = 620 mT
5. Current = 6,700 μT
6. Length = 25.3 km

1. *0.000 045 T*
2. *0.775 A*
3. *0.120 m*
4. *0.620 T*
5. *0.006 700 T*
6. *25,300 m*

I do

A wire measuring 110 mm long was suspended in a magnetic field of flux density 21 mT. The current flowing was 300 mA. Calculate the force on the wire.

Values

Equation

Substitute

Rearrange

Answer

Units

We do A current of 1.5 μA flows through a conductor on a circuit board. 0.5 mm of the wire passes through a magnetic field with a strength of 7.5 mT. The field and wire are at right angles. What is the force exerted on the conductor?

Values

Equation

Substitute

Rearrange

Answer

Units

You do

A wire has 540 mA of current flowing in it through a magnetic field with magnetic flux density of 86 μT. The length of wire is 0.1 m. What is the force exerted on the wire?

Values

Equation

Substitute

Rearrange

Answer

Units

Rearranging the equation

I do

What current flowing in a wire will be needed for a force of 12N to be exerted on 0.2m of wire in a magnetic flux density of 0.4T.

Values

Equation

Substitute

Rearrange

Answer

Units

We do

A 0.4 m length of wire passes through a magnetic field and experiences a force of 0.24 N. The current flowing is 1.5 Amps. Calculate the strength of the magnetic field. Give the unit.

Values

Equation

Substitute

Rearrange

Answer

Units

You do

A wire in a magnetic field has a force of 0.13 N exerted on it due to the current flowing in it. The wire is 450 mm long and the magnetic field has a magnetic flux density of 85,000 nT. What current is flowing in the wire?

Values

Equation

Substitute

Rearrange

Answer

Units

Force = magnetic flux density × current × length of wire practice

1. A wire 0.3m long is carrying a current of 2.3 Amps and is subject to a magnetic field of 0.0035 Tesla. Calculate the force on the wire.

2. A wire measuring 200 mm is carrying a current of 800 mA and within a magnetic field of 4 mT. Calculate the force on the wire.

3. A wire 500 mm long carrying a current of 8 mA is at right angles to a 400 μT magnetic field. What is the size of the force exerted on the wire?

4. A straight wire 0.10 m long carrying a current of 2.0 A is at right angles to a magnetic field. The force on the wire is 0.04 N. What is the strength of the magnetic field?

Force = magnetic flux density × current × length of wire practice

5. A wire 750 mm long carrying a current of 600 mA is at right angles to a uniform magnetic field. The magnitude of the force acting on the wire is 0.60 N. What is the strength of the magnetic field?

6. A wire that is 63 mm long hangs at right angles to a magnetic field of 15 μT and experiences a force of 58 mN. Calculate the current flowing in the wire. Give your answer to 2 significant figures.

7. A wire measuring 2.3×10^{-2}m is suspended in a magnetic field of 1.5×10^{-1} Tesla and carrying a current of 6.1×10^{-2} Amps. Calculate the force on the wire. Give your answer in standard form to 2 significant figures.

Force = magnetic flux density × current × length of wire solutions

1. 0.002415N
2. 0.00064N
3. 0.000 001 6N
4. 0.2 T
5. 1.33 T
6. 6137.5 = 6100 A
7. 2.1 x 10^{-4} N

We Do

A maglev train carriage has a mass of 25,000 kg and a length of 20m. The maximum magnetic flux density that can be generated is 45 T. What current is needed to create sufficient force to lift the carriage?

Gravitational field strength = 9.8 N/kg

You Do

1. A thin filament wire has a mass of 45 mg, is 45 mm long and has a current of 0.01A flowing in it. The wire is suspended within a magnetic field so that the weight of the wire balances the magnetic force. Calculate the magnetic flux density of the magnetic field.

You Do

2. The cables in the National Grid are suspended from huge pylons to support their heavy weight. An engineer suggests that by using very light wires and large currents, the cables would be suspended by the magnetic force due to the Earth's magnetic field and ugly pylons would not be needed.

What would the mass of cable for a 2.5 km length need to be if the current is 250 A, the magnetic flux density of the Earth's magnetic field is 45,000 nT and the gravitational field strength is 9.8 N/kg.

Exam Question

Calculate the magnetic flux density on a 0.5 m long conductor when a current of 0.8 A flows.

The force produced is 0.6 N.

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