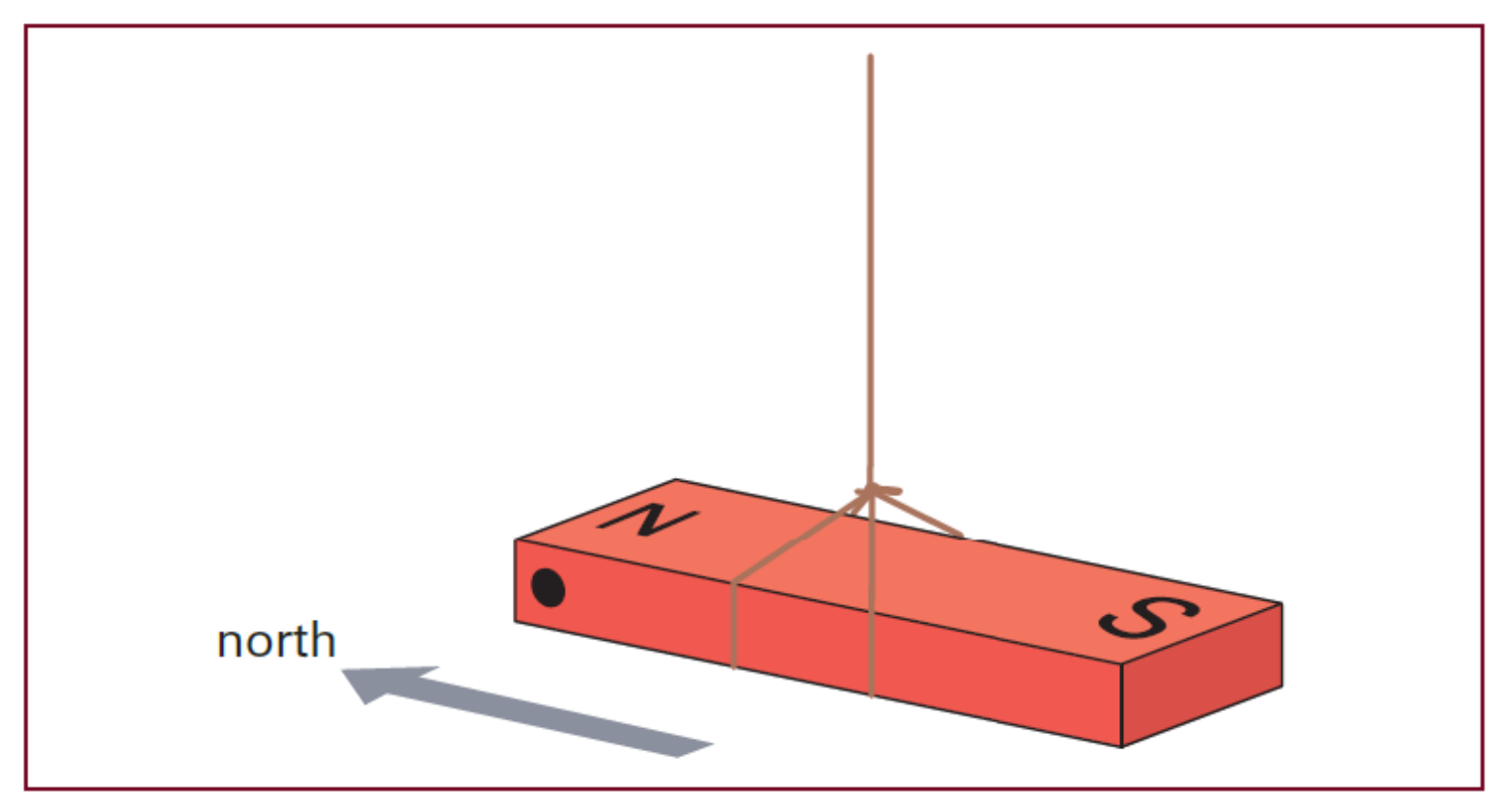
Section 4.1

Magnetism

4.1.1 **Permanent magnets**

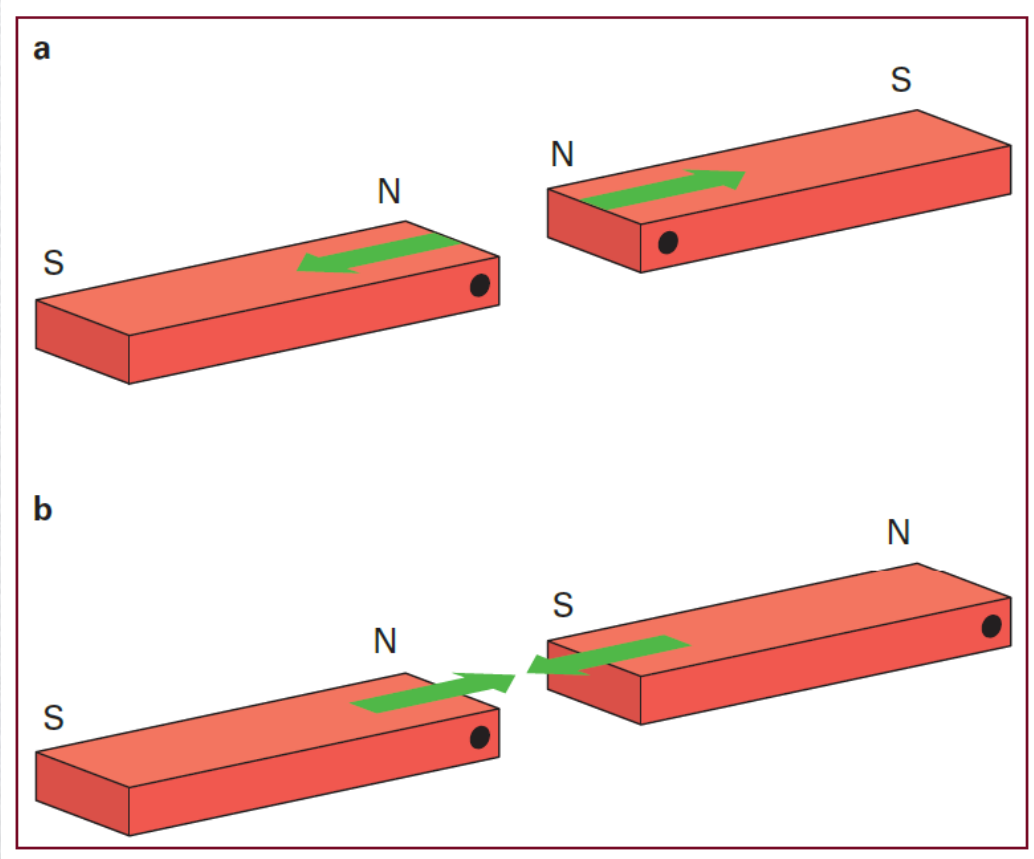
4.1.2 Magnetic fields

Permanent magnets



A freely suspended magnet turns so that it points north–south.

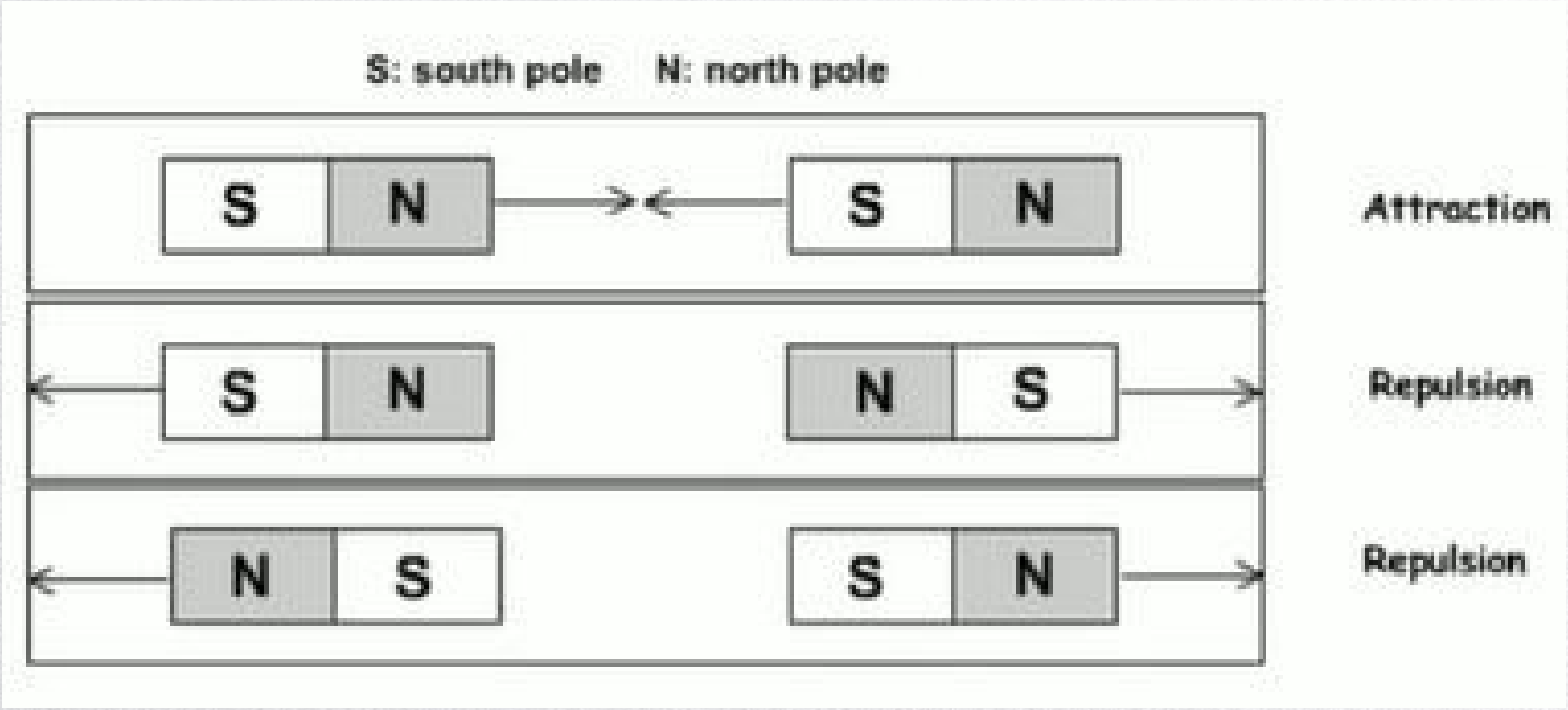
Permanent magnets



a. Two like magnetic poles repel one another.
b. Two unlike magnetic poles attract each other

Like poles repel; Unlike poles attract.

South & north poles



Magnetic & Non-magnetic materials

- The materials which get attracted towards a magnet are magnetic
  - ✓ e.x.: iron, nickel, cobalt.
- The materials which are not attracted towards a magnet are non-magnetic materials
  - ✓ e.x. : rubber, coins, feather, and leather.

Magnetic Materials

Magnetic materials:

- Hard steel
- Ferrite: a ceramic material used for making fridge magnets and the magnets sometimes used to keep cupboard doors shut

Magnetic elements:

- Iron
- Cobalt
- Nickel

*Note: 1) Most magnetic materials (including steel and ferrite) contain iron, which is the commonest magnetic element.

2) **If a material contains iron, this is not a guarantee that it will be magnetic.** Ex. Stainless steel contains a lot of iron, but magnets will not stick to it.

Magnetic Materials

Classifications of magnetic materials:

Type of magnetic material	Description	Examples	Uses
Hard	retains magnetism well, but difficult to magnetise in the first place	hard steel	permanent magnets, compass needles, loudspeaker magnets
Soft	easy to magnetise, but readily loses its magnetism	soft iron	cores for electromagnets, transformers and radio aerials

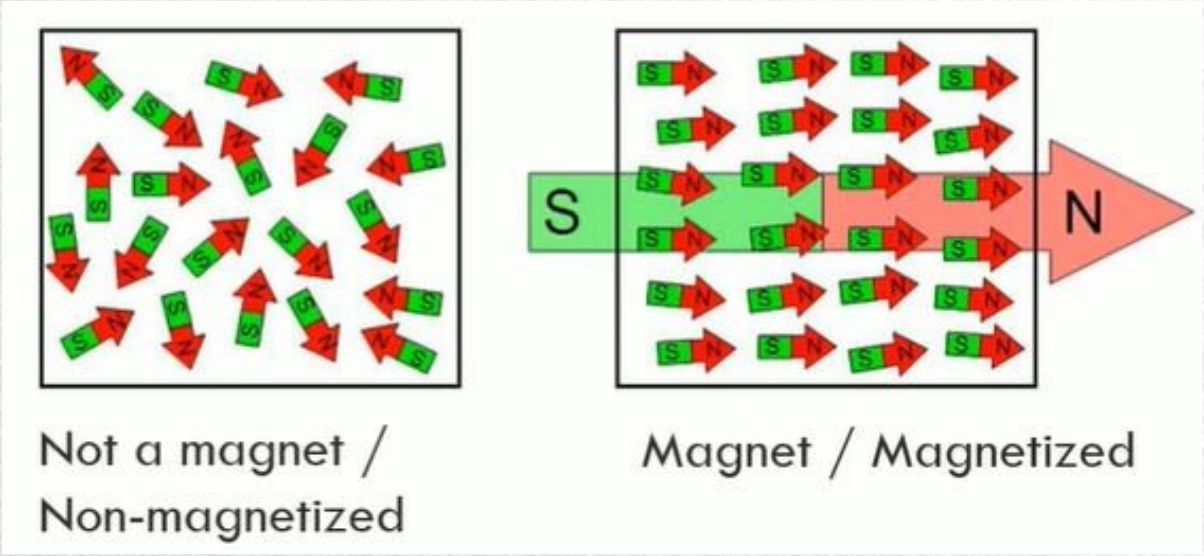
*Note: you need to know how to describe a hard or a soft magnetic material.

Permanent magnets vs. Electromagnets

Scrap metal moving

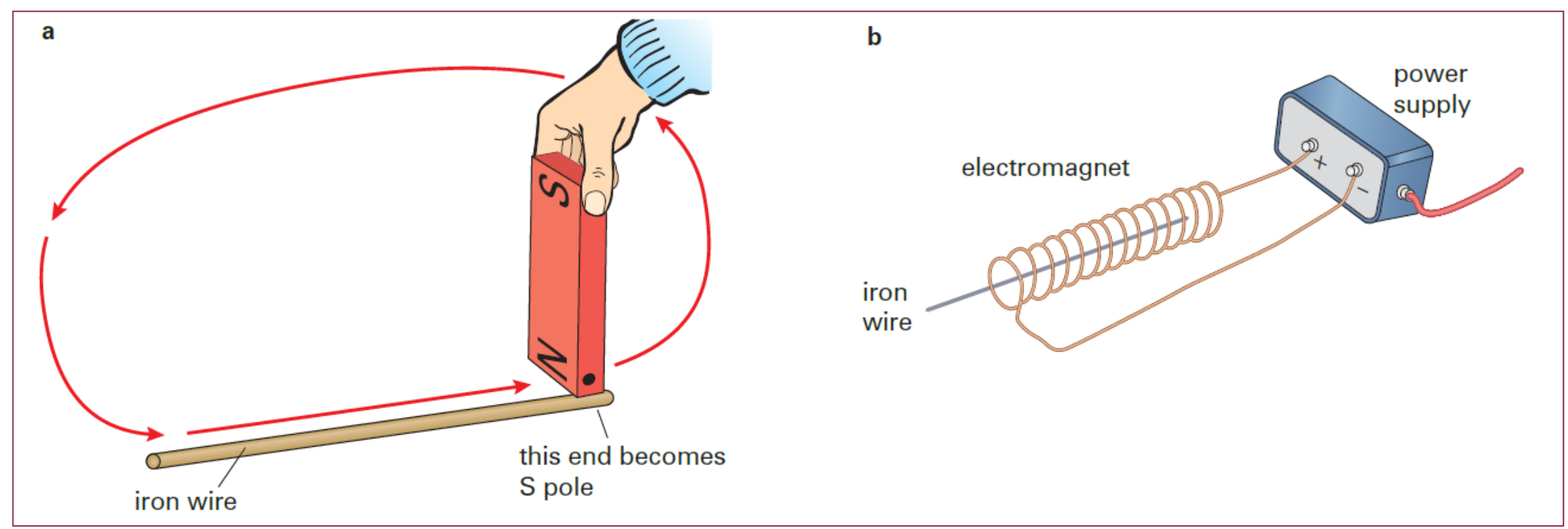
- **Permanent magnets** are designed with **hard** magnetic materials, and used for purposes where magnetism is needed over a **long period of time**, i.e. fridge doors
- **Electromagnets** use a **solenoid** to create a magnetic field. It is used for when a magnetic field needs to **be turned on and off**, i.e. scrap metal moving

Magnetism



- Permanent magnets are made of **ferromagnetic material** (mainly iron/steel). In ferromagnetic materials, smaller groups of atoms band together into areas called **domains**, in which all the electrons have the same **magnetic orientation**.
- All magnets have **north and south** poles
- The Earth has a **magnetic south pole** close to its **geographical North Pole**.

Magnetization

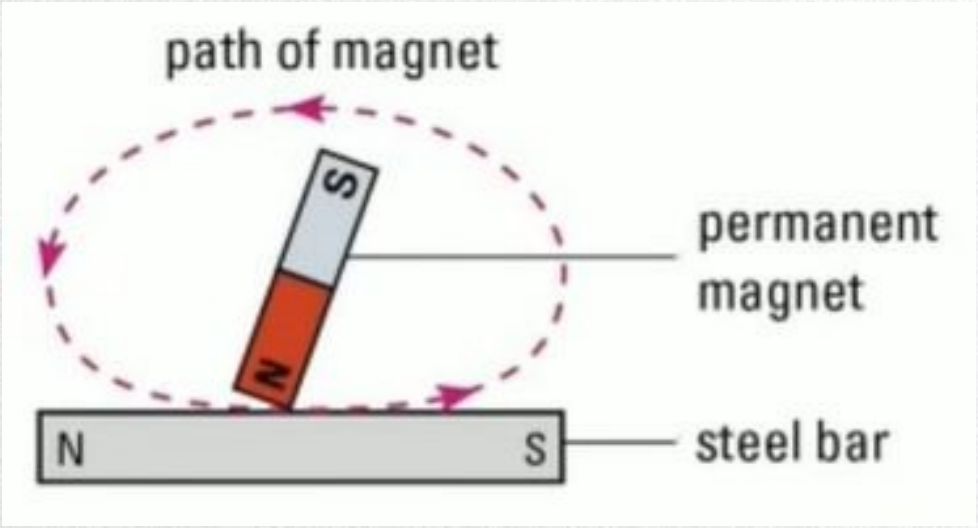


Two methods for magnetising an iron wire:

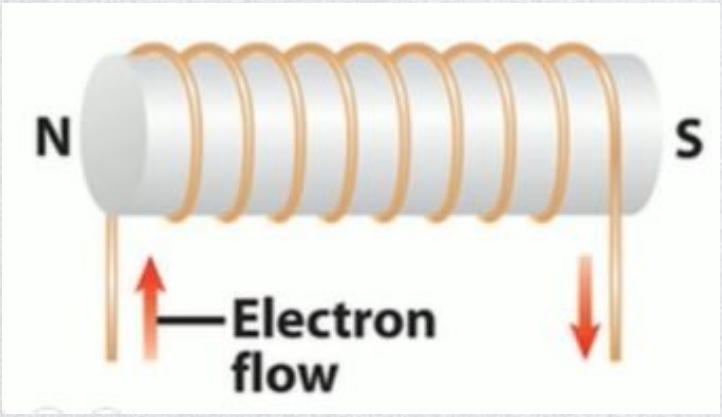
a. using a permanent magnet (stroking);
b. using an electromagnet connected to a supply of direct current (d.c.).

Magnetization (cont'd)

- Stroking



- Placing metal inside solenoid (i.e. coil of wire) with direct current (d.c.)



Magnetization (cont'd)

Usually, magnetic materials are in an *unmagnetized state*, and they must be magnetised. Two methods of doing this (called **magnetization**):

1. A piece of the material may be stroked with a permanent magnet. By stroking it consistently from one end to the other (never going in the reverse direction), it becomes magnetised.

2. Place the material in a strong magnetic field, as produced by an electromagnet. An electromagnet is a coil of wire and, for this purpose, it is connected to a battery or power supply so that a steady direct current (d.c.) flows through it. This produces a magnetic field inside the coil, and this field magnetises the material.

Demagnetization (cont'd)

There are several ways of demagnetising a magnet. 3 methods of doing this (called demagnetisation) are listed below:

1. **Heat the magnet**. If its temperature goes above a certain temperature, it will lose its magnetism.

2. **Hammer the magnet (Physical impact)**. When a magnet is placed in an **east–west direction** and hammered, it loses its magnetism. This explains why the magnets used in school labs gradually lose their magnetism if they are repeatedly dropped and bashed about.

3. **Place the magnet in the field of an electromagnet that is connected to an alternating current (a.c.) supply**. The magnetic field will vary back and forth. Gradually reduce the current to zero. The magnet will be demagnetised.

*Note: a material that is hard to magnetise is also hard to demagnetise.

Study question #1

An old and expensive steel watch becomes magnetised.

The owner wants to use the watch again. He must demagnetise the watch.

What is the **best** method to do this?

A Insert the watch in a solenoid that carries alternating current and then slowly remove it.

B Insert the watch in a solenoid that carries direct current and then slowly remove it.

C Pass alternating current through the watch.

D Pass direct current through the watch.

[1]

[Total: 1]

Study question #1

An old and expensive steel watch becomes magnetised.

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B Insert the watch in a solenoid that carries direct current and then slowly remove it.

C Pass alternating current through the watch.

D Pass direct current through the watch.

[1]

[Total: 1]

Study question #2

A student demagnetises a magnetised steel bar.

He places the bar in a solenoid connected to a power supply. He then removes the bar from the solenoid.

Which row indicates the most effective way of demagnetising the bar?

	type of power supply	speed to remove bar
A	a.c.	fast
B	a.c.	slow
C	d.c.	fast
D	d.c.	slow

[1]

[Total: 1]

Study question #2

A student demagnetises a magnetised steel bar.

He places the bar in a solenoid connected to a power supply. He then removes the bar from the solenoid.

Which row indicates the most effective way of demagnetising the bar? **B**

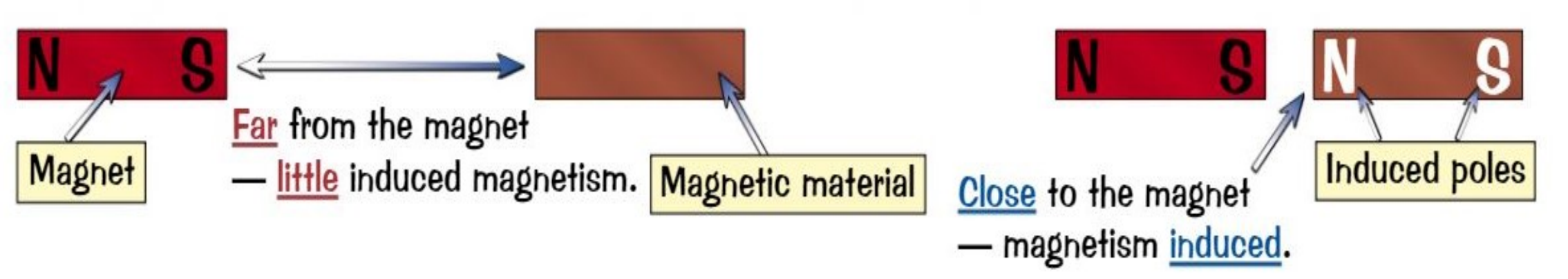
	type of power supply	speed to remove bar
A	a.c.	fast
B	a.c.	slow
C	d.c.	fast
D	d.c.	slow

[1]

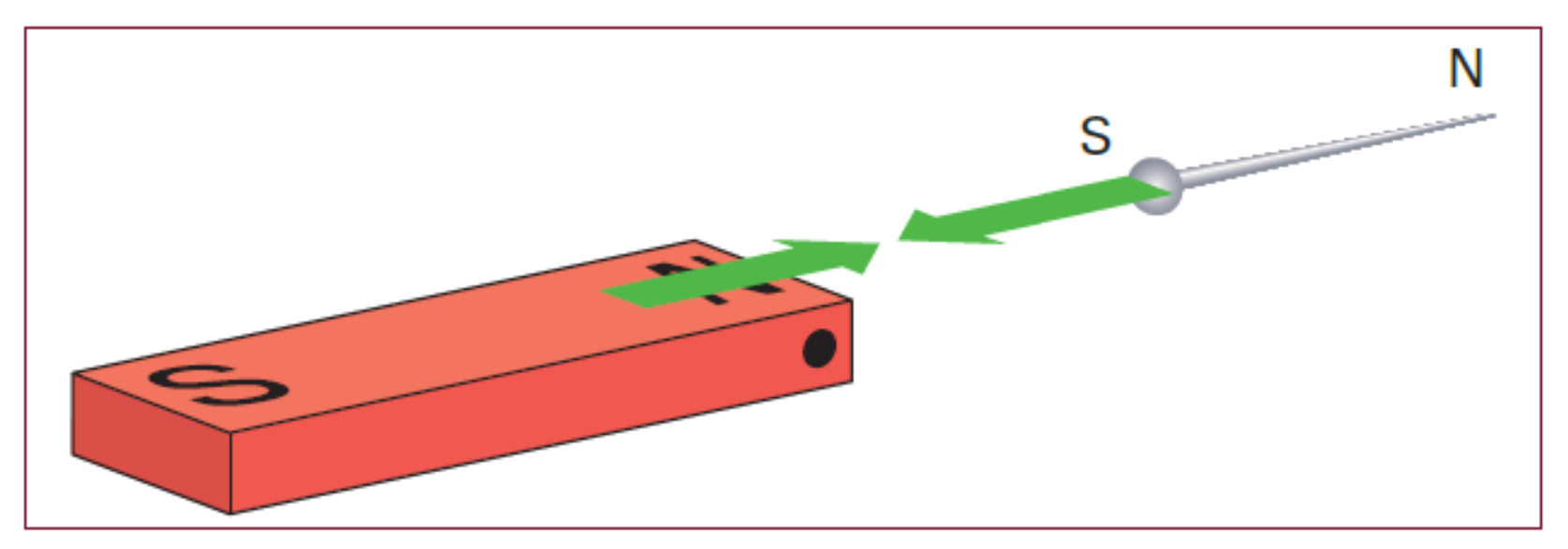
[Total: 1]

Induced magnetism

- When magnetic materials are brought near to a magnet (into its magnetic field), that material acts as a magnet.
- The **closer** the magnet and the magnet material get, the **stronger** the induced magnetism will be.



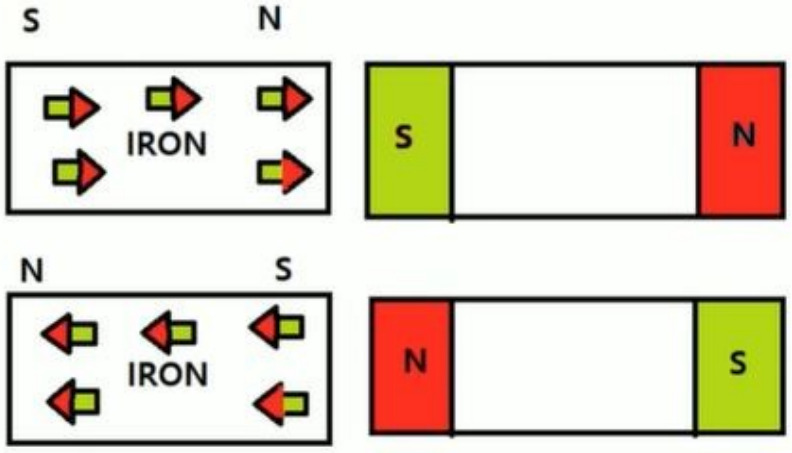
Induced magnetism

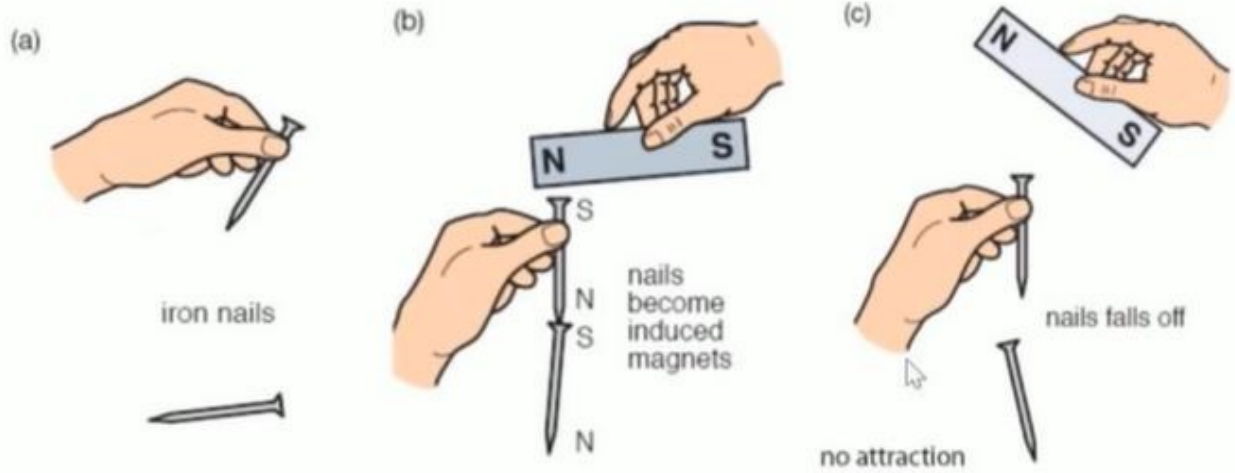


A steel pin is temporarily magnetised when a permanent magnet is brought close to it. **Steel pins are made of a magnetic material**. When the north pole of a permanent magnet is brought close to a pin, the pin is attracted. The attraction tells us that the end of the pin nearest the magnetic pole must be a magnetic south pole. This is known as **induced magnetism**. When the permanent magnet is removed, the pin will return to its unmagnetised state (or it may retain a small amount of magnetism).

Induced magnetism

- By placing a magnet near a piece of iron, the iron will become magnetized
- This is because the magnet will cause the iron domains to align themselves
- **Iron** loses magnetism very quickly therefore it is a **temporary magnet**
- **Steel** retains some of its magnetism so becomes a **permanent magnet** (until demagnetized)



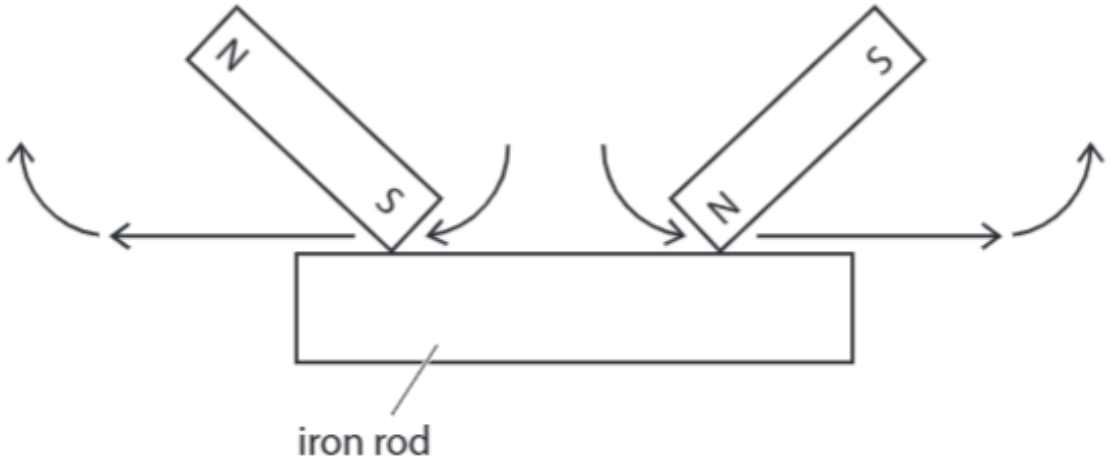


Study question #3

A student has two powerful bar magnets and an iron rod.

The student uses the N pole of one magnet and the S pole of the other magnet. Starting from the centre of the iron rod he rubs the poles against the rod out to its ends. He repeats this many times.

The figure shows how the student uses the two magnets to make the iron rod into a magnet.



Suggest a material that could be used to make a permanent magnet.

..... [1]

[Total: 1]

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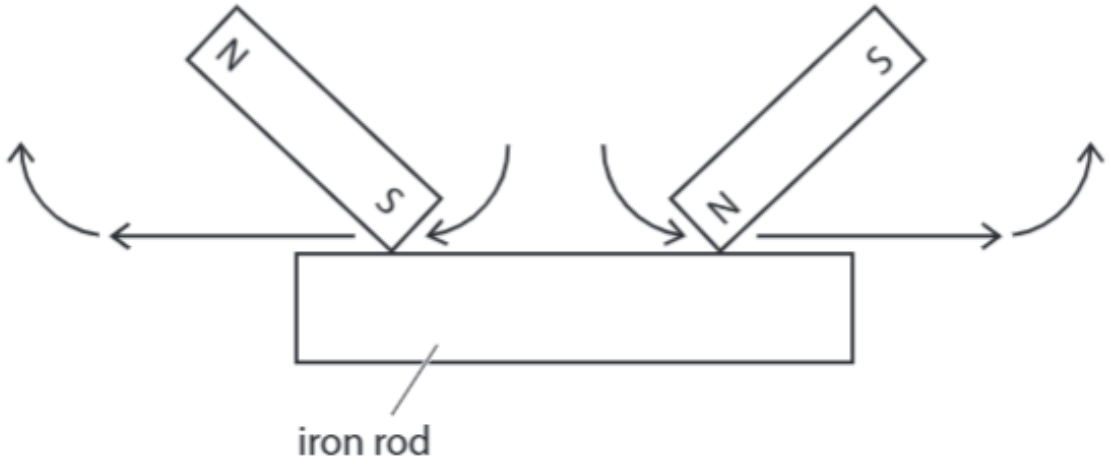

Suggest a material that could be used to make a permanent magnet.

Steel ..... [1]

[Total: 1]

Study question #4

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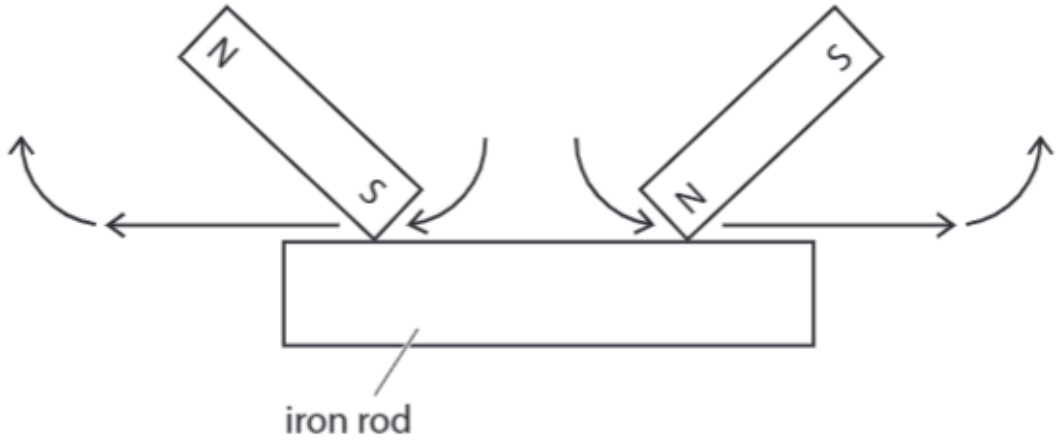

Label the magnetic poles created on the iron rod. [1]

[Total: 1]

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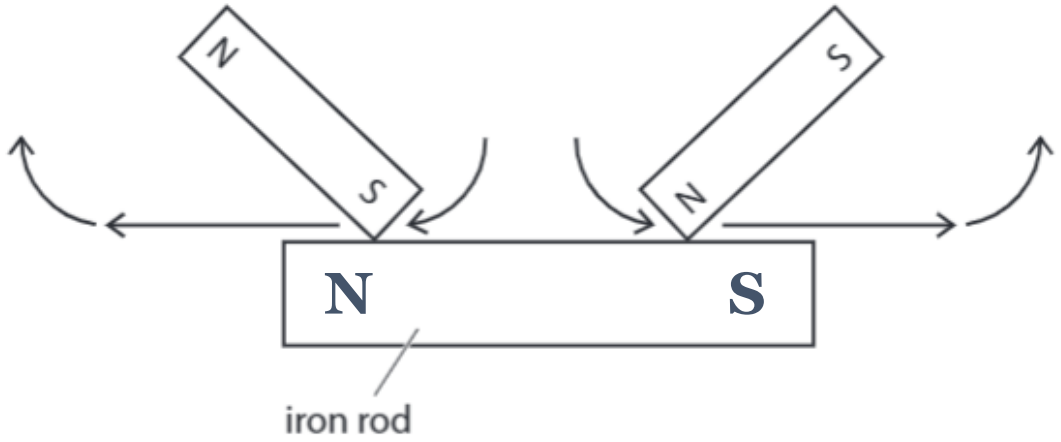

Label the magnetic poles created on the iron rod. [1]

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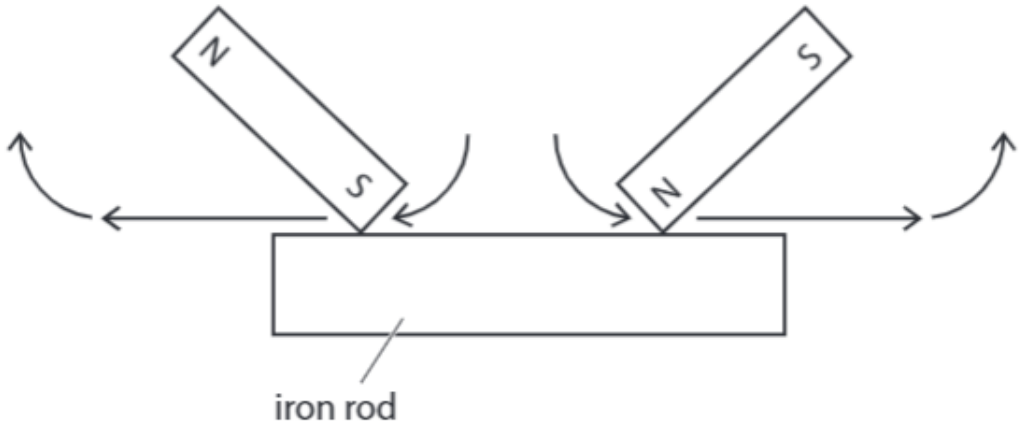

Describe how to test whether the iron rod has become a magnet.

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..... [1]

[Total: 1]

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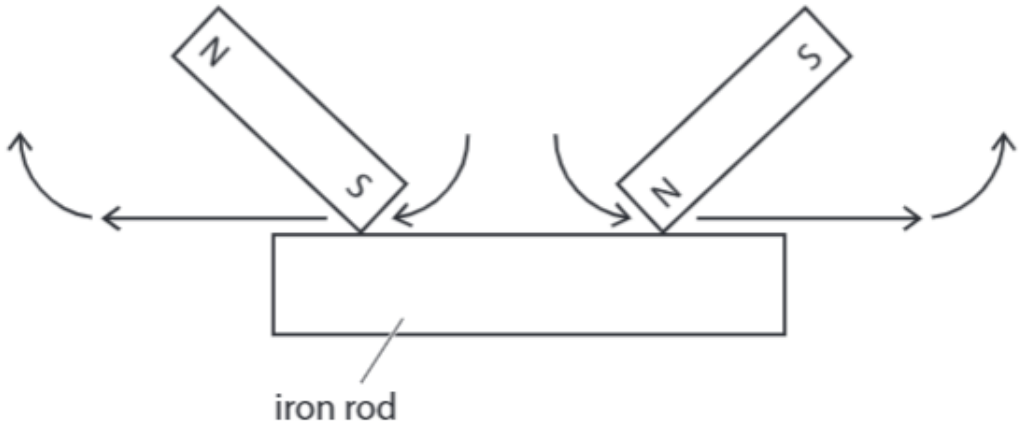

Describe how to test whether the iron rod has become a magnet.

Repels (a known) magnet / attracts unmagnetised iron/steel

[1]

[Total: 1]

THANK YOU