MAGICAL MAGNETS

Just what are they? And where do these magnetic fields come from?

NOT EXAMINABLE BACKGROUND INFORMATION ----------

When you go deeper and deeper into understanding magnetic materials you arrive at *quantum physics* and the fact that quantum particles i.e. quarks (the things that make up protons and neutrons) and electrons have mass and charge. They also have magnetic properties. It is as fundamental to say an electron has a charge as it is to say an electron is like a tiny magnet. IT JUST IS!

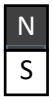
LEVEL 1 PARTICLE or QUANTUM LEVEL

The 3 quarks that make up a proton give it magnetic properties, just like a bar magnet, but it is very very weak.
An electron also has magnetic properties, just like a bar magnet, and this is _____ times stronger than a proton.

But one electron is nowhere near close to being strong enough but it is a start.

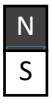
LEVEL 2 ATOMIC LEVEL

The magnetic properties of an atom is largely determined by the _____.

Atoms with few electrons or mostly filled electron *shells* will not be magnetic due to equal numbers of electrons cancelling each other out as well as electron pairs existing in 

AND 

combinations which cancel each other.

We have to look at the electrons in atoms with half-filled outer electron shells where the electrons exist as either 

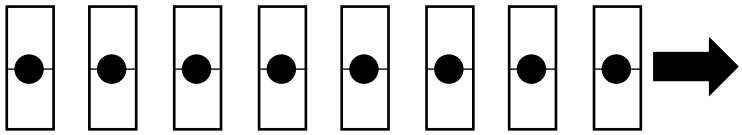
OR 

so they all produce magnetism in the same direction.

This makes an atom magnetic but as the next level up explains not all magnetic atoms will make a magnetic material/solid

LEVEL 3 CRYSTALS

When these magnetic atoms start to group together into a solid structure they can align in three possible arrangements



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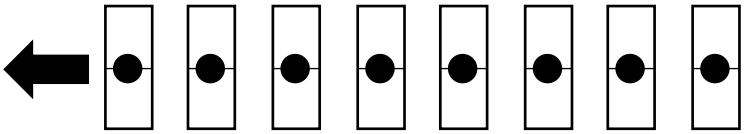

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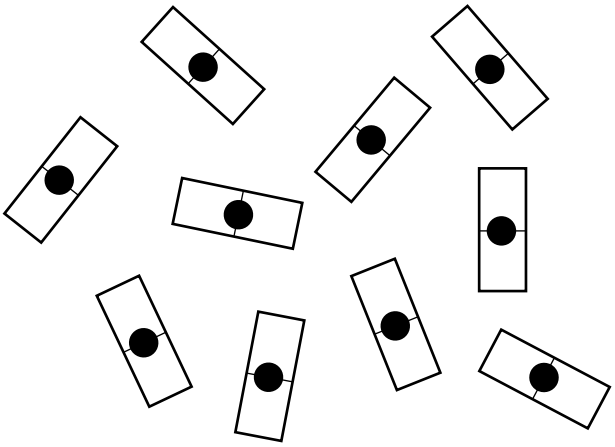

_____

_____ atoms **are** magnetic and can either create strong magnetic fields OR become strongly magnetised in the presence of a magnetic field.

Examples include

Fe - _____ Co - _____

Ni - _____ Gd - _____
(only when colder than ~20°C)

_____ atoms like Chromium **are** magnetic but do not produce magnetic fields or become magnetised in the presence of a magnetic field.

_____ atoms can become very weakly magnetised but only in the presence of a magnetic field. The effects are forces of attraction.

LEVEL 4 DOMAINS

The diagram below represents the domains within a _____ material e.g. Iron before and after being in the presence of a magnetic field.

NOT MAGNETISED

MAGNETISED

Typically there are _____ atoms in a domain.

If the domains all line up then we have a permanent magnet with a magnetic field that we can experience *feel*. And now we pick up GCSE again…

EXAMINABLE INFORMATION ----------

We draw a simple permanent magnet normally as a bar magnet as below. The **magnetic field lines** are drawn from the North pole to the South pole. *The colour on diagrams is irrelevant.*

The magnetic field around a bar magnet (which also includes the Earth!) is **non-uniform** because…

_____

_____

Placing small **permanent magnets** like a compass needle in the magnetic field will see it align itself along these field lines with the North Pole of the small magnet always pointing towards the South pole of the larger magnet.

Placing small ferromagnetic materials which are still unmagnetised e.g. an iron nail next to a permanent magnet with a magnetic field will see the nail become an **induced magnet** with the opposite poles facing each other. They may stay like this!

Lastly, two permanent magnets with opposing poles facing each other will produce a magnetic field between them. This will cause them to be attracted. If **stronger magnets** are used then we draw the magnetic field with **more** lines between them.

We call these lines of a magnetic field the **magnetic flux**. More lines mean a greater **magnetic flux density**. A greater flux density means a stronger magnetic force.