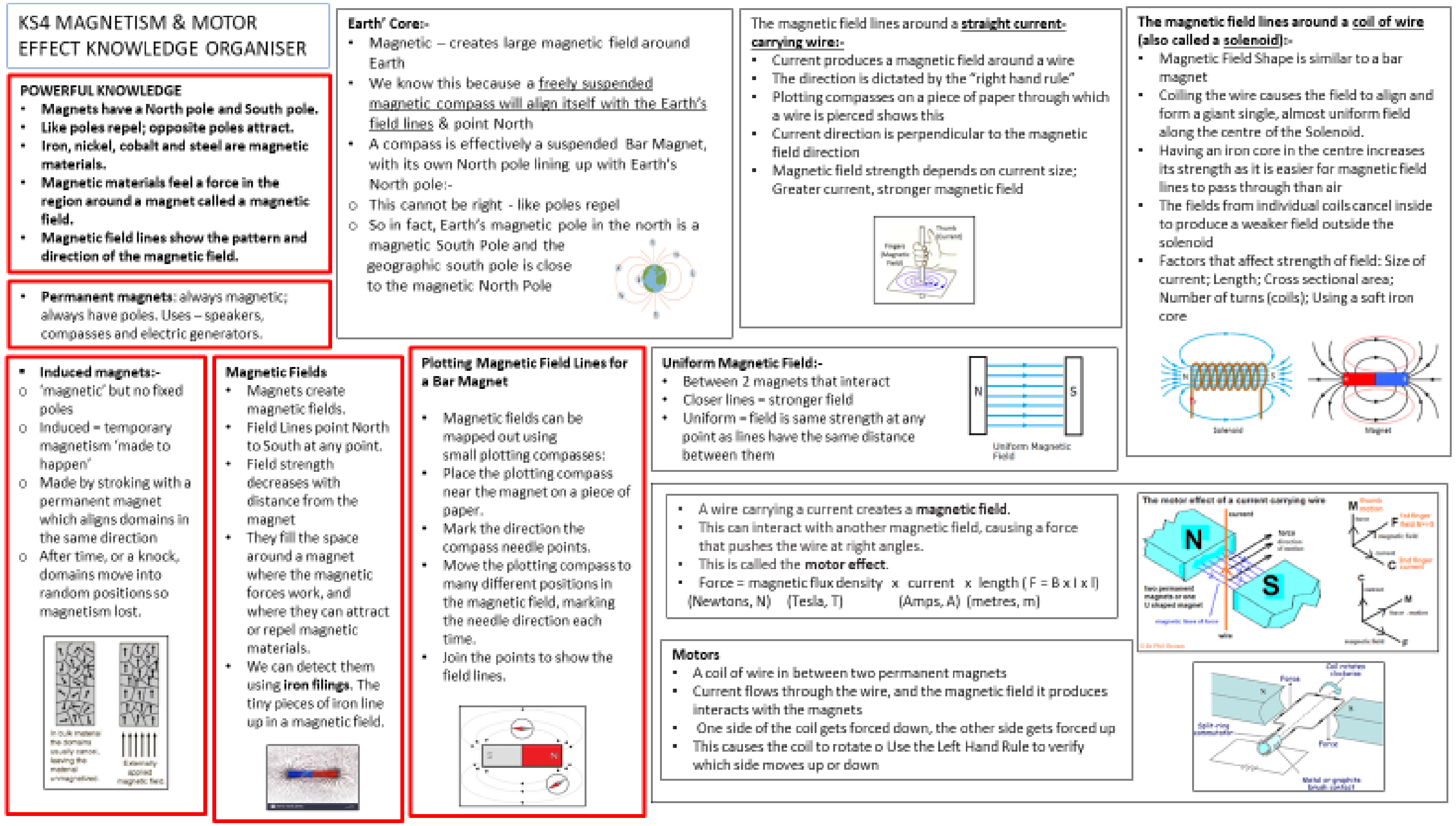
Topic: KS4: Magnetism & the Motor Effect	Duration: 5 Lessons	Composite: Unit test

Key vocabulary:	Core knowledge Components Powerful knowledge components crucial to commit to long term memory (IN RED BOX)	Links to previous and future topics
Pole Magnetic Field Force Permanent Induced Domain Earth Current Uniform Magnetic flux density Tesla Solenoid Motor	See knowledge organiser below	Y7: Electricity Y8: Magnetism KS4: Conservation of Energy; Forces & their Effects; Electromagnetism KS5: Magnetic Fields; Electric Fields



KS4 MAGNETISM & MOTOR EFFECT KNOWLEDGE ORGANISER

POWERFUL KNOWLEDGE

- **Magnets have a North pole and South pole.**
- **Like poles repel; opposite poles attract.**
- **Iron, nickel, cobalt and steel are magnetic materials.**
- **Magnetic materials feel a force in the region around a magnet called a magnetic field.**
- **Magnetic field lines show the pattern and direction of the magnetic field.**

- **Permanent magnets**: always magnetic; always have poles. Uses – speakers, compasses and electric generators.

Earth' Core:-

- Magnetic – creates large magnetic field around Earth
- We know this because a freely suspended magnetic compass will align itself with the Earth's field lines & point North
- A compass is effectively a suspended Bar Magnet, with its own North pole lining up with Earth's North pole:-
  - This cannot be right - like poles repel
  - So in fact, Earth's magnetic pole in the north is a magnetic South Pole and the geographic south pole is close to the magnetic North Pole

The magnetic field lines around a **straight current-carrying wire:-**

- Current produces a magnetic field around a wire
- The direction is dictated by the "right hand rule"
- Plotting compasses on a piece of paper through which a wire is pierced shows this
- Current direction is perpendicular to the magnetic field direction
- Magnetic field strength depends on current size; Greater current, stronger magnetic field

The magnetic field lines around a coil of wire (also called a solenoid):-

- Magnetic Field Shape is similar to a bar magnet
- Coiling the wire causes the field to align and form a giant single, almost uniform field along the centre of the Solenoid.
- Having an iron core in the centre increases its strength as it is easier for magnetic field lines to pass through than air
- The fields from individual coils cancel inside to produce a weaker field outside the solenoid
- Factors that affect strength of field: Size of current; Length; Cross sectional area; Number of turns (coils); Using a soft iron core

- **Induced magnets:-**
  - 'magnetic' but no fixed poles
  - Induced = temporary magnetism 'made to happen'
  - Made by stroking with a permanent magnet which aligns domains in the same direction
  - After time, or a knock, domains move into random positions so magnetism lost.

Magnetic Fields

- Magnets create magnetic fields.
- Field Lines point North to South at any point.
- Field strength decreases with distance from the magnet
- They fill the space around a magnet where the magnetic forces work, and where they can attract or repel magnetic materials.
- We can detect them using **iron filings.** The tiny pieces of iron line up in a magnetic field.

Plotting Magnetic Field Lines for a Bar Magnet

- Magnetic fields can be mapped out using small plotting compasses:
- Place the plotting compass near the magnet on a piece of paper.
- Mark the direction the compass needle points.
- Move the plotting compass to many different positions in the magnetic field, marking the needle direction each time.
- Join the points to show the field lines.

Uniform Magnetic Field:-

- Between 2 magnets that interact
- Closer lines = stronger field
- Uniform = field is same strength at any point as lines have the same distance between them

- A wire carrying a current creates a **magnetic field.**
- This can interact with another magnetic field, causing a force that pushes the wire at right angles.
- This is called the **motor effect.**
- Force = magnetic flux density x current x length (F = B x I x l)
  (Newtons, N) (Tesla, T) (Amps, A) (metres, m)

Motors

- A coil of wire in between two permanent magnets
- Current flows through the wire, and the magnetic field it produces interacts with the magnets
- One side of the coil gets forced down, the other side gets forced up
- This causes the coil to rotate o Use the Left Hand Rule to verify which side moves up or down

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
https://www.nhs.uk/conditions/mri-scan/ https://newcastleclinic.co.uk/honouring-inventor-mri-scanner/	Explain how an MRI scan works	Explain how an MRI scan works	Construction of magnetic field diagrams	Medical imaging/ Radiographer in hospitals (MRI), Electrical Power Technician, Geomagnetist, Chemical Physicist, Robotics Engineer, Magnet Engineer

CULTURAL CAPITAL: Peter Mansfield (who couldn't do Science allegedly!), the MRI scanner and a Nobel Prize.

SEND

- Opportunities for retrieval practice and building on prior knowledge – Knowledge Recall Starter slide each lesson
- Multi-sensory approach using video, watching teacher demonstrations/modelling, tactile activities, practical work, team/paired work
- Additional curriculum time allocated to after school revision sessions.
- MRI/Peter Mansfield case study chosen to support cultural capital at KS4/KS5
- MRI/Peter Mansfield case study chosen as relatable
- MRI/Peter Mansfield case study chosen that are life skills or work-related to support the pathway into adulthood
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning
- Texts used/alternative texts available with a consideration to reading age
- Activities are scaffolded with over-learning of previous content to encourage independence

Topic: Radioactivity (Combined – Foundation and Higher)

KS4 National Curriculum sub-topics:-

Physics - Atomic Structure

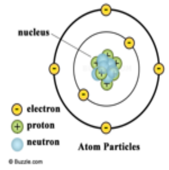
Duration: 8 lessons

Composite: Unit test

Key vocabulary	Core knowledge Components	Powerful knowledge components crucial to commit to long term memory (IN RED)	Links
Isotope Ion Ionising Atom Proton Neutron Electron Electro-magnetic Activity Penetrating Alpha Beta Gamma Becquerels Radioactive Half-life Nuclear Positron	(see below)	(see below)	Y7 Chemical Reactions; Elements and Compounds Y7 Energy Resources Y8 Light and Sound KS4 Physics - Electromagnetic Spectrum KS4 Chemistry – Atomic Structure KS4 Chemistry – Ionic Bonding KS5 Physics – Radioactivity KS5 Physics – Nuclear Physics

The Atom

- Every atoms contains a certain number of Protons, Neutrons and Electrons.
- All atoms have the same number of protons and neutrons. This causes them to be neutral.
- The Protons and Neutrons sit within the nucleus of the atoms.
- The Electrons orbit the nucleus in the 'Electron shells' which are at different set distances.



- Electrons can move between the 'Electron shells' by absorbing or emitting electromagnetic radiation.

Subatomic Particle	Mass	Charge	Position in the Atom
Proton	1	+1	Nucleus
Neutron	1	0	Nucleus
Electron	0	-1	Electron Shells
Positron	0	+1	-

Type of Ionising Radiation	Mass	Charge	Made of?
Alpha	4	+2	2 protons and 2 neutrons
Beta +	0	+1	1 positron
Beta -	0	-1	1 electron
Gamma	0	0	Gamma ray

Atomic Symbols

$^{13}_{6}C$

This is a carbon atom.

- The bigger number represents the number of protons and neutrons in the atom.
- The smaller number is the number of protons in the atom.

Ions

- An ion is formed from an atom when it gains or loses an electron.
- Ions always have a charge.
- If the atom loses an electron, it becomes a positive ion.
- If the atom gains an electron, it becomes a negative ion.

Ionising Radiation

- There are four types of ionising radiation: Alpha, Beta +, Beta – and Gamma.
- All ionising radiation originates from an unstable nucleus.
- It is called 'ionising radiation' because when it interacts with an atom it can cause an electron, or multiple electrons, to gain energy and leave the atom, turning the atom into an ion.

Production of Ionising Radiation

- All ionising radiation is produced from a nucleus that is becoming more stable.
- Alpha is produced when 2 protons and 2 neutrons 'split' away from an unstable nucleus making the nucleus more stable.
- Beta – is produced when a neutron changes into a proton and releases an electron.
- Beta + is produced when a proton changes into a neutron and releases a positron.
- Gamma rays are produced when the particles within a nucleus re-arrange themselves, becoming more stable than it was before.

Type of Ionising radiation	Stopped by?	Ionising Power
Alpha	Paper	Most Ionising
Beta -/+	Aluminium	Less Ionising than Alpha More Ionising than Gamma
Gamma	Lead	Least Ionising

Isotopes

- Isotopes are atoms with the same proton numbers but different numbers of neutrons.
- Isotopes always differ in mass due to having a different number of neutrons.
- Below is the symbols for two isotopes of Carbon. C-13 and C12.

$^{13}_{6}C$ $^{12}_{6}C$

Dangers of Radiation

- Can mutate the DNA within cells, causing cancer.
- Gamma is the most dangerous outside the body as it can penetrate the skin.
- Alpha is the most dangerous if ingested as it is the most ionising and will ionise body tissue.

Measuring Radioactivity

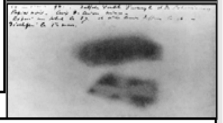
There are two ways in which we can measure the radioactivity of a material. These are a Geiger-Muller tube or Photographic film.

Geiger-Muller Tube

- This is a small tube containing an element that becomes ionised when radiation is present. A counter connected to the tube will record when an atom in the element becomes ionised. This counts the amount of radiation present per second, called the 'count rate'.

Photographic Film

- A thin white sheet that begins to turn black when ionising radiation is present. The more radiation, the darker it appears.



Background Radiation

- Radiation comes from many sources such as; food, cosmic rays, rocks and soil and all living things.
- This causes radiation to be present within our atmosphere, we call this 'background radiation'.
- The background radiation you experience is different depending on your environment. For example, rocky areas have higher amounts of background radiation.
- In the UK, the background radiation is at safe levels, meaning it can't cause any harm. Some places in the world, such as Chernobyl, have extremely high amount of background radiation which can be fatal.

Nuclear Equations

$$^{235}_{92}U \longrightarrow {}^{4}_{2}He + {}^{231}_{90}Th$$

- Nuclear decays can be represented as a nuclear equation.
- The mass before the decay must equal the mass after the decay.
- The charge before the decay must equal the charge after the decay.
- An arrow represents a decay taking place.

Activity

- The activity of a radioactive substance is the amount of radiation given off every second. This is measured in Becquerels.

Half-Life

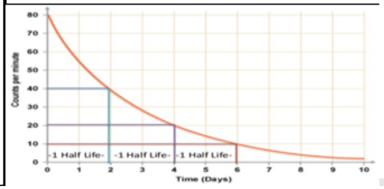
- The half life of a substance is the amount of time it takes for the activity of the substance to reduce to half its original value.

Safety when handling/using radioactive substances

- Wear Gloves
- Limit doses if used medically
- Wear a Geiger muller tube or photographic film (dosimeter)
- Never point source at someone
- Store substance in lead box

Calculating Half Life Graphically

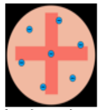
We can calculate the half life of a substance from a graph of count rate against time. Draw a line from when the count rate falls to half its original value to the line on the graph. This will show the time it has taken to fall to half, which is the half life.



Atomic Models

Dalton Model – One of the early models of the atoms which stated that all atoms were like solid balls.

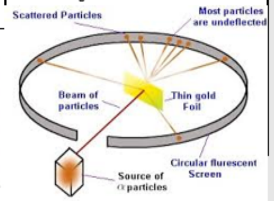
Plum Pudding Model – this model came after the discovery of the electron, stating that the atom was a solid positive sphere with negative electrons stuck to it.



Bohr Model – This is the current model of the atom as we know it.

Rutherford's Gold Scattering Experiment

- In 1909 Rutherford fired alpha particles at gold foil. The positive alpha particles did one of three things; Pass straight through, deflect or 'bounce off' the gold.
- Only 1 in 200 particles 'bounced off' suggesting the gold atoms have a very small, positive nucleus.
- Thus the negative electrons must be orbiting the nucleus.



Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Read large amounts of information about the uses and dangers of radiation.	Compare different types of radiation.	THINK HARD: Describe the evolution of the model of	Students completing nuclear equations.	Research fellow, Radiographer, Radiology technician, Military Service Officer (RAF/Navy), Nuclear Power Plant Engineer, Doctor/Nurse.

Information will be summarised into a table by the students.		the atom from the Dalton model to the Bohr model.		

Cultural Capital

Marie Curie – The Dangers of Radiation.

- Students will investigate the work of Marie Curie and what lead to her receiving two Nobel prizes.
- Students will then relate her work to her early death and the dangers of radiation.

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Topic: Forces in a Newtonian World	Duration: 11 lessons	Composite: Unit test

Key vocabulary:

- Force
- Newton
- Speed
- Velocity
- Distance
- Displacement
- Vector
- Scalar
- Acceleration
- Direction
- Gradient
- Area
- Mass
- Weight
- Centripetal
- Gravitational Field Strength
- Balanced
- Unbalanced
- Initial
- Final
- Friction
- Resultant
- Magnitude
- Braking
- Stopping
- Thinking
- Momentum
- Light gate
- Motion

Core knowledge Components and Powerful knowledge components (P) crucial to commit to long term memory

Year 10 Forces and Motion (Page 1)

Core and Powerful (P) knowledge questions

What is the difference between a scalar and a vector quantity? (P)
A **vector** quantity has **size** and **direction**.
A **Scalar** quantity has **size only**

Name some vector and scalar quantities

Scalars	Vectors
direction	displacement
speed	velocity
mass	forces (including weight)
temperature	acceleration
energy	momentum

State some everyday speeds:

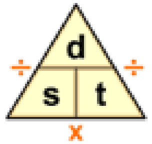
Walking 1.5m/s
Running 3 m/s
Cycling 6m/s
Car 25m/s
Train 50m/s
Plane 250m/s

What are the units for distance, speed, acceleration, force, mass, time and momentum?

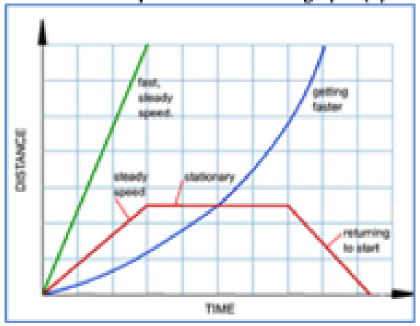
Distance, m	Speed, m/s	Acceleration, m/s2	Force, N	Mass, kg	Time, s	Momentum kgm/s

What equation links velocity, distance and time? (P)

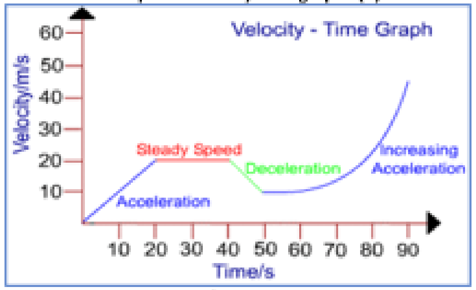
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$



How do we interpret a distance time graph? (P)



How do we interpret a velocity time graph? (P)

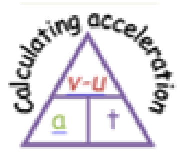


What does the gradient of a velocity time graph equate to? (P) Acceleration

What does the area under a velocity time graph equate to? (P) Distance travelled

What is the equation that links acceleration with change in velocity and time? (P)

$$a = \frac{(v - u)}{t}$$

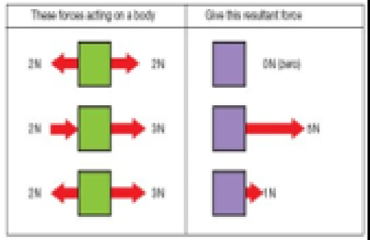


Which equation links acceleration with change in velocity and distance travelled?

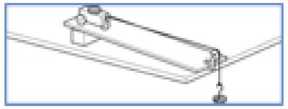
$$v^2 - u^2 = 2 \times a \times x$$

What happens to an object if there is a resultant force acting on it? (P) The object moves in a straight line at a steady speed

What happens to an object if there is no resultant force acting on it? (P) The object accelerates



Required practical: Watch again: Investigating force, mass and acceleration



Links to previous and future topics

KS2: Forces & Magnets, Forces

Y7: Forces & Space

Y9 Forces in a Newtonian World

Y9 Motion and Pressure in a Newtonian World

KS4: Forces and Matter

KS4: Forces and their effects

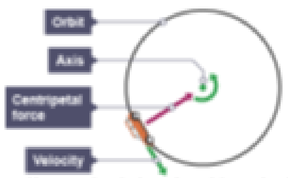
KS4: Forces and Work

Year 10 Forces and Motion (Page 2)

Core and Powerful (P) knowledge questions

What is the name of the type of force that keeps an object moving in a circle? (H)
Why is an object moving in a circle constantly accelerating? (H)

Objects travelling in a circular motion are prevented from moving off in a straight line by **centripetal force**. This resultant force pulls objects toward the centre of the circle, continually changing the direction that an object is travelling in to keep it in circular motion.



What does Newton's First Law of Motion State?

An object remains in the same state of motion unless a resultant force acts on it. If the resultant force on an object is zero, this means:

- a stationary object stays stationary
- a moving object continues to move at the same velocity (at the same speed and in the same direction)

What does Newton's Second Law of Motion State?

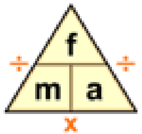
The law can be described by this equation which shows that the acceleration of an object is: $F = m \times a$

- proportional to the resultant force on the object
- inversely proportional to the mass of the object

In other words, the acceleration of an object increases if the resultant force on it increases, and decreases if the mass of the object increases

What is the equation that links force, mass and acceleration? (P)

$$F = m \times a$$



What is weight?
What is the difference between mass and weight?

Mass and weight are not the same!

- **Mass** is the **amount of matter** in an object and is measured in **kilograms**. Mass is not a force.

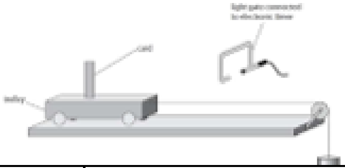
  Mass will have the same value anywhere in the Universe, including space.

- **Weight** is a **force** and is caused by the pull of gravity acting on a mass. Like other forces, weight is measured in **newtons** and has both magnitude and direction.

What does Newton's Third Law of Motion State?

Whenever two objects interact, they exert equal and opposite forces on each other

How do light gates work?
A **light gate** is connected **to** a device that measures the time the **light** is blocked when the card passes through it.



What is the equation that links momentum, mass and velocity? (H)

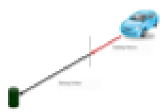
$$p = m \times v$$

What equation links change in momentum to force? (H)

$$F = \frac{(mv - mu)}{t}$$

How is overall stopping distance linked to braking and thinking distance? (P)

Stopping distance = Thinking distance + Braking distance



Which different factors affect thinking and braking distance? (P)

Thinking distance	Braking distance
Speed of car	Speed of car
Drugs and alcohol	Road conditions
Tiredness	Condition of tyres
Medication	Condition of brakes

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
				Various careers available in engineering, design and sports science that demand an understanding of forces and how they affect motion.

CULTURE CAPITAL: Rocket Science: How do we get a satellite into orbit? Newtons cannonball theory: https://www.youtube.com/watch?v=ALRdYPMpqQs . Isaac Newton postulated many years before humans made it into space how something could get into orbit

SEND

- Opening activity/theme is Knowledge Recall to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge using Knowledge Recall.
- Multi-sensory approach using reading, listening, watching, doing practicals, talking, observing demonstrations…
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity

- Links to prior learning explicitly highlighted to support non-verbal reasoning – then, now, next
- Activities are scaffolded with over-learning of previous content to encourage independence