Topic: Electricity A: Circuits

Duration:

Composite: Unit test

Key vocabulary:

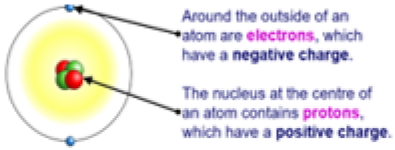
- Circuit
- Potential difference
- Voltage
- Current
- Resistance
- Ohm
- Amp
- Volt
- Series
- Parallel
- Branch
- Junction
- Component
- Voltmeter
- Ammeter
- Power
- Charge
- Equation
- Resistor
- Filament Lamp
- LDR
- Thermistor
- Variable resistor
- Cell
- Battery

Core knowledge Components

Powerful knowledge components crucial to commit to long term memory - Questions in bold, (C)

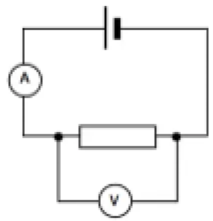
Electricity A: Circuits

What are atoms made of? (C)



What are the properties of the sub-atomic particles? (C)

Subatomic particle	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
electron, e⁻	1/2000	-1



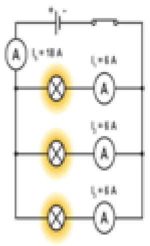
How is a voltmeter connected to measure potential difference across a component? ***In parallel***

How is an ammeter connected to measure the current flowing through a component? ***In series***

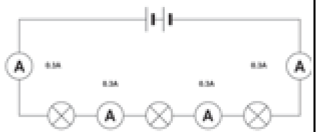
How do we define potential difference? ***PD is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb***

How do we define an electrical current? ***An electric current is the rate of flow of charge***

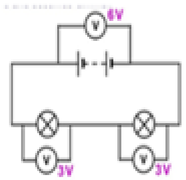
What are the key differences between series and parallel circuits? (C)



In a series circuits the current flowing is the same in every part of that circuit.

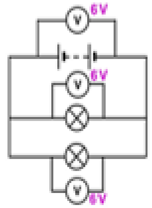


In a parallel circuit, the current is split between branches.



In a series circuit the potential difference from the power supply is shared across the components

In a parallel circuit each branch has the same potential difference across it



What equation links potential difference, current and resistance?

V = I x R

$$V = I \times R$$

What equation links charge, current and time?

$$I = \frac{Q}{t}$$

I = Current
Q = Total charge
t = time taken

What equation links power, energy transferred and time? (C)

$$P = \frac{E}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}}$$

What equation links energy transferred to potential difference, current and time?

$$E = VIt$$

What equation links power to potential difference and current? (C)

$$P = I \times V$$

What equation links power to current and resistance?

$$P = I^2 \times R$$

How does changing resistance in a circuit affect current? (C) ***Increasing the resistance will decrease the current. Decreasing the resistance will increase the current***

What does a variable resistor do? ***It changes the current within a circuit***

How can unwanted energy transfer in wires be reduced? ***By using wires with lower resistance***

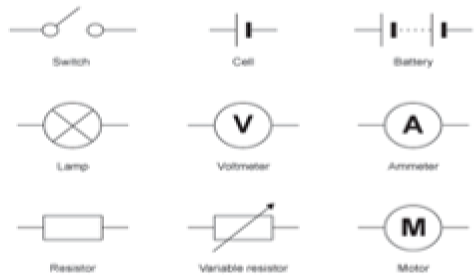
Why does an electric current have a heating effect? ***This is due to electrons colliding with metal ions within a lattice***

What are the benefits and disadvantages of the heating effect of a current?
Benefits:
Can be used in a variety of appliance to transfer energy as heating e.g. toaster, heater, kettle

Disadvantages:
Causes appliances to be inefficient, energy is dissipated to the surroundings

What properties do LDRs and Thermistors have?
LDR: Resistance increases with lower light intensity
Thermistor: Resistance increases as temperature gets lower

What circuit symbols do I need to know?



Links to previous and future topics

Year 7 Electricity
Year 7 Energy
Year 9 Energy
Year 10 Conservation of Energy
Year 11 Electricity B: Using Electricity in the Home
Year 11 Magnetism

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
			Students will need to be taught how to test circuits themselves and to problem solve circuits.	Many electrical and engineering career paths available with this knowledge.

Topic: Electricity B: Using Electricity in the Home	Duration: 3 lessons	Composite: Unit test

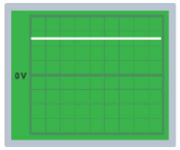
Key vocabulary:

- Alternating
- Direct
- Current
- Potential Difference
- Mains
- Frequency
- Live
- Neutral
- Earth
- Terminal
- Circuit breaker
- Power rating
- Fuse

Core knowledge Components

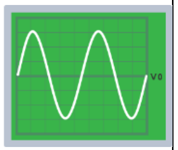
Powerful knowledge components crucial to commit to long term memory - Questions in bold, (P)

What is the difference between direct and alternating current? (P)



A direct current flows in one direction only

In an alternating current the direction of charge movement regularly changes



What type of current do cells and batteries supply?

Cells, batteries and solar cells all supply direct current

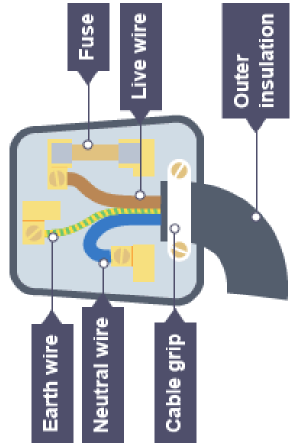
What is the frequency and voltage of mains domestic electricity supply in the UK?

50Hz, a.c. 240V

What are the functions of the live, neutral and earth wires? (P)

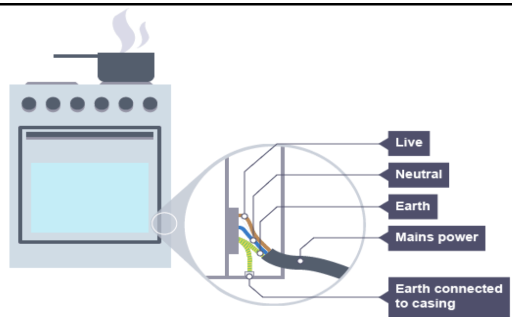
What are the potential differences between the live, neutral and earth wires?

Wire	Function
Live wire	Copper wire coated with brown plastic - this wire connects to the alternating potential difference pushing the current in the circuit
Neutral wire	Copper wire coated with blue plastic - this wire is connected to a voltage close to zero, to ensure the live voltage always has a difference in potential to make the push for the current
Earth wire	Copper wire coated in striped plastic that provides a path for current to flow from the case of the device to the ground (also a zero-voltage connection) if there is a fault



How does earthing work?

The earth wire is connected to the case and is attached to a metal plate. The earth wire provides a low resistance path to the ground. In the event of a fault, the live current passing through the case will follow this path to the ground instead of passing through a person. Once the fuse has melted, the circuit is broken and no more current flows through the device. This means the case of the device is no longer live and there is no more risk of electrocution.



How does a circuit breaker work?

A circuit breaker can serve the same function as a fuse but can be reset without the need for replacement if it trips.

The fuse or circuit breaker must be connected in the live wire side of a domestic circuit to ensure that it keeps high voltage from reaching the user, or surroundings, if a fault develops.

Links to previous and future topics

Year 7 Electricity
Year 7 Energy
Year 9 Energy
Year 10 Conservation of Energy
Year 11 Electricity A: Circuits
Year 11 Magnetism

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
				Many electrical and engineering career paths available with this knowledge.

CULTURAL CAPITAL:

SEND

- Opening activity/theme is … to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge via Knowledge Recall slide
- Multi-sensory approach using video, practical work, teacher explanation/modelling, paired work
- Technology: video used to support accessibility
- 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

Topic: PARTICLE MODEL – Physics Combined Science & Separate Physics

Duration: 9 LESSONS

Composite: Unit test

Key vocabulary:

Particle
State
Melting
Solidification
Boiling
Evaporation
Condense
Sublimation
Density
Energy
Specific heat capacity
Specific latent heat
System
Temperature
Pressure
Volume
Kelvin

Core knowledge Components

Powerful knowledge components crucial to commit to long term memory (IN RED BOX)

KS4 PARTICLE MODEL

Density

- Depends on the spacing of the atoms in matter
- Solids and liquids have similar densities as the space between particles is similar.
- Usually liquids have a lower density than solids (main exception is ice and water)
- Gases have a far lower density
  spacing between atoms increases x 10
  - particles have lots of kinetic energy
  - volume increases greatly
  - density decreases

Heating a System

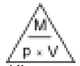
- Heating increases the energy the particles have
- Particles vibrate more
- This either raises the temperature of the system
  Or produces a change of state
- The 'system' could be an ice cube, a gas etc...

Absolute Zero

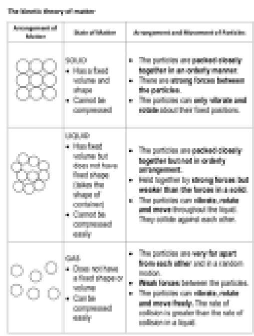
- This temperature is 0 Kelvin, or -273°C
- the coldest possible temperature
- Particles at this temperature have no energy, so they do not vibrate at all, they remain perfectly still.

Converting Kelvin to Centigrade:
T kelvin = (T – 273) centigrade
so 4K = –269°C and 0°C = 273K
- the difference of 1°C is the same as 1 Kelvin

density = mass / volume



density (ρ) is measured in kilograms per cubic metre (kg/m3)
mass (m) is measured in kilograms (kg)
volume (V) is measured in cubic metres (m3)



The kinetic theory of matter

Arrangement of Motion	State of Matter	Arrangement and Movement of Particles
	SOLID • Has a fixed volume and shape • Cannot be compressed	• The particles are packed closely together in an orderly manner. • There are strong forces between the particles. • The particles can only vibrate and rotate about their fixed positions.
	LIQUID • Has fixed volume but does not have fixed shape (takes the shape of container) • Cannot be compressed easily	• The particles are packed closely together but not in orderly arrangement. • Held together by strong forces but weaker than the forces in a solid. • The particles can vibrate, rotate and move throughout the liquid. They collide against each other.
	GAS • Does not have a fixed shape or volume • Can be compressed easily	• The particles are very far apart from each other and in a random motion. • Weak forces between the particles. • The particles can vibrate, rotate and move freely. The rate of collision is greater than the rate of collision in a liquid.

Temperature Changes

Specific Heat Capacity: The amount of energy required to raise the temperature of 1kg of a substance by 1°C.

Specific Latent Heat : The amount of energy needed to change the state of 1kg of a substance without a change in temperature.

Specific Latent Heat

$E = m \times L$

E = Energy in Joules, J
m = mass in kilograms, kg
L= specific latent heat in Joules per kilogram, J/kg.

- Energy is absorbed when melting and evaporating
- Energy is released when freezing and condensing.

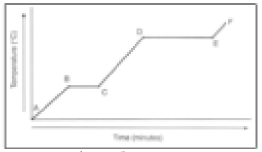
Specific Heat Capacity

$\Delta E = m \times c \times \Delta T$

ΔE: change in thermal energy, in Joules J,
C = specific heat capacity, in Joules per kilogram per degree Celsius, $Jkg^{-1}°C^{-1}$,
m = mass kilograms, kg
ΔT = temperature change in degrees Celcius °C .

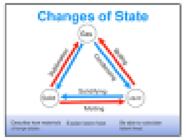
Graph here shows the temperature of ice:

- At A it is Solid.
- At B, reaches 0°C .
- From B to C there is no temperature change because the energy is involved in melting.
- From C to D it is in liquid state.
- From D to E the water is changing state. It is boiling. This takes longer, because evaporation takes more energy.
- From E to F the gas is heating.



Changes of State

- Mass is conserved during a change of state.
- These physical changes are reversible, and not chemical changes
- They are not chemical because the material retains its original properties when reversed

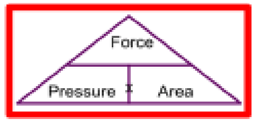


Pressure of a Gas

- Particles in a gas move randomly in every direction
- A Fluid can be a liquid or a gas
- Pressure produces a net force at right angles to any surface
- Particles collide with a wall, changing velocity
- This means they change momentum during their collision
- So they exert a force on the wall (as force = Δmomentum time)
- Pressure is the force across the area of the wall.

Temperature and Pressure (in a constant volume)

- Increased temperature means more energy given to the particles
- The thermal energy is transferred to kinetic
o Particles move at faster speed
o Collisions with walls occur more often
o The particles also hit the wall with greater impact
o So pressure increases



Links to previous and future topics

Y7: Forces & Space; Particles & Solutions

Y8: Heating and Cooling

Y9: Energy; Motion & Pressure

KS5 Physics: Thermal Physics, Ideal Gases

Pressure changes (Physics Only)

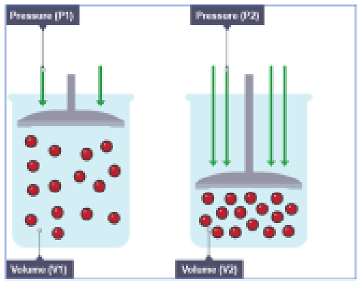
Gases want to remain at a constant temperature:-

- Increasing the pressure of the gas causes it to compress (have a smaller volume)
    - o Pressure increases, so greater force per area
    - o Same force is exerted on walls, as temperature and energy of particles is constant
    - o Force needs to be exerted on a smaller area and volume decreases
- Other way round?
    - o Volume increases, so a greater area that particles collide with
    - o Same force is exerted on the walls as velocity is constant (as velocity is only affected by temperature) and pressure decreases

- So this means pressure ∝ 1 / volume (inversely proportional)

For a gas at fixed mass and temperature: P1V1 = P2V2

Where P is pressure and V is volume in states 1 and 2.



PARTICLE MODEL KS4 SEPARATE SCIENCE PHYSICS ONLY

Doing Work on a Gas (Physics Only):-

- Doing work on a gas increases its temperature

WD = Force × distance = Force / Area × (area × distance) = Pressure × Volume

work done = pressure × volume

Adding More Particles to A Fixed Volume (Physics Only):-

o Doing work on a gas means compressing or expanding the gas, so changing the volume
o Pumping more gas into the same volume means more particles are present, so more collisions occur per unit time with the walls, so pressure increases.
o Energy is transferred to the particles when more gas is added into the fixed volume, so this heats the gas

A Fixed Number of Particles with A Decreasing Volume (Physics only):-

o The particles collide with the wall which is moving inward
o So the particles gain momentum, as the rebound velocity is greater than the approaching velocity
o So as the particle has a greater velocity, the pressure increases as the particles collide with the walls more frequently (time between collisions decreases)
o And the temperature also increases, as the kinetic energy of each particle increases

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
https://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content	Egg/hot water/conical flask demo: Ask students to suggest why egg goes into flask as water cools - what happens, in terms of the difference in air pressure between the inside and outside the flask	*Core Practical: Investigate the properties of water by determining the specific heat capacity of water and obtaining a temperature-time graph for melting ice*	*P14.3: Core practical: Investigate the densities of solid and liquids*	Heating Engineer, Product Design, Aeronautical Engineering, Environmental Scientist; Thermal Physics

CULTURAL CAPITAL: Understanding the link between Specific Heat Capacity, Global warming and rising sea-levels (Impressive Reading)

SEND

- Opening activity/theme is … to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge via Knowledge Recall slide
- Multi-sensory approach using video, practical work, teacher explanation/modelling, paired work
- Global warming and rising ocean temperature case study chosen to support cultural capital
- Global warming and rising ocean temperature case study chosen as relatable
- Global warming and rising ocean temperature case study chosen due to cross curricular links with Geography supporting non-verbal reasoning
- Technology: video used to support accessibility
- 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

Topic: Electromagnetism (Combined Foundation)

KS4 National Curriculum sub-topics:-

Physics – Waves

Duration: lessons

Composite: Unit test

Key vocabulary

Wavelength
Frequency
Hertz
Amplitude
Period
Peak
Trough
Pitch
Speed
Refraction
Reflection
Velocity
Energy
Radio wave
Microwave
Infrared
Gamma
Ultraviolet
Mutation
Sterilising
Thermal
Spectrum

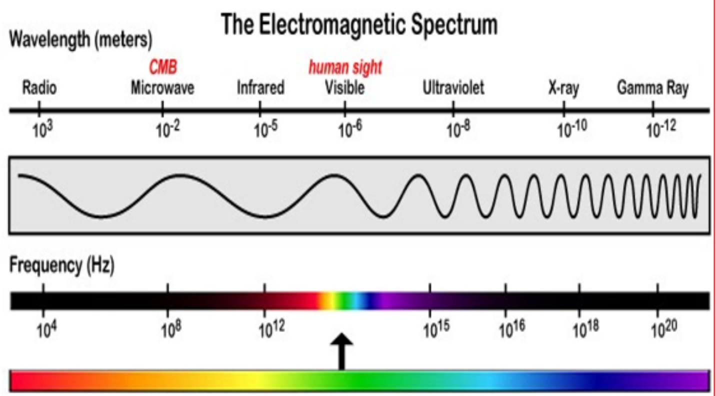
Core knowledge Components

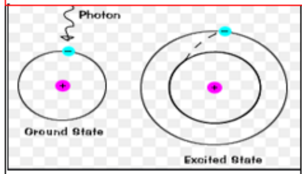
Electromagnetic Waves

- All electromagnetic waves are transverse
- Visible light is an example of an electromagnetic wave
- All electromagnetic waves can move through a vacuum and always travel at the speed of light in a vacuum.
- Electromagnetic waves transfer energy from a source, the an observer. For example, the sun transfers energy to the Earth via electromagnetic waves.

Atoms and the Electromagnetic Spectrum

- Electrons sit within shells of an atom.
- If an electron absorbs an electromagnetic wave, it moves up a shell.
- If an electron moves down a shell, it will emit an electromagnetic wave.
- This can cause atoms to produce a wide range of electromagnetic waves with different frequencies.





Electromagnetic Waves and Us

- Humans can only see Visible light. This is because our eyes can only see wavelengths between roughly 380nm and 700nm.
- The more energy that an electromagnetic wave has, the more dangerous that it becomes.
- Gamma rays are the most dangerous to us, with radio waves being the least dangerous.

Powerful knowledge components crucial to commit to long term memory (IN RED)

Uses and Dangers of the Electromagnetic Spectrum.

EMAG Spectrum	Uses	Dangers
Radio waves	Broadcasting, communications	-
Microwaves	Cooking, communications and satellite transmissions	Internal heating of body cells
Infrared	Cooking, thermal imaging, short range communications, optical fibres, television remote controls	Skin burns
Visible	Vision, photography	Damage to eyes
Ultraviolet	Security marking, fluorescent lamps, detecting forged bank notes	Damage to surface cells and eyes, leading to skin cancer and eye conditions
X-Rays	Observing the internal structure of objects, airport security scanners and medical x-rays	Mutation or damage to cells in the body
Gamma Rays	Sterilising food and medical equipment, and the detection of cancer and its treatment	Mutation or damage to cells in the body

Links

Y7 – Energy Resources

Y8 Light and Sound

Y9 - Waves

KS5 Physics – Waves 1

KS5 Physics – Waves 2

KS5 Physics – Quantum Physics

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Students will read large amounts of information about the uses and dangers of EM radiation, extracting the key information	Discuss the refraction of light through a rectangular block	Write a description as to why the sky is blue in the day but red during the sunset.	Students require long periods of focus and concentration when completing long independent study tasks like the uses and dangers of EM radiation.	Research fellow – Astrophysicist, radio engineer; product design, civil, aeronautical, sound, electronic engineering, meteorology, seismology, oceanography, radiographer.

Cultural Capital

If EM radiation can harm our bodies, why is it still widely used in medicine?

- Students investigate the harmful effects of EM radiation
- Students investigate the benefits of EM radiation on the body
- Students discuss the benefits to EM radiation and measures taken to ensure safety

SEND

Topic: Electromagnetism (Combined Higher)

KS4 National Curriculum sub-topics:-

Physics – Waves

Duration: 7 lessons

Composite: Unit test

Key vocabulary

Wavelength
Frequency
Hertz
Amplitude
Period
Peak
Trough
Pitch
Speed
Refraction
Reflection
Velocity
Energy
Radio wave
Microwave
Infrared
Gamma
Ultraviolet
Mutation
Sterilising
Thermal
Spectrum

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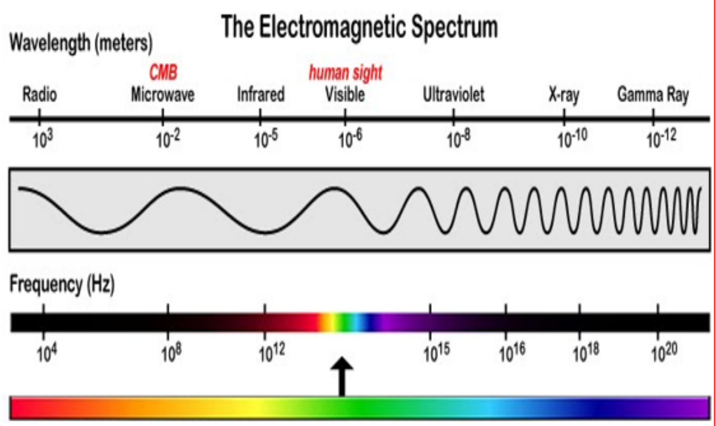

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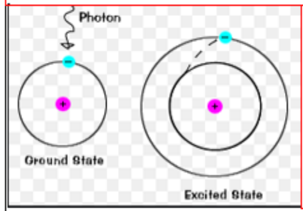

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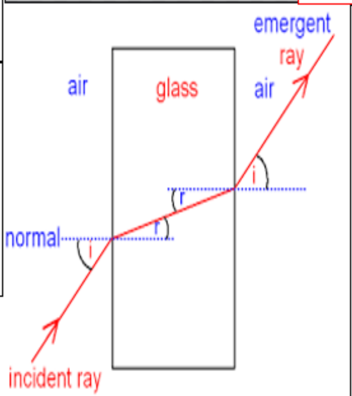
- The more energy that an electromagnetic wave has, the more dangerous that it becomes.
- Gamma rays are the most dangerous to us, with radio waves being the least dangerous.

Radio Waves and Electrical Circuits

- When Radio-waves interact with the atoms in electrical circuits, they can 'excite' the atoms.
- Exciting an atom causes an electron to change a shell.
- This can cause an oscillation in the circuit as an electrical current begins to flow.



Refraction of Light

- When an electromagnetic wave enters a material with a different density, like a glass block, it can refract.
- This can cause the block to change speed and direction.
- The frequency of the wave will always remain the same, meaning the wavelength changes.
- This can cause the light to separate into its individual colours (wavelengths)
- We always measure the angle of incidence and angle of refraction to the normal.
- The normal is a dashed line at 90 degrees to the surface that the light enters.

Powerful knowledge components crucial to commit to long term memory (IN RED)

Uses and Dangers of the Electromagnetic Spectrum.

EMAG Spectrum	Uses	Dangers
Radio waves	Broadcasting, communications	-
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Links

Y7 – Energy Resources

Y8 Light and Sound

Y9 - Waves

KS5 Physics – Waves 1

KS5 Physics – Waves 2

KS5 Physics – Quantum Physics

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Students will read large amounts of information about the uses and dangers of EM radiation, extracting the key information	Discuss the refraction of light through a rectangular block	Write a description as to why the sky is blue in the day but red during the sunset.	Students require long periods of focus and concentration when completing long independent study tasks like the uses and dangers of EM radiation.	Research fellow – Astrophysicist, radio engineer; product design, civil, aeronautical, sound, electronic engineering, meteorology, seismology, oceanography, radiographer.

Cultural Capital

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- Students investigate the harmful effects of EM radiation
- Students investigate the benefits of EM radiation on the body
- Students discuss the benefits to EM radiation and measures taken to ensure safety

SEND

Topic: KS4 FORCES AND MATTER	Duration: 4 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
Force Stretch Compress Elastic Inelastic Plastic Deformation Linear Non linear Hooke Proportionality Energy Work done Potential	(see below)	Y7: Forces and Space Y9: Forces in a Newtonian World, Motion & Pressure KS4: Forces, Energy – Forces doing Work; Forces & their Effects, Conservation of Energy KS5 Physics: Forces in Action; Work, Energy and Power

KS4 FORCES AND MATTER

SPRINGS:

Stretching, Bending and Compressing:-
- More than one force has to be applied

o If a single force is applied, the object will just move in the force's direction

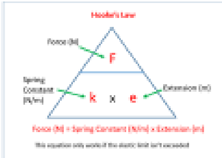
o If forced inwards from opposite sides, the object (e.g. a spring) will compress

o If fixed at one end of the spring and a force is applied at the other, more than one force is still being applied to the spring (a reaction force from the fixed point)

Deformation:-
- This means changing shape
- **Elastic Deformation**
  - o The object returns to its original shape when the load/force has been removed
  - o Eg. An elastic band
- **Plastic Deformation** (distortions)
  - o The object does not return to its original shape when the load has been removed
  - o Eg. A spring when pulled too far

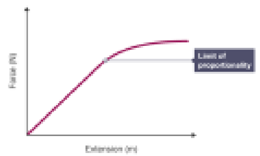
Linear Elastic Distortions, Hooke's Law

- Spring constant k = Force required to extend a spring by one metre
- Hooke's Law: The extension of a spring is directly proportional to the force applied.
- Directly proportional means e.g. that if force doubles, extension doubles.
- It will be a **linear (straight line)** graph starting at the origin.



Limit of Proportionality/Elastic Limit:-

- **Spring constant** is a measure of the stiffness of a spring up to its limit of proportionality or elastic limit.
- The **limit of proportionality** is the point beyond which Hooke's law is no longer true when stretching a material.
- The **elastic limit** of a material is the furthest point it can be stretched or deformed while being able to return to its previous shape.
- Once a material has gone past its elastic limit, its deformation is said to be **inelastic**. The graph curves at this point. The material will not return to its original length.



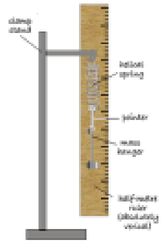
Energy stored in a spring:-

- Work is done when a spring is extended or compressed.
- Elastic potential energy is stored in the spring.
- Provided inelastic deformation as not occurred:-

Work done = Elastic Potential Energy
(Both are measured in Joules, J)

Hooke's Law Investigation

Variables:-
Independent = mass added to spring
Dependent = extension of spring
Control = material of spring, original length of spring, person judging extension length
NB: pointer; absolutely vertical ruler
Consider: range (need change but not overstretch); safety
Plot graph of F against e:
- gradient = spring constant
- Area under line = Work done



Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Linking Physics and Springs to the human body:- https://www.nhs.uk/conditions/hamstring-injury/ What is the link between Physiotherapy and this topic? https://www.nhs.uk/conditions/physiotherapy/	Identify forces acting on objects stretching, compressing, bending or none of the above	Linking topic with muscle injury and Physiotherapy	Required practical: Investigating Hooke's Law	Architect, Product design, Civil and Aeronautical Engineering, Geophysicist, Physiotherapist, Sports Scientist

CULTURAL CAPITAL: Understanding the link between Hooke's Law, hamstring injury and Physiotherapy

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- 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…
- Muscle injury/physiotherapy link case study chosen to support cultural capital at KS4/KS5
- Muscle injury/physiotherapy link case study chosen as it is relatable and for career opportunities/aspirations beyond school.
- Muscle injury/physiotherapy topic chosen due to cross curricular links with PE supporting non-verbal reasoning
- 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

Topic: Waves (Combined Foundation)

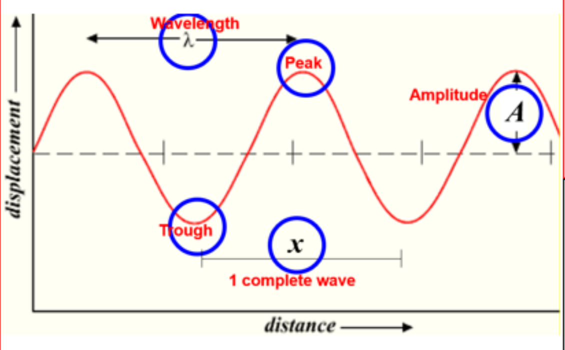
KS4 National Curriculum sub-topics:-

Physics – Waves

Duration: 6 lessons

Composite: Unit test

Key vocabulary	Core knowledge Components	Powerful knowledge components crucial to commit to long term memory (IN RED)	Links
Wavelength Frequency Hertz Amplitude Period Peak Trough Pitch Speed Refraction Reflection Velocity Matter Energy	(see below)		Y7 – Energy Resources Y8 Light and Sound Y9 - Waves KS4 – The Electromagnetic Spectrum KS5 Physics – Waves 1 KS5 Physics – Waves 2 KS5 Physics – Quantum Physics



Key Terms;
Amplitude -> The distance between the peak of a wave and the equilibrium position.
Wavelength -> The distance between two identical points on the wave, this could be the distance between two peaks.
Peak -> The highest point on a wave.
Trough -> The lowest point on a wave.
Frequency -> The amount of wave cycles every second.
Period -> How long it takes a wave to complete one wave cycle.
Wave Velocity -> The amount of distance in meters that a wave travels every second.

Units!
Amplitude -> Meters (m)
Wavelength -> Meters (m)
Frequency -> Hertz (Hz)
Period -> Seconds (s)
Wave Velocity -> Meters per second (m/s)

What does a wave do?
A wave will transfer energy from one place to another without the transfer of matter.

How does a wave do this?
Each particle in the wave will oscillate back and forth, transferring energy to any particles that they collide with.

Water Waves
A water wave is an example of a **transverse** wave. The particles oscillate at right angles to the direction of energy transfer. We can see this when a duck floats on a lake. If a wave passes underneath the duck, it will move up and down while the wave moves along the surface of the water.

Sound Waves
A sound wave is an example of a **longitudinal** wave. The particles vibrate and collide with each other. When they do energy is transferred. However, the particles themselves will oscillate due to the collisions with other particles.

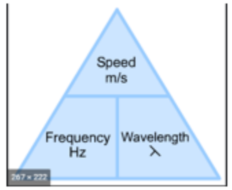
Transverse Waves
A transverse wave will oscillate at right angles to the direction of energy transfer.
Common Examples; Electromagnetic (Light), water and S-waves.

Longitudinal Waves
A longitudinal wave will oscillate parallel to the direction of energy transfer.
Common Examples; Sound and P-Waves.

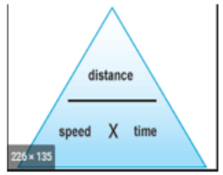
Refraction
When waves enter a material or gas that has a different density, called a boundary, they will refract. Refraction is when the wave changes the direction that it is travelling. The wave can also slow down, or speed up when this happens.

The Wave Equations!
There are two equation that we need to know and recall.

$$Speed = Frequency \times Wavelength$$



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



Measuring Velocity
We can measure the velocity of waves by investigating their properties such as frequency and wavelength and then using our equation to calculate velocity.

We can use a ripple tank to measure the speed of a water wave. We can measure the wavelength by projecting the wave onto a screen and measuring the distance between peaks. The frequency is set by the oscillator that creates the wave.

Waves and Refraction
Different substances interact with waves differently. When a wave hits a boundary a few different things can happen depending on the wavelength of the wave. The wave can…
- Be absorbed by the substance
- Be Transmitted through the substance
- Refract or Reflect

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Read and apply key terms about waves to a wave diagram.	Discuss the properties of waves, relating this to the ripple tank	Describe how we can measure the speed, frequency and wavelength of a wave in a solid and a fluid	Students completing calculations involving two separate equations, combining both when required	Research fellow – Astrophysicist, radio engineer; product design, civil, aeronautical, sound, electronic engineering, meteorology, seismology, oceanography, radiographer.

Cultural Capital
Gravitational Waves - What are gravitational waves? - Amber L. Stuver (**https://www.youtube.com/watch?v=hebGhsNsjG0**) • Why are they important? • Key scientists that have contributed to our understanding of gravitational waves • What event did we use gravitational waves to observe?
SEND