Topic: Electromagnetism (Triple Higher) KS4 National Curriculum sub-topics:- **Physics – Waves**		Duration: 14 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 Energy Radio wave Microwave Infrared Gamma Ultraviolet Mutation Sterilising Thermal Spectrum			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: Waves (Triple Higher)

KS4 National Curriculum sub-topics:-

Physics – Waves

Duration: 10 lessons

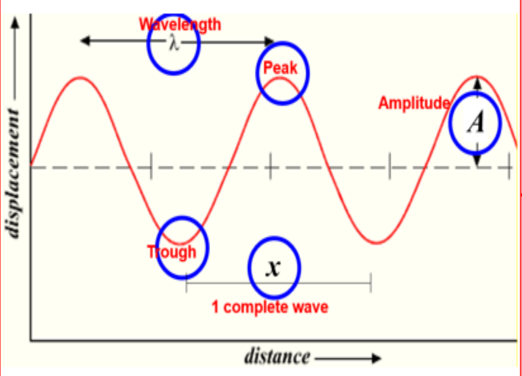
Composite: Unit test

Key vocabulary

Wavelength
Frequency
Hertz
Amplitude
Period
Peak
Trough
Pitch
Speed
Refraction
Reflection
Velocity
Matter
Energy
Depth
Wave-front
Transmission
Absorption
Interface
Seismic
Infrasound
Ultrasound

Core knowledge Components

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



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.

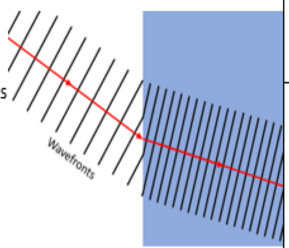
Wave Velocity -> The amount of distance in meters that a wave travels every second.

Units!

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

Wavefronts

A wavefront is a bird-eye view of a wave. Each line represents the peak of a wave. This gives an easy way of measuring The wavelength of a wave. Wavefronts are often used to help us understand refraction.



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.

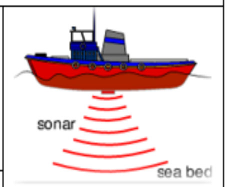
Common Examples; Sound and P-Waves.

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.

Calculating Depth

We can calculate the depth of water, such as the ocean using waves! A high frequency sound wave is directed at the bottom of the sea. This will reflect when it hits the bottom and come back to the boat. We can then use the equation, distance = time x speed to calculate the total distance travelled by the wave. This need to halved to find the depth of water.



The Wave Equations!

There are two equation that we need to know and recall.

$Speed = Frequency \times Wavelength$

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

Infrasound

- Any sound wave with a frequency below 20Hz.
- Used to explore the core of the Earth.
- Infrasound doesn't travel through the whole of the core suggesting there is a difference in density at the core.

Ultrasound

- Any sound wave with a frequency greater than 20kHz.
- Used to calculate the depth of water and in sonar.
- Used for medical purposes such as foetal scanning.

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

Speed, Frequency and Wavelength

- When a wave refracts, its frequency never changes.
- If the wave enters a more dense material, it will slow down which causes the wavelength to decrease.
- If the wave enters a less dense material, it will speed up which causes the wavelength to increase.

The Human Ear

Sound waves enter the ear canal and cause the eardrum to vibrate. Three small bones transmit these vibrations to the cochlea. This produces electrical signals which pass through the auditory nerve to the brain.

The Cochlea

- At the base, the membrane is thicker and stiffer at the base and thinner at the apex.
- The frequency of the sound dictates what part of the membrane vibrates.
- The brain interprets signals from different areas of the cochlea as different pitches of sound.

Links

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

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

Topic: Year 10 Conservation of Energy

Duration:

Composite: Unit test

Key vocabulary:

Energy
Joule
Conservation
Store
Thermal
Kinetic
Gravitational
Potential
Elastical;
Chemical
Nuclear
Transfer
Mechanical
Radiation
System
Wasted
Dissipate
Efficiency
Lubrication
Insulation
Sankey Diagram
Fossil Fuel
Nuclear fuel
Biofuel
Hydroelectricity
Tidal
Solar
Fission
Emit
Carbon dioxide
Renewable
Carbon neutral

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

What is the unit for energy? (P)

((joule, J)

Define the Law of the Conservation of Energy (P)

Energy cannot be created or destroyed but can be transferred from one store to another

Name 6 energy stores (P)	
Thermal	Kinetic
Gravitational Potential	Elastic potential
Chemical	Nuclear

State 5 ways that energy can be transferred between stores (P)

1. Heating
2. Mechanically
3. Electrically
4. Radiation
5. Sound

What is a system?
An object or group of objects being studied that are energy stores)

What's the equation for Gravitational Potential Energy (P)?

$$\Delta GPE = m \times g \times \Delta h$$

What is the equation for kinetic energy (P)?

$$KE = \frac{1}{2} \times m \times v^2$$

What is useful energy?
Energy that has been transferred to a desired store

What is wasted energy? Energy that has not been transferred to a useful store

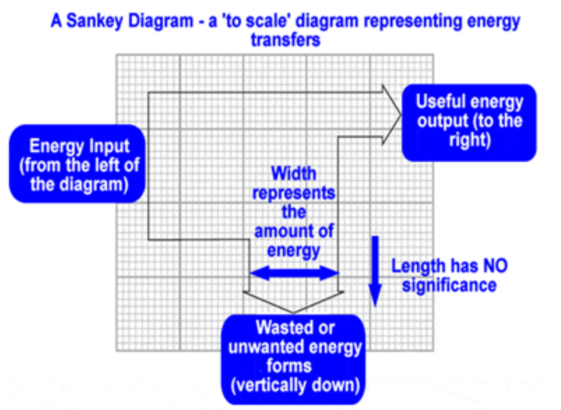
What does dissipate energy mean?
It means that energy spreads out thinly into the surroundings and so cannot be transferred to a useful store

State what is meant by energy efficiency? (P) It is a measure of how good a machine is at transferring energy into useful stores)

State 2 ways in which efficiency can be increased. (P) Lubrication and insulation

What is the equation for efficiency? (P)

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$



Describe how energy resources are used (P)

Energy Source	How do they work?	Advantages	Disadvantages
Fossil Fuels	Fossil fuels are burned. The heat released is used to create steam which drives a turbine which in turn drives a generator.	These are a concentrated energy source and are easily used in engines	When they burn they emit carbon dioxide which contributes to climate change. They are also non-renewable.
Nuclear fuels	Uranium and polonium release heat through a process called fission. The heat released is used to create steam which drives a turbine which in turn drives a generator.	These are a very concentrated energy source They do not emit carbon dioxide and so do not contribute to climate change	Produces radioactive waste that remains dangerous for thousands of years There is the risk of major catastrophic events (e.g. Chernobyl)
Biofuels	Biofuels are burned. The heat released is used to create steam which drive a turbine which in turn drives a generator.	They are carbon neutral (when they burn they produce the same amount of carbon dioxide as the plants take out of the air when they are growing). They are renewable	This reduces the land available for growing food. This can raise the cost of food.. Some energy is needed to produce them so they are not really carbon neutral.
Wind	The kinetic energy in wind is used to turn a wind turbine which in turn drives a generator.	They are renewable. There are no on-going fuel cost and they do not emit carbon dioxide.	Can be noisy, unsightly and only work when it is windy.
Hydroelectricity	The kinetic energy in moving water turns a wind turbine which drives a generator.	They are renewable. Can be started and stopped very quickly.	Can only work where there is high rainfall. Land is needed to create large reservoirs.
Tides	The kinetic energy in tidal water is used to turn a wind turbine which drives a generator.	They are renewable and very reliable – tides are predictable.	Very expensive to build and can destroy many habitats for wildlife.
The Sun	Solar cells transfer the energy in photons into a flow of electrons in photovoltaic cells.	They are renewable. They are renewable. There are no on-going fuel cost and they do not emit carbon dioxide.	Can be very expensive and only produce electricity when the sun is shining.

Links to previous and future topics

Year 7: Energy resources –many of the concepts about stores and transfers; and energy resources have been introduced at that point.
Year 8: Heating and Cooling
Year 9: Energy (Concept of efficiency introduced here)

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Students can analyse data (including graphs, text and tables) referring to different energy sources	Students have 2 minutes to explain their chosen energy resources to another group or to the class	Homework: Write a letter to the Prime Minister persuading him/ her of a strategy for renewable energy	Students will carry out a variety of calculations within this unit; some may be able to perform some more complex work for example calculating the velocity from the kinetic energy formula.	Many job opportunities available within this sector: Energy efficiency; wind farm engineer, nuclear science etc

CULTURAL CAPITAL: Show extracts from 'The boy who harnessed the wind' https://www.youtube.com/watch?v=nPkr9HmglG0 **or listen to the TED Talk** https://www.youtube.com/watch?v=G8yKFVPOD6o

Born in Kasungu, Malawi, William Kamkwamba is a young schoolboy who comes from a family of farmers William also dabbles in fixing radios for his friends and neighbors and spends his free time looking through the local junkyard for salvageable electronic components. Although he is soon banned from attending school due to his parents' inability to pay his tuition fees, William blackmails his science teacher (who is in a secret relationship with William's sister) into letting him continue attending his class and have access to the school's library where he learns about electrical

engineering and energy production. By the mid-2000s, failing crops due to drought and the resulting famine have devastated William's village, leading to riots over government rationing and William's family being robbed of their already meager grain stores. People soon begin abandoning the village, and William's sister elopes with his former teacher in order to leave her family "one less mouth to feed". Seeking to save his village from the drought, William devises a plan to build a windmill to power an electric water pump that he had scavenged earlier. William builds a small proof of concept prototype which works successfully, but to build a larger windmill, William requires his father, Trywell, to give permission to dismantle the family bicycle for parts, which is the only bicycle in the village and the family's last major asset. His father believes the exercise futile and destroys the prototype. However, after intervention from William's mother, William and his father reconcile, and with the help of his friends and the remaining members of the village, they built a full-size wind turbine which leads to a successful crop being sown	