AQA Physics – Waves Journey of Knowledge

Context and introduction to the unit: Wave behaviour is common in both natural and man-made systems. Waves carry energy from one place to another and can also carry information. Designing comfortable and safe structures such as bridges, houses and music performance halls requires an understanding of mechanical waves. Modern technologies such as imaging and communication systems show how we can make the most of electromagnetic waves.**KS3:** Year 9: Waves - Light and sound

CORE KNOWLEDGE

6.6.1 Waves in air, fluids and solids

6.6.1.1 Transverse and longitudinal waves

Waves may be either transverse or longitudinal. The ripples on a water surface are an example of a transverse wave. Longitudinal waves show areas of compression and rarefaction. Sound waves travelling through air are longitudinal. Transverse waves travel perpendicular to energy transfer and longitudinal travel parallel to energy transfer.

6.6.1.2 Properties of waves

The amplitude of a wave is the maximum displacement of a point on a wave away from its undisturbed position. The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave. The frequency of a wave is the number of waves passing a point each second. Time period can be calculated using;

$$\textbf{period} = \frac{1}{frequency} \quad (T = \frac{1}{f})$$

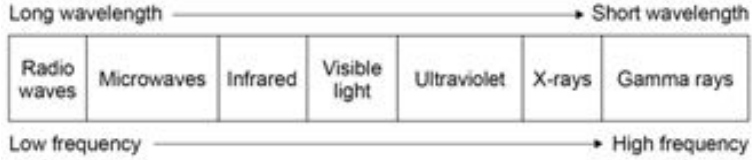
Period, T, in seconds, s. Frequency, f, in hertz, Hz. The wave speed is the speed at which the energy is transferred (or the wave moves) through the medium. Wave speed can be calculated using:

wave speed = frequency × wavelength ($v = f \times \lambda$)

Wave speed, v, in metres per second, m/s. Frequency, f, in hertz, Hz. Wavelength, λ, in metres, m.

6.6.2 Electromagnetic waves

6.6.2.1 Types of electromagnetic waves



Electromagnetic waves are transverse waves that transfer energy from the source of the waves to an absorber. Electromagnetic waves form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum(space) or air. The waves that form the electromagnetic spectrum are grouped in terms of their wavelength and their frequency. Going from long to short wavelength (or from low to high frequency) the groups are: radio, microwave, infrared, visible light (red to violet), ultraviolet, X rays and gamma rays. Our eyes only detect visible light and so detect a limited range of electromagnetic waves.

6.6.2.2 Properties of electromagnetic waves 1

(HT only) Different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength.

(HT only) Some effects, for example refraction, are due to the difference in velocity of the waves in different substances

6.6.2.3 Properties of electromagnetic waves 2

(HT only) Radio waves can be produced by oscillations in electrical circuits.

(HT only) When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can themselves induce oscillations in an electrical circuit. Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range. Gamma rays originate from changes in the nucleus of an atom. Ultraviolet waves, X-rays and gamma rays can have hazardous effects on human body tissue. The effects depend on the type of radiation and the size of the dose. Radiation dose (in sieverts) is a measure of the risk of harm resulting from an exposure of the body to the radiation. 1000 millisieverts (mSv) = 1 sievert (Sv) Ultraviolet waves can cause skin to age prematurely and increase the risk of skin cancer. X-rays and gamma rays are ionising radiation that can cause the mutation of genes and cancer.

6.6.2.4 Uses and applications of electromagnetic waves

EMS waves have many practical applications. Radio waves – television and radio, microwaves – satellite communications, cooking food, infrared – electrical heaters, cooking food, infrared cameras, visible light – fibre optic communications, ultraviolet – energy efficient bulb, sun tanning, X-rays and gamma rays – medical imaging and treatment.

Disciplinary knowledge

Required practical activity 20: make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements.**WS 2.3,2.6,3.8,4.2,4.3**

HT-Required practical activity 21: investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface. **WS 2.3, 2.6, 4.2, 4.3**

Vocabulary

Amplitude, compression, frequency, mechanical, oscillate, period, rarefaction, transverse, longitudinal, wavelength, electromagnetic, radiation

Reading is Power

Waves – Incredible Science – Searching for invisible light P108-109

Where next?

A Level – Waves

AQA Physics – Waves Journey of Knowledge SEPS Only

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KS3: Year 9: Waves - Light and sound

CORE KNOWLEDGE

4.6.1.3 Reflection of waves (physics only)

Waves can be reflected at the boundary between two different materials. Waves can be absorbed or transmitted at the boundary between two different materials.
Required practical activity 9 (physics only): investigate the reflection of light by different types of surface and the refraction of light by different substances.

4.6.1.4 Sound waves (physics only) (HT only)

Sound waves can travel through solids causing vibrations in the solid. Within the ear, sound waves cause the ear drum and other parts to vibrate which causes the sensation of sound. The conversion of sound waves to vibrations of solids works over a limited frequency range. This restricts the limits of human hearing. The range of normal human hearing is from 20 Hz to 20 kHz.

4.6.1.5 Waves for detection and exploration (physics only) (HT only)

Ultrasound waves have a frequency higher than the upper limit of hearing for humans. Ultrasound waves are partially reflected when they meet a boundary between two different media. The time taken for the reflections to reach a detector can be used to determine how far away such a boundary is. This allows ultrasound waves to be used for both medical and industrial imaging. Seismic waves are produced by earthquakes. P-waves are longitudinal, seismic waves. P-waves travel at different speeds through solids and liquids. S-waves are transverse, seismic waves. S-waves cannot travel through a liquid. P-waves and S-waves
provide evidence for the structure and size of the Earth's core. Echo sounding, using high frequency sound waves is used to detect objects in deep water and measure water

4.6.2.5 Lenses (physics only)

A lens forms an image by refracting light. In a convex lens, parallel rays of light are brought to a focus at the principal focus. The distance from the lens to the principal focus is called the focal length. Ray diagrams are used to show the formation of images by convex and concave lenses. The image produced by a convex lens can be either real or virtual. The image produced by a concave lens is always virtual. The magnification produced by a lens can be calculated using the equation:

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Magnification is a ratio and so has no units. Image height and object height should both be measured in either mm or cm.

In ray diagrams a convex lens will be represented by:

A concave lens will be represented by:

4.6.2.6 Visible light (physics only)

Each colour within the visible light spectrum has its own narrow band of wavelength and frequency. Reflection from a smooth surface in a single direction is called specular reflection. Reflection from a rough surface causes scattering: this is called diffuse reflection. Colour filters work by absorbing certain wavelengths (and colour) and transmitting other wavelengths (and colour). The colour of an opaque object is determined by which wavelengths of light are more strongly reflected. Wavelengths that are not reflected are absorbed. If all wavelengths are reflected equally the object appears white. If all wavelengths are absorbed the objects appears black. Objects that transmit light are transparent or translucent.

4.6.3 Black body radiation (physics only) 4.6.3.1 Emission and absorption of infrared radiation

All bodies (objects), no matter what temperature, emit and absorb infrared radiation. The hotter the body, the more infrared radiation it radiates in a given time. A perfect black body is an object that absorbs all of the radiation incident on it. A black body does not reflect or transmit any radiation. Since a good absorber is also a good emitter, a perfect
black body would be the best possible emitter.

4.6.3.2 Perfect black bodies and radiation

All bodies (objects) emit radiation and the intensity and wavelength distribution of any emission depends on the temperature of the body

Disciplinary knowledge
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