CHURCH STRETTON SCHOOL

Triple Science - Physics

SP5 Knowledge organiser

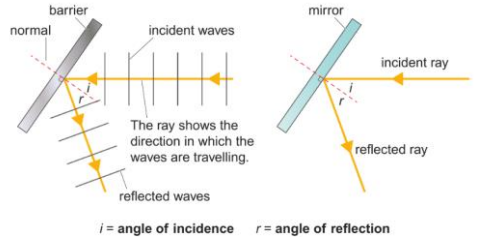
P5: Light and the electromagnetic spectrum

Lesson sequence

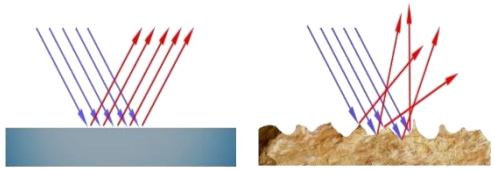
1. Ray diagrams
2. Core practical - Investigating refraction
3. Colour
4. Lenses
5. Electromagnetic waves
6. The electromagnetic spectrum
7. Using the long wavelengths
8. Radiation and temperature
9. Core practical – investigating radiation
10. Using the short wavelengths
11. Dangers of EM radiation

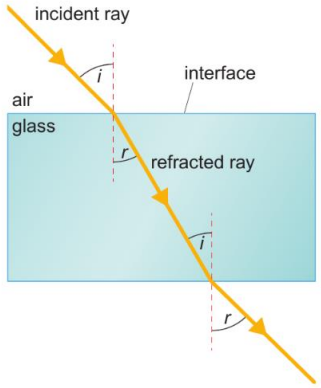
1. Ray diagrams	
Ray diagram	A diagram that traces the path that light takes
Incident ray	A ray of light that strikes a surface
Reflected ray	A ray of light which is thrown back from a nonpermeable or non-absorbing surface
Refracted ray	A ray that passes through an interface between two media and travels into the medium on the other side of the interface
Normal	A line at right angles to a given line or surface
Refraction	A change in direction of a wave
Total internal reflection (TIR)	The complete reflection of a ray of light within a medium such as water or glass from the surrounding surfaces back into the medium

Critical Angle	The angle of incidence that provides an angle of refraction of 90-degrees.
Interface	A point where two medium meet and interact



2. Core practical – investigating refraction	
Angle of incidence	Angle between the incident ray and the normal
Angle of refraction	Angle between the refracted ray and the normal.
Aim	To explore how changing the angle of incidence changes the angle of refraction
Setup	Place a glass block on a sheet of paper, point a beam of light from a ray box at it, trace around the block and draw in the light ray.
Measurement	Use a protractor to draw a normal, then measure the angles of incidence and refraction.
Variations	Repeat 5 times, from 5 different angles, including head-on.
Results	The greater the angle of incidence, the greater the angle of refraction.





3. Colour	
White light	It contains all the wavelengths of the visible spectrum at equal intensity.
Visible spectrum	Is the portion of the electromagnetic spectrum that is visible to the human eye
Diffuse reflection	is the reflection of light or other waves or particles from a surface such that a ray incident on the surface is scattered at many angles rather than at just one angle
Specular reflection	the incident light is reflected into a single outgoing direction
luminous	An object that gives off light

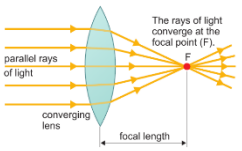
Exam-style question

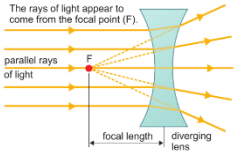
Compare and contrast the way light is reflected by a mirror and by a sheet of paper. *(2 marks)*

4. Lenses	
Converging lens	Are lenses which converge the light rays coming towards them. Converging lenses form a real image
Diverging lens	Are lenses which diverge the rays coming towards them. diverging lenses form a virtual image
Focal point	The point at which rays or waves meet after reflection or refraction, or the point from which diverging rays or waves appear to proceed.

Focal length	The distance between the centre of a lens or curved mirror and its focus.
Virtual image	An optical image formed from the apparent divergence of light rays from a point.
Real image	An image where light converges

5. Electromagnetic waves	
Electromagnetic waves	Transverse waves that travel at the speed of light.
Speed of light	300,000,000 m/s (3 x 10^8 m/s)
Frequency	The number of waves that pass a point every second.
Wavelength	The distance in m from the top of one wave to the top of the next.
EM wave similarities	All are transverse, all travel at the speed of light.
EM wave differences	Different frequencies, different wavelengths.
Visible light	The only type of EM radiation that our eyes can detect.
Interface	The boundary between two different materials.
Refraction and wave speed	Light travels at different speeds in different materials causing it to refract when hitting the interface at an angle.
Prisms and the colour spectrum	Different wavelengths slow down by different amounts when they hit glass causing each colour to refract differently.
Infrared discovery	Light split into a spectrum. Thermometer placed on every colour plus next to red. Red was hot, next to red was hottest.





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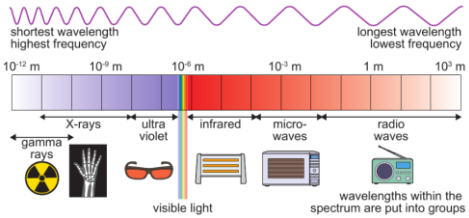
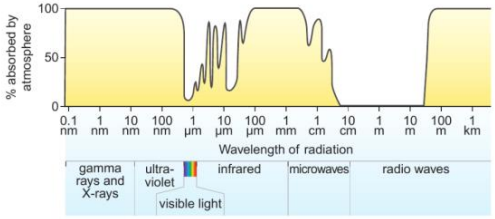
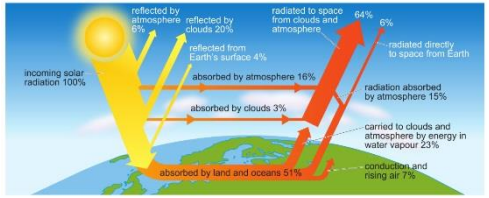


6. The electromagnetic spectrum	
EM spectrum mnemonic	**R**ubbish **M**emories **I**nclude **V**isiting **U**r **X** **G**irlfriend
EM spectrum – lowest to highest frequency or energy	Radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, gamma rays
EM spectrum – lowest to highest wavelength	Gamma rays, x-rays, ultraviolet, visible light, infrared, microwaves, radio waves
EM spectrum	The full range of types of EM radiation.
EM Radiation and the atmosphere	Some EM radiation (visible, radio) passes through the atmosphere, most is absorbed.
Space telescopes	For radiation absorbed by the atmosphere, a telescope must be placed in space.

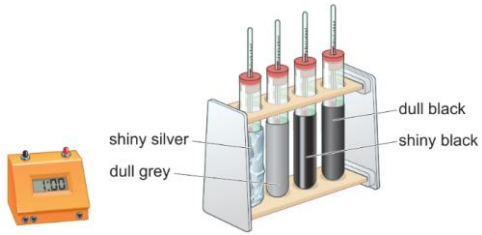


7. Using the long wavelengths	
Visible light uses	Illumination, photography
Infrared uses	Short-range communications (TV remotes), fibre optics, cooking (grills and toasters), security cameras.
Microwave uses	Microwave ovens, mobile phone and satellite communications.
Radio wave uses	Radio and TV signals.
Producing radio waves	Oscillating electricity in a metal rod produces radio waves.
Receiving radio waves	Radio waves absorbed by a metal rod cause electrical oscillations.

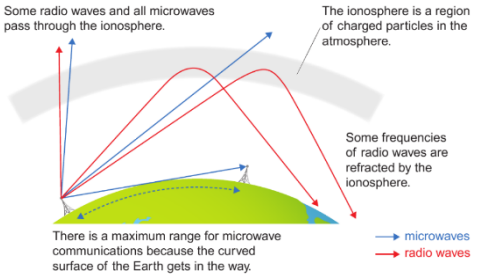
8. Radiation and temperature	
Global warming	A gradual increase in the overall temperature of the Earth's atmosphere
Greenhouse gases	A gas that absorbs and emits radiant energy. The primary **greenhouse gases** in Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4)
Greenhouse effect	A process that occurs when gases in Earth's atmosphere trap the Sun's heat.
Power	The amount of energy transferred in a certain time. It is measured in watts (W) (1W = 1 J/s)



9. Core practical – investigating temperature	
Thermal energy	(Also called heat energy) is produced when a rise in temperature causes atoms and molecule to move faster and collide with each other.
Independent variable	A variable (often denoted by *x*) whose variation does not depend on that of another. The variable you change
Dependent variable	A variable (often denoted by *y*) whose value depends on that of another. The variable you measure
Control variable	A variable that is held constant in order to assess the relationship between two other variables.
Aim	To investigate the effect of different coloured surface on the amount of energy transferred by radiation from a tube of hot water.
Setup	Cover four boiling tubes in different coloured materials. Pour some hot water into each tube.
Measurement	Measure the temperature at the start and record the decrease in temperature every 2minues for 20 minutes.
Variations	Repeat 3 times.
Results	The darker surfaces absorb and emit thermal radiation.



10. Using the short wavelengths	
Fluorescence	Absorbing ultraviolet and re-emitting it as visible light.
Ultraviolet uses	Fluorescent security inks, fluorescent light bulbs, sterilising water.
X-ray uses	Hospital x-rays, baggage scanners.
Gamma ray uses	Killing bacteria on food or surgical instruments, detecting and treating cancer.



11. EM radiation dangers	
Infrared dangers	Surface heating causing burns.
Microwave dangers	Absorbed by water causing it to heat up → burns under the skin.
Ionisation	High energy radiation causes ions to form in our cells, damaging DNA and causing cancer.
Ultraviolet dangers	Skin cancer, snow blindness.
X-ray dangers	Cancer
Gamma ray dangers	Cancer