Physics 6: Waves

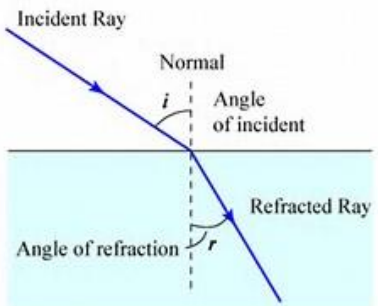
Section 1: Key words and definitions

Absorbed	Taken in by an object.
Amplitude	Distance “from rest to crest”. Maximum displacement of the wave.
Crest	The highest point of a wave.
Diffraction	When waves pass through a gap or past an edge and spread out.
Electromagnetic spectrum	A family of waves that all travel at 300,000,000 m/s in empty space
Emitted	Given out by an object.
Equilibrium	The rest position of the wave, where displacement is zero.
Frequency	The number of waves passing a point in one second. Units – Hertz (Hz)
Longitudinal	A wave where the oscillation or displacement is parallel with the velocity
Oscillation	A regular movement that repeats over and over
Oscilloscope	An electronic device that can be used to study waves
Period	The time for one wave to pass a point.
Refraction	When waves pass across a boundary between two materials and their velocity changes. Makes the waves change direction.
Transverse	A wave where oscillation or displacement is perpendicular to velocity
Trough	The lowest point of the wave
Ultrasound	A sound wave with frequency higher than 20,000 Hz
Wavelength	The exact distance from one crest to the next crest

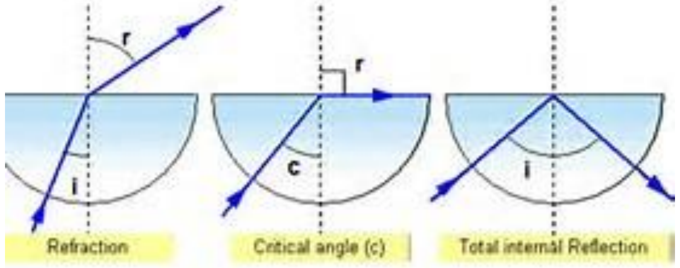
Section 2: Equations to learn

Calculation	Equation	Symbol equation	Units
Wave speed or velocity	Velocity = frequency x wavelength	$V = f \times \lambda$	m/s
Wavelength	Wavelength = velocity ÷ frequency	$\lambda = v \div f$	m
Frequency	Frequency = velocity ÷ wavelength	$f = v \div \lambda$	Hz
Period	Period = 1 ÷ frequency	$T = 1 / f$	s

Refraction

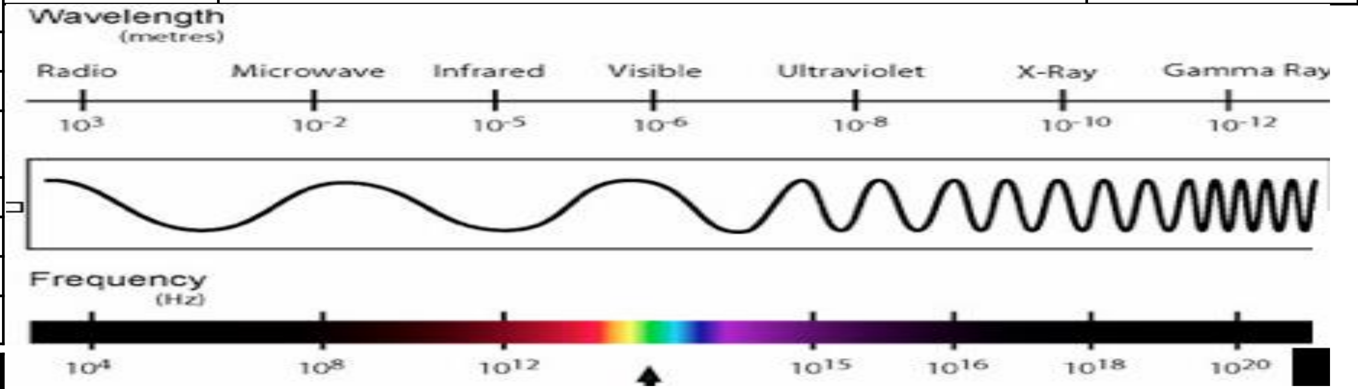


total internal reflection



Section 3: Electromagnetic Spectrum

Wave	Uses	Dangers
Gamma Rays	Sterilising surgical instruments, sterilising fruit, medical imaging, radiotherapy	Ionising – can cause cancer
X-Rays	Looking at shadow pictures of bones and teeth, security scanning luggage at airports	Ionising – can cause cancer
Ultra Violet (UV)	In sunbeds for tanning, security marking	Skin cancer, sunburn
Visible	To see, to take photographs	Blindness
Infra Red	Cooking food, thermal imaging cameras, TV remote control, fibre optic communication	Burns
Microwaves	Cooking food, communicating with satellites, mobile phone communication, “RADAR” speed-guns	Burns
Radio Waves	Carrying radio and TV signals	None known



Radar can tell you how far away an object is. A radar device emits a wave and listens for any echo. If there is an object in the path of the wave, it will reflect some of the wave back to the radar device. EM waves move through the air the speed of light, so the radar device can calculate how far away the object is based on how long it takes the signal to return. Radar can measure the speed of an object, due to Doppler shift. EM waves have a certain wavelength. When the radar gun and the car are both standing still, the echo will have the same wavelength as the original signal. When the car is moving away from the radar gun, the wave gets “stretched out” increasing its wavelength. If the car is moving toward the radar gun, the wavelength decreases.

Section 4: Ultrasound

Medical uses	Industrial Uses
Pre-natal scanning Breaking up kidney stones Measuring the speed of blood flow	Cleaning delicate mechanisms Finding cracks in solid metal objects Sonar – to find the depth of the ocean

Ultrasound scans do not damage living cells (like x-rays do) and they produce images of soft tissue (which x-rays don’t). Ultrasound is sent into the patient's body. Some ultrasound is reflected at each boundary between different tissues or organs. The depth of each layer is calculated using the time taken for each reflected wave to return. The reflected waves are processed by a computer to produce a picture of the inside of the body.

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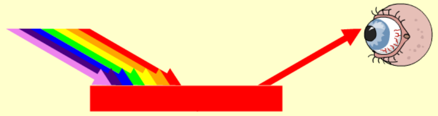
Section 5: Lenses and Describing Images

Focal point	Sometimes called "principal focus". The point where parallel incoming rays cross after passing through a lens.
Focal length	The distance from the centre of the lens to the focal point
magnification	Magnification = image size ÷ object size
Real	Image formed where actual light rays cross. Image can be shown on a screen.
Virtual	Image is NOT made by actual light rays that cross over. Cannot show image on a screen.
Magnified	Image is larger than object
Diminished	Image is smaller than object
Upright	The right way up
Inverted	Upside down

Section 6: Seeing Colour

Dispersion	A prism will separate out all the colours that make up white light because each colour has a different wavelength and the wavelength affects how much light is refracted through the prism. Red light has longest wavelength and refracts the least. Violet light has the shortest wavelength and refracts the most.
Spectrum	What you see when white light gets split up into wavelength order (colours ROYGBIV)
Absorbed	If a wavelength (colour) of light is absorbed, it is removed from the spectrum.
Reflected	"Bounces off" (do not say bounces off in the exam!)
Transmitted	Allowed to pass through
Filter	A material that allows only some wavelengths of light to pass through and absorbs all others
Primary colours	RED GREEN BLUE – you can't make these by mixing other colours of LIGHT. (Ignore paint mixing!)
Secondary colours	GREEN + BLUE = CYAN; RED + BLUE = MAGENTA; RED + GREEN = YELLOW

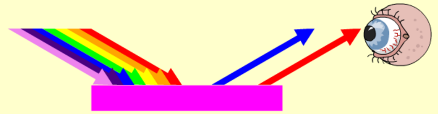
Why does a **red** object look **red** in white light?



A red object absorbs all the colours of the spectrum **except red**.

Only red light is reflected from the object into your eye, so the object appears **red**.

Why does a **magenta** object look **magenta** in white light?



A magenta object absorbs all the colours of the spectrum **except red and blue**.

Red and blue light are reflected from the object into your eye, so the object appears **magenta**.

Why does a **black** object look **black** in white light?

A black object absorbs **all** the colours of the spectrum.

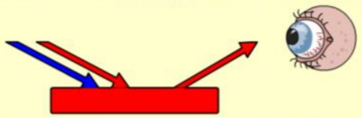
No light is reflected from the object into your eye, so the object appears **black**.

What colour does a **red object** appear in **green light**?

Green light shines on the red object and is absorbed by it.

The red object does not reflect any light into your eye, so it appears **black**.

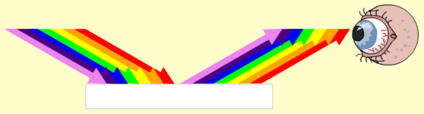
What colour does a **red object** appear in **magenta light**?



Magenta light, made up of red and blue light, shines on the red object.

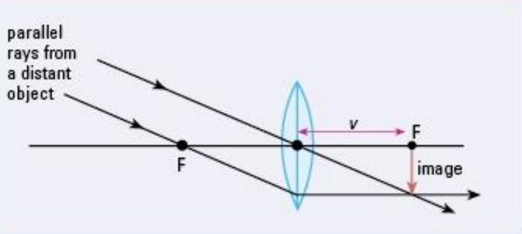
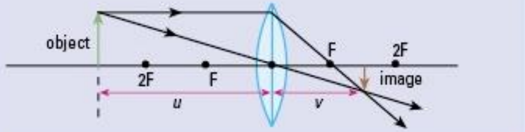
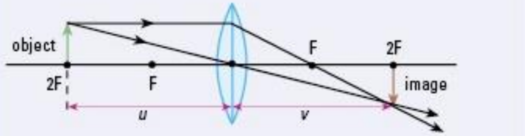
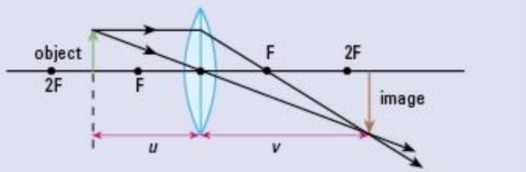
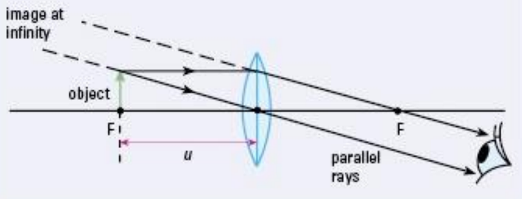
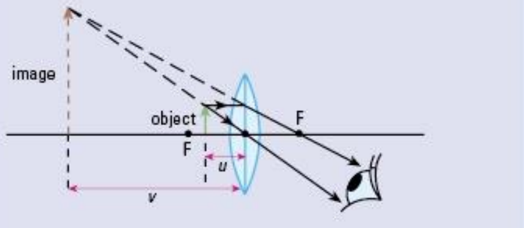
The red object absorbs the blue light and reflects the red light, so it appears **red**.

Why does a **white** object look **white** in white light?



A white object **does not** absorb any of the colours of the spectrum.

The whole spectrum is reflected from the object into your eye, so the object appears **white**.

Object distance (*u*)	Ray diagram	Type of image	Image distance (*v*)	Uses
u = ∞		- inverted - real - diminished	*v* = *f* - opposite side of the lens	- object lens of a telescope
u > 2*f*		- inverted - real - diminished	*f* < *v* < 2*f* - opposite side of the lens	- camera - eye
u = 2*f*		- inverted - real - same size	*v* = 2*f* - opposite side of the lens	- photocopier making same-sized copy
f < *u* < 2*f*		- inverted - real - magnified	*v* > 2*f* - opposite side of the lens	- projector - photograph enlarger
u = *f*		- upright - virtual - magnified	- image at infinity - same side of the lens	- to produce a parallel beam of light, e.g. a spotlight
u < *f*		- upright - virtual - magnified	- image is behind the object - same side of the lens	- magnifying glass