

Definitions and Concepts for AQA Physics A Level

Topic 9: Astrophysics

Absolute Magnitude (M): The apparent magnitude that an object would have if it were placed at a distance of 10 parsecs away from Earth.

Achromatic Doublet: A convex lens made of crown glass and a concave lens made of flint glass cemented together in order to focus all light rays in the same position. An achromatic doublet is a solution for spherical and chromatic aberration.

Apparent Magnitude (m): How bright an object appears in the sky. This depends on the object's brightness and its distance from Earth.

Arcsecond: A unit used to measure small angles. An arcsecond is equal to 1/3600th of a degree.

Astronomical Unit (AU): The average distance between the centre of the Earth and the centre of the Sun.

Big Bang Theory: The theory that the universe originated as a small, dense and hot region that expanded and cooled forming the structures in the universe we see today.

Binary Star System: Two stars orbiting a common centre of mass.

Black Body Radiator: A perfect emitter and absorber of all possible wavelengths of radiation.

Black Hole: A region which has an escape velocity greater than the speed of light. Black holes are formed when the core of a giant star collapses.

Cassegrain Reflecting Telescope: A reflecting telescope with a concave primary mirror and a small convex secondary mirror in the centre, with the eyepiece lens just behind the centre of the primary mirror.

Charge-Coupled Device (CCD): An array of light-sensitive pixels which become charged when they are exposed to light (by the photoelectric effect).

Chromatic Aberration: An effect caused by the different focal lengths of different wavelengths of light that leads to different colours being focused at different points. This can cause a white object to appear as if it has coloured edges.

Collecting Power: A measure of the ability of a lens or mirror to collect incident EM radiation. Collecting power is directly proportional to the area of the objective lens/primary mirror.



Concave/Diverging Lens: A lens which spreads out incident light – the light rays diverge.

Convex/Converging Lens: A lens which focuses incident light – the light rays converge.

Cosmological Microwave Background Radiation (CMBR): After the big bang the hot dense state of the universe was full of photons which interacted with the matter in the universe. At a certain time this interaction stopped due to the lower temperature of the universe and these photons were allowed to propagate freely, at this point these photons were gamma rays. At present the universe has expanded, redshifting these photons so that they are microwaves.

Doppler Effect: The apparent change in the wavelength of a wave as the source moves relative to an observer. For a source moving away the wavelength increases (red shift), for a source moving towards the observer the wavelength decreases (blue shift).

Eclipsing Binaries: A binary star system in which the stars' plane of orbit is in the line of sight of the Earth. This means that the stars will appear to cross over each other as they orbit.

Event Horizon: The boundary of a black hole, along which the escape velocity is equal to the speed of light.

Exoplanet: Planets that are not part of our solar system and orbit other stars. They are often difficult to detect due to the light of their host star obscuring them.

Eyepiece Lens: The lens in a telescope that magnifies the image produced by the objective lens. It produces a virtual image at infinity in order to reduce eye strain for the user.

Focal Length (f): The distance between the centre of the lens and the principal focus.

Hipparcos Scale: A way of classifying astronomical objects by their apparent magnitude. The brightest stars have an apparent magnitude of 1 and the faintest visible stars have an apparent magnitude of 6. The intensity of a magnitude 1 star is 100 times greater than a magnitude 6 star so the scale is logarithmic.

Hubble's Law: The speed of a galaxy moving away from ours is proportional to its distance away from us. The constant of proportionality is Hubble's constant.

Hydrogen Balmer Spectrum: A spectrum formed from the excitation of hydrogen atoms from the $n=2$ level. The prominence of the Balmer lines from a star can give an indication of the star's temperature and state of the hydrogen within it.

Intensity: The power received from a star per unit area.



Lens Power: A measure of how closely a lens can focus a beam that is parallel to the principal axis (i.e. how long the focal length is). The shorter the focal length, the more powerful the lens.

Light Year (ly): The distance that an electromagnetic wave travels in a year in a vacuum.

Long-Lived Gamma Ray Burst: Bursts of gamma radiation that last anywhere between 10 and 1000 seconds. These are thought to be associated with a type II supernova (the death of a massive star).

Luminosity: The rate of light energy released by a star. This is the same as the power output of a star.

Magnifying Power/Angular Magnification (M): The ratio of the angle made by the image from the eyepiece to the angle made by the object with the unaided eye.

Main Sequence Star: The equilibrium stage of a star's life cycle, where the inward gravitational forces balance the outward forces caused by fusion. In this stage, hydrogen nuclei fuse to form helium.

Neutron Star: An incredibly dense star that is formed when the core of a large star collapses. Protons and electrons are forced together under gravity to form neutrons.

Normal Adjustment: When the distance between the objective and eyepiece lenses in a refracting telescope is equal to the sum of their focal lengths.

Objective Lens: The lens in a telescope that collects light and creates a real image. Objective lenses should have long focal lengths and be large in order to collect as much light as possible.

Parallax: The apparent change of position of a nearer star in comparison to distant stars in the background. This happens as a result of the Earth's orbit around the sun.

Parsec (pc): The distance at which the angle of parallax is 1 arcsecond.

Primary Mirror: The mirror equivalent of an objective lens. The primary mirror collects light and focuses it onto a secondary mirror in a reflecting telescope.

Principal Axis: The line passing through the centre of the lens, perpendicular to its surface.

Principal Focus (F): In a converging lens: the point where incident rays travelling parallel to the principal axis will converge. In a diverging lens: the point from which the light rays appear to come.

Protostar: A young star formed when clouds of gas and dust are pulled together under gravity. Protostars are surrounded by a circumstellar disc, and when the centre becomes hot enough, the star will begin to fuse elements.



Quantum Efficiency: The percentage of photons incident on a CCD which causes an electron to be released.

Quasar: Active galactic nuclei – supermassive black holes surrounded by a disc of matter, which, as it falls into the black hole, causes jets of radiation to be emitted from the poles. Quasars display very large red shift, indicating they are very far away. The power output of a quasar is around that of an entire galaxy.

Radial Velocity Method: A method of detecting exoplanets. It involves the observation of the host star's line spectrum. If it is blue-shifted when it moves towards the Earth and red-shifted when it moves away from the Earth, it suggests that the star is 'wobbling' and so there must be a mass (exoplanet) exerting a gravitational force on it.

Rayleigh Criterion: This states that two objects will not be resolved if any part of the central maximum of either of the images falls within the first minimum diffraction ring of the other.

Real Image: Formed when light rays cross after being refracted by a lens. Real images can be projected onto a screen.

Red Giant: A stage in the life cycle of a star less than 3 solar masses, in which the hydrogen has run out and the temperature of the star increases. Helium nuclei fuse to form heavier elements.

Red Shift (z): The shifting of an object's wavelength towards the red end of the spectrum due to the object moving away from the Earth (Doppler effect). Red shift is evidence for the expansion of the universe. The more distant the object, the greater its red shift.

Red Supergiant: For massive stars that are greater than 3 solar masses, when the hydrogen runs out, instead of transitioning into a red giant, the star will transition into a red supergiant (same processes as a red giant but on a larger scale). The temperature increases and fusion up to iron can occur.

Reflecting Telescope: A telescope which uses mirrors to focus incident light onto an eyepiece lens.

Refracting Telescope: A telescope which uses lenses to focus incident light.

Resolving Power: The ability of a telescope to produce separate images of close-together objects.

Schwarzschild Radius (R_s): The name given to the radius of a black hole's Event Horizon.

Short-Lived Gamma Ray Burst: Short bursts of gamma radiation that last anywhere between 0.01 and 1 second. These are thought to be associated with merging neutron stars (forming a black hole) or a neutron star falling into a black hole.



Spectroscopic Binaries: A binary star system in which the stars are too close together to be resolved by a telescope. The Doppler shifts of the light from the stars as they move towards or away from the Earth are used to detect these binary systems.

Spherical Aberration: An effect caused by the curvature of a lens or mirror that can lead to light rays at the edges to be focused in different places to those from the centre. This can cause an image to be blurry or distorted.

Stefan's Law: A law stating that the power output (luminosity) of a star is directly proportional to its surface area and its absolute temperature to the 4th power.

Supernova: When a star greater than 1.4 solar masses dies, the core collapses rapidly inward and becomes rigid. The outer layers then fall inward and rebound off of the core in a shockwave, causing heavy elements to be fused and distributed into space.

Transit Method: A method of detecting exoplanets. It involves the monitoring of the host star's light intensity. If a planet crosses in front of it, the intensity will dip. Timings and other data can be combined to determine information about the size and speed of the exoplanet.

Type I Supernova: The consequence of a star in a binary system accumulating matter from its companion star. When the star reaches critical mass, it will explode.

Type Ia Supernova: A consequence of a white dwarf star exploding. They can be used as a standard candle since they always reach the same maximum absolute magnitude (-19.3).

Type II Supernova: The consequence of a high mass star dying when it runs out of fuel.

Virtual Image: Formed on the same side of the lens as the object. The light rays do not cross after refraction, so the image cannot be projected onto a screen.

White Dwarf: A stage in the life cycle of a small star (less than 1.4 solar masses) that occurs when all the fuel has been used up. The star contracts since there is no longer an outwards force caused by fusion.

Wien's Displacement Law: A law stating that the peak wavelength of emitted radiation is inversely proportional to its absolute temperature.

