**Astronomy GCSE Glossary**

**A**

**Absolute magnitude** The apparent magnitude that a star would have if it were seen from a standard distance of 10 parsecs, or 32.6 light-years.

**Absolute zero** A temperature equivalent to -273.15 oC; all atoms and molecules stop moving at this temperature.

**Absorption spectrum** Created by gas absorbing light at particular wavelengths that are unique to a chemical.

**Accommodation** Shape changes in the lens of the eye enabling a person to focus on near and far objects.

**Accretion** Material coming together to create, or increase the size of, a celestial object.

**Accretion disc** Material coming on to a spinning star or AGN becomes ﬂattened due to the high spin speed. A binary star may have a spinning white dwarf taking matter from a red giant. This creates a nova which suddenly brightens up to x10,000 before dimming. This process is repeated. A spinning supermassive black hole draws material on to a ﬂattened accretion disc.

**Achromatic object-glass** An object-glass corrected for false colour; it is made up of two separate components, made of different types of glass.

**Active galactic nucleus** A supermassive black hole, together with its accretion disc, at the centre of an active galaxy.

**Albedo** The reflecting power of a body, from 0 (black) to 100 (a perfect reflector).

**ALSEP** Apollo Lunar Surface Experiments Package.

**Altazimuth mount** A type of telescope mount in which the telescope can be moved freely in both altitude and azimuth.

**Altitude** The angular distance of a celestial body above the horizon, from 0o at the horizon to 90o at the zenith.

**Amplitude** Maximum displacement of a wave measured from the mean position.

**Ångstrom unit** One hundred-millionth part of a centimetre.

**Annihilation** Destruction caused by interaction of a particle with its anti-particle.

**Antimatter** Matter made up of anti-particles, such as positrons.

**Aphelion** The position of a planet or other body when at its greatest distance from the Sun.

**Apogee** The point at which an object is furthest from the Earth in its elliptical orbit (this is for the Moon and artificial satellites).

**Apparent magnitude** The brightness of a star as you see it in the night sky (symbol ***m***).

**Asterism** A shape within a constellation (often better known than the constellation).

**Asteroids** Minor planets. Small planets, most of which move around the Sun between the orbits of Mars and Jupiter.

**Astronomical unit (AU)** The mean distance between the Earth and the Sun: 149,598,500 km or, in round numbers, 150,000,000 km.

**Atmosphere** The layer of gases surrounding a planet.

**Atmospheric pressure** The pressure exerted by the atmosphere of the Earth; at sea level the atmospheric pressure is 100 kPa.

**Atom** The basic ‘building block’ of an element that cannot be chemically broken down.

**Atomic number** The number of protons inside the nucleus of an atom (same as the proton number).

**Aurorae** Glows in the upper atmosphere, due to charged particles from the Sun: Aurora Borealis in the northern hemisphere, Aurora Australis in the southern hemisphere.

**Avogadro’s law** Equal volumes of all gases contain an equal number of moles of gas.

**Azimuth** The angular bearing of a celestial object, measured from north (0o) through east (90o), south (180o) and west (270o) back to north (360o or 0o).

**B**

**Baily’s Beads** The ‘beads’ of light which are seen near to a total eclipse. Sunlight shines through the valleys of the Moon just prior to a total eclipse, or just afterwards - giving the beads of light seen below (named in 1836 by Francis Baily, a British astronomer).

**Barred-spiral galaxy** These galaxies have a nucleus with a bar shape extending either side of the central bulge. The spiral arms grow out from the bar.

**Barycentre** The centre of gravity of the Earth-Moon system. It lies within the Earth’s globe.

**Beta-minus (β-) decay** Emission of an electron from an unstable nucleus.

**Beta-plus (β+) decay** Emission of a positron from an unstable nucleus.

**Beyer System** Naming stars in a constellation in order of their brightness. Stars in a constellation are given a Greek letter.

**Big Bang** An ‘explosion’ (technically an expansion) some 13.8 thousand million years ago that created both space and time.

**Big Bang theory** The theory that all matter in the Universe came into existence at the same moment, approximately 13.8 thousand million years ago. ‘Space’ was created at the same time.

**Binary star** A star made up of two components, physically associated.

**Black dwarf** A dead star, which has used up all its energy. It is not certain whether the Universe is yet old enough for any black dwarfs to have been formed.

**Black hole** A region round an old, massive, collapsed star from which nothing – not even light – can escape.

**Blazar** An Active Galactic Nucleus (AGN) has a supermassive black hole. Jets of particles shoot out at right angles from the spinning disc of the nucleus, along the axes in either direction. When one of the two jets of highly energetic particles points directly towards Earth, the AGN is known as a blazar.

**Bode’s law** A mathematical series linking the distances of the planets from the Sun. It has probably no real significance.

**Bolide** A meteor that bursts into a ﬁreball.

**Brown dwarf** A failed star because its mass (less than about 8% of our Sun) is too small for a nuclear reaction.

**C**

**Captured rotation** Also called synchronous rotation. If the axial rotation of a body is equal to its revolution period round its primary, the rotation is ‘captured’, and the body keeps the same face permanently towards its primary.

**Cassegrain reflector** A type of reflecting telescope in which the light from the object under observation is sent from the main mirror on to a convex secondary mirror, and is then reflected back to the eyepiece through a hole in the main mirror.

**CCD** Charge-coupled device. A very sensitive electronic device, far more sensitive than a photographic plate

**Celestial sphere** An imaginary sphere surrounding the Earth, whose centre is the same as that of the Earth.

**Centripetal force** The resultant force acting at right angles to the velocity of an object that gives rise to circular motion.

**Cepheid** A short-period variable star. The variations are perfectly regular; the period is linked with the real luminosity of the star..

**Chromosphere** That part of the Sun’s atmosphere lying above the bright surface or photosphere. It consists mainly of hydrogen.

**Ciliary muscles** Muscles that help to change the shape of the eye lens.

**Circumpolar star** A star that never sets from the place of observation.

**Clusters, stellar** Groups of stars that have a common origin.

**CMB radiation** Cosmic microwave background radiation. The ‘left-over’ radiation from the Big Bang – radiation coming very faintly from all directions in space.

**Colour blindness** A sex-linked genetic disorder caused by a mutation on the X chromosome.

**Colour index** A measure of a star’s colour; the difference between the photographic magnitude and the visual magnitude – positive if the star is reddish, negative if the star is bluish, zero if the star is white.

**Colures** Great circles on the celestial sphere. The equinoctial colure passes through right ascension 0 hours and 12 hours; the solsticial colure passes through right ascension 6 hours and 18 hours.

**Compressions** Regions where particles are pushed together and create a region of higher pressure in a sound wave.

**Conjunction** a) A planet is in conjunction with a star, or another planet, when it passes close by it in the sky; it is of course a line-of-sight effect. b) A planet is in superior conjunction when it is on the far side of the Sun with respect to the Earth, and in inferior conjunction when passing between the Sun and the Earth. Obviously, only Mercury and Venus can pass through inferior conjunction.

**Constellation** A group of stars named after a mythological character or an animate or inanimate object. Since the stars in a constellation are at very different distances from us, the pattern is of no real significance.

**Continuous spectrum** The full visible spectrum.

**Convective zone** The upper 500km of the Sun, where energy is brought to the surface by convection currents

**Converging lens** A lens that focuses parallel rays of light to a point.

**Copernican System** The system in which the Sun is the central body, with the planets moving around it. Also known as the heliocentric system (Greek, *helios*, ‘sun’).

**Cornea** The curved layer over the front of the eye.

**Corona** The outermost part of the Sun’s atmosphere, made up of thin gas at a very high temperature.

**Coronagraph** An instrument used to observe the corona even when there is no total solar eclipse.

**Coronal hole** A region of exceptionally low density in the solar corona. Charged particles escape through these holes and produce the solar wind.

**Coronal mass ejection** The largest explosions from the Sun’s surface. CMEs ﬁre bursts of plasma into space creating the solar wind. They are linked with the release of very high energy gamma rays and X-rays.

**Cosmic rays** These are not rays at all, but high speed atomic particles from outer space. The heavy cosmic rays are broken up in the upper air, and only their fragments reach the ground.

**Cosmic year** The time taken for the Sun to complete one orbit around the centre of the Galaxy: about 225,000,000 years.

**Coudé system** An optical system in which the light from the body under observation is received in a fixed direction.

**Counterglow** The English name for the faint skyglow known more commonly as the Gegenschein.

**Critical angle** The angle of incidence in a denser material that gives an angle of refraction equal to 90o.

**Culmination** The maximum altitude of a celestial body above the horizon.

**D**

**Dark energy** The energy causing a repelling force in the Universe. 73% of the universe is thought to be made up of dark energy. This dark energy creates a repelling force great enough to keep the universe expanding forever.

**Dark matter** Invisible matter found in space between the galaxies in clusters of galaxies.

**Day** The time taken for the Earth to spin once on its axis, with respect to the stars (sidereal day), the Sun (solar day) or the mean Sun (mean solar day).

**Deceleration** Negative acceleration.

**Declination** The angular distance of a celestial body north or south of the celestial equator.

**Degree of arc** A unit for measuring angles. A full circle contains 360o; each degree contains 60 minutes of arc, and each minute contains 60 seconds of arc.

**Density** The density of a substance is found by dividing its mass by its volume. For most cases water is taken as unity. The mean density of the Earth is 5.52 times that of water (this is the Earth’s specific gravity).

**Dichotomy** The time of exact half-phase of the Moon, Mercury or Venus.

**Diminished** An image that is smaller than the object.

**Dioptre** A unit for the optical power of a lens.

**Direct motion** Bodies which move round the Sun in the same sense as the Earth; the term is also used for satellites of other planets.

**Diurnal motion** The apparent daily rotation of the sky, due to the real rotation of the Earth.

**Diverging lens** A lens that makes parallel rays of light spread out rather than focus to a point.

**Doppler effect** The change in wavelength or frequency of a wave as a result of relative motion between the source and observer. If a light-source is approaching, the wavelength is shortened (blueshift); if receding, the wavelength is increased (redshift).

**Double star** A star made up of two components. Double stars may be *optical*, due to line-of-sight effects, or *binary* systems, which are physically associated.

**Down quark** A fundamental particle with a charge of -1/3.

**Drake equation** An equation to estimate the number of planets supporting life in our galaxy.

**E**

**Early type stars** Stars of spectral type W, O, B and A. The name was given when it was still thought that the spectral sequence was a true evolutionary sequence.

**Earthshine** The dim visibility of the non-sunlit side of the Moon, due to light reflected on to the Moon from the Earth.

**EASEP** Early Apollo Surface Experiments Package.

**Eccentricity** The extent that an orbit or elliptical galaxy differs from a circle.

**Eclipses, lunar** The entry of the full moon into the shadow cast by the Earth. They may be either total or partial.

**Eclipses, solar** The temporary blotting-out of the Sun when the new moon passes in front of it. Solar eclipses may be total, partial or annular.

**Eclipsing binary** Also called an eclipsing variable. A binary system in which, as seen from the Earth, the components pass regularly in front of each other and cause the apparent magnitude of the system to drop.

**Ecliptic** The projection of the Earth’s orbit on to the celestial sphere; it may also be defined as the apparent yearly path of the Sun against the stars. It is inclined to the celestial equator by 23.5o.

**Electrons** Tiny negatively-charged particles within an atom that orbit the nucleus – responsible for current in electrical circuits.

**Elements** Substances made out of only one type of atom.

**Elongation** The apparent angular distance of a planet or comet from the Sun. At opposition, elongation is 180o. For the inferior planets this can never occur; the maximum elongation for Mercury is 28o, for Venus 47o.

**Emission spectrum** The specific frequencies of light an element emits or gives out..

**EM spectrum** Electromagnetic spectrum. Electromagnetic waves ordered according to wavelength and frequency, ranging from low-frequency radio waves to high-frequency gamma rays.

**EM waves** A group of transverse waves that carry different amounts of energy, ranging from radio waves to gamma rays – they can travel through a vacuum at 300 million m/s.

**Ephemeris** A table showing the predicted positions of a moving celestial body.

**Epoch** A date chosen for references purposes in quoting astronomical data.

**Equation of time** The interval by which the real Sun is ahead of or behind the mean sun. It can never exceed 17 minutes.

**Equator, celestial** The projection of the Earth’s equator onto the celestial sphere. It divides the sky into two hemispheres.

**Equatorial mounting** A mounting in which the telescope is set upon an axis that is parallel to the axis of the Earth. When moved in azimuth, the altitude looks after itself.

**Equinox** A point where the ecliptic cuts the celestial equator. The Sun reaches the vernal equinox (First Point of Aries) about 21 March, and the autumnal equinox (First Point of Libra) about 22 September.

**Escape velocity** The minimum velocity at which an object must move in order to escape from the surface of a planet, or other body, without being given any extra impetus.

**EVA** Extra Vehicular Activity.

**Exosphere** The outermost part of the Earth’s atmosphere.

**Extinction** a) When species die out (cease to exist). b) The dimming of the light from a celestial body when near the horizon. It amounts to 3 magnitudes for a star 1o above the horizon, but 1 magnitude for a star at 10o, and above 45o it is very slight.

**Extraterrestrial** A term used to describe things ‘beyond Earth’.

**Eyepiece** Also known as the ocular. The lens at the end of a telescope which you look through. It is responsible for magnifying the image produced by the object-glass or mirrors.

**F**

**Faculae** Bright, temporary patches above the Sun’s bright surface or photosphere. They are usually associated with sunspot groups.

**False colour technique** The use of colours on an image or chart in order to help in analysis.

**Far point** The furthest point the eye can see clearly.

**Finder** A small, wide-field telescope attached to a larger one, to help in locating target objects.

**Fireball** An exceptionally bright meteor (above magnitude -5).

**First contact** When the Moon ﬁrst starts to cover the disc of the Sun at the start of a total solar eclipse.

**First Point of Aries** The vernal equinox.

**Flame test** The heating of metal ions in a flame to produce a colour as an aid to identifying the metal ion.

**Flares, solar** Brilliant outbreaks in the Sun’s atmosphere, usually associated with active spot-groups. They emit charged particles and short-wave radiation.

**Focal length** The distance between the centre of the lens and the focal point (principal focus).

**Focus** The point where rays of light meet after having been converged by a lens or a mirror.

**Force of gravity** An attractive force between all particles that have mass.

**Fraunhofer lines** The dark lines in the spectrum of the Sun.

**Free-body** A diagram showing all the forces acting on an object.

**force diagram**

**Free fall** The normal state of motion of an object in space under the influence of the pull of a central body. The Earth is in free fall around the Sun.

**Frequency** The number of vibrations per second or number of complete waves passing a set point per second.

**Friction** Energy losses caused by two or more objects rubbing against each others.

**Fusion** A reaction in which lighter nuclei join together (fuse) and produce energy.

**G**

**Galaxy** A collection of billions of stars held together by the force of gravity.

**Galilean satellites** The four large satellites of Jupiter: Io, Europa, Ganymede and Callisto.

**Gamma rays** Electromagnetic waves of short wavelength (10-12 m or less) emitted from unstable nuclei.

**Gauss** The standard unit of measurement for a magnetic field. The magnetic field at the Earth’s surface ranges between 0.3 and 0.6 gauss.

**Gegenschein** A faint sky-glow, seen opposite to the Sun, and due to the illumination of thinly-spread interplanetary material.

**Geocentric model** Earth-centred model of the Solar System.

**Geostationary orbit** An orbit used to maintain a satellite directly above the same part of the Earth.

**Gibbous phase** The phase of a body, shining by reflected light, when between half and full.

**Globular cluster H**undreds of thousands of stars tightly clustered together. Globular clusters were the ﬁrst generation of stars formed in our galaxy about 12 billion years ago. All the stars in the cluster are related to the group gravitationally. The 158 globular clusters known are found outside the plane of the Milky Way in the halo region.

**Gnomon** The pointer on a sundial. The shadow of the gnomon on the dial gives the time. Also known as the style.

**Goldilock’s zone** The region where conditions are right for life in a Solar System around a star.

**GPE** Gravitational potential energy. Energy due to the position of an object in the Earth’s gravitational field.

**Granules, solar** Features of the Sun’s bright surface or photosphere. The granules last for only about 10 minutes each, and represent upcurrents.

**Gravitation** The force of attraction that exists between all particles of matter in the Universe. If F is the attractive force between two bodies, m1 and m2 their masses, d is the distance between them and G is the gravitational constant then: F = (Gm1m2) / d2.

**Gravitational field** Gravitational force acting on an object per unit mass.

**strength**

**Great circle** A circle on the surface of a sphere (such as the Earth) whose plane passes through the centre of the sphere.

**Great Dark Spot** A storm seen on the surface of Neptune as the Voyager 2 mission passed by in 1989. The storm has disappeared, but new dark spots have since appeared.

**Great Red Spot** A storm seen on the surface of Jupiter since the 1600s. The red spot travels across the planet, with wind speeds of 350 km/hour. The Earth could fit twice into the Great Red Spot.

**Greenhouse effect** A process in which the atmosphere is warmed up by infrared radiation; it then re-radiates some of the infrared radiation back towards the Earth’s surface, which warms the surface.

**Greenhouse gases** Gases in the atmosphere whose absorption of infrared solar radiation is responsible for the greenhouse effect, *e.g.* carbon dioxide, methane and water vapour.

**Greenwich Mean Time** GMT. The local time at Greenwich, reckoned according to the mean sun.

**Greenwich meridian** The line of longitude that passes through the Old Royal Observatory in Greenwich Park. It marks longitude 0o.

**Gregorian calendar** The calendar now in use.

**Gregorian telescope** An obsolete type of reflector in which the secondary mirror was concave, and the image was sent back to the eyepiece through a hole in the main mirror. Unlike the Cassegrain, it gave an erect image.

**H**

**H.I and H.II regions** Clouds of hydrogen in the Milky Way. In H.I regions the hydrogen atoms are complete; in H.II regions they are ionised by the radiation from very hot stars. H.II regions shine as gaseous nebulae.

**Halley’s Comet** The only bright periodical comet. It has a period of 76 years, and is next due at perihelion in 2061.

**Halo, galactic** The spherical-shaped cloud of stars around the Galaxy.

**Harvest Moon** The full moon nearest to the autumnal equinox.

**Heliacal rising** The rising of a celestial body at the same time as sunrise. Generally taken to mean the date when the body first becomes visible with the naked eye in the dawn sky.

**Heliocentric model** Sun-centred model of the Solar System.

**Helium** The second lightest element. Its atom has two electrons.

**Hoba meteorite** The biggest meteorite in the world. The largest meteorite ever found is ‘Hoba’, in Namibia, weighing in at 60 tonnes. This is what remains – so much more will have been destroyed as it passed through the atmosphere.

**Horizon** The great circle on the celestial sphere which is everywhere 90o from the overhead point or zenith.

**Hour angle** The time that has passed since a celestial object crossed the meridian.

**Hour circle** The great circle on the celestial sphere passing through both celestial poles. The zero hour circle coincides with the observer’s meridian.

**H-R Diagram** The Hertzsprung-Russell Diagram. A diagram in which stars are plotted according to their spectral types and their absolute magnitudes. If colour index is used on one scale, it becomes a colour-magnitude diagram.

**Hubble constant** A constant relating the recessional velocity of galaxies. Usually taken as 77 km/s/Mpc.

**Hubble time** The time that has elapsed since the origin of the Universe.

**Hunter’s Moon** The full moon following Harvest Moon.

**I**

**Immersion** The entry of a celestial object into occultation or eclipse.

**Inferior conjunction** The position of an inferior planet (Mercury or Venus) when between the Earth and the Sun. Some comets and asteroids can also pass through inferior conjunction.

**Infrared radiation** Electromagnetic radiations with wavelengths between 10-6 and 10-4 metres; thermal energy.

**Infrared waves** Non-ionising waves with a wavelength longer than red light that are radiant heat.

**Intensity** The power of radiation per unit area.

**Interplanetary dust** The dust particles from old comet tails or from asteroids left in space between the planets. The interplanetary dust burns up on hitting the atmosphere at high speed. The heat ionises the air at about 100 km altitude, creating a meteor or shooting star.

**Inverse square law** A relationship between quantities where doubling one quantity reduces the related quantity by a factor of four.

**Ion** An atom with an electrical charge, due to gaining or losing one or more electrons; may therefore be positive or negative.

**Ionisation** A process in which radiation transfers some or all of its energy to liberate an electron from an atom.

**Ionisation energy** The energy required to remove an electron from an atom.

**Ion tail** The straight, gaseous tail of a comet.

**Ionosphere** The region of the Earth’s atmosphere above the stratosphere, containing charged particles. It contains the layers that reflect some radio waves back to the ground, making long-range communication possible.

**IRAS** The Infra-Red Astronomical Satellite.

**Iris** The coloured part of the eye that controls the amount of light entering the eye.

**Irregular galaxy** These galaxies come in all shapes and sizes - not ﬁtting into any form of classiﬁcation. Many irregular galaxies are formed from the collision of two galaxies. Over ⅓ of all galaxies are irregular galaxies.

**Isophote** A line on a diagram joining all points of equal density or intensity.

**Isotopes** a) Nuclei of atoms with the same number of protons but a different number of neutrons; b) Atoms with the same number of protons but different numbers of neutrons.

**J**

**Julian day** A count of the days, reckoning from 12 noon on 1 January 4713 BCE (the name has nothing to do with Julius Caesar!).

**Joule** The unit of work done and energy; one joule is the work done when a force of 1 N moves a distance of 1 m in the direction of the force.

**K**

**Kelvin scale** A temperature scale where temperature is measured in Kelvin (K).

**Kepler’s laws** Three important Laws of Planetary Motion, announced by Johannes Kepler between 1609 and 1618.

**Kiloparsec** One thousand parsecs (3260 light-years).

**Kinetic energy** The energy that moving objects have.

**L**

**Lander** A robotic space probe sent to planets and moons to carry out soil analysis.

**Late-type stars** Conventionally, stars of spectral types M, R, N and S.

**Latitude** The angle of a location above or below the equator - also known as the angular distance.

**Lens equation** An equation that relates image distance *v*, object distance *u*, and the focal length *f* of a lens: (1/*u*) + (1/*v*) = (1/*f*).

**Librations** The apparent tilts that enable us to see, at one time or another, 59 percent of the Moon’s surface from the Earth.

**Life cycle** A term used to describe the journey of a star in time.

**Light-curve** A graph showing the changing brightness of a variable star, or other body that changes in brilliancy.

**Light energy** Energy due to light (electromagnetic) waves – anything that glows (such as a light bulb) gives out light energy.

**Light-year** The distance travelled by light in one year: 9.4607 million million kilometres.

**LM** Lunar Module.

**Local Group** The group of galaxies of which our Galaxy is a member. Systems in our Local group are the only galaxies not receding from ours.

**Longitudinal waves** Waves with vibrations parallel to the direction in which they travel.

**LRRR** Laser Ranging Retroreflector.

**Luminosity** The brightness/magnitude of a star, galaxy or other celestial object.

**Lunation** The interval between successive new moons: 29d 12h 44m.

**M**

**Magma** Hot molten rock found in the mantle, below the Earth’s surface.

**Magnetic storm** A sudden disturbance of the Earth’s magnetic field, due to charged particles sent out by the Sun.

**Magnetosphere** The area round a celestial body in which the magnetic field of that body is dominant.

**Magnification** The magniﬁcation of a telescope can be adjusted by changing the eyepiece. Calculated by the focal length of the objective / focal length of the eyepiece.

**Magnified** An image that is larger than the object.

**Magnitude** a) Apparent: the apparent brightness of a celestial body – the lower the magnitude, the brighter the object; b) Absolute: the apparent magnitude that an object would have if seen from a distance of 10 parsecs; c) Photographic: the magnitude measured from the apparent size of the body on a photographic plate.

**Main Sequence** the belt on the H-R Diagram running from upper left to lower right. Most stars lie on the Main Sequence.

**Maksutiv telescope** An astronomical telescope that makes use of both mirrors and lenses.

**Mantle** Semi-liquid layer of the Earth beneath the crust.

**Mass** The amount of matter inside an object, measured in kilograms.

**Mass-energy equation** Einstein’s equation *E* = *mc*2, which links mass with the energy of the system.

**Mass number** Total number of protons and neutrons within the nucleus of an atom (same as the nucleon number).

**Matter** A general term to describe anything that has mass an volume.

**Maunder minimum** The period between 1645 and 1715, when sunspots were rare.

**Mean** The midpoint in an arithmetic progression.

**Mean sun** An imaginary body travelling eastward along the celestial equator, at a rate of motion equal to the average rate of the real Sun along the ecliptic.

**Melting point** The temperature at which a solid becomes a liquid.

**Meridian, celestial** The great circle on the celestial sphere, which passes through the zenith and both celestial poles. It cuts the observer’s horizon at the exact north and south points.

**Messier numbers** The numbers allotted to clusters and nebulae in the catalogue drawn up by Charles Messier in 1781.

**Mesosphere** Part of the ionosphere at an altitude of 50 km to 80 km above the Earth’s surface. The mesosphere is the region where meteors burn up in the atmosphere. As the dust/small particles (meteoroids) ﬂy into the mesosphere at high speed, the meteoroid heats up, vaporises and causes the air to glow - forming a ‘shooting star’. The mesosphere is the coldest part of the atmosphere, with temperatures dropping to -100 ˚C. Ice clouds form in this region called noctilucent clouds. These can be seen in the west after sunset during summer months. The thin, wispy clouds are the highest clouds in our atmosphere.

**Meteor** A small particle, usually smaller than a grain of sand, which is seen when it enters the Earth’s upper atmosphere and is burned away by friction. Meteors are cometary debris.

**Meteorite** A solid body that strikes the Earth from space. Most are iron, stone or a mixture of both materials. They are not associated with comets, and probably come from the asteroid belt.

**Meteoroid** A name for all the different sizes of chunks of rock in space orbiting the Sun.

**Micrometeorites** extremely small particles, not massive enough to produce luminous effects when they enter the upper atmosphere.

**Micron** A unit of length: one-thousandth of a millimetre. There are 10,000 Ångstroms to one micron. The usual symbol is the Greek letter μ.

**Microwaves** Electromagnetic radiations, intermediate between infrared and radio waves; wavelengths 1 mm to 1 metre.

**Milky Way** The luminous band crossing the sky, due to the fact that in this direction we are looking along the main plane of the Galaxy.

**Minerals** Solid metallic or non-metallic substances found naturally in the Earth’s crust.

**Minor planets** Another (and more suitable!) name for asteroids.

**Minute of arc (‘)** One-sixtieth of a degree.

**Mira stars** Variable stars with periods of a few weeks or months. They are named after the prototype star, Mira Ceti.

**Molecule** A stable association of atoms. Thus a water molecule consists of two hydrogen atoms with one atom of oxygen (H2O).

**Momentum** A quantity calculated by multiplying the mass of an object by its velocity.

**Month** a) Calendar: the civil month – 30 or 31 days (28 or 29 in February); b) Sidereal: the time taken for the Moon to complete one orbit (27.32 days).

**Moving clusters** Groups of stars sharing a common motion through space.

**Multiple star** A star made up of more than two physically-associated components (*e.g.* Theta Orionis, Epsilon Lyrae).

**N**

**NASA** The National Aeronautics and Space Administration (USA).

**NGC** The New General Catalogue of Clusters and Nebulae, compiled by J.L.E. Dreyer a century ago.

**Nadir** The point on the celestial sphere immediately below the observer, and therefore opposite the observer’s zenith.

**Nanometre** One thousand millionth of a metre.

**Neap tide** The tide produced when the Sun and Moon are at right angles to the Earth.

**Near point** The closest distance the eye can focus an object.

**Nebula** A mass of ‘dust’ and tenuous gas in space. Reflection nebulae shine only by reflected starlight; with emission nebulae, the associated stars are hot enough to make the material emit a certain amount of light on its own account.

**Neutrino** A fundamental particle with no electrical charge and, apparently, no rest mass. Produced during beta-plus decay of an unstable nucleus.

**Neutron** A fundamental particle with no electrical charge, but a mass practically equivalent to that of a proton.

**Neutron star** A star made up mainly of neutrons – the remnant of a supernova outburst, Neutron stars rotate rapidly, sending out pulsed radio waves (pulsars).

**Newtonian reflector** The most common type of reflecting telescope, in which the light is reflected from the main mirror onto a secondary flat mirror and thence to the eyepiece.

**Newton’s first law** A body will remain at rest or continue to travel at a constant velocity unless acted on by an external force.

**Newton’s second law** A law expressed by the equation: force = mass x acceleration.

**Newton’s third law** When two bodies interact, each exerts an equal and opposite force on the other.

**Nodes** The points at which the orbit of the Moon, a planet, comet or asteroid cuts the plane of the ecliptic.

**Nova** A stellar outburst in the white dwarf component of a binary system.

**Nuclear energy** Energy that is stored inside the nuclei of atoms.

**Nuclear fusion** The fusing together of hydrogen nuclei to produce helium nuclei.

**Nucleon** A term used to refer to either protons or neutrons.

**Nucleon number** Total number of protons and neutrons within the nucleus of an atom (same as the mass number).

**Nucleus** a) The central core of an atom, which contains protons and neutrons and has a positive charge; b) a distinct structure in the cytoplasm of cells that contains the genetic material.

**O**

**Object-glass** Also called the objective. The main lens of a refracting telescope. Most objectives are compound, made up of two or more components.

**Obliquity of the ecliptic** The angle between the ecliptic and the celestial equator: 23o26’24”, usually given as 23 1/2o.

**Occultation** The covering-up of one celestial body by another. Strictly speaking, a solar eclipse is an occultation of the Sun by the Moon.

**Ocular** Alternative name for the eyepiece.

**Olbers’ paradox** A paradox discussed by H. Olbers in 1825: why is the sky dark at night?

**Oort cloud** A theory in which there is a cloud of comets orbiting the Sun at a distance of about a light-year.

**Open cluster** A loose galactic cluster of stars.

**Opposition** The position of a planet when exactly opposite the Sun in the sky.

**Optical double** A double star in which the two components are not genuinely associated, but merely lie in the same line of sight.

**Optical power** A quantity found using ‘1/focal length of the lens in metres’.

**Optical window** The region of the electromagnetic spectrum in which radiations can pass through the atmosphere and reach the Earth’s surface. It extends from about 300 to 900 nanometres (3000 to 9000 Ångstroms).

**Orbit** The path of a celestial body.

**Orrery** A model showing the Solar System, with the planets capable of being moved around the Sun at their correct relative velocities.

**P**

**Parallax, trigonometrical** The apparent shift of an object when observed from two different directions.

**Parsec** The distance at which a star would show a parallax of 1 second of arc; 3.26 light-years, 206,265 astronomical units 0r 30.857 million million kilometres.

**Peak** Uppermost point of a wave.

**Peer review** The process of evaluating the quality of research using anonymous reviews by experts in a particular field.

**Penumbra** a) The area of partial shadow to either side of the main cone of shadow cast by the Earth; b) The lighter part of a sunspot.

**Perigee** The position of the Moon in its orbit when closest to the Earth.

**Perihelion** The position of a body in the Solar System when at its closest to the Sun.

**Perturbations** The disturbances in the orbit of a celestial body produced by the gravitational pulls of other bodies.

**Phase** Non-circular shape that includes a crescent.

**Phase angle** The angle between the Earth and the Sun, as seen from another body in space.

**Photoelectric cell** An electronic device. Light falls upon the cell, and produces an electric current; the strength of the current depends upon the intensity of the light.

**Photoelectric photometer**

An instrument used for measuring the brightness of celestial objects. It consists basically of a photoelectric cell used together with a telescope.

**Photography** The process of producing permanent images.

**Photon** The smallest ‘unit’ of light.

**Photosphere** The bright surface of the Sun.

**Plages, solar** Brighter regions on the Sun’s surface, observed in the light of one element only (hydrogen or calcium). Also called flocculi.

**Planetary nebula** A small, hot dense star surrounded by a shall of gas.

**Plasma** Gas in which the atoms are wholly ionised.

**Pogson’s ratio** The ratio between the brightness of two stars at successive magnitudes. It is logarithmic; the ratio is 2.512 (since 2.512 is the fifth root of 100).

**Polar orbit** An orbit where a satellite passes regularly over the north and south poles.

**Poles, celestial** The north and south points of the celestial sphere.

**Populations, stellar** Two main types of star regions: (I) in which the brightest stars are hot and white; (II) in which the brightest stars are old red giants and supergiants.

**Position angle** The apparent direction of one object with reference to another, from north (0o), through east (90o), south (180o) and west (270o) back to north (360o or 0o).

**Positron** The anti-particle of an electron, a particles with a mass similar to that of an electron but with a positive charge of +1.6 x 10-19 C.

**Power** The rate of work done or the rate of energy transfer.

**Precession** The apparent slow movement of the celestial poles. This also means a shift of the celestial equator, and hence of the equinoxes. The vernal equinox moves by 50 seconds of arc per year, and is now in Pisces rather than Aries.

**Prime meridian** The meridian on the Earth’s surface that passes through both poles and the Old Royal Observatory at Greenwich.

**Principal focus** Also known as the focus or focal point. The point at which rays of light parallel to the principal axis of a converging lens converge, or the point from which rays parallel to the principal axis of a diverging lens appear to come.

**Principle of conservation of energy**

Energy cannot be created or destroyed, it can simply be transferred from one form to another.

**Principle of conservation of momentum**

For a system of colliding objects, where there are no external forces, the total momentum before and after the collision remains the same.

**Prism** A block of glass used to split white light into a visible spectrum.

**Prominences** Masses of glowing gas, mainly hydrogen, rising from the Sun’s surface. They were once (misleadingly) called Red Flames.

**Proper motion** The individual motion of a star on the celestial sphere.

**Protons** Small positively-charged particles found in the nucleus of an atom.

**Proton number** Number of protons inside the nucleus of an atom (same as the atomic number).

**Protoplanetary disc** A disc of dust seen around a protostar from which planets form. As a protostar forms within a nebula, dust collects in a sphere around it. As the protostar spins faster, the sphere becomes ﬂattened into the protoplanetary disc. The disc is held in the region around the star and will probably form planets in a Solar System in the years ahead. The more dense solid material will be drawn nearer to the star creating rocky inner planets. More gaseous material remains further from the star and gives rise to gas giants.

**Protostar** A fragment of a nebula which gives of light as a star begins to form.

**Ptolemaic System** The old geocentric theory of the Solar System, with the Earth in the centre.

**Pulsar** A rapidly-rotating neutron star, sending out pulsed radio waves.

**Pulsating variable** A variable star in which the changes are intrinsic, so the star swells and shrinks.

**Pupil** The central hole produced by the iris.

**P wave** Primary (longitudinal) seismic wave.

**Q**

**QSO** Quasi-Stellar Object. Alternative name for a quasar.

**Quadrant** An astronomical measuring instrument used in ancient times. It consisted of an arc graduated into 90o, with a sighting pointer.

**Quadrature** The position of the Moon or a planet when at right angles to the Sun as seen from the Earth. The Moon is at quadrature when at half-phase.

**Quantum** The energy possessed by one photon of light.

**Quark** A fundamental particle within particles such as neutrons and protons.

**Quasar** A very remote, super-luminous object; probably the core of a very active galaxy.

**R**

**Radial velocity** The towards-or-away movement of a celestial body; positive if the object is receding, negative if it is approaching.

**Radiant** The point in the sky from which the meteors of any particular shower appear to radiate.

**Radiation** Any form of energy that originates from a source, including waves and particles.

**Radiative zone** The zone that radiates heat from the Sun’s core to within 500 km of its surface.

**Radioactive isotopes** Atoms with the same number of protons but different numbers of neutrons, with an unstable nucleus that achieves stability by emitting ionising radiation.

**Radio telescope** An instrument used for collecting and analysing natural radio waves from space.

**Radio window** The region of the electromagnetic spectrum that is transparent to radio waves from space. It extends from about 20 metres down to a few millimetres.

**Radius vector** An imaginary line joining the centre of a planet (or comet) to the centre of the Sun. It also applies to satellites orbiting planets.

**Rarefactions** Regions where particles are pulled apart and create regions of low pressure in sound waves.

**Rayleigh scattering** The colours in the sky are produced by the atmosphere around Earth scattering light - dependent on the amount of each wavelength scattered by the particles of differing sizes in the atmosphere.

**Real image** Image formed on the other side of the lens to the object – a real image can be formed on a screen.

**Recurrent nova** A star that has been known to suffer more than one nova outburst.

**Red giant** A huge expanded star with a cooler surface.

**Red-shift** The apparent increase in wavelength of the light of a body that is receding from the observer.

**Reflecting telescope** An optical telescope in which the light from the target object is collected by a curved mirror.

**Reflection** When a wave is bounced off a surface.

**Refraction** The ‘bending’ or change of direction of a ray of light when passing through a transparent surface. The shorter the wavelength, the greater the amount of refraction.

**Refractor** A telescope in which the light from the target object is collected by a lens (object-glass, or objective).

**Regolith** The outermost layer of the surface of the Moon or planetary body.

**Resolving power** The ability of a telescope to separate objects that are close together. Generally speaking, the resolving power R of a telescope of aperture D is R = 12/D, where R is in seconds of arc and D in centimetres.

**Retardation** The difference in the time of moonrise on successive nights.

**Retina** Covering of light-sensitive cells at the back of the eyeball.

**Retrograde motion** Orbital or rotational movement in the sense opposite to that of the Earth’s movement or rotation. A planet is said to move in an apparent retrograde direction when shifting from east to west on the celestial sphere.

**Reversing layer** The gaseous layer above the Sun’s bright surface. It is responsible for the Fraunhofer lines in the solar spectrum.

**Right ascension (RA)** The angular distance of a star from the vernal equinox, measured westward. It is usually given in units of time, and is the interval between the transit of the vernal equinox and the transit of the body concerned.

**Rill** Otherwise spelled rille. Crack-line feature on the Moon’s surface. True rills are collapse features, but some are really craterlet-chains. They are alternatively known as clefts.

**Rods and cones** Different types of photoreceptor.

**RR Lyrae variables** Variable stars with regular light curves and very short periods of a day or less. All are about 90 times as luminous as the Sun.

**RTG** Radioisotope Thermoelectric Generator.

**S**

**Satellites** Minor bodies orbiting planets.

**Scalar** A quantity that only has size or magnitude.

**Schmidt telescope** A type of telescope using a spherical mirror together with a special correcting plate. It can photograph a relatively wide area of the sky with a single exposure.

**Scientific conferences** Meetings where participants exchange and present new ideas for research.

**Scientific journals** Periodic publications with articles contributed to by scientists reporting on their new research.

**Scintillation** The official name for ‘twinkling’ of a star or other celestial body.

**Secular acceleration** The apparent speeding-up of the Moon in its orbit, due to gradual slowing down of the Earth’s rotation by an average of 0.000 000 02 seconds per day.

**Seismic waves** Shock waves from earthquakes.

**Seismometer** An earthquake-detecting instrument.

**Seyfert galaxies** Galaxies with small, bright nuclei and weak spiral arms. Most are active, and most are radio sources.

**Shooting-star** The popular name for a meteor.

**Sidereal period** Also called periodic time. The time taken for a body to complete one orbit round its primary: with the Earth, 365.25 days.

**Sidereal time** The local time measured according to the apparent rotation of the celestial sphere. The sidereal time is 0 hours when the vernal equinox crosses the observer’s meridian.

**Snell’s law** An equation that relates the angle of incidence *i* in a vacuum (or air), the angle of refraction *r* in a medium and the refractive index *n* of the medium: sin *i* / sin *r* = *n*.

**Solar day** From noon one day to noon the next day (when the Sun is due south, at its highest point in the sky).

**Solar System** The Sun and all the objects orbiting it (planets, asteroids, comets *etc*.)

**Solar time, apparent** The local time, reckoned according to the mean sun.

**Solar wind** A flow of charged particles streaming out from the Sun.

**Solstices** The times when the Sun is at its northernmost point in the sky (declination 23.5oN), around 22 June, and at its southernmost point (declination 23.5oS) around 22 December. The actual dates vary somewhat because of the complications in our calendar due to Leap Years.

**Spectrometer** A device used to analyse light from various sources.

**Spectroscope** An instrument for splitting up the light from a light-source, using a prism, diffraction grating or some equivalent device.

**Spectroscopy** A sophisticated type of flame test: substances are heated until they produce their own unique emission spectrum.

**Spectroscopic binary** A binary system whose components are too close together to be seen separately, but which can be detected spectroscopically because of the Doppler effect.

**Speculum** The main mirror of a reflecting telescope.

**Speed** How fast an object travels, calculated using the equation: speed (metres per second) = distance / time.

**Spherical Earth** The Earth is an oblate spheroid (a ﬂattened sphere).

**Spring tide** The tide produced when the Sun and Moon are pulling in the same sense, *i.e.* at new and full moon.

**Steady State theory** The theory that the Universe has always existed, and will exist forever, so that new material is being created spontaneously out of nothing to keep its density the same. It has now been rejected.

**Stratosphere** The region of the Earth’s atmosphere between the troposphere and the ionosphere.

**Strong nuclear force** An attractive force between all neutrons and protons.

**Style** The pointer or gnomon of a sundial.

**Summer triangle** An unofficial name for the pattern made by the stars Vega, Deneb and Altair. (Patrick Moore introduced it in a *Sky at Night* television programme many years ago, and now everyone seems to use it!).

**Sunspots** Caused by magnetic effects on the Sun’s surface and appear dark on the photosphere, as they can be 2,000˚C cooler. Sunspots are produced over an 11 year cycle - starting far from the equator. Numbers increase up to the solar maximum with new sunspots being nearer the equator. After the maximum, numbers drop with new sunspots moving to within 5˚ of the equator. The last maximum was in 2012. More sunspots is a sign of more activity within the Sun.

**Superior planet** A planet moving round the Sun at a distance greater than that of the Earth (*i.e.* all the planets apart from Mercury and Venus).

**Supernova** A stellar explosion. (Type I) The complete destruction of the white dwarf component of a binary system. (Type II) The collapse of a very massive star.

**Super red giant** A huge expanded star larger than a red giant.

**S wave** Secondary (transverse) seismic wave.

**Synodic period** The interval between successive oppositions of a superior planet, or between successive inferior conjunctions of Mercury or Venus.

**Syzygy** The position of the Moon in its orbit when new or full.

**T**

**Tektites** Small, glassy objects found in a few restricted areas on the Earth. They may be special types of meteorites, but are more probably of terrestrial origin.

**Terminator** The boundary between the daylit and night hemispheres of the Moon or a planet.

**Thermosphere** Part of the ionosphere at an altitude of 80 km to 120 km above the Earth’s surface. Charged particles from space collide with atoms and molecules. The atoms and molecules give of energy as they drop from their excited high energy states. The energy is lost as photons - oxygen glows green and nitrogen glows red. Another key feature of the thermosphere is that this region absorbs most of the harmful X-ray radiation.

**Transit** a) The passage of a celestial object across the observer’s meridian; b) The projection of Mercury or Venus against the disc of the Sun.

**Transit instrument** A telescope mounted so that it can only move in declination; it is kept pointing at the meridian, and is used for timing the passages of stars across the meridian. The Airy transit instrument at Greenwich marks longitude 0o.

**Troposphere** The lowest region of the Earth’s atmosphere from ground level up to the stratosphere. The troposphere contains 75% of the mass of the Earth’s atmosphere, providing us with our oxygen and weather systems - keeping us in the required temperature range. Almost all the planet’s water (99%) is in the troposphere. The troposphere’s changing manner is vital for maintaining the water cycle. Hot air rises (keeping the surface of the Earth at an ideal temperature for life). Dust taken into the air allows water droplets to form, so that the water rains back down to Earth. The height that the troposphere reaches is variable: 8 km above the poles, 15 km above the equator. At the very top of the troposphere is the jet stream where winds up to 250 km/hr race around the planet.

**U**

**Ultraviolet radiation** The region of the electromagnetic spectrum between wavelength 10-8 metres and 4 x 10-7 metres (approximately 100 Ångstroms to 4000 Ångstroms). It lies between the visible and the X-ray range.

**Umbra** The dark, inner part of: a) a shadow cast by a celestial object - like the central part of the shadow of the Moon where a total eclipse is seen; b) a sunspot.

**Universe** The whole of space containing all the galaxies.

**Up quark** A fundamental particle with a charge of +2/3.

**V**

**Vacuum** Empty space that has no particles.

**Validated** To establish the soundness of, or to corroborate, evidence.

**Van Allen zones** Zones around the Earth in which charged particles are trapped by the Earth’s magnetic field. The outer zone is made up chiefly of electrons, the inner zone of protons.

**Variable stars** Stars that change in magnitude over relatively short periods.

**Vector** A quantity that has both magnitude and direction.

**Velocity** How fast an object is moving in a certain direction: velocity = displacement / time.

**Vernal equinox** The First Point of Aries.

**Virgo Cluster** Over 2,000 galaxies spread over a diameter of about 10 million light years. The Milky Way is associated with the Virgo Cluster even though we are 55 million light-years away. This is because the Milky Way is part of a supercluster of galaxies centred on the Virgo Cluster. All the galaxies of the supercluster interact gravitationally even though they are so far apart.

**Virtual image** Image formed on the same side of the lens as the object – a virtual image can be seen by looking through the lens, it cannot be projected onto a screen.

**W**

**Watt** The unit of power. One watt is equal to one joule per second.

**Wave equation** The equation: speed = frequency x wavelength.

**Wavelength** Distance between neighbouring wave peaks (or troughs).

**Weight** The gravitational force acting on an object, measured in newtons.

**White dwarf** A small, very dense star that has exhausted its reserves of nuclear power.

**Wien’s law** The wavelength of the peak emission of a star in the electromagnetic spectrum is related to the temperature of the star. Astronomers can work out the temperature of the surface of a star, just by knowing the peak wavelength emission - even when the star is billions of light years away.

**Wilson effect** The foreshortening of a sunspot near the solar limb, so that the penumbra appears broadest towards the limb.

**Work done** The product of force and distance moved in the direction of the force.

**Wrinkle ridges** Wavy, raised markings seen running across the lunar seas. Wrinkle ridges are usually found on the surface of Maria. They can be seen snaking across the Mare surface for hundreds of kilometres. When the early basalt lavas cooled and the ground contracted, the ridges formed as the ground settled around them. When the name dorsa is seen in a moon label, this is for a wrinkle ridge, *e.g.* Dorsa Smirnov.

**X**

**X-ray radiation** The electromagnetic radiations with wavelengths between about 10-12 metres and 10-8 metres (0.01 to 100 Ångstroms), between the ultraviolet and gamma ray regions.

**Y**

**Year** The time taken for the Earth to complete one orbit round the Sun. The *sidereal year* (365.26 days) is the true revolution period of the Earth; the *tropical year* (365.24 days) is the interval between successive passages of the Sun across the vernal equinox.

**Z**

**Zenith** The observer’s overhead point (altitude 90o).

**Zenith hourly rate** The number of naked-eye meteors from a particular shower that could be expected to be seen by an observer under ideal conditions, with the radiant of the shower at the zenith.

**Zenith distance** The angular distance of a celestial body from the zenith.

**Zodiac** A belt stretching right round the sky, 8o to either side of the ecliptic, in which the Sun, Moon and planets (aside from Pluto) are always to be found.

**Zodiacal light** A cone of light rising from the horizon, stretching along the ecliptic. It is due to the illumination of thinly-spread material in the main plane of the Solar System.

**Zürich number** Also known as the Wolf number. A measure of sunspot activity. The formula is Z = k (10*g* + n) where Z is the Zürich number, *g* is the number of groups, and n is the total number of spots; k is a constant, usually about 1, depending upon the experience and equipment of the obsrever.