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| **P7 Section 1** |  |
| Sun appears to travel east-west across the sky once every 24 hoursStars appear to travel east-west across the sky once in 23h 56 mins (sidereal day)Moon appears to travel east-west across the sky once in 24h 49 mins |  |
| A sidereal day, a rotation of 360° of the Earth, is different from a solar day due to the orbital movement of the Earth. |  |
| Mercury, Venus, Mars, Jupiter and Saturn can be seen with the naked-eye All the planets appear to move with the stars but also to change their position relative to the fixed stars |  |
| Explain the apparent motions of the Sun, stars, Moon and planets. |  |
| Explain the phases of the Moon  |  |
| Explain why different stars are seen at different times of the year |  |
| Explain why retrograde motion for planets. |  |
| Astronomical objects are described in terms of two angles (e.g. right ascension and declination) and understand how the angles relate to the celestial sphere. |  |
| **P7 Section 2** |  |
| The speed of waves is affected by the medium they are travelling through |  |
| A change in the speed of a wave causes a change in wavelength as frequency cannot change, and that this may cause a change in direction |  |
| Refraction of light waves can be explained by a change in their speed when they pass into a different medium |  |
| Describe how refraction leads to the formation of an image by a convex/converging lens |  |
| Draw diagrams to show how convex/converging lenses bring parallel light to a focus |  |
| Draw and interpret ray diagrams for convex/converging lenses gathering light from distantpoint sources (stars), off the principal axis of the lens and extended sources (planets ormoons in our solar system, galaxies) |  |
| A lens with a more curved surface is more powerful than a lens with a less curved surface. |  |
| Calculate the power of a lens from: power = 1/focal length (dioptres) (metres–1) |  |
| Astronomical objects are so distant that light is effectively a parallel sets of rays |  |
| A simple optical telescope has two converging lenses of different powers, with the more powerful lens as the eyepiece |  |
| A telescope has two optical elements:a. an objective lens/ mirror to collect light from object being observed and form an image.b. an eyepiece produces a magnified image of the image from the objective that we see. |  |
| Calculate the angular magnification of a telescope from the powers of the two lensesusing: magnification = focal length of objective lens focal length of eyepiece lens |  |
| Most astronomical telescopes have concave mirrors, not converging lenses, as objectives. |  |
| Understand how concave mirrors bring a parallel beam of light to a focus |  |
| Large telescopes are needed to collect the weak radiation from faint or distant sources |  |
| Draw and interpret diagrams showing wave diffraction through gaps |  |
| Recall that waves can spread out from a narrow gap and that this is called diffractionDraw and interpret diagrams showing wave diffraction through gaps. |  |
| Light can be diffracted, and is most noticeable when it travels through a very small gap, comparable to the wavelength of the wave. |  |
| Radiation is diffracted by the aperture of a telescope, and that the aperture must be very much larger than wavelength of radiation detected by the telescope to make sharp images |  |
| A spectrum can be produced by refraction in a prism |  |
| Recall that a spectrum can be produced by a diffraction grating. |  |
| Section 3 |  |
| **Parallax** makes closer stars seem to move relative to distant ones over year.**Parallax** angle is half the angle moved against background of distant stars in 6 months.Smaller **parallax** angle means that the star is further awayA **parsec** (pc) is the distance to a star with a parallax angle of one second of arcDist in pc = 1/angle in arc secondsA **parsec** is similar in size to a **light year** - interstellar distances are a few parsecsIintergalactic distances are typically measured in megaparsecs (Mpc) |  |
| **Luminosity** of a star depends on its temperature and its sizeThe **observed intensity** of light from a star depends on luminosity and its distance |  |
| **Cepheid variable** stars pulse in brightness, with a period related to their luminosity.Using their average brightness as well distances can be calculated to the Cepheid.Cepheid variable stars in establishing the scale of the Universe and the nature of most spiral nebulae as distant galaxies |  |
| Telescopes revealed the existence of many fuzzy objects (**nebulae**) in the night sky. |  |
| **Curtis-Shapley** debate: whether spiral nebulae were objects within the Milky Way or separate galaxies outside it. |  |
| **Hubble’s observations of Cepheid variables** in one spiral nebula indicated that it was much further away than any star in the Milky Way, and so he concluded that this nebula was a separate galaxy. |  |
| Cepheid variable stars in distant galaxies has given better values of the Hubble constant |  |
| Hubble’s Law speed of recession = Hubble constant × distance speed in km/s. Hubble Constant s-1 or km/s per Mpc, distance in km or Mpc |  |
| Motions of galaxies suggests that space itself is expanding |  |
| Scientists believe the Universe began with a ‘big bang’ about 14 thousand million years ago |  |
| recall that all hot objects (including stars) emit a continuous range of electromagneticradiation, whose luminosity and peak frequency increases with temperature |  |
| **Section 4** |  |
| Removal of electrons from atoms is called ionisation **explain how electron energy levels within atoms give rise to line spectra** |  |
| recall that specific spectral lines in the spectrum of a star provide evidence of the chemical elements present in it  |  |
| use data on the spectrum of a star, together with data on the line spectra of elements, to identify elements present in it  |  |
| understand that the volume of a gas is inversely proportional to its pressure at a constant temperature and explain this using a molecular model  |  |
| explain why the pressure and volume of a gas vary with temperature using a molecular model |  |
| understand that both the pressure and the volume of a gas are proportional to the absolute temperature |  |
| interpret absolute zero using a molecular model and kinetic theory |  |
| recall that –273°C is the absolute zero of temperature, and convert temperatures in K to temperatures in °C (and vice versa)  |  |
| use the relationships:a pressure × volume = constantb. pressure = constant temperaturec. volume = constant temperature |  |
| explain the formation of a protostar in terms of the effects of gravity on a cloud of gas, which is mostly hydrogen and helium |  |
| understand that as the cloud of gas collapses its temperature increases, and relate this to the volume, pressure and behaviour of particles in a protostar  |  |
| understand that nuclear processes discovered in the early 20th Century provided a possible explanation of the Sun’s energy source  |  |
| understand that, if brought close enough together, hydrogen nuclei can fuse into helium nuclei releasing energy, and that this is called nuclear fusion  |  |
| complete and interpret nuclear equations relating to fusion in stars to include the emission of positrons to conserve charge  |  |
| understand that energy is liberated when light nuclei fuse to make heavier nuclei with masses up to that of the iron nucleus  |  |
| **understand that Einstein’s equation E = mc2 is used to calculate the energy released during nuclear fusion and \_ ssion (where E is the energy produced, m is the mass lost and c is the speed of light in a vacuum)**  |  |
| recall that the more massive the star, the hotter its core and the heavier the nuclei it can create by fusion |  |
| recall that the core (centre) of a star is where the temperature and density are highest and where most nuclear fusion takes place  |  |
| understand that energy is transported from core to surface by photons of radiation and by convection  |  |
| recall that energy is radiated into space from the star’s surface (photosphere) |  |
| recall that the Hertzsprung-Russell diagram is a plot of temperature and luminosity andidentify regions on the graph where supergiants, giants, main sequence and white dwarf stars are located  |  |
| In a main sequence star, hydrogen fusion to helium takes place in the core |  |
| A star leaves the main sequence when its core hydrogen runs out; it swells tobecome a red giant or supergiant and its photosphere cools |  |
| recall that in a red giant or supergiant star, helium nuclei fuse to make carbon, followed by further reactions that produce heavier nuclei such as nitrogen and oxygen  |  |
| A low-mass star (similar to the Sun) becomes a red giant, which lacks the mass to compress the core further at the end of helium fusion; it then shrinks to form a white dwarf  |  |
| In a white dwarf star there is no nuclear fusion; the star gradually cools and fades |  |
| recall that in a high-mass star (several times the mass of the Sun) nuclear fusion canproduce heavier nuclei up to and including iron; when the core is mostly iron, it explodes as a supernova creating nuclei with masses greater than iron and leaving a dense neutron star or a black hole |  |
| Section 5 |  |
| Understand that astronomers have found convincing evidence of planets around hundreds of nearby stars  |  |
| understand that, if even a small proportion of stars have planets, many scientists think that it is likely that life exists elsewhere in the Universe |  |
| No evidence of extraterrestrial life has so far been detected. |  |
| recall that major optical and infrared astronomical observatories on Earth are mostly situated in Chile, Hawaii, Australia and the Canary Islands  |  |
| Factors that influence the choice of site for major astronomical observatories including:a. high elevationb. frequent cloudless nightsc. low atmospheric pollution and dry aird. sufficient distance from built up areas that cause light pollution |  |
| describe ways in which astronomers work with local or remote telescopes |  |
| explain the advantages of computer control of telescopes including:a. being able to work remotelyb. continuous tracking of objectsc. more precise positioning of the telescoped. computer recording and processing of data collected |  |
| Main advantages and disadvantages of using telescopes outside the Earth’satmosphere including:a. avoids absorption and refraction effects of atmosphereb. can use parts of electromagnetic spectrum that the atmosphere absorbsc. cost of setting up, maintaining and repairingd. uncertainties of space programme |  |
| understand the reasons for international collaboration in astronomical research in terms of economy and pooling of expertise  |  |
| describe two examples showing how international cooperation is essential for progress in astronomy |  |
| Non-astronomical factors are important considerations in planning, building,operating, and closing down an observatory including:a. cost b. environmental and social impact near the observatoryc. working conditions for employees |  |