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| Lesson |  title | Spec statements | Teaching ideas | resources |
| 1 | Observing the sky | * recall that the Sun appears to travel east-west across the sky once every 24 hours; that the stars appear to travel east-west across the sky once in a very slightly shorter time period **(23 h 56 min);** that the Moon appears to travel east-west across the sky once in a slightly longer time period **(about 25 hours)**, and that the naked-eye planets (Mercury, Venus, Mars, Jupiter and Saturn) appear to move with the stars but change their positions in complicated patterns;
* explain the apparent motions of Sun, stars, Moon **and planets** in terms of rotation of the Earth and the orbits of the Earth, Moon **and planets;**
 | Handout overviewHandout keywordsBasics quiz, what do you know about the night sky?Could be done using handsets if there is timeStellarium in R11 neededAnimations of 24 hours- kineasthetic model of the earth moon-sun system which is videoed (student wears a T0shirt with Britain, America, china, aussie | <http://www.zooniverse.org/>getting the students interested |
| 2 | Eclipses and the moon | * explain the phases of the Moon in terms of the relative positions of the Sun, Moon and Earth;
* explain eclipses in terms of the positions of the Sun and Moon **and explain the low frequency of eclipses in terms of the relative tilt of the orbits of the Moon about the Earth and the Earth about the Sun;**
 | McGraw-hill animation of moon phasesShadow demonstration with Ball and torch...scale model of Earth moon (youtube video scale)Students draw diagrams of total eclipseWonders of the Solar system video of elipse in india | Phases of the moon<http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::800::600::/sites/dl/free/0072482621/78778/Lunar_Nav.swf::Lunar%20Phases%20Interactive>Moon-earth scale<http://www.youtube.com/user/1veritasium#p/u/19/Bz9D6xba9Og>animation of eclipses including angles[http://highered.mcgraw-hill.com/sites/0072482621/student\_view0/interactives.html#](http://highered.mcgraw-hill.com/sites/0072482621/student_view0/interactives.html) |
| 3 | Coordinates and astronomy | * explain why a sidereal day, a rotation of 360° of the Earth, is different from a solar day due to the orbital movement of the Earth **and that a sidereal day is 4 minutes less than a solar day;**
* explain why different stars are seen in the night sky at different times of the year, in terms of the movement of the Earth and the sun;
* recall that planets move in complicated patterns relative to the ‘fixed’ stars.
* explain that the positions of astronomical objects are measured in terms of angles as seen from Earth;
 | What angle does the Earth spin in 24 hours? Kinaesthetic model againPio up images of the constellations around the room in their right places, give students constellations worksheetsUse stellarium again to reinforce movement of planets over months-look at inferior and superior planetsNeed to check what is expected (declination, RA? or just qualitative) |  |
| 4 | Converging lenses | * recall that convex/converging lenses bring parallel light to a focus;
* recall that more powerful lenses of the same material have more curved surfaces;
* draw and interpret diagrams showing the formation of a real image of a distant point source (off the principal axis of a lens) and of a distant extended source;
* calculate the power of a lens from:

 | Lenses practical, making real images using different lenses and three different objects, a bright lamp at three different positions within the roomTables of lenses which they then have to fill inPrinciple ray diagram questions for books  | Lenses ppt form triple sci support |
| 5 | Telescopes | * understand that astronomical objects are so distant that light from them is effectively parallel;
* recall that a simple telescope has two converging lenses of different powers, with the more powerful lens as the eyepiece;
* **calculate the angular magnification of a telescope from the powers of the two lenses using:**

**magnification = focal length of objective lens / focal length of eyepiece lens*** recall that most astronomical telescopes have concave mirrors, not convex lenses, as their objectives;
* understand how concave mirrors bring parallel light to a focus.
 | Parallel laser beams neededMaking a telescope using some simple apparatus (borrow from Bassett?)Concave mirror neededEstimate magnification of my telescope, then calculate for the different lens combinationsEstimate the magnification of binos | No resources to support, though it is easy |
| 6 | Astronomical distances and brightness | * explain how parallax makes some stars seem to move relative to others over the course of a year;
* define the parallax angle of a star as half the angle moved against a background of distant stars in 6 months;
* explain that a
* smaller parallax angle means that the star is further away;
* define a parsec (pc) as the distance to a star with a parallax angle of one second of arc;
* calculate distances in parsecs for simple parallax angles expressed as fractions of a second of arc;
* recall that a parsec is similar in magnitude to a light-year;
* recall that typical interstellar distances are a few parsecs;
* recall that the intrinsic brightness of a star depends on its temperature and its size;
* explain qualitatively why the observed brightness of a star (as seen on Earth) depends on its intrinsic brightness and its distance from Earth;
 | Relative distances quiz, using worksheet to match distances to their measurement unitDifficulty in working out apparent distances using Orion constellation. Which is the closest star, use the paper and straws to represent the constellationsParallax, 3D glassesBlinking to see position of thumb move against backgroundPractise calculations for parsecs Show images of candles | <http://www.youtube.com/watch?v=pfcwfLAEpJ4>parallax animation |
| 7 | The scale of the universe | * recall that Cepheid variable stars pulse in brightness, with a period related to their brightness;
* explain qualitatively how this relationship enables astronomers to estimate the distance to Cepheid variable stars;
* understand the role of observations of Cepheid variable stars in establishing the scale of the Universe and the nature of most nebulas as distant galaxies. (IaS 1.3, 1, 4);
* recall that telescopes revealed that the Milky Way consists of very many stars and led to the realisation that the Sun was a star in the Milky Way galaxy;
* recall that telescopes revealed the existence of many fuzzy objects in the night sky, and that these were originally called nebulae;
* recall the main issue in the Curtis-Shapley debate: whether nebulae were objects within the Milky Way or separate galaxies outside it;
* recall that Hubble’s observations of Cepheid variables in one nebula indicated that it was much further away than any star in the Milky Way, and hence that this nebula was a separate galaxy;
* recall that intergalactic distances are typically measured in megaparsecs (Mpc);
* recall that Cepheid variable data in distant galaxies has given accurate values of the Hubble constant;
* use the following equation to calculate, given appropriate data, the speed of recession, **the Hubble constant and the distance to distant** **galaxies:**
* speed of recession = Hubble constant × distance
* (km/s) (s-1) (km)
 | Creating animations of Cepheid variable starsEstimating using graphs which galaxies are closerWorksheet on Cephied variable starsWorksheet “the great debate”M31 cephied variable stars exampleHubble speed of recession graph use to calculate H0 from the hubbles law worksheet. Doppler shift made using sense of using Mcgraw-hill animation [http://highered.mcgraw-hill.com/sites/0072482621/student\_view0/interactives.html#](http://highered.mcgraw-hill.com/sites/0072482621/student_view0/interactives.html) | <http://www.scaleoftheuniverse.com/> |
| 8 | Gas behaviour | * recall that when the volume of a gas is reduced its pressure increases and be able to explain this using a molecular model;
* explain why the pressure or volume of a gas varies with temperature and interpret absolute zero using a molecular model;
* recall that -273°C is the absolute zero of temperature, and be able to convert temperatures in K to temperatures in °C (and vice versa);
* explain the formation of a protostar in terms of the effects of gravity compressing a cloud of gas;
* explain that compressing the gas, e.g. in a protostar, will raise its temperature;
 | Pressure temperature relationshipBike pump and tyresCoke can demonstration to show relationship between temperature and volumeWorksheets for measuring temperature and volume of gas | Worksheet createdGas energy transfer apparatus (generate a temperature change just by compressing a gas)Compressed can of air lower pressure=lower temp |
| 9 | Structure of the stom | * describe the results of the Rutherford-Geiger-Marsden alpha particle scattering experiment as indicating that a gold atom contains a small, massive, positive region (the nucleus);
* recall that the nucleus contains positive protons and neutral neutrons;
* explain that protons are held together in the nucleus by a strong force much greater than the repulsive electrical force between them;
 | Atomscope demonstrationKinaesthetic demonstrationStrong force rope holding together the repulsion due to EM force |  |
| 10 | Fusion and stellar spectrum | * recall that all hot objects (including stars) emit a continuous range of electromagnetic radiation, whose total intensity and peak frequency increases with temperature;
* recall that the removal of electrons from atoms is called ionisation and that electron movement within atoms produces line spectra;
* recall that the spectrum of a star also contains some specific spectral lines, and that these 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;
* recall that hydrogen nuclei can fuse into helium nuclei, releasing energy, if brought close together;
* understand that nuclear processes discovered in the early 20th Century provided a possible answer to the mystery of the Sun’s energy source;
* recall that a star contains: a hotter core, where fusion takes place; a convective zone, where energy is transported to the surface by convection; the photosphere, where energy is radiated into space;
 | Blackbody radiation graphsPhet blackbody radiation emissionAnalysing spectra worksheet Look at live pictures of the sun, try to cast an image of the sun using binos, or telescope?Possible previous questions for pptSun labelling diagram | <http://solarstormwatch.com/> |
| 11 | The birth and death of stars | * understand that all stars change when there is insufficient hydrogen in the core for fusion to continue;
* recall that small stars like our Sun become red giants when the core hydrogen is depleted, while larger stars become red supergiants;
* understand that red giants and red supergiants liberate energy by fusing helium into larger nuclei such as carbon, nitrogen and oxygen;
* explain that red giants lack the mass to compress the core further at the end of the helium fusion, and they then shrink into hot white dwarfs, which gradually cool;
* explain that fusion in red supergiants continues to larger nuclei due to the higher pressures in the core;
* recall that fusion in large stars ceases when the core has been largely converted into iron, and the star then explodes in a supernova, leaving a dense neutron star or black hole.
 | Stellar evolution word loopStellar evolution tabooBuild your own star animation from websiteStar Life Cycle worksheet |  |
| 12 | Observing with telescopes | * Candidates will be assessed on their ability to:
* recall two examples of the location of major astronomical observatories;
* explain that large telescopes are needed to collect the weak radiation from faint or very distant sources;
* **explain that radiation is diffracted by the aperture of a telescope, and that the aperture must be very much larger than the wavelength of the radiation detected by the telescope to produce sharp images;**
* describe two ways in which astronomers work with local or remote telescopes;
* explain the advantages of computer control in remote telescopes;
* explain the main advantages and disadvantages of using telescopes outside the Earth’s atmosphere
	+ avoids absorption and refraction effects of atmosphere;
	+ can use parts of electromagnetic spectrum that the atmosphere absorbs;
	+ cost of setting up, maintaining and repairing;
	+ uncertainties of space programme;
* understand the need for international collaboration in terms of economy and pooling of expertise;
* describe one example showing how international cooperation is essential for progress in expensive ‘big science’ projects such as astronomy;
* describe two astronomical factors that influence the choice of site for major astronomical observatories;
* understand that non-astronomical factors:
* cost;
* environmental and social impact near the observatory;
* working conditions for employees;

are important considerations in planning, building, operating, and closing down an observatory. | Research into two major astronomical observatoriesOne space telescopeOne Earth based telescopeExplain why they need large aperturesWhy are radiotelescopes so large?Describe how astronomers can work with local and remote telescopesExplain the advantages of computer control in remote telescopesExplain the advantages and disadvantages of using space telescopes inc effects of the atmpshere, costs, the need for international collaborationExplain why most telescopes are mounted on mountains, why they are far from citiesExplain what possible negatives there are to builind g your own telescope | Homework based given out a week prior to this lesson |
| 13 | Revision and test |  |  |  |
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