Paper 2 Telescopic Astronomy Edexcel GCSE Astronomy Learning Plan
November 2020 (J.Thomas)

This is a personal suggestion for how to split up the learning points in the specification according to how successful a candidate might be in finding information from online or hardcopy sources and learning these without a teacher's help.

- The first column includes items where the candidate could expect to find and learn facts without assistance.
- Items in the second column might need some teacher assistance, so a candidate should make a note of questions to ask their teacher during self-study of these topics.
- Items in the third column are judged to be more challenging for a candidate to understand without assistance or they may require some practise with past paper questions to appreciate the level of understanding and application required.

This extract from the Edexcel GCSE Astronomy Specification should be read before starting any revision or self-study using this plan:

Content
*The specification points all begin with either **'know', 'understand' or 'be able to'**. These command words indicate the depth to which the content must be studied.*

*A '**know**' statement is limited to recalling the facts in the specification content.*
*An'**understand**' statement includes all aspects of 'know' and additional depth to reach an understanding of the content.*
*A '**be able to**' statement includes all aspects of 'know' and understand', as well as application of skills for the specification content.*

***For example** specification statement 1.4 states 'Be able to use the latitude and longitude co-ordinate system'. This means that students can be expected to use the longitude and latitude system in questions relating to positions on Earth. They could also be asked to explain how longitude and latitude are different to each other and also to recall a definition for longitude and latitude.*
(https://qualifications.pearson.com/en/qualifications/edexcel-gcses/astronomy-2017.html)

Paper 2: Telescopic Astronomy

Items where the student can learn facts	Items where understanding is required (these may need teacher explanation)	Items where teaching and exam question practise is recommended
Topic 9 – Exploring the Moon		
9.2 Understand the major differences between the appearance of the Moon's near and far sides	9.1 Understand the Moon's major internal divisions in comparison with those of the Earth	9.4 Understand that a spacecraft traveling to the Moon must reach the Earth's escape velocity, the energy requirements of which can be met only by the use of rockets
9.3 Understand how information has been gathered about the Moon's far side	9.5 Understand the Giant Impact Hypothesis and alternative theories of the Moon's origin, including Capture Theory and Co-accretion Theory	
Topic 10 – Solar astronomy		
10.2 Know the location and relative temperatures of the Sun's internal divisions, including: a core b radiative zone c convective zone d photosphere	10.1 Understand methods of observing the Sun safely, including: a telescopic projection b H-alpha filter	10.3 Understand the role of the Sun's internal divisions in terms of energy production and transfer
10.5 Know the location, temperature and relative density of components of the solar	10.6 Understand the structure, origin and evolution of sunspots	10.4 Understand the principal nuclear fusion process in the Sun (the proton-proton cycle)

atmosphere, including: a chromosphere b corona	10.9 Understand the different appearance of the Sun when observed using radiation from the different regions of the electromagnetic spectrum	10.7 Be able to use sunspot data to determine the mean solar rotation period
10.12 Know the shape and position of the Earth's magnetosphere including the Van Allen Belts	10.10 Understand the nature, composition and origin of the solar wind	10.8 Be able to use sunspot data relating to the solar cycle
	10.11 Understand the principal effects of the solar wind, including: a aurorae b cometary tails c geomagnetic storms d the effects on satellites, aircraft travel and manned missions	
Topic 11 – Exploring the Solar System		
11.1 Be able to use data about the names and relative locations of bodies in the Solar System, including: a planets b dwarf planets c Small Solar System Objects (SSSOs): asteroids, meteoroids and comets	11.3 Understand the orbits of short-period comets and their likely origin in the Kuiper Belt	11.9 Be able to use the astronomical unit (1 AU = 1.5 × 108 km), light year (l.y.) and parsec (pc)
11.2 Understand the structure of comets (nucleus, coma and tails)	11.4 Understand the orbits of long-period comets and their likely origin in the Oort Cloud	11.12 Understand the use of transits of Venus (as proposed by Halley) to determine the size of the astronomical unit and thus the absolute size of the Solar System

11.5 Understand the location and nature of the Kuiper Belt, Oort Cloud and the heliosphere	11.7 Understand the main theories for the formation and current position of the gas giant planets in our Solar System	11.15 Understand how the objective element of a telescope captures and focuses light so that the image can be magnified by an eyepiece
11.6 Understand the following principal characteristics of the planets: a relative size b relative mass c surface temperature d atmospheric composition e presence of satellites f presence of ring systems	11.10 Understand the origin and structure of meteoroids and meteorites	11.16 Know that convex (converging) lenses and concave (diverging) mirrors can be used to collect and focus light from astronomical objects
11.8 Be able to use information about the size of the Solar System	11.13 Understand the main theories for the origin of water on Earth	11.17 Understand how simple telescopes can be made by combining an objective (lens or mirror) with an eyepiece
11.11 Know that most bodies in the Solar System orbit the Sun in, or close to, a plane called the ecliptic	11.18 Understand the basic design of the following in terms of their key elements: a Galilean refracting telescope b Keplerian refracting telescope c Newtonian reflecting telescope d Cassegrain reflecting telescope (detailed ray diagrams not required)	11.19 Understand that the ‘light grasp’ of a telescope is directly proportional to the area of the objective element and thus the square of the diameter of the objective element
11.14 Know that the human eye is limited in astronomical observations by its small aperture and limited sensitivity in low light	11.25 Understand the advantages of reflecting telescopes compared to refracting telescopes, in terms of: a chromatic aberration b very long focal lengths c using large aperture objectives d use of multiple mirrors	11.22 Understand the resolution of a telescope is: a proportional to the diameter of the objective element b reduced by observing at a longer wavelength
11.20 Know that the aperture of a telescope is related to the diameter of the objective	11.26 Understand the advantages and disadvantages of the major types of space	11.23 Be able to use the formula for the magnification of a telescope:

element	probe: a fly-by b orbiter c impactor d lander	magnification = f_e / f_o where f_o is the focal length of the objective element and f_e is the focal length of the eyepiece
11.21 Know that the field of view is the circle of sky visible through the eyepiece, measured in degrees or arcmin	11.29 Understand the advantages and disadvantages of direct observation via manned missions	11.28 Understand that a space probe must reach the Earth's escape velocity, the energy requirements of which can be met only by the use of rockets
11.24 Understand the importance of Galileo's early telescopic observations in establishing a heliocentric (Sun-centred) model of the Solar System	11.30 Understand the main features of the Apollo programme to land astronauts on the Moon	
11.27 Know an example of each type of space probe, including target body and major discoveries, including: a fly-by – New Horizons (Outer Solar System) b orbiter – Juno (Jupiter) or Dawn (asteroids Vesta and Ceres) c impactor – Deep Impact (comet Tempel 1) d lander – Philae (comet 67P/Churyumov–Gerasimenko)		
Topic 12 – Formation of planetary systems		
12.5 Understand the requirements for life and the possibility of lifeforms existing elsewhere, including: a on Titan b on Europa c on Enceladus d outside our Solar System	12.3 Understand the main theories for the formation of gas giant planets in planetary systems	12.1 Be able to identify the operation of each of the following in our Solar System: a gravitational attraction producing regular motion, including the orbits of planets and moons b tidal gravitational forces producing effects, including ring systems, asteroid belts

		and internal heating c gravitational interactions of multiple bodies producing effects such as gradual shifts in orbits, chaotic motion, resonances and the significance of Lagrangian Points (detailed mathematical descriptions not required) d accidental collisions causing impact craters, changes to orbital motions or planetary orientations e solar wind affecting comets, planetary atmospheres and the heliosphere
12.6 Understand the relevance of the Goldilocks (Habitable) Zones	12.4 Understand the current methods for discovering systems of exoplanets, including transit method, astrometry and radial velocity measurements	12.2 Be able to identify the operation of each of the following interactions in the formation of planets and moons: a the interaction between tidal gravitational and elastic forces to determine whether a body is broken apart (Roche Limit) b the interaction between attractive gravitational and elastic forces in determining a body's spherical or irregular shape c the interaction between gravitational and thermal factors in determining the presence of an atmosphere
12.7 Understand how factors in the Drake equation can be used to allow us to estimate the number of civilisations in our Galaxy		
12.8 Understand the search for extra-terrestrial intelligence, by receiving radio waves (SETI), including the benefits		

and dangers of discovering extra-terrestrial life		
Topic 13 – Exploring starlight		
13.2 Understand the term absolute magnitude	13.1 Understand the astronomical magnitude scale and how apparent magnitude relates to the brightness of stars as viewed from Earth	13.3 Be able to use the distance modulus formula to determine the absolute (M) or apparent magnitude (m) of a star, given the distance to the star (d): $M = m + 5 - 5\log d$ where d is the distance in parsec
13.20 Know that most modern astronomical observations are recorded using digital sensors that convert light into electrical signals, which can then be processed and stored as data files	13.5 Understand how stars can be classified according to spectral type	13.4 Understand what information can be obtained from a stellar spectrum, including a chemical composition b temperature c radial velocity
13.22 Know that the Earth's atmosphere blocks almost all of the radiation of different wavelengths in the electromagnetic spectrum, except visible light and radio waves	13.6 Understand how a star's colour and spectral type are related to its surface temperature	13.9 Understand the inverse square relationship between distance and brightness/intensity
13.23 Know that only optical and radio telescopes should be located at sea level on the Earth's surface	13.7 Be able to sketch a simple Hertzsprung-Russell diagram, including labelled axes and indicate the positions of the following: a main sequence stars b the Sun c red and blue giant stars d white dwarf stars e supergiant stars	13.11 Understand the term parsec (pc)

13.24 Understand how a simple radio telescope operates	13.8 Understand how a star's life cycle relates to its position on the Hertzsprung-Russell diagram, for stars similar in mass to the Sun and those with masses that are much greater	13.12 Be able to determine astronomical distances using heliocentric parallax
13.25 Understand why radio telescopes need extremely large apertures in order to maintain a useful resolution	13.10 Understand that an angle of one degree (°)comprises 60 minutes of arc (arcmin) (60') and that each arcminute is comprised of 60 seconds of arc (arcsec) (60')	13.13 Understand how to use a Hertzsprung-Russell diagram to determine distances to stars
13.27 Know that radio astronomy has been important in the discovery of quasars, jets from black holes, the structure of the Milky Way and protoplanetary discs	13.15 Understand the causes of variability in the light curve of eclipsing binary stars	13.14 Understand the light curves of the following variable stars: a short/long period b eclipsing binary c Cepheid d novae and supernovae
13.28 Understand why some infrared telescopes can operate in high-altitude locations, on the Earth's surface	13.17 Understand the structure of gravitationally bound stellar groupings such as binary stars and clusters	13.16 Understand how Cepheid variables can be used to determine distances
13.29 Know that infrared astronomy has been important in the discovery of protostars, dust and molecular clouds and hotspots on moons	13.18 Understand how the period of an eclipsing binary star can be deduced from its light curve	13.21 Understand how astronomers obtain and study the patterns of spectral lines in the light from astronomical objects
13.30 Understand the detrimental effect of the Earth's atmosphere on the quality of images formed by telescopes on the Earth's surface	13.19 Be able to use star trail photographs to determine the length of the sidereal day	13.26 Understand how multiple radio telescopes can operate as an aperture synthesis system (array)
13.31 Understand why telescopes operating		13.34 Understand how a telescope alters the

outside the optical and radio 'windows' need to be sited above the Earth's atmosphere		appearance of: a stars b double stars c binary stars d open clusters e globular clusters f nebulae g galaxies
13.32 Understand the advantages and disadvantages of space telescopes and detectors, including orbital observing platforms		
13.33 Understand how gamma ray, x-ray and ultraviolet astronomy have been important in the discovery of gamma ray bursts, black hole accretion discs and the corona and chromosphere structure of young stars		
Topic 14 – Stellar evolution		
14.1 Be able to use the Messier and New General Catalogue (NGC) in cataloguing nebulae, clusters and galaxies	14.3 Understand the effects of the interaction between radiation pressure and gravity in a main sequence star	
14.2 Be able to use the Bayer system for naming the brightest stars within a constellation	14.4 Understand changes to the radiation pressure-gravity balance at different stages in the life cycle of a star with a mass similar to the Sun	
14.9 Understand the principal stages and timescales of stellar evolution for stars of similar mass to the Sun, including: a emission and absorption nebula b main sequence star c planetary nebula d red giant	14.5 Understand the balance between electron pressure and gravity in a white dwarf star	

e white dwarf f black dwarf		
14.10 Understand the principal stages and timescales of stellar evolution for stars of much larger mass than the Sun, including: a emission and absorption nebula b main sequence star c red giant d white dwarf e supernova f neutron star g black hole	14.6 Understand changes to the radiation pressure-gravity balance at different stages in the life cycle of a star with a mass much greater than the Sun	
14.11 Understand how astronomers study and gather evidence for the existence of black holes	14.7 Understand the balance between neutron pressure and gravity in a neutron star	
	14.8 Understand the effect the Chandrasekhar Limit has on the outcome on the final stages of the life cycle of a star	
Topic 15 – Our place in the Galaxy		
15.1 Understand the appearance of the Milky Way from Earth as seen with binoculars or a small telescope	15.13 Understand why galaxies are grouped in larger clusters and superclusters	15.3 Understand how 21 cm radio waves, rather than visible light, are used to determine the structure and rotation of our Galaxy
15.2 Know the size and shape of our Galaxy and the location of the Sun, dust, sites of star formation and globular clusters	15.14 Understand the main theories for the formation and evolution of galaxies	
15.4 Know that the group of galaxies gravitationally linked to the Milky Way is		

called the Local Group 1		
5.5 Know the composition and scale of the Local Group, including its principal components: a Andromeda Galaxy (M31) b Large and Small Magellanic Clouds (LMC and SMC) c Triangulum Galaxy (M33)		
15.6 Be able to classify galaxies using the Hubble classification system, including: a spiral b barred spiral c elliptical d irregular		
15.7 Know how the different types of galaxies were placed by Hubble on his 'Tuning Fork' diagram		
15.8 Know that the Milky Way is a barred spiral (SBb) type galaxy		
15.9 Know that some galaxies emit large quantities of radiation in addition to visible light		
15.10 Know that an Active Galactic Nucleus (AGN) is powered by matter falling onto a super-massive black hole		
15.11 Know types of active galaxies, including: a Seyfert galaxies b quasars c blazars		

15.12 Know that information about AGNs can be obtained from many regions of the electromagnetic spectrum		
Topic 16 – Cosmology		
16.1 Know that observations of galaxies outside the Local Group show that light is shifted to longer wavelengths (redshift)	16.4 Understand the evidence to confirm the discovery of the expanding universe	16.2 Understand that redshift is caused by galaxies receding from us
	16.10 Understand the significance and possible nature of dark matter and dark energy	16.3 Be able to use the formula: $\lambda - \lambda_0 / \lambda_0 = c/v$ where λ is the observed wavelength, λ_0 is the emitted wavelength, v is the radial velocity of the source, c is the speed of light
	16.11 Understand the difficulties involved in the detection of dark matter and dark energy	16.5 Be able to use the relationship between distance and redshift of distant galaxies (Hubble's law) including the formula: $v = H_0 d$ where v is the radial velocity of the recession of the galaxy, H_0 is the Hubble constant and d is the distance of the galaxy from Earth.
	16.12 Understand that current models of the Universe predict different future evolutionary paths	16.6 Understand the estimation of the age and size of the Universe using the value of the Hubble constant
		16.7 Understand how the expansion of the Universe supports both the Big Bang theory and the Steady State theory

		16.8 Understand the major observational evidence in favour of the Big Bang theory: a quasars (QSOs) b cosmic microwave background (CMB) radiation c Hubble Deep Field image
		16.9 Understand the significance of the fluctuations in the CMB radiation for theories of the evolution of the Universe, including discoveries by the Wilkinson Microwave Anisotropy Probe (WMAP) and the Planck mission