Specification

Edexcel GCSE in Astronomy (1627)

First examination 2003

December 2000

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Acknowledgements

This specification has been produced by Edexcel on the basis of consultation with teachers, examiners, consultants and other interested parties. Edexcel recognises and values all those who contributed their time and expertise to the development of GCSE specifications.

Authorised by Sue Parker

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Contents

Introduction

The Edexcel GCSE in Astronomy is an interesting subject that is accessible to a wide range of age groups.

Astronomy is one of the oldest of the sciences. It has had a significant influence on cultural development throughout the world and astronomical ideas permeate everyday life.

Recent advances made in astronomical discovery through the application of science and the use of new technology, especially in the realm of space exploration, further illustrate the relevance and value of studying GCSE Astronomy.

Key features

- Provides enrichment opportunities for a flexible curriculum at Key Stage 4 or post 16.
- A wide range of delivery options.
- Complements GCSE Science and GCE AS/A Physics.
- Clear amplification of subject content.
- Coursework guide.
- A subject suitable for all age groups.

Summary of the specification content

GCSE Astronomy	
Unit	**Content**
1	Planet Earth
2	The Moon and the Sun
3	The Solar System
4	Stars and galaxies
5	Observing techniques and space exploration

Summary of scheme of assessment

GCSE Astronomy	**Mode of assessment**	**Weighting**	**Length**
Written paper	External	75%	2 hours
Coursework	Internal	25%	–

Availability of external assessment

First assessment of this specification will be in June 2003. Assessment will be available in each summer examination session thereafter.

Prior learning and progression

GCSE Astronomy provides progression from the National Curriculum Key Stage 3 programme of study in the core subjects.

It provides a suitable course for students who have already achieved a qualification in a GCSE Science and wish to undertake further studies in physical science in a new subject area.

GCSE Astronomy may be used as a foundation to, or may be delivered alongside the following courses:

- GCSE Science and GCE AS and Advanced Physics
- AVCE Science
- Other Science related courses at Level 3.

Scientific requirements

To satisfy the requirements of this astronomy specification candidates will not need to have reached a similar level of achievement in Key Stage 4 Science. Only those scientific skills, abilities and understanding which are necessary for the demonstration of knowledge, skills and understanding in GCSE Astronomy will be required.

Further details can be found in *Appendix 3 – Subject specific requirements,* on page 72.

Forbidden combinations and links with other subjects

Every specification is assigned to a national classification code indicating the subject area to which it belongs. Centres should be aware that students who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the school and college performance tables.

The classification code for this specification is 1690.

There are no forbidden combinations involving GCSE Astronomy and other subjects.

The content of this specification complements other Level 2 qualifications:

Foundation or Intermediate GNVQ Science

GCSE Science qualifications:

- Science: Physics
- Science: Single Award
- Science: Double Award

GCSE Mathematics

GCSE Design & Technology: Resistant Materials

GCSE Design & Technology: Graphic Products.

Specification aims and assessment objectives

National Qualifications Framework criteria

This specification is based on the common criteria and the GCSE criteria, which are prescribed by the regulatory authorities including QCA and are mandatory for all awarding bodies. It is also derived from the prescribed subject criteria for Science as appropriate.

Aims

This specification is aimed at students of all ages. The aims of the specification are to:

a enable students to acquire knowledge and understanding of the study and practice of astronomy and of its methods of enquiry and the skills needed to apply these in a range of contexts

b stimulate students' curiosity, interest and enjoyment in astronomy and its methods of enquiry and to enable them to take an informed interest in current astronomical investigations, discoveries and space exploration

c enable students to appreciate that the study and practice of astronomy are co-operative and cumulative activities and to appreciate the links between astronomy and other branches of science

d promote an awareness that the study and practice of astronomy are subject to social, economic, technological, ethical and cultural influences and limitations and that the applications of astronomy and space exploration may be both beneficial and detrimental to the individual and the community

e develop students' abilities and skills that are relevant to the study and practice of astronomy and that have useful practical applications beyond the confines of the subject itself, using ICT where appropriate

f enable students to select, organise and present information clearly and logically, using appropriate terms and conventions, using ICT where appropriate.

Assessment objectives

This specification requires that all students demonstrate the following assessment objectives in the context of the content and skills prescribed. Within each of the assessment objectives the assessment will take account of candidates' ability to communicate clearly and logically, using specialist vocabulary and conventions where appropriate.

AO1 Knowledge and understanding

Candidates must be able to:

- describe the Universe and describe and understand the physical nature and theory of astronomical phenomena
- recognise, recall and show understanding of specific astronomical facts, terminology, principles, concepts and observing and measuring techniques
- demonstrate understanding of and limitations of astronomical ideas and theories and appreciate how historical and cultural factors affect how these ideas and theories develop
- show understanding of the benefits and drawbacks of applications of astronomy
- select, organise and present relevant information.

AO2 Application of knowledge and understanding, analysis and evaluation

Candidates must be able to:

- describe, explain and interpret astronomical phenomena, ideas and theories in terms of astronomical principles and concepts, presenting arguments and ideas clearly and logically
- interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams and graphs
- carry out relevant calculations
- apply astronomical principles and concepts to unfamiliar situations, including those related to applications of astronomy in a range of contexts
- evaluate astronomical information and make informed judgements from it.

AO3 Practical and observing skills

Candidates must be able to:

- demonstrate appropriate observing and measuring techniques, including safe and skilful practical techniques, obtaining data which are sufficient and of appropriate precision, recording these methodically
- interpret data to draw conclusions which are consistent with their evidence, using astronomical knowledge and understanding, whenever possible, in explaining their observations
- evaluate data and methods.

Scheme of assessment

Entry tier

Candidates for this qualification are entered for one tier of assessment which provides access to grades G – A*.

Differentiation

Differentiation in external assessment will be achieved by:

- incline of difficulty within questions and across the written paper.

Additionally, differentiation will be achieved by the coursework component by:

- setting activities for candidates which take account of differing levels of ability
- teacher assessment allowing activities to be set to differentiate by outcome.

Assessment of the specification consists of:

External assessment (75%)

External assessment is via a written paper. All questions on the written paper will be compulsory. There will be a variety of questions on the paper, comprising structured questions involving both short answer and some extended prose responses.

Internal assessment (25%)

Internal assessment is via coursework. Candidates are required to submit two pieces of coursework:

	Choose **one** task from this column	**and**	Choose **one** task from this column
List A	Observations	List B1	Graphical and computational work
		List B2	Constructional work

These two pieces of coursework are equally weighted.

Internal assessment moderation procedures

The internal assessment weighting of this specification is 25%. The detailed requirements are set out in the section *Internal assessment* starting on page 20. To assist centres and provide all the information required within this document, detailed internal assessment moderation procedures are given in *Appendix 2* on page 66. If it proves necessary to amend these procedures in any way in the future, centres will receive separate notification.

Relationship of assessment objectives to scheme of assessment

Component	Assessment objectives			Totals
	AO1	AO2	AO3	
Written Paper	45 – 55%	25 – 35%	–	75%
Coursework	–	–	25%	25%
Totals	45 – 55%	25 – 35%	25%	100%

Quality of written communication (QoWC)

Assessment of quality of written communication will be across all assessment objectives.

In the written paper quality of written communication will be assessed in some questions that involve the writing of continuous prose. The mark schemes for questions will take into account the quality of written communication used by candidates in their answers. This will be signposted in the written papers by the following icon:

Candidates will be assessed on their ability to:

- present relevant information in a form that suits its purpose
- ensure that spelling, punctuation and grammar are accurate, so that the meaning is clear
- use a suitable structure and style of writing.

Quality of written communication will be assessed in the coursework component and will form 5% of the coursework component marks. See page 28.

Awarding, reporting and equivalence

The grading, awarding and certification of this specification will comply with the requirements of the GCSE and GCE A/AS Code of Practice for courses starting in September 2001, which is published by QCA. Qualifications will be graded and certificated on an eight grade scale from

A* to G.

GCSEs have broad equivalence to General National Vocational Qualifications in the following terms:

- two GCSEs at grade D to G and two GCSEs at grade A* to C are equivalent to one three-unit GNVQ at Foundation and Intermediate level respectively
- four GCSEs at grade D to G and four GCSEs at grade A* to C are equivalent to one six-unit GNVQ at Foundation and Intermediate level respectively.

Assessment language

Assessment of this specification will be available in English only. Assessment materials will be published in English only and all written and spoken work submitted for examination and moderation must be produced in English.

Students with particular requirements

Regulations and guidance relating to students with special requirements are published annually by the Joint Council for General Qualifications and are circulated to examinations officers. Further copies of guidance documentation may be obtained from the following address or by telephoning 0870 240 9800.

Edexcel will assess whether or not special consideration or concession can be made for students with particular requirements. Requests should be addressed to:

Special Requirements
Edexcel Foundation
Stewart House
32 Russell Square
London WC1B 5DN

Private candidates

This specification is not available to private candidates.

Specification content

All formulae required will be given in the appropriate questions in examination papers.

1 Planet Earth

- The Earth
- Days and seasons

The Earth

Candidates should be able to:

1.1 Describe the shape and size of the Earth, Moon and Sun in relation to the scale of the Solar System, making use of a scale model with balls of different sizes at appropriate spacings.

1.2 State the approximate diameter of the Earth (13 000 km).

1.3 State that the Earth's orbit is not quite circular and is elliptical.

1.4 Explain the meaning of the terms perihelion and aphelion.

1.5 State that the Earth's axis is tilted, and explain the meaning of the terms equator and ecliptic.

1.6 Explain the meaning of the terms latitude, longitude, pole, meridian, zenith and horizon.

1.7 State that the distance between the Earth and the Sun is known as one Astronomical Unit (1 AU), assuming that the Earth has a circular orbit.

1.8 Explain that 1 AU is more accurately described as the *mean* distance between the Earth and the Sun, because the Earth has an elliptical orbit.

1.9 Describe the features of the Earth which distinguish it from the other planets, including its extensive water surface and atmosphere.

1.10 Describe the effect of the Sun and Moon on the Earth's water surface (tides).

1.11 Explain scattering in the atmosphere and why the sky is blue.

1.12 Describe the benefits and drawbacks of the Earth's atmosphere to mankind in general and astronomers in particular.

1.13 Describe the problems of optical and chemical pollution of the atmosphere and the conditions affecting the siting of an observatory.

1.14 Describe radio interference from human causes and its effect on radio astronomical observations.

1.15 Describe the location and nature of the Van Allen belts and aurorae.

Days and seasons

Candidates should be able to:

1.16 Explain that the apparent East-West motion of the Sun and Moon implies a rotation of the Earth from West to East.

1.17 Explain the need for time zones due to the rotation of the Earth.

1.18 State the astronomical significance of a day and a year.

1.19 Distinguish between a solar and a sidereal day, and explain why the Earth's rotation period is 4 minutes less than 24 hours.

1.20 Describe how the Sun moves in the ecliptic and the significance of the terms equinox and solstice.

1.21 Explain the connection between the tilt of the Earth's axis, orbital movement and the seasons.

1.22 Explain the astronomical significance of observations made with a shadow stick.

1.23 Construct diagrams to show the variation in daylight length in a year given appropriate data.

1.24 Describe how a horizontal and vertical sundial is graduated and the reason for the angle of the gnomon.

1.25 Explain the seasonal variations in the rising and the setting of the Sun through the year.

1.26 Explain the terms mean sun and mean solar time.

1.27 Explain the equation of time (apparent solar time – mean solar time), and perform simple calculations.

2 The Moon and the Sun

- The Moon
- The Sun
- Eclipses

The Moon

Candidates should be able to:

2.1 State the approximate diameter of the Moon (3500 km) and its approximate distance from the Earth (380 000 km).

2.2 Explain that the same side of the Moon always faces the Earth as it orbits the Earth.

2.3 Explain why it is possible to observe more than 50% of the Moon's surface from the Earth.

2.4 Explain the Moon's phases, the shadow terminator and its effect on observations of visible lunar surface.

2.5 Describe the principal features of the Moon.

2.6 Describe the origins of lunar features, including craters, domes, maria, mountains, mascons, rilles and wrinkle ridges.

2.7 State the relative masses of the Earth and Moon and that the gravitational strength of the Earth is approximately six times that of the Moon.

The Sun

Candidates should be able to:

2.8 Describe the dangers of direct observation of the Sun and simple techniques for safe observation.

2.9 State that the Sun is a star.

2.10 State that the Sun's energy is produced by nuclear reactions in its interior, converting hydrogen into helium.

2.11 State the approximate diameter of the Sun (1.4 million km), its approximate distance from the Earth (150 million km) and its surface temperature (5700 K).

2.12 Describe the solar corona, photosphere and chromosphere.

2.13 Describe the temperature distribution through the layers of the Sun and the high temperature of the corona.

2.14 Describe the influence of the Sun's magnetic field on the appearance of the corona.

2.15 Describe the appearance of sunspots (umbra, penumbra and groups), prominences and solar flares.

2.16 Describe the long-term drift of sunspots, and the sunspot cycle.

2.17 Recognise the main characteristics of the Fraunhofer Spectrum and its uses, for example in determining the chemical composition of the Sun.

2.18 Describe the solar wind and explain the influence of the solar wind on the Van Allen belts and aurorae.

Eclipses

Candidates should be able to:

2.19 Describe the appearance of solar and lunar eclipses.

2.20 Describe with the aid of diagrams the mechanism causing solar and lunar eclipses.

2.21 Explain the different durations of eclipses of the Sun and Moon, and the reasons for partial and annular eclipses.

2.22 Explain why the corona can only be observed from the surface of the Earth at the time of a total solar eclipse.

3 The Solar System

The formulae given in this section will be stated in the appropriate questions on the examination papers.

- Planets and asteroids
- Meteors and comets

Planets and asteroids

Candidates should be able to:

3.1 Name the planets and state their approximate relative sizes and spacings.

3.2 State that Mercury, Venus, Mars, Jupiter and Saturn have been observed since ancient times.

3.3 Outline the discoveries of Uranus, Neptune and Pluto.

3.4 Describe the main physical characteristics of the planets, including brief qualitative details of surface features, atmosphere, temperature and composition.

3.5 Explain why the Earth is the most suitable planet for life.

3.6 State the existence of the planetary satellite systems and describe the appearance and physical features of the following satellites:

- Jupiter: Io
- Saturn: Titan
- Uranus: Miranda
- Neptune: Triton.

3.7 Describe the main differences between Pluto and the other major planets, and the grounds for believing that Pluto could be classified as an example of a new type of object in the Solar System.

3.8 Describe the appearance, physical nature and composition of the ring systems of Saturn and Uranus.

3.9 Distinguish between planets and stars and state that stars emit light and that planets shine by reflected starlight.

3.10 State that the planets move in elliptical orbits around the Sun, slightly inclined to the ecliptic, and appear to move in a band known as the zodiac.

3.11 Explain how the position of a planet in the sky depends on the relative positions of the Earth and the planet.

3.12 Identify the main features of a planetary track on a star map, including direct and retrograde motion and stationary points.

3.13 Explain the meaning of the terms greatest elongation, conjunction and opposition.

3.14 Explain the meaning of the terms transit and occultation.

3.15 Explain what asteroids are and how they may have been formed.

3.16 Describe the appearance and motion of the asteroids and where the orbits of most lie within the Solar System.

3.17 Explain why the impact of Comet Shoemaker-Levy 9 with Jupiter in 1994 has contributed to serious consideration of the risk of a collision between the Earth and a comet or an asteroid.

3.18 Describe the main contributions of Copernicus, Kepler and Galileo to the heliocentric theory.

3.19 Show a simple appreciation of the main discoveries attributed to Galileo:

- sunspots
- the phases of Venus
- the relief features of the Moon
- the principal satellites of Jupiter
- the unusual appearance of Saturn
- resolving the Milky Way into stars.

3.20 State Kepler's laws of planetary motion:

1 Planets move in elliptical orbits with the Sun at one focus.

2 The Sun-planet line sweeps out equal areas in equal times.

3 The orbital period of a planet squared is proportional to its mean distance from the Sun cubed, when different planets are compared.

3.21 Use Kepler's third law to relate orbital periods and distances:

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3$$

where T = period

r = mean distance from primary

and 1 and 2 refer to orbiting bodies.

3.22 Use Kepler's third law for one body in the form:

$$T^2 = r^3$$

where T is given in years

and r is given in Astronomical Units.

3.23 Describe the idea of the inverse square law as applied to the gravitational attraction between two bodies and to the relation between light intensity and distance.

3.24 Use Newton's Law of Gravitation in simple applications:

$$F = \frac{GM_1M_2}{r^2}$$

where F = force

G = Universal Gravitational constant

M = mass

r = mean distance between the two bodies
and 1 and 2 refer to each body.

3.25 Explain the connection between Newton's Law of Gravitation and Kepler's earlier work.

Meteors and comets

Candidates should be able to:

3.26 Describe the main features of meteor showers and explain that they arise from small dust particles orbiting the Sun.

3.27 Explain the occurrence of periodic meteor showers and account for their divergence from a radiant point.

3.28 Explain the connection between comets and meteoroids.

3.29 Describe the nature of meteorites and micrometeorites.

3.30 Describe the main features of comets; account for the composition of comets and their tails and how comets shine; and explain how the nucleus of a comet can develop a coma and two tails.

3.31 Distinguish between planetary and cometary orbits.

3.32 Describe the location and nature of the Oort Cloud, and the origin of the long period comets.

3.33 Describe the location and nature of the Kuiper Belt, and the possible derivation of the short period comets from this region.

4 Stars and galaxies

- Constellations
- Stars
- Galaxies

Constellations

Candidates should be able to:

4.1 Recognise and draw Ursa Major, Orion, Taurus and Cassiopeia.

4.2 State the names and draw the shapes of four other prominent constellations in the northern or southern hemispheres.

4.3 Use pointers to find Polaris, and Orion's Belt to find Sirius.

4.4 Explain the difference between a constellation and a physical grouping of stars.

4.5 Explain that a planet may temporarily alter the appearance of a constellation.

4.6 State that different constellations are visible at different times of the night and of the year.

4.7 Distinguish between optical double stars and binary star systems.

4.8 State what is meant by the term circumpolar stars; and explain the connection between the apparent motion of the northern stars around Polaris and the Earth's rotation.

4.9 Interpret and use long exposure photographs of star trails as evidence of the apparent motion of the stars.

Stars

Candidates should be able to:

4.10 Explain the terms right ascension and declination and use a star map and planisphere.

4.11 Explain that if a star is circumpolar from latitude L, then the declination D of the star $\geq 90 - L$.

4.12 Describe the method of heliocentric parallax for determining the distances of nearby stars.

4.13 State how a parsec is defined and show how it is used as a unit of distance in our Galaxy and beyond.

4.14 Identify the light curves of eclipsing binaries, Cepheid variables, novae and supernovae.

4.15 Explain the causes of variability in the light from eclipsing binaries, Cepheid variables, novae and supernovae.

4.16 Demonstrate a qualitative understanding of the scale of apparent magnitude, and how it relates to observed brightness, by recalling that:

- for a faint star apparent magnitude m = 6
- for a bright star m = 1
- for a bright planet m = -2.

4.17 Describe the discovery of and evidence for planets orbiting other stars.

4.18 Explain the meaning of the term absolute magnitude.

4.19 Use the scale of apparent magnitude, recalling that:

- a magnitude difference of 1 is equal to a brightness ratio of 2.5
- a magnitude difference of 5 is equal to a brightness ratio of 100
- 2.5^5 is approximately equal to 100.

4.20 Use the relationship between absolute magnitude M, apparent magnitude m and distance d:

$$M = m + 5 - 5 \lg d$$

performing simple calculations involving powers of 10 only.

4.21 Explain how Cepheid variables are used as distance indicators.

4.22 Describe how a stellar spectrum is obtained at the telescope.

4.23 Describe the appearance of a stellar spectrum, including emission and absorption lines.

4.24 Classify stars according to their spectral type (colour, surface temperature and composition).

4.25 Describe how information can be obtained from a spectrum, including the resolving of the components of a spectroscopic binary, and the differential rotation of the Sun.

4.26 Describe the evolutionary cycle of a star with solar mass and of stars with greater mass.

4.27 Describe and identify the main components of the Hertzsprung-Russell diagram.

4.28 Describe the observational evidence for black holes, including accretion discs or orbiting binary companions.

Galaxies

Candidates should be able to:

4.29 Describe how the Solar System and all the visible stars of the constellations form part of a galaxy which is part of a larger system called the Universe.

4.30 Describe the appearance of the Milky Way as seen with the naked eye, with binoculars and with a small telescope.

4.31 Explain that the observed Milky Way forms the plane of our own Galaxy.

4.32 State the position of the Sun in the Galaxy.

4.33 Describe the physical shape and size of the Milky Way Galaxy and its constituent parts.

4.34 Compare different types of nebula (emission, absorption [dark] and planetary) and star cluster (open and globular) in the Galaxy from an observational point of view.

4.35 Show some understanding of the physical characteristics of different types of nebula and star cluster.

4.36 State that galaxies are clustered in groups.

4.37 Describe the appearance of spiral, elliptical and irregular galaxies.

4.38 State the Hubble classification of galaxies.

4.39 Describe quasars.

4.40 Describe the cosmic background radiation.

4.41 Describe the observational evidence for the expanding Universe.

4.42 State the Doppler principle: light emitted from stars and galaxies that move away from the observer appear to have a longer wavelength, ie towards the red end of the visible spectrum, and that this is called ‘red shift’.

4.43 Explain why the search for dark matter in the Universe is important to cosmologists at the present time.

4.44 Describe the main arguments of the evolutionary (‘Big Bang’) theory of the Universe.

5 Observing techniques and space exploration

- Observing the Universe
- Exploring the Universe

Observing the Universe

Candidates should be able to:

5.1 Describe the differences between refracting and reflecting telescopes.

5.2 Describe the optical principles and relative merits of refracting and reflecting telescopes.

5.3 Explain that astronomers use telescopes to reveal more detail of the Moon and planets, and to enable observations to be made of many very faint stars.

5.4 Calculate the magnification of a telescope using:

$$\text{Magnification} = \frac{\text{focal distance of objective}}{\text{focal length of eyepiece}}$$

5.5 Explain that light-gathering power is proportional to the area of the aperture of a telescope, and that this is often a more significant factor in observations than magnification (eg in observing faint sources).

5.6 Draw accurate ray diagrams for a refracting telescope and Newtonian and Cassegrain reflecting telescopes.

5.7 Describe how exterior lighting affects the visibility of the stars.

5.8 Explain why large telescopes are often built on high mountains.

5.9 Explain that refraction in the atmosphere alters the apparent position of objects in the sky.

5.10 Describe the use of photographic techniques in astronomy, including star trails and arcs around the pole, meteor trails, and enhancing the light from faint objects such as comets.

5.11 Draw a simple diagram to show the passage of white light through a prism.

5.12 State that visible light and radio waves are both part of the electromagnetic spectrum.

5.13 State the principal wavebands of the electromagnetic spectrum and their order in terms of wavelength.

5.14 Distinguish between active radio astronomy (radar) and passive techniques (receipt of radio waves from space).

5.15 Describe how the distance of a nearby object can be determined using radar reflection.

5.16 Explain why the scale of a radio telescope is so much greater than that of an optical telescope, making qualitative use of the relationship between wavelength and resolution (eg longer wavelength gives poorer resolution).

5.17 Describe the general principles of observing techniques at other wavelengths in the electromagnetic spectrum especially infra-red, ultra-violet and X-ray astronomy.

5.18 Describe the main components and functioning of a simple radio dish.

5.19 Describe the contribution of radio and infra-red astronomy to the contemporary picture of the Universe.

5.20 State that the Sun's corona emits X-rays.

Exploring the Universe

Candidates should be able to:

5.21 Distinguish between the appearances of Earth satellites, stars, meteors and aircraft.

5.22 Explain why the light from an Earth satellite may suddenly cut out due to entry of the satellite into shadow.

5.23 Distinguish between a rocket and a spacecraft and explain the energy requirements involved in launching spacecraft.

5.24 State the names and main purposes of major space missions including Apollo, Voyager, Giotto, Galileo, Magellan and Cassini/Huygens.

5.25 Discuss the problems and advantages of the Hubble space telescope.

5.26 Describe some of the uses, benefits and limitations of unmanned space-flight and describe some of the main human problems involved in manned space flight.

5.27 Describe some of the limitations of space travel outside the confines of the immediate solar system.

5.28 Discuss some of the technical, financial and ethical issues arising from space research.

5.29 Describe the historical development of our knowledge of the scale of the Universe.

Internal assessment

The coursework component

Safe practice

Attention is drawn to the need for safe practice when candidates carry out practical activities or observe demonstrations. Reference must be made to COSHH regulations and any specific Local Education Authority restrictions.

Relevant advice can be obtained from the following publications:

COSHH; Guidance for Schools (HSC, 1989) HMSO ISBN 011 885 5115

Topics in Safety – 3rd Ed (Association for Science Education [ASE], 2001) ISBN 086 357 3169

CLEAPPS Laboratory Handbook and Hazards (available from CLEAPPS School Science to members or associates only).

The nature of the coursework and its assessment

The coursework component is weighted at 25% of the total assessment.

Two pieces of work are to be chosen, **one** from list A **and one** from lists B1 or B2:

	Choose **one** task from this column	**and**	Choose **one** task from this column
List A	Observations	List B1	Graphical and computational work
		List B2	Constructional work

The two tasks have equal weighting. The tasks are given on the following pages.

The assessment of tasks may be carried out by teachers at any time during the period of study leading to the GCSE examination. Practical work involving the skills and processes associated with astronomy will normally be related to the specification content.

Criteria for the assessment of the coursework component

For this specification, teachers must make a judgement of candidates' coursework using the performance criteria specified below. Teachers should check carefully that the students' work is their own work, and is not copied from source material without any attempt by the students to make the material their own.

A mark for quality of written communication must also be awarded according to the criteria specified on page 28.

Further details are given in *Appendix 2 – Procedures for moderation of internal assessment* on page 66.

List A Observations

Choose **one** task from this list.

Naked eye observations

1 Observe and draw the Moon's phases over a period of at least one lunar month, recording the dates, times, seeing and weather conditions, and rising and setting times.

2 Observe and make detailed drawings of three different constellations, recording dates, times, seeing and weather conditions and noting colours (if possible) and magnitudes by comparison with reference stars.

3 Observe a meteor shower. Record meteor trails on a drawing of the stellar background from sketches and estimate magnitudes of the meteors. Locate and show the position of the radiant.

4 Use a shadow stick to record the direction of the Sun at different times on at least two days and hence determine (a) the time of local noon and (b) the observer's longitude.

Photographic, binocular and telescopic observations

5 Observe the Moon with the aid of a suitable optical instrument and present photographs and/or drawings of lunar craters and/or other surface phenomena on at least two occasions, including details of the instrument(s) used with dates, times, and seeing and weather conditions.

Please note **If the full Moon is observed directly using a telescope at high magnification, then, owing to its brightness, a student's ability to make other observations directly afterwards will be impaired.**

6 Observe three different celestial objects with the aid of binoculars or a telescope and present photographs and/or drawings of these objects, including details of the instrument(s) used with dates, times, and seeing and weather conditions.

7 Project the image of the Sun onto a suitable background and either observe and record sunspots over a sufficiently long period of time to determine the Sun's rotation period or observe and record the various stages of a partial or total solar eclipse.

WARNING **The Sun must NOT be viewed directly, either with or without optical aids.**

8 Take long-exposure photographs of the circumpolar stars around Polaris or the South celestial pole and use them to explain and determine the length of the sidereal day.

Criteria for tasks taken from List A – Observations	
Statement of task	**Maximum 2**
Clear and precise statement of nature and purpose of task	2
Vague statement of nature and purpose of task	1
No statement of nature and purpose of task	0
Observational details	**Maximum 3**
• Full details given, including such factors as: – locations – dates – times – weather – seeing conditions.	3
• Some of the above details given	2
• Very few of the above details given	1
• No details given	0
Observations Award a mark on a linear scale from 0 to 6 for material submitted, taking into account such factors as: • size • clarity • use of colour (if applicable) • labelling • access to information • correct terminology.	**Maximum 6**
Detailed observations/deductions Award a mark on a linear scale from 0 to 4 for any detailed observations or calculations or deductions	**Maximum 4**
Presentation	**Maximum 4**
Material is neat and very well presented in a logical order	4
Material is fairly neat and fairly well presented in a logical order	3
Material is satisfactorily presented	2
Material is poorly presented	1
Material is poorly presented in a haphazard order	0

List B1Graphical and computational work

Choose **one** task from this list, **or one** task from List B2 (page 26)

1 Construct a star chart on a large rectangular grid using stars of the main constellations. Plot the positions and path(s) of at least one planet using either original observations or published ephemerides (eg Handbook of the BAA).

2 Draw a large chart of the Moon from references to photographic material, marking in and naming principal features and positions of Apollo and other notable lunar landing sites.

3 Use a spreadsheet and/or a graphing package or write a computer program to plot the stars of the main constellations and plot the positions and path(s) of at least one planet using either original observations or published ephemerides (eg Handbook of the BAA).

4 Use a spreadsheet and/or a graphing package or write a computer program which simulates the scaled orbits of either at least four planets around the Sun or the major satellites of a named planet.

Criteria for tasks taken from List B1 – Graphical and computational work	
Statement of task	**Maximum 2**
Clear and precise statement of nature and purpose of task	2
Vague statement of nature and purpose of task	1
No statement of nature and purpose of task	0
Quality of material	**Maximum 6**
Award a mark on a linear scale from 0 to 6 for the quality of material, taking into account such factors as: • size • clarity • use of colour (if applicable) • labelling.	
Information displayed	**Maximum 5**
Award a mark on a linear scale from 0 to 5 for the information contained on the chart or on the print-outs, taking into account such factors as: • relevance of information • access to information • correct terminology and units.	
References	**Maximum 2**
Good references giving full information	2
Incomplete references	1
No references	0
Presentation	**Maximum 4**
Material is neat and very well presented in a logical order	4
Material is fairly neat and fairly well presented in a logical order	3
Material is satisfactorily presented	2
Material is poorly presented	1
Material is poorly presented in a haphazard order	0

List B2 Constructional work

Choose **one** task from this list, **or one** task from List B1 (page 24)

1 Design and make a simple telescope using a variety of tubes, lenses and/or mirrors. Test the instrument in the night sky and estimate its power of magnification, field of view, magnitude limit and angular resolution.

2 Design and make a sundial. Use the sundial to record the times of day on at least three widely separated occasions and compare these with the mean local times.

3 Design and make a model of an eclipsing binary system using a motor, lamps and simple electronic components (eg LDR). Obtain measurements suitable for drawing a light curve for the model and compare this with the light curve of a real eclipsing binary system.

4 Design and make a model of the Sun-Earth-Moon system using lamps, spheres etc to illustrate how solar and lunar eclipses occur. Use it to account for the relative occurrences and durations of each type of eclipse.

Note

The report of this task should include at least one photograph of the instrument or model under construction and at least one photograph of the finished article. It is **not** necessary to send the finished article itself to the coursework moderator.

Criteria for tasks taken from List B2 – Constructional work	
Statement of task	**Maximum 2**
Clear and precise statement of nature and purpose of task	2
Vague statement of nature and purpose of task	1
No statement of nature and purpose of task	0
Design	**Maximum 3**
Care and consideration for size and materials	3
Some care and consideration for size and materials	2
Little care and consideration for size and materials	1
No real thought about design	0
Construction	**Maximum 4**
Award a mark on a linear scale from 0 to 4 for the actual construction of the instrument or model, taking into account such factors as: • size • materials • robustness • cost.	
Testing/use	**Maximum 4**
The instrument or model is fully tested and evaluated	4
Some use and evaluation	3
Little use and evaluation	2
Some evaluation but no testing or use	1
No evaluation, testing or use	0
References	**Maximum 2**
Good references giving full information	2
Incomplete references	1
No references	0
Presentation	**Maximum 4**
Material is neat and very well presented in a logical order	4
Material is fairly neat and fairly well presented in a logical order	3
Material is satisfactorily presented	2
Material is poorly presented	1
Material is poorly presented in a haphazard order	0

Quality of written communication

For more information, see page 6.

Marks for quality of written communication will be awarded in accordance with published regulations.

For the coursework, 5% of the total marks available are allocated to quality of written communication according to the performance criteria below.

Below threshold performance	**0 mark**	
Threshold performance	**1 mark**	Candidates spell, punctuate and use the rules of grammar with reasonable accuracy; they use a limited range of specialist terms appropriately.
High performance	**2 marks**	Candidates spell, punctuate and use the rules of grammar with considerable accuracy; they use a good range of specialist terms with facility.

Recording and collecting supporting evidence

Teachers must keep records of assessment for each student during the course and these must be available for use by the moderator at the end of the course. The Coursework Record Sheet, which should be photocopied for use in centres, is found on page 75. The assessments may be carried out by teachers at any time during the period of study leading to the GCSE examination.

Further details are given in *Appendix 2 – Procedures for moderation of internal assessment* on page 66.

Standardisation and moderation

The marks submitted to Edexcel for coursework will be moderated in accordance with the requirements of the National General Criteria (paragraphs 47-52) and the Mandatory Code of Practice for the GCSE.

Centres must ensure there is full and effective internal standardisation of the assessments made by different teachers and of different teaching groups within a centre. This will establish an overall order of merit for the students in the centre. A listing of the actual order of merit is NOT required.

Further details are given in *Appendix 2 – Procedures for moderation of internal assessment* on page 66.

Edexcel will provide centres with the results of moderation of their coursework assessments soon after the examination. A moderator's report on the assessment will be sent to each centre; this will provide comments and advice.

The Chief Examiner's Report will contain a section on coursework. It will cover the main points arising from moderation of the coursework assessment and provide guidance on good practice.

Grade descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by students awarded particular grades. The descriptions must be interpreted in relation to the specification content; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the student has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performances in others.

Grade F

A candidate awarded grade F should be able to:

- recall a limited range of information, for example by describing some of the principal features of the Moon
- show an appreciation of the historical development of astronomy, for example by describing some of Galileo's main discoveries
- obtain information from simple tables, charts and graphs and identify simple patterns in information and observations
- use and apply knowledge and understanding in some everyday contexts, for example by explaining that the apparent motion of the stars around the pole is really due to the rotation of the Earth
- link cause and effect in simple contexts, make use of scientific and technical vocabulary and make simple generalisations from given information
- use simple apparatus to make appropriate astronomical observations, record observations and measurements in tables and graphs, and offer simple explanations consistent with the evidence obtained.

Grade C

A candidate awarded grade C should be able to:

- recall a range of astronomical information from all areas of the specification, for example by comparing the different types of nebula that occur in the galaxy
- show the relevance of astronomy to human affairs, for example by explaining the need for time zones due to the rotation of the Earth
- use knowledge and understanding of astronomy to make inferences, identify and explain patterns within data, and make predictions from them
- use and apply astronomical knowledge and understanding in some general contexts, for example by explaining the role of gravity in the motions of a ball, bullet and satellite
- describe links between related phenomena in different contexts, use diagrams, charts and graphs to support arguments, and make use of appropriate scientific and technical vocabulary to explain a range of astronomical phenomena
- use a range of apparatus to make careful and precise astronomical measurements and systematic observations, recognising the need to repeat them when necessary, and present data appropriately in tables and graphs, drawing conclusions consistent with the evidence and explaining them using knowledge and understanding of astronomy.

Grade A

A candidate awarded grade A should be able to:

- recall a wide range of astronomical information from all areas of the specification, for example by describing the temperature distribution through the layers of the Sun, the appearance of a stellar spectrum and the emission of X-rays from the corona
- show an informed awareness of the social and economic implications of astronomy, for example by discussing some of the implications of space exploration
- use knowledge and understanding of astronomy to make inferences, identify and explain patterns within data, and make predictions from them by combining data of different kinds or from more than one source
- use detailed astronomical knowledge and understanding in a range of applications, for example by showing how different astronomical objects may be best observed at different wavelengths in the electromagnetic spectrum
- draw together and communicate knowledge from more than one area of astronomy, using diagrams, charts and graphs to support arguments, and making use of appropriate scientific and technical vocabulary to a consistently high standard in explaining a wide range of astronomical phenomena
- use knowledge and understanding of astronomy to select appropriate apparatus, make careful and precise astronomical measurements and systematic observations, recognising the need to repeat them when necessary, present data appropriately in tables and graphs, drawing conclusions consistent with the evidence and explaining them using knowledge and understanding of astronomy, and identifying and explaining shortcomings in the methods used and anomalous observations and measurements.

The wider curriculum

Key skills

This specification will provide opportunities, as appropriate, to develop the key skills of communication, information technology, application of number, improving own learning and performance, working with others and problem solving.

Examples of such opportunities throughout the specification are signposted. It is important that these opportunities fall naturally into a programme of study, and it may be that not all the examples are appropriate for all programmes. The examples offered may be adapted to suit particular situations, and it will be possible to devise many alternative opportunities and approaches. The development of key skills can enhance teaching and learning strategies and can be a stimulus to new approaches, and increase levels of student involvement.

Key skills opportunities are detailed more fully in *Appendix 1*, page 44.

Mathematical skills

Candidates need to have been taught and to have acquired competence in the areas of mathematics set out below in order to develop knowledge, understanding and skills in the subject content.

Candidates are permitted to use electronic calculators in the written paper in accordance with the current regulations.

Candidates able to satisfy the requirements of this astronomy specification are not required to have reached a similar level of achievement in KS4 Mathematics. Only those mathematical skills and abilities which are necessary for the demonstration of knowledge, skills and understanding in Astronomy at a level appropriate to the candidate will be required.

Candidates will be expected to perform:

- the operations of addition, subtraction, multiplication and division
- manipulation of simple fractions and decimals
- the drawing and interpreting of graphs and extracting information
- calculations involving percentages
- the solution of simple algebraic equations within the scope of the specification
- substitution of given numerical data into a formula and simple cases of changing the subject of the formula
- calculations on a calculator involving +, –, ×, ÷, x^2, x^3, $\sqrt{}$
- simple calculations involving angles
- the conversion of numbers into and out of standard form and appreciation of order of magnitude and appropriate levels of approximation
- simple calculations involving the use of integral values of base 10 logarithms (eg lg 100 = 2) and the inverse (eg 2 = lg 100).

Spiritual, moral, ethical, social and cultural issues

The teaching of this specification provides many opportunities for candidates to explore these wider curriculum issues. The content of the specification raises issues through addressing:

- theories on the origin and nature of the Universe
- the cultural significance of observing the heavens
- historical views on the nature of the Solar System
- theories on the origin of the Solar System.

Education for citizenship

This specification makes a contribution towards coverage of the Key Stage 4 programme of study for citizenship; in particular through studying astronomical topics students will gain knowledge, skills and understanding which will enable them to play an effective role in society at local, national and international levels. This could be stimulated by their studies of the possibility of an impact on the Earth by a comet or an asteroid, or the implications of space exploration.

Through researching topics students can obtain and use different kinds of information, including the media, to help them to become informed, thoughtful and responsible citizens who are aware of astronomical issues affecting society, and enable them to express opinions on issues they encounter. For example, their studies will lead to a consideration of economic systems through their study of the implications and use of natural resources and use of energy resources in launching satellites balanced against the potential income from applications of this technology. This may lead to an awareness of issues relating to sustainable development.

An awareness of astronomical issues such as the effect of light pollution and atmospheric pollution can lead to students taking part in school and community-based activities and foster a willingness and commitment in them to evaluate such activities critically. Engaging in such activities will enable students to demonstrate personal and group responsibility in their attitudes to themselves and others. This may develop their ability to evaluate the effectiveness of different ways of bringing about change at different levels of society. This would promote their spiritual, moral, social and cultural development, making them more self-confident and responsible citizens, and would help prepare them to take a full and active role in society.

Information and communication technology

Candidates should be given opportunities to apply and develop their ICT capability through the use of ICT tools to support their learning in GCSE Astronomy.

Examples may include the use of:

- data loggers
- spreadsheets
- graphical packages
- simulations
- word processing
- databases
- Internet.

This specification may be used to address the key skill *Information Technology*. Further details are given in *Appendix 1*, page 44.

Environmental education

Environmental awareness will be developed in this specification through the context of:

- conservation of energy
- effects of light pollution
- resources required and disposal of materials used in imaging
- resources required to build and launch satellites and space probes
- fate and consequences of satellites reaching the end of their life.

Health and safety education

The following topics indicate content complementing the personal social and health education programmes as set out in the National Curriculum:

- hazards involved in observing the Sun and the Moon
- safety whilst making observations at night
- health risks of sustained viewing of VDUs.

In all aspects of practical work and making observations candidates are required, in the context, to consider the safety of themselves and others. Centres are responsible for the overall risk assessment of practical work and making observations undertaken by candidates.

European and global dimension

Many of the topics studied in GCSE Astronomy provide a European and global dimension to theories, views and discoveries. This can be further enhanced by candidates accessing current developments through use of the Internet, and by keeping abreast of the work of the European Space Agency. This dimension is also supported through addressing the issue of atmospheric pollution and considering the implications of European legislation.

Textbooks and other teaching resources

A wide range of resources are available for various sources, for example:

Royal Observatory Greenwich

Leaflets are available for the Royal Observatory Greenwich (now based at the National Maritime Museum). Most are at an appropriate level for GCSE Astronomy.

These are available from:

The National Maritime Museum
Park Row
Greenwich
London
SE10 9NF

Tel: 020 8858 4422
www.rog.nmm.ac.uk

Association for Astronomy Education (AAE)

The AAE can provide information on books suitable for a wide range of ages:

The Association for Astronomy Education
c/o The Royal Astronomical Society
Burlington House
Piccadilly
London
W1V 0NL

www.star.ucl.ac.uk/~aae/aaehomep.htm (Home page)

Particle Physics and Astronomy Research Council (PPARC)

PPARC will provide details of extensive resources:

PPARC
Communications Unit
Polaris House
North Star Avenue
Swindon
Wiltshire
SN2 1SZ

Tel: 01793 442 000
www.pparc.ac.uk (Home page)
www.pparc.ac.uk/PUS/pp_resource/index.html (Index to on-line resources)

Textbooks

Strongly recommended reading

Henbest N – *Universe* (Macmillan USA) ISBN 0025509217

Henbest N – *The Planets* (Penguin) ISBN 014013414X

Jones B – *Exploring the Planets* (Trodd) ISBN 1853611727

Marshall N – *GCSE Astronomy: A guide for pupils and teachers* (Mickledore) ISBN 0953634507

Moore P – *Astronomy for GCSE* (Duckworth) ISBN 0715623095

Moore P – *Exploring the Night Sky with Binoculars* (Cambridge University Press) ISBN 0521793904

Ridpath I (ed) – *Norton's 2000.0 Star Atlas* (Longman) ISBN 058203163

Useful back-up material

Baxter W N – *The Sun and the Amateur Astronomer* (David and Charles) ISBN 0600303489

Chown M – *Afterglow of Creation* (University Science) ISBN 0935702401

Jones B – *An Introduction to Practical Astronomy* (Chartwell) ISBN 1555217281

Mills R and Couper H – *Practical Astronomy* (Horwood) ISBN 1898563004

Moore P – *The Moon* (Duckworth) ISBN 0855333103

Moore P and Hunt G – *The Atlas of the Solar System* (Bounty Books) ISBN 075370014X

Novikov I – *Black Holes and the Universe* (Cambridge University Press) ISBN 0521558700

Ridpath I – *Young Astronomer's Handbook* (Hamlyn)

Seymour P – *Adventures with Astronomy* (John Murray)

Cox and Monkhouse – *Philip's Colour Star Atlas* (Philip's) ISBN 0540063169

Ridpath I and Tirion W – *Monthly Sky Guide* (Cambridge University Press) ISBN 0521667712

Astronomy Now (Monthly) – (Current information, articles and reviews. Good for second-hand instruments)

The Times Night Sky Guide (Annual) – (Provides a month by month summary for the year)

Other books

Baker D – *The Hamlyn Guide to Astronomy* (Hamlyn) ISBN 0600303489

Chartrand M Skyguide – *A Field Guide to the Heavens* (Golden, New York) ISBN 0307136671

Covington I – *Astrophotography for the Amateur* (Cambridge University Press) ISBN 0521627400

Henbest N and Marten M – *The New Astronomy* (Cambridge University Press) ISBN 0521408717

Levy D – *The Sky: A User's Guide* (Cambridge University Press) ISBN 0521459583

Muirden J – *Pocket Book of Astronomy* (Kingfisher) ISBN 0862722756

North G – *Mastering Astronomy* (Macmillan) ISBN 0332456564

Ronan C (ed) – *Amateur Astronomy* (Newnes)

Snowden S – *The Young Astronomer* (Usborne) ISBN 0860206513

Stott C (ed) – *Images of the Universe* (Cambridge University Press) ISBN 0521424194

Wilson C – *Starseekers* (Hodder and Stoughton)

Moore P (ed) – *Yearbook of Astronomy* (As above but with more details and longer articles)

Astronomy (Monthly) – (USA glossy with good graphics and photographs. Topical)

Videos

Encyclopaedia Galactica (5 volumes)
Tel: 020 8669 4355

Computer software

Too numerous to mention but students should have access to one of the modern programs which offer a desktop planetarium facility and database. Software available for PC, Macs and CD ROM can be advertised in *Astronomy Now*.

Instruments

Suppliers can be found advertising in *Astronomy Now*. Cheaper binoculars found in retail outlets are adequate. Ideally, they should be attached via a binocular clamp to a tripod for stability.

For most students the financial outlay for a reasonable beginner's telescope (£200 – £400) is rarely justified by its use. A cheap or home made 4" or 6" 'Dobsonian' tends to be robust. There is also a lively market in second-hand instruments. A telescope is not essential for the course.

Suppliers

Videos, slides, planispheres, posters, etc may be obtained mail order from sources such as Armagh Planetarium.
Tel: 01861 524725

'Earth and Sky' specialises in mail order astronomy resources, mainly books.
Tel: 01328 820083

Specialist instrument outlets include:

Orion Optics	01270 500089
Broadhurst Clarkson and Fuller	020 7405 2156
David Hines	01442 827768
Beacon Hill	01472 693959
Scope City	0151 7094149

Useful contacts

The Society for Popular Astronomy (formerly JAS)
36 Fairway
Keyworth
Nottingham
England
NG12 5DU

(Magazine to members plus special interest groups; good for the enthusiast)
www.popastro.com

European Association For Astronomy Education
www.algonet.se/~sirius/eaae.htm
www.star.ucl.ac.uk/~aae/eaaehome.htm (UK Home page)

British Astronomical Association
Burlington House
Piccadilly
London
W1V 9AG
(Tel. 020 7734-4145
Fax. 020 7439-4629)
www.ast.cam.ac.uk/~baa/

European Space Agency
www.esrin.esa.int

NASA
http://www.nasa.gov
http://spacelink.nasa.gov/products (Online educational products)

Astronomy Now On-line
www.astronomynow.com

AstroWeb
Astronomy/Astrophysics on the Internet – a collection of pointers to astronomy-related information available on the Internet.
www.cv.nrao.edu/fits/www/astronomy

Support and training

Training

A programme of INSET courses covering various aspects of the specifications and assessment will be arranged by Edexcel each year on a regional basis. Full details may be obtained from:

INSET
Edexcel Foundation
Stewart House
32 Russell Square
London WC1B 5DN

Tel: 020 7758 5620
Fax: 020 7758 5950
020 7758 5951 (second fax number)
E-mail: inset@edexcel.org.uk

Website

www.edexcel.org.uk

Please visit the Edexcel website, where further information about training and support for all qualifications, including this GCSE, can be found.

The website is regularly updated, and an increasing amount of support material and information will become available through it.

Edexcel Publications

Edexcel will provide support for teachers in centres offering this specification. This will include:

- amplification of the internal assessment scheme
- examples of suitable practical activities for assessment
- full analyses of some practical activities as a guide to setting and marking activities
- examples of assessed candidates' work, showing how marks are awarded for the two tasks.

Support materials and further copies of this specification can be obtained from:

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4FN

Tel: 01623 467467
Fax: 01623 450481
E-mail: publications@linneydirect.com

The following support materials will be available from spring 2001 onwards:

- specimen papers
- internal assessment guide.

Regional Offices and Customer Response Centre

Further advice and guidance is available through a national network of regional offices. For general enquiries and for details of your nearest office please call the Edexcel Customer Response Centre on 0870 240 9800.

Appendices

Appendix 1 – Key skills

The GCSE in Astronomy offers a range of opportunities for students to:

- develop their key skills
- generate assessed evidence for their portfolio.

In particular, the following key skills can be developed and assessed through this specification at level 2:

- application of number
- communication
- information technology
- improving own learning and performance
- working with others
- problem solving.

Copies of the key skills specifications can be ordered from Edexcel Publications.

The individual key skills units are divided into three parts:

- **Part A**: what you need to know – this identifies the underpinning knowledge and skills required of the student
- **Part B**: what you must do – this identifies the evidence that students must produce for their portfolio
- **Part C**: guidance – this gives examples of possible activities and types of evidence that may be generated.

This GCSE specification signposts development and internal assessment opportunities which are based on Part B of the level 2 key skills units. For those students working at level 1, these level 2 opportunities can also be used to generate evidence at level 1. Reference should be made to the appropriate level 1 statements in the key skills specifications.

The evidence generated through this GCSE will be internally assessed and contribute to the student's key skills portfolio. In addition, in order to achieve the key skills qualification, students will need to take the additional external tests associated with communication, information technology and application of number. Centres should check the current position on proxy qualifications as some students may be exempt from part or all of the assessment of a specific key skill.

Each section within the GCSE in Astronomy will provide opportunities for the development of all six of the key skills identified. This appendix identifies the key skills evidence requirements and also provides a mapping of those opportunities. Students will need to have opportunities to develop their skills over time before they are ready for assessment. This appendix contains illustrative activities for each key skill that will aid development and facilitate the generation of appropriate portfolio evidence. To assist in the recording of key skills evidence Edexcel has produced recording documentation which can be ordered from Edexcel Publications.

Mapping of key skills: summary table

	Unit				
Key skills (level 2)	**1** **Planet Earth**	**2** **The Moon and the Sun**	**3** **The Solar System**	**4** **Stars and galaxies**	**5** **Observing techniques and space exploration**
Application of number					
N2.1	3	3	3	3	3
N2.2	3	3	3	3	3
N2.3	3	3	3	3	3
Communication					
C2.1a	3	3	3	3	3
C2.1b	3	3	3	3	3
C2.2	3	3	3	3	3
C2.3	3	3	3	3	3
Information technology					
IT2.1	3	3	3	3	3
IT2.2	3	3	3	3	3
IT2.3	3	3	3	3	3

	Unit				
Key skills (level 2)	**1** **Planet Earth**	**2** **The Moon and the Sun**	**3** **The Solar System**	**4** **Stars and galaxies**	**5** **Observing techniques and space exploration**
Working with others					
WO2.1	3	3	3	3	3
WO2.2	3	3	3	3	3
WO2.3	3	3	3	3	3
Improving own learning and performance					
LP2.1	3	3	3	3	3
LP2.2	3	3	3	3	3
LP2.3	3	3	3	3	3
Problem solving					
PS2.1	3	3		3	
PS2.2	3	3		3	
PS2.3	3	3		3	

Application of number level 2

The GCSE in Astronomy provides opportunities for students to both develop the key skill of application of number and also to generate evidence for their portfolio. As well as undertaking tasks related to the three areas of evidence required students are also required to undertake a substantial activity that includes straightforward tasks. This will involve students obtaining and interpreting information, using this information when carrying out calculations, and interpreting and presenting the results of the calculations.

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
N2.1	Interpret information from **two** different sources, including material containing a graph	1 – 5	Students are required to obtain and use the information required, selecting appropriate methods to get the results required. Suitable subjects are: • The scale of the Solar System. (1.1) • Time zones. (1.17) • Equation of time. (1.27) • Interpreting the Fraunhofer Spectrum. (2.17) • Interpreting star maps. (3.12 and 4.10) • Interpreting Kepler's third law. (3.21) • Interpreting long-exposure photographs of star trails. (4.9 and 5.10) • Declination calculations. (4.11) • Heliocentric parallax, the parsec and distance of stars. (4.12 and 4.13) • Analysing light curves. (4.14) • Apparent magnitude. (4.19) • Classification of stars. (4.24) • Using the Hertzsprung-Russell diagram. (4.27) • Magnification of telescopes. (5.4) • Light gathering power of telescopes. (5.5) Additionally, this whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
N2.2	Carry out calculations to do with: a amounts and sizes b scales and proportions c handling statistics d using formulae.	1 – 5	Students must carry out their calculations, which could relate to volumes, ratios, averages, formulae, etc, and show their methods of working. They must show how they have checked results and corrected their work as necessary. Suitable subjects are: • The scale of the Solar System. (1.1) • Time zones. (1.17) • Shadow stick observations. (1.22) • Equation of time. (1.27) • Interpreting the Fraunhofer Spectrum. (2.17) • Interpreting star maps. (3.12 and 4.10) • Interpreting Kepler's third law. (3.21) • Interpreting long-exposure photographs of star trails. (4.9 and 5.10) • Declination calculations. (4.11) • Heliocentric parallax, the parsec and distance of stars. (4.12 and 4.13) • Analysing light curves. (4.14) • Apparent magnitude. (4.19) • Classification of stars. (4.24) • Using the Hertzsprung-Russell diagram. (4.27) • Magnification of telescopes. (5.4) • Light gathering power of telescopes. (5.5) Additionally, this whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
N2.3	Interpret results of your calculations and present your findings. You must use at least **one** graph, **one** chart and **one** diagram	1 – 5	Based on their findings, students must select effective methods of presentation, using as appropriate tables, graphs, charts and diagrams. Students should explain how the results of their calculations meet the purpose of the activity undertaken. Suitable subjects are: • The scale of the Solar System. (1.1) • Time zones. (1.17) • Shadow stick observations. (1.22) • Equation of time. (1.27) • Interpreting the Fraunhofer Spectrum. (2.17) • Interpreting star maps. (3.12 and 4.10) • Interpreting Kepler's third law. (3.21) • Interpreting long-exposure photographs of star trails. (4.9 and 5.10) • Declination calculations. (4.11) • Heliocentric parallax, the parsec and distance of stars. (4.12 and 4.13) • Analysing light curves. (4.14) • Apparent magnitude. (4.19) • Classification of stars. (4.24) • Using the Hertzsprung-Russell diagram. (4.27) • Magnification of telescopes. (5.4) • Light gathering power of telescopes. (5.5) Additionally, this whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)

Evidence

Student evidence for application of number could include:

- description of the substantial activity
- copies of source materials
- records of calculations showing methods used
- descriptions of findings.

Communication level 2

For the communication key skill, students are required to hold discussions and give presentations, read and summarise information, and write documents. Students will be able to develop all of these skills through an appropriate teaching and learning programme based on this GCSE specification.

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
C2.1a	Contribute to a discussion about a straightforward subject	1 – 5	Many of the topics in this specification are suitable as the basis of a group discussion. The discussion should be about a straightforward subject. This may be a subject often met in their studies, etc and the vocabulary will be familiar. During the discussion students should make clear and relevant contributions, listen and respond to others, helping to move the discussion forward. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
C2.1b	Give a short talk about a straightforward subject, using an image	1 – 5	Following a period of research students could be given the opportunity to give a short talk to the rest of their group. During the talk students should speak clearly in a way that suits the subject and situation. They should keep to the subject. The structure of the talk should help listeners follow points made. The talk should include an image to illustrate main points clearly. Images could include charts, graphs, diagrams of apparatus and processes, pictures and photographs. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (3.7, 1.9, 1.10, 1.11, 2.5, 2.18, 3.4 and 3.6) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.17, 3.15 and 3.16) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)
C2.2	Read and summarise information from **two** extended documents about a straightforward subject One of the documents should include at least **one** image	1 – 5	Students will have a number of opportunities to read and synthesise information from two extended documents. For example, as part of their preparation for the discussion and talk, or as preparation for a piece of written work for their GCSE. Extended documents may include textbooks and reports and articles of more than three pages. At least one of these documents should contain an image from which students can draw appropriate and relevant information.

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
			Students will need to select and read relevant material. From this information they will need to identify accurately the lines of reasoning and main points from the text and images. Students will then need to summarise this information in a form that suits the purpose – eg for a talk, discussion or a presentation. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via of a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (3.7, 1.9, 1.10, 1.11, 2.5, 2.18, 3.4 and 3.6) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)
C2.3	Write **two** different types of documents about straightforward subjects One piece of writing should be an extended document and include at least **one** image	1 – 5	Students are required to produce two different types of document. At least one of these should be an extended document, for example a report of more than three pages. The document should present relevant information in an appropriate form. At least one of the documents should include an appropriate image that contains and effectively conveys relevant information. The information in the document should be clearly structured eg through the use of headings, paragraphs, etc. Students should ensure that the text is legible and that spelling, punctuation and grammar are accurate. The two types of documents could be the basis of a presentation to the class and a project or practical work write-up presented to the teacher. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
			a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (3.7, 1.9, 1.10, 1.11, 2.5, 2.18, 3.4 and 3.6) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)

Evidence

Student evidence for communication could include:

- tutor observation records
- preparatory notes
- audio/video tapes
- notes based on documents read
- essays.

Information technology level 2

When producing work for their GCSE in Astronomy students will have numerous opportunities to use information technology. The internet, CD ROM, etc could be used to collect information. Documents can be produced using relevant software and images may be incorporated in those documents. Early drafts of documents could be e-mailed to tutors for initial comments and feedback.

If students undertaking coursework as part of their GCSE in Astronomy use information technology, they will have opportunities to generate evidence for all three sections identified in Part B of the key skills specification.

In addition, students will be able to use information technology to generate evidence for the communication key skill. For example the extended document with images, required for C2.3, could be generated using appropriate software.

As part of their Astronomy programme students may not be able to generate sufficient evidence required for this unit. For example working with numbers through the use of a spreadsheet application, or some aspects of database use. In this situation, students may use stand alone IT sessions for development and evidence generation and/or other parts of their GCSE course.

Key skill portfolio evidence requirement		**GCSE Astronomy unit**	**Opportunities for development or internal assessment**
IT2.1	Search for and select information for **two** different purposes	1 – 5	Students will need to identify suitable sources of information and effectively search for information using multiple criteria. Information selected should be interpreted and students should decide what is relevant for their purpose. This key skill can be addressed along with Communication by students undertaking research for a practical activity or a project. The two purposes could be a presentation to the class and a project or practical work write-up presented to the teacher. The key skill communication may also be addressed alongside this aspect of this key skill. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
			• The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)
IT2.2	Explore and develop information, and derive new information for **two** different purposes	1 – 5	Students are required to bring together information in formats, such as tables, that help development. The information should be explored by, for example, changing information in a spreadsheet model. Information should also be developed and new information derived as appropriate, for example through the use of headings, tables, charts and graphs. New information should be derived from, for example, comparing information from different sources, using formulae to perform calculations, or processes may be modelled using IT. The two purposes could be a presentation to the class and practical work write-up or a project presented to the teacher. Subjects in Section IT2.1 which are suitable for research are also suitable for this aspect of the key skill. The key skill communication may also be addressed alongside this aspect of this key skill. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
			• Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28) Additionally, the following subjects are suitable for modelling by means of spreadsheets, or modelling programs: • The size and scale of the Solar System. (1.1) • Shadow stick observations. (1.22) • Variation in daylight length. (1.23) • Phases of the Moon. (2.4) • Solar and lunar eclipses. (2.20 and 2.21) • The position of planets and their tracks. (3.11 and 3.12) • Kepler's laws. (3.20, 3.21 and 3.22) • Periodic meteor showers. (3.26 and 3.27) • Position of constellations. (4.6) The following may be modelled using ultrasound sensors connected to a datalogger as well as with a spreadsheet or modelling program: • Using radar to determine the distance of objects. (5.15)
IT2.3	Present combined information for **two** different purposes This work must include at least **one** example of text, **one** example of images and **one** example of numbers	1 – 5	In presenting combined information students will need to select and use appropriate layouts in a consistent way through, for example, the use of margins, headings, borders, font size, etc. Layouts, etc should be refined to suit both the purpose and the needs of the audience (early drafts should be kept as portfolio evidence). The final piece of work should be suitable for its purpose and audience eg GCSE coursework, OHTs/hand-outs for a presentation, etc. The document should have accurate spelling (use of spell-checker) and have been proofread. The two purposes could be a presentation to the class and a project or practical work write-up presented to the teacher. Subjects already identified as being suitable for the key skill IT are also suitable for this aspect of IT. The key skill communication may also be addressed alongside this aspect of this key skill. This whole key skill may be addressed through the means of a practical investigation. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
			This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)

Evidence

Student evidence for information technology could include:

- tutor observation records
- notes of sources used
- print-outs with annotations
- draft documents.

Working with others level 2

To achieve this key skill, students are required to carry out at least two activities. One example must show that they can work in one-to-one situations and one example must show that they can work in group situations. Students will plan their work with others and confirm working arrangements; work co-operatively towards achieving identified objectives, and exchange information on progress.

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
WO2.1	Plan straightforward work with others, identifying objectives and clarifying responsibilities, and confirm working arrangements	1 – 5	Students should identify the objectives of working together in groups to plan the successful completion of a set activity. Students should also identify the tasks, resources and timescales required to meet these objectives. Information should be exchanged to clarify responsibilities. For example suggesting ways help can be given, asking what others can do, checking their own and others' responsibilities. The group needs to confirm responsibilities and working arrangements. A suitable activity could be a project, an experiment or a practice investigation. This key skill may be combined with other key skills: communication and IT by including research and presentation as part of the activity; and additionally application of number if the activity is a practical activity. If this is done then students will need to have individually covered aspects of all the key skills involved. This whole key skill may be addressed through the means of a practical investigation. Centres will need to ensure that the work of individual candidates can be identified if the practical investigation is used as evidence for the coursework component of this specification, and may be advised not to use the same activity for both purposes. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar Eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
			• The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)
WO2.2	Work co-operatively with others towards achieving identified objectives, organising tasks to meet responsibilities	1 – 5	When working towards agreed objectives students could work in pairs or small groups for project work and pairs for practical activities. Students will need to organise tasks so that responsibilities can be met, for example obtaining resources, completing tasks on time, etc. For example, whilst one student is researching for a project, another can be working on its presentation, or proof-reading an earlier draft; or one student could clear away apparatus from a previous stage of an investigation whilst the other is beginning the next stage. Tasks should be completed accurately and safely. Co-operative ways of working should be supported through, for example, anticipating the needs of others, avoiding actions that offend, etc. Advice from others, including group members, tutor, etc should be sought when needed. Students will need to plan and organise their work effectively so that they meet agreed deadlines and maintain appropriate working relationships. This whole key skill may be addressed through the means of a practical investigation. Centres will need to ensure that the work of individual candidates can be identified if the practical investigation is used as evidence for the coursework component of this specification, and may be advised not to use the same activity for both purposes. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
WO2.3	Exchange information on progress and agree ways of improving work with others to help achieve objectives	1 – 5	Once completed the full group needs to review outcomes against the agreed objectives. In doing this they should identify what has gone well and what has gone less well. Students should listen and respond to progress reports from others and agree ways of improving work with others to help achieve objectives. Students should identify areas of the exercise that could be improved and should suggest ways in which the group or pair could have worked differently and perhaps more effectively. This whole key skill may be addressed through the means of a practical investigation. Centres will need to ensure that the work of individual candidates can be identified if the practical investigation is used as evidence for the coursework component of this specification, and may be advised not to use the same activity for both purposes. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6) This whole key skill may also be addressed via a project. Suitable subjects for a project are: • The distinguishing features of Earth. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Observations and the Earth's atmosphere and pollution. (1.12, 1.13, 5.7, 5.8 and 5.25) • Solar and lunar eclipses. (2.19, 2.20, 2.21 and 2.22) • The features of the satellites Io, Titan, Miranda and Triton. (3.6) • The distinguishing features of Pluto. (1.9, 1.10, 1.11, 2.5, 2.18, 3.4, 3.6 and 3.7) • Shoemaker-Levy 9 and the risk of comets and asteroids colliding with Earth. (3.15, 3.16 and 3.17) • The heliocentric theory. (3.18) • The work of Galileo. (3.19) • The discovery of planets around other stars. (4.17) • The fate of the Universe. (4.41, 4.43, 4.44 and 5.29) • The purposes of space missions. (5.24) • Space flight – benefits, limitations and issues. (5.26, 5.27 and 5.28)

Evidence

Student evidence for working with others could include:

- tutor observation records
- preparatory notes
- records of process and progress made.

Improving own learning and performance level 2

Within GCSEs in Astronomy programmes, students will have opportunities to develop and generate evidence that meets part of the evidence requirement of this key skill.

To achieve this key skill, students will need to provide at least two examples of meeting the standard required. Students are also required to improve their performance through studying a straightforward subject and through learning through a straightforward practical activity. This GCSE in Astronomy will provide opportunities for students to study a straightforward subject. Evidence for learning through a practical activity may come from other GCSEs in the students' programme or from enrichment activities.

Activities that generate evidence for this skill should take place over a period of a few weeks. Over the period of the activity there will be times when the students should work without close supervision. However, students should seek and receive feedback, from tutors and others, on their target setting and performance.

Any project work (including coursework) is a suitable learning activity and may be used to generate evidence for this key skill.

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
LP2.1	Help set short-term targets with an appropriate person and plan how these will be met	1 – 5	Students could draw up a plan to show how they intend to cover the assignments, tests and practice examination papers in their preparation for a test. They will set realistic dates and targets in consultation with their tutor. They will identify potential problems and suggest alternative courses of action. If a coursework activity is chosen that entails working over a long timescale, then this may also be used to contribute evidence for achievement at this whole key skill.
LP2.2	Take some responsibility for some decisions about your learning, using your plan and support from others to help meet targets. Improve your performance by: • studying a straightforward subject • learning through a straightforward practical activity	1 – 5	Students will use their plan to meet targets and work effectively. This may involve prioritising tasks, managing their time effectively and amending their plan as necessary. Students will seek and use feedback from their tutor to help them improve their learning and performance. This may involve repeating a task or attempting a closely related one. Students may need to use different approaches to learning. These could include IT-based tutorial material, pairing up with another student to review work, sharing tasks with other students or use of learning resource centres. If a coursework activity is chosen that entails working over a long timescale, then this may also be used to contribute evidence for achievement at this whole key skill.
LP2.3	Review progress with an appropriate person and provide evidence of your achievements, including how you have used learning from one task or activity to meet the demands of a new task	1 – 5	Students should review their own progress and the quality of their learning and performance. They should be aware of the likely outcome if they are failing to meet targets or to make progress. Students may need to take remedial action and to seek help in an attempt to improve their performance. This may require an action plan to be drawn up and implemented. If a coursework activity is chosen that entails working over a long timescale, then this may also be used to contribute evidence for achievement at this whole key skill.

Evidence

Student evidence for improving own learning and performance could include:

- tutor records
- annotated action plans
- records of discussions
- learning log
- work produced.

Problem solving level 2

To achieve this key skill, students will need to provide at least two examples of meeting the standard required. They need to show that they can identify problems, plan and try out options and check whether the problem has been solved. For this GCSE, students may not be able to try out options and check results as there may be difficulties in implementing practical solutions in a school or college context.

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
PS2.1	Identify a problem and come up with **two** options for solving it	1, 2 and 4	As part of their programme of practical work students could be given the problem to investigate. Students could work alone or in teams to suggest different ways of solving the problem. They would recognise that the problem is complex and that no simple solution identifying the substance is possible. They would select and use appropriate astronomical methods for exploring the problem and describe its main features. Students would have to agree the standards to be met to show that the problem has been addressed and analysed to the required degree of precision and accuracy. All aspects of this key skill may be addressed through the means of a practical investigation. Centres will need to ensure that the work of individual candidates can be identified if the practical investigation is used as evidence for the coursework component of this specification. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)
PS2.2	Plan and try out at least **one** option for solving the problem, obtaining support and making changes to your plan when needed	1, 2 and 4	Students would be expected to generate at least two options for tackling the problem. They would compare the main features of each option including materials and apparatus requirements, timescales to carry out the exercise, and health and safety factors. Students would select the option that has the most realistic chance of success, and justify their choice. All aspects of this key skill may be addressed through the means of a practical investigation. Centres will need to ensure that the work of individual candidates can be identified if the practical investigation is used as evidence for the coursework component of this specification. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)

Key skill portfolio evidence requirement		GCSE Astronomy unit	Opportunities for development or internal assessment
PS2.3	Check if the problem has been solved by applying given methods, describe results and explain your approach to problem solving	1, 2 and 4	For a laboratory-based problem students would have to draw up detailed plans for quantities of materials and apparatus required. They could carry out a risk assessment before obtaining permission to go ahead with their experiments. Students would carry out their plan, using support and feedback from others, including their tutor. Progress would be reviewed. The plan may have to be revised as the experiment or investigation progresses. All aspects of this key skill may be addressed through the means of a practical investigation. Centres will need to ensure that the work of individual candidates can be identified if the practical investigation is used as evidence for the coursework component of this specification. Suitable subjects for a practical investigation are: • Shadow stick observations. (1.22) • Design of a sundial. (1.24) • Observations of phases of the Moon. (2.4) • Observations of constellations. (4.1, 4.2 and 4.6)

Evidence

Student evidence for problem solving could include:

- description of the problem
- tutor records and agreement of standards and approaches
- annotated action plans
- records of discussions
- descriptions of options
- records of reviews.

Appendix 2 – Procedures for moderation of internal assessment

All centres will receive Optically-read Teacher Examiner Mark Sheets (OPTEMS) for each coursework component.

Centres will have the option of:

EITHER

- recording marks on an Optically-read Teacher Examiner Mark Sheet (OPTEMS) (see Section 1)

OR

- recording marks on computer for transfer to Edexcel by means of Electronic Data Interchange (EDI) (see Section 2).

Sections 3 and 4 apply whichever option is selected and deal with Final Mark Aggregation Sheets and the sample of work required for moderation.

Section 1: Centres using OPTEMS

1.1 OPTEMS will be pre-printed on three-part stationery with specification and paper number, centre details and candidate names in candidate number order. A number of blank OPTEMS for candidates not listed will also be supplied.

The top copy is designed so that the marks can be read directly by an Optical Mark Reader. It is important therefore to complete the OPTEMS carefully in accordance with the instructions below. **Please do not fold or crease the sheets**.

1.2 Before completing the OPTEMS, please check the specification, paper and centre details, to ensure the correct sheet is being completed.

1.3 All candidates entered by the deadline date will be listed on the OPTEMS, except those carrying forward their centre-assessed marks from the previous year. Such candidates will be listed on a separate OPTEMS coded T for Transferred. Any OPTEMS coded T should be checked, signed to confirm the transfer, and the top copy returned to Edexcel. No mark should be entered.

1.4 Late entries will need to be added in pencil either in additional spaces on the pre-printed OPTEMS or on one of the blank OPTEMS which will be supplied. Please note that full details of the centre, specification, paper, candidates' names and candidate numbers must be added to ALL blank OPTEMS.

1.5 The OPTEMS should be completed **using an HB pencil.** Please ensure that you work on a firm flat surface and that figures written in the marks box go through to the second and third copies.

1.6 For each candidate, first ensure you have checked the arithmetic on the Final Mark Aggregation Sheet, then transfer the **Total Mark** on the box on the OPTEMS in the column headed 'Marks' for the correct candidate (please see exemplar).

1.7 Encode the mark on the right-hand side by drawing a line show the appropriate marks. Clear, dark **HB pencil** lines must be made but they must not extend beyond the limit of the box at the mark. Take care to remember the trailing zeros for candidates scoring 10, 20 etc and the leading zero for single figures, as shown.

If you make a mistake rub out the incorrect marks completely. Amend the number in the marks box and in the encoded section, but **please remember to amend separately the second and third copies** to ensure that the correct mark is clear.

Every candidate listed on the OPTEMS must have either a mark or one of the following codes in the marks box.

a 0 (zero marks) should be entered only if work submitted has been found to be worthless. It should **not** be used where candidates have failed to submit work.

b ABS should be entered in the marks box and an A in the encoded section for any candidate who has been absent or has failed to submit any work, even if an aegrotat award has been requested.

c W should be entered in the marks box and the encoded section where the candidate has been withdrawn.

EXEMPLAR

Encoded section

Candidate name	Number	Marks												
NEW ALAN SP	*3200	0	~~(•0•)~~ ~~(•0•)~~	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
OTHER AMY SP	*3201	5	~~(•0•)~~ (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) ~~(•5•)~~	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
SMITH JOHN AW	3202	27	(•0•) (•0•)	(•10•) (•1•)	~~(•20•)~~ (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) ~~(•7•)~~	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
WATTS MARK SP	*3203	ABS	(•0•) (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) ~~(•A•)~~	(•200•) (•W•)
STEVEN JANE AW	3204	36	(•0•) (•0•)	(•10•) (•1•)	(•20•) (•2•)	~~(•30•)~~ (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) ~~(•6•)~~	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
JONES ANN AW	*3205	40	(•0•) ~~(•0•)~~	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	~~(•40•)~~ (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
WEST SARA SP	3207	W	(•0•) (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) ~~(•W•)~~

1.8 Where more than one teacher has assessed the work, the teachers' initials should be given to the right of each candidate's name as illustrated.

1.9 The authentication and internal standardisation statement on the OPTEMS must be signed. **Centres are reminded that it is their responsibility to ensure that internal standardisation of the marking has been carried out**.

Once completed and signed the three-part sets should then be divided and despatched, or retained as follows:

a **top copy** to be returned direct to Edexcel in the envelope provided **to be received by 1 May for the May/June examination series**. Please remember this form **must not be folded or creased**

b **second copy** to be sent **with the sampled coursework** as appropriate (see Section 4) to the moderator. The name and address of the moderator will either be printed on the OPTEMS or supplied separately

c **third copy** to be retained by the centre.

Section 2: Centres using EDI

2.1 Marks must be recorded on computer and transmitted to Edexcel by **1 May for the May/June examination series**. They must be recorded in accordance with the specifications in the booklet 'Formats for the Exchange of Examination Related Data using Microcomputers'. Each mark has a status as well as a value. Status codes are:

V – valid non-zero mark recorded; candidate not pre-selected as part of the sample for moderation

S – valid non-zero mark recorded and candidate included in sample for moderation (refer to OPTEMS and Section 4)

Z – zero mark recorded for work submitted

N – no work submitted but candidate **not** absent

A – absent for component

M – missing mark; no information available about the candidate's previous performance

F – mark carried forward from a previous examination series. (If the mark status is 'F', then no mark follows.)

The OPTEMS provided will indicate, with asterisks, the candidates whose work is to be sampled, where this is pre-selected (see Section 4).

2.2 **Printout**

Centres are required to produce a printout of the centre-assessed marks and annotate it as described below, before forwarding it **together with the sampled coursework** as appropriate (see Section 4) to the moderator, **to be received by 1 May for the May/June examination series**. The name and address of the moderator will either be printed on the OPTEMS or supplied separately.

ABS – absent

W – withdrawn

* – sampled candidate

4 – additional sampled candidates.

Where more than one teacher has assessed the work the teachers' initials or the set number should be given beside each candidate's name.

Centres are reminded that it is their responsibility to ensure that internal standardisation of the marking is carried out. The following **authentication** and internal standardisation statement should be written at the bottom of the printout and signed by the teacher responsible:

'*I declare that the work of each candidate for whom marks are listed is, to the best of my knowledge, the candidate's own and that where several teaching groups are involved the marking has been internally standardised to ensure consistency across groups.*'

Signed . . . . . Date . . . .

Centres are advised to retain a copy of the annotated printout.

Section 3: Coursework Record Sheets

A copy of the Coursework Record Sheet is provided on page 75 for centres to photocopy. The Coursework Record Sheet, to be completed for each candidate, provides details for the moderator of how each candidate's total mark is reached. It is the teacher's responsibility to ensure that:

- all marks are recorded accurately and that the arithmetic is correct
- the total mark is transferred correctly onto the OPTEMS or via EDI.

Where a candidate's work is included in the sample, the Coursework Record Sheet should be attached to the work.

Section 4: Sample of work for moderation

4.1 **The pre-printed OPTEMS is asterisked** indicating the candidates whose work is required for moderation. This work, together with the second copy of the OPTEMS, should be posted to reach the moderator by 1 May. The name and address of the moderator will either be printed on the OPTEMS or supplied separately.

In addition, the centre must send the work of the candidate awarded the **highest** mark and the work of the candidate awarded the **lowest** mark, if these are not already included within the initial sample selected. The centre should indicate the additional work by means of a tick (4) in the left-hand column against the names of each of the candidates concerned.

For all sampled work the associated Coursework Record Sheet must be attached to each candidate's work.

If the pre-selected sample does NOT adequately represent ALL parts of the entire mark range for the centre, additional work in the range(s) not covered should also be sent to the moderator. As above, additional work should be indicated by means of a tick (4).

For centres submitting marks by EDI the candidates in the sample selected on the OPTEMS should be marked with an asterisk (*) or a tick (4), as appropriate, on the EDI printout. The annotated printout must be sent to the moderator with the sample of work.

4.2 **In all cases** please note that the moderator may request further samples of coursework, as required, and the work of all candidates should be readily available in the event of such a request.

4.3 **Internal standardisation**

Centres are reminded that it is their responsibility to ensure that where more than one teacher has marked the work, internal standardisation has been carried out. This procedure ensures that the work of all candidates at the centre is marked to the same standards. The statement confirming this on the OPTEMS or the EDI printout must be signed.

Appendix 3 – Subject specific requirements

Astronomical requirements

Candidates will be expected to utilise:

- concepts of force and resultant force
- knowledge that light travels in straight lines and can be reflected and refracted
- the relationship between speed, distance and time.

Symbols, units and physical quantities required

Candidates will be expected to be familiar with SI units and with multiples and sub-multiples in common use.

Candidates will also be expected to understand and use terms and abbreviations of particular relevance to astronomy:

- the 24 hour clock
- the use of hours and minutes
- using the celestial co-ordinate system: right ascension (RA) and declination (dec)
- the use of degrees, arc minutes and arc seconds
- the terms parsec (pc), light year (l. y.) and Astronomical Unit (AU).

In examination questions, the following values will be used:

Earth diameter	13 000 km
Moon diameter	3500 km
Sun diameter	1.4 million km
Earth-Moon distance	380 000 km
Earth-Sun distance	150 million km

Units and nomenclature

In the written papers and tests, the units and the nomenclature used will conform to the recommendations contained in the following booklets:

Signs, Symbols and Systematics, The ASE Companion to 16-19 Science (ASE 1st Ed, 2000).

Appendix 4 – Coursework Record Sheet

GCSE ASTRONOMY (1627)

	Examination year
Centre name	**Centre number**
Candidate name	**Candidate number**

Two pieces of work are to be chosen: **one** from List A **and one** from Lists B1 **or** B2.

Title of task and marks awarded						**TOTAL**
List A: Observations Title						
Statement of task /2	Observational details /3	Observations /6	Detailed obs. /deductions /4	Presentation /4		/19
Either:						
List B1: Graphical and computational work Title						
Statement of task /2	Quality of material /6	Information displayed /5	References /2	Presentation /4		/19
or:						
List B2: Constructional work Title						
Statement of task /2	Design /3	Construction /4	Testing/Use /4	References /2	Presentation /4	/19
				Total		/38
				Quality of written communication		/2

Maximum mark	/40

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