Pearson
BTEC

Pearson BTEC Level 2 Certificate in Space Studies

Specification

BTEC Specialist qualification

First registration January 2022

About Pearson

We are the world's learning company operating in 70 countries around the world with more than 22,500 employees. We provide content, assessment and digital services to schools, colleges and universities, as well as professional and vocational education to learners to help increase their skills and lifelong employability prospects. We believe that wherever learning flourishes so do people.

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All information in this specification is correct at time of publication.

Publication code: VQ000213

Contents

1 Introducing the qualification

Qualification purpose

The Pearson BTEC Level 2 Certificate in Space Studies is for learners who are working in, or who are intending to work in, the aviation, aerospace and engineering sectors.

The Pearson BTEC Level 2 Certificate in Space Studies is suitable for learners to:

- develop knowledge related to aviation, aerospace and engineering sectors
- achieve a qualification to prepare for progression to further learning and qualifications
- achieve a nationally-recognised Level 2 qualification
- develop personal growth and engagement in learning.

Industry support and recognition

This qualification has been endorsed and is supported by the Royal Air Force (RAF) Air Cadets and has been developed alongside them.

2 Qualification summary and key information

Qualification title	**Pearson BTEC Level 2 Certificate in Space Studies**
Qualification Number (QN)	610/0244/6
Regulation start date	01/01/2022
Operational start date	01/01/2022
Approved age ranges	Pre 16 16–18 18+
Total qualification time (TQT)	340 hours
Guided learning hours (GLH)	200 hours
Assessment	Internal assessment
Grading information	The qualification and units are graded Pass/Fail. Learners must achieve a Pass in all units in order to achieve the qualification.
Entry requirements	No prior knowledge, understanding, skills or qualifications are required before learners register for this qualification.
Progression	Learners who pass the Pearson BTEC Level 2 Certificate can progress to further or higher education studies in aviation, aerospace and engineering sectors. Alternatively, they may become an apprentice in a similar field or join the Armed Forces.

3 Qualification structure

Pearson BTEC Level 2 Certificate in Space Studies

The requirements outlined in the table below must be met for Pearson to award the qualification.

Minimum number of units that must be achieved	5
Minimum number of GLH that must be achieved at Level 2 or above	200
Number of mandatory units that must be achieved	5

Unit number	Mandatory units	Level	Guided learning hours
1	Applications of Space Technology	2	40
2	Exploring Space	2	40
3	The Moon Our Nearest Neighbour	2	40
4	Planetary Landscapes	2	40
5	Life on Mars	2	40

4 Assessment requirements

The table below gives a summary of the assessment methods used in the qualification.

Units	Assessment method
All units	Internal assessment (centre-devised assessments)

Language of assessment

Learners must use English only during the assessment of this qualification.

A learner taking the qualification may be assessed in British Sign Language where it is permitted for the purpose of reasonable adjustment.

Further information on the use of language in qualifications is available in our *Use of languages in qualifications policy*, available on our website, qualifications.pearson.com

Internal assessment

Internally assessed units are subject to standards verification. This means that centres set and mark the final summative assessment for each unit, using the examples and support that Pearson provides.

To pass each internally assessed unit, learners must:

- achieve all the specified learning outcomes
- satisfy all the assessment criteria by providing sufficient and valid evidence for each criterion
- prove that the evidence is their own.

Centres must ensure:

- assessments are marked by assessors with relevant expertise in both the occupational area and assessment. For the occupational area, this can be evidenced by a relevant qualification or current (within three years) occupational experience that is at an equivalent level or higher than this qualification. Assessment expertise can be evidenced by qualification in teaching or assessing and/or internal quality assurance or current (within three years) experience of assessing or internal verification
- internal verification systems are in place to ensure the quality and authenticity of learners' work, as well as the accuracy and consistency of assessment.

Learners who do not successfully pass an assessment are allowed to resubmit evidence for the assessment or to retake another assessment, however, items must be different and this should be evidenced as part of standards verification.

Assessment of units

To pass each unit, learners must independently complete assessment(s) that show that the learning outcomes and assessment criteria for the unit have been met.

Format of assessments for units:

- all learning outcomes and assessment criteria must be covered
- assessments are independently completed as a distinct activity after the required teaching has taken place
- learning outcomes must not be split into more than one assessment.

5 Centre recognition and approval

Centres must have approval prior to delivering or assessing any of the units in this qualification.

Centres that have not previously offered BTEC qualifications need to apply for, and be granted, centre recognition as part of the process for approval to offer individual qualifications.

Guidance on seeking approval to deliver BTEC qualifications is given on our website.

Approvals agreement

All centres are required to enter into an approvals agreement with Pearson, in which the head of centre or principal agrees to meet all the requirements of the qualification specification and to comply with the policies, procedures, codes of practice and regulations of Pearson and relevant regulatory bodies. If centres do not comply with the agreement, this could result in the suspension of certification or withdrawal of centre or qualification approval.

Centre resource requirements

As part of the approval process, centres must make sure that the resource requirements below are in place before offering the qualification:

- appropriate physical resources (for example IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification
- suitable staff for delivering and assessing the qualification (see *Section 4 Assessment requirements*)
- systems to ensure continuing professional development (CPD) for staff delivering and assessing the qualification
- health and safety policies that relate to the use of equipment by learners
- internal verification systems and procedures (see *Section 4 Assessment requirements*)
- any unit-specific resources stated in individual units.

6 Access to qualifications

Access to qualifications for learners with disabilities or specific needs

Equality and fairness are central to our work. Our *Equity, diversity and inclusion policy* requires all learners to have equal opportunity to access our qualifications and assessments, and that our qualifications are awarded in a way that is fair to every learner.

We are committed to making sure that:

- learners with a protected characteristic (as defined by the Equality Act 2010) are not, when they are taking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve from their qualification and that this achievement can be compared fairly to the achievement of their peers.

For learners with disabilities and specific needs, the assessment of their potential to achieve the qualification must identify, where appropriate, the support that will be made available to them during delivery and assessment of the qualification.

Centres must deliver the qualification in accordance with current equality legislation. For full details of the Equality Act 2010, please visit www.legislation.gov.uk

Reasonable adjustments and special consideration

Centres are permitted to make adjustments to assessment to take account of the needs of individual learners. Any reasonable adjustment must reflect the normal learning or working practice of a learner in a centre or a learner working in the occupational area.

Centres cannot apply their own special consideration – applications for special consideration must be made to Pearson and can be made on a case-by-case basis only.

Centres must follow the guidance in the Pearson document *Guidance for reasonable adjustments and special consideration in vocational internally assessed units*.

7 Recognising prior learning and achievement

Recognition of Prior Learning (RPL) considers whether a learner can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and so do not need to develop through a course of learning.

Pearson encourages centres to recognise learners' previous achievements and experiences in and outside the workplace, as well as in the classroom. RPL provides a route for the recognition of the achievements resulting from continuous learning.

RPL enables recognition of achievement from a range of activities using any valid assessment methodology. If the assessment requirements of a given unit or qualification have been met, the use of RPL is acceptable for accrediting a unit, units or a whole qualification. Evidence of learning must be sufficient, reliable and valid.

Further guidance is available in our policy document *Recognition of prior learning policy and process*, available on our website.

8 Quality assurance of centres

For the qualification in this specification, the Pearson quality assurance model will consist of the following processes.

Centres will receive at least one visit from our Standards Verifier, followed by ongoing support and development. This may result in more visits or remote support, as required to complete standards verification. The exact frequency and duration of Standards Verifier visits/remote sampling will reflect the level of risk associated with a programme, taking account of the:

- number of assessment sites
- number and throughput of learners
- number and turnover of assessors
- number and turnover of internal verifiers
- amount of previous experience of delivery.

Following registration, centres will be given further quality assurance and sampling guidance.

For further details, please see the work-based learning quality assurance handbooks, available in the support section of our website:

- *Pearson centre guide to quality assurance – NVQs/SVQs and competence-based qualifications*
- *Pearson delivery guidance & quality assurance requirements – NVQs/SVQs; competence-based qualifications and BTEC Specialist qualifications.*

9 Units

This section of the specification contains the units that form the assessment for the qualification.

For explanation of the terms within the units, please refer to *Section 13 Glossary.*

It is compulsory for learners to meet the learning outcomes and the assessment criteria to achieve a Pass. All content must be delivered, but assessments may not cover all content.

Where legislation is included in delivery and assessment, centres must ensure that it is current and up to date.

Unit 1: Applications of Space Technology

Level: 2

Unit type: Mandatory

Guided learning hours: 40

Unit introduction

In this unit you will explore what is in near space around the Earth. You will begin by examining the layers of the Earth's atmosphere and describing the Kármán line, which denotes the start of space.

You will also look at the ways technology that was designed for use in space has been adapted and used in other ways on Earth. Many products we use and take for granted today were developed because of space travel.

In the final section of this unit you will cover how satellites have transformed the way we live and work and how they provide data that otherwise would have been very difficult, or even impossible, to obtain. You will also look at some different types of satellites and look at how they are used.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Know where space begins	1.1 List and order each layer of the Earth's atmosphere 1.2 List the characteristics of each atmospheric layer and typical objects found within each layer
2. Understand how space technology has been used to create or improve products on Earth	2.1 Explain why fire-resistant materials were developed for use in space and give two examples of how they are used on Earth 2.2 Describe how robotic arms are used in space and give two examples of how this technology is used on Earth 2.3 Identify three reasons why laptops were developed for use in space

Learning outcomes	Assessment criteria
	2.4 Describe how the hand tool technology developed for use in space influenced the development of portable hand tools on Earth 2.5 Explain why memory foam was needed in space and give examples of how this technology is used on Earth
3. Know types of satellites and understand how they are used	3.1 List three common uses and applications of environmental monitoring satellites 3.2 Identify five common uses and applications of global communications satellites 3.3 Describe five types of astronomy satellites and their applications 3.4 Describe the five main types of navigational satellites and their five main uses 3.5 Describe six common applications of observation satellites and six limitations of using this technology

Unit content

What needs to be learned
Learning outcome 1: Know where space begins
1.1 Layers of the atmosphere: key facts about each layer, including altitude, temperature and typical objects found in each layer of the troposphere, stratosphere, mesosphere, thermosphere and exosphere; the Kármán line which defines the beginning of outer space.
Learning outcome 2: Understand how space technology has been used to create or improve products on Earth
2.1 NASA technology transfer programme: brief description of the programme and its main aim: to share new technology to the public after its development and use on space missions *2.2 Overview of technology from space*: general overview of the products listed below that have been designed from space technology. *2.3 Firefighting*: PBI flame-resistant material and Durette developed as a result of the Apollo 1 disaster; uses of satellites in disaster management applications such as forest fires; Real-Time Emergency Management via Satellite (REMSAT) and its role in combatting forest fires by linking command centres with firefighters. *2.4 Robotic arms*: uses of robotic arms in space on the ISS; how the Canadarm uses precision technology to grab things in space and how this relates to robotic arms used in medical applications to perform remote and precision surgery as well as robotic arms used in manufacturing to increase productivity and accuracy. *2.5 Laptops*: description of the first laptop used in space, the GRID Compass laptop, and how its innovations contributed to the design factors of future laptops; key considerations of using a laptop in space: weight, durability, reliability and non-reflective screens; evolution of laptops in space and on the ISS. *2.6 Portable hand tools*: first uses in space; evolution of space drill to Black+Decker Dustbuster portable vacuum cleaner; development of cordless tools on Earth; development of cordless tools used in space. *2.7 Memory foam*: initial use as customised seat padding for astronauts; early attempts at production for the mass market on Earth; uses of modern memory foam on Earth, including mattresses and seating which stemmed from material design at NASA.
Learning outcome 3: Know types of satellites and understand how they are used
3.1 Structure of a satellite communication system: transmitting ground station; uplink; satellite transponder; downlink; receiving ground station. *3.2 Environmental monitoring*: use and application of the Sentinel satellite constellation, weather forecasting; monitoring of the sea; land monitoring.

What needs to be learned
3.3 Types of global communication satellites: TELSTAR 1, the first communications satellite; Astra satellites; Starlink satellites.
3.4 Astronomy: Benefits of astronomy satellites over terrestrial-based observation; advantages and disadvantages of using telescopes in space, including the lack of atmospheric interference compared with the high cost and difficulty in maintenance; Hubble Space Telescope; Compton Gamma Ray Observatory; Chandra X-ray Observatory; Spitzer Space Telescope.
3.5 Satellite navigation: main uses of satellite navigation, including farming, science, precise timing and navigation, emergency response; comparisons between global satellite constellations, GPS (USA), GLONASS (Russia), Galileo (Europe), Beidou (China).
3.6 Observation: uses of observational satellites, including atmosphere monitoring, marine environment monitoring, land monitoring, climate change, emergency management, security; limitations of satellite imaging, resolution, cost, legislation; privacy and ethical implications, global differences in approach.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Delivery

This unit can be delivered as part of an integrated training programme for the Air Training Corps (ATC) or Combined Cadet Force (CCF – Royal Air Force section) as part of their bespoke space syllabus.

The delivery of the units that make up the Edexcel BTEC Level 2 Certificate in Space Studies will support and be integral to general cadet training.

The delivery of each unit will follow the structure laid down by Royal Air Force Air Cadets (RAFAC) Instructor Delivery Guides to support and guide the syllabus for each unit. Each guide and associated training material provides a structured learning programme that will aid the delivery of the unit content, and materials that can be used for formative assessment of learning.

Assessment

The unit is internally assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind. All assessment criteria should be assessed and achieved in order to pass the unit.

Unit 2: Exploring Space

Level: 2

Unit type: Mandatory

Guided learning hours: 40

Unit introduction

In this unit you will explore key moments in the Earth's history of space travel and chronicles of the achievements of some space pioneers – the first animal in space, the first woman in space, the first Briton in space and the first space tourist.

Humans have always been curious about space and how to travel beyond the Earth. The Chinese were among the earliest to attempt space travel in the 16th century, but it was not until the 20th century that humans successfully sent anything into space, based on rocket technology developed for war. This unit explores the history of rocketry and how this led to the development of rockets that are used in space.

Modern rockets engines are sophisticated machines and this unit examines different types of rocket engines and their uses. Developments in technology over the last few decades have helped lower the cost of sending satellites into space significantly. There are thousands of active satellites in service, but also thousands of pieces of 'space junk' which can be dangerous to astronauts, rockets and working satellites.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Know key events in the history and development of rocket technology	1.1 Identify milestones in the history of the very first rockets 1.2 Describe the developments of rockets up to World War II 1.3 Outline the history of the German V2 rocket and its role in the development of rockets launched into space

Learning outcomes	Assessment criteria
	1.4 Identify key milestones in the history of the Cold War space race
2. Understand how different types of rocket engines work	2.1 Outline how a solid-fuel rocket engine works 2.2 Outline how a liquid-fuel rocket engine works 2.3 Outline how an ion-propulsion rocket engine works
3. Know what is in the space around the Earth	3.1 Define what space debris is and why it is a problem in space 3.2 Describe the damage space debris can do to active satellites orbiting the Earth 3.3 Describe one possible solution to the space debris problem 3.4 List and describe three common satellite orbits
4. Know the achievements of selected pioneers of space exploration	4.1 Identify the first animal, first woman, first Briton and first space tourist being launched into space 4.2 List the key mission highlights of the first animal in space, the first woman in space, the first Briton in space and the first space tourist 4.3 List the key mission legacies of the first woman in space, the first Briton in space and the first space tourist

Unit content

What needs to be learned
Learning outcome 1: Know key events in the history and development of rocket technology
1.1 History of the first rockets: the Flying Pigeon and the Aeolipile; looking into early rocket technology from China in the 11th to 14th centuries, such as the weapons used in the siege of Kaifeng-fu, known as fei huo tsiang or flying fire lances; spread of rocket technology across Europe in the 14th to 15th centuries, early rockets using gunpowder, rockets launched in tubes; rockets in the 16th century, early attempts at transportation, rockets as fireworks. *1.2 Early rocket development*: early development of scientific theory by Sir Isaac Newton and the three laws of motion; development of the Congreve rocket for military use, addition of fins to rockets to increase stability; decline in the use of rocketry in warfare from the mid-19th century due to increased use of artillery. *1.3 Rockets and the war years*: Konstantin Tsiolkovsky and his research into liquid-fuel rockets, as well as multi-stage rockets that led to the creation in 1924 of the Soviet Union's Bureau for the Study of the Problems of Rockets; the launch of a liquid-fuel rocket by Robert Goddard in the USA in 1926; German V2 rocket technology during World War II, developed by Wernher von Braun; use of V2 rocket technology post-World War II by the USSR and the USA to develop high-altitude missiles. *1.4 The Cold War space race*: the space race between the USA and the USSR to launch satellites and humans into space; political influence of Khrushchev and Eisenhower in space rocket development in the USSR and the USA that led to the R-7 rocket, designed by Sergei Korolev, that launched the Sputnik-1 satellite, and the launch of Soviet space dog Laika inside the Sputnik-2 satellite in 1957; the recruitment of German scientists in the USA that led to the creation of NASA in 1958; space rocket development in the USA, launch of the Explorer 1 satellite with the Jupiter-C rocket, further launch of Explorer 3 and 4 satellites.

What needs to be learned
Learning outcome 2: Understand how different types of rocket engines work
2.1 Basic principles of rocket technology: Newton's third law of motion, the force of exhaust gases coming out of the nozzle creates thrust, which needs to be greater than the mass of the rocket to cause a lift-off; requirement of oxygen, fuel and heat to create combustion resulting in methods of chemical propulsion in an airless environment, such as space, using propellant, oxidiser and an ignitor to push a rocket forward. *2.2 Solid-fuel rockets*: parts of a solid-fuel rocket, ignition charge, casing, grain, seal, nozzle; principles of solid-fuel rocketry, fuel and oxidiser are mixed together and put into a hollow cylinder, which acts as the combustion chamber; advantages, simple construction, no moving parts; disadvantages, uncontrolled burn rate, weight and size of fuel tanks. *2.3 Liquid-fuel rockets*: parts of a liquid-fuel rocket, oxidiser tank, propellant tank, pressurant tank, injector plate, ignitor; principles of liquid-fuel rocketry, oxidiser and propellant are stored separately, they are pumped into a combustion chamber through use of the pressurant, where they are mixed together via the injector plate, and ignitor then causes combustion, from which the gases create the thrust; advantages, more controlled thrust than solid-fuel rockets; disadvantages, low temperature and high-pressure storage, complex rocket design using tanks, pumps, valves, injectors and piping. *2.4 Ion propulsion*: parts of an ion propulsion system, anode, cathode, battery; principles of ion propulsion, ionising a neutral gas by passing it through an arc, created by voltage difference between the anode and cathode to form plasma which provides thrust by accelerating ions through an electric field; advantages, much more efficient than using other methods, less propellant required than chemical rockets; disadvantages, low thrust and low acceleration, meaning it is an unsuitable method for launching from Earth; applications of ion propulsion, repositioning of satellites, rocket propulsion outside of the atmosphere.
Learning outcome 3: Know what is in the space around the Earth
3.1 Space debris: definition of space debris, a non-functional object or fragment of an object left by humans in space; increases in the amount of debris in space due to human space activity; the Kessler effect, once past a certain critical mass the total amount of space debris will keep on increasing. *3.2 Damage from space debris*: how debris can damage active satellites through impact; danger to the International Space Station and implications for crew safety; how satellites avoid space debris by performing manoeuvres using limited fuel reserves. *3.3 Cleaning up space*: monitoring of existing space debris through tracking and computer modelling, prevention of new pieces of space debris through international guidelines; principles of existing and future missions to clean up space debris, re-use, controlled re-entry, satellite docking, harpoon, tethered net capture.

What needs to be learned
3.4 Types of satellite orbits: geostationary orbit (GEO), 35 786 km above the equator, keeping pace with the rotation of the Earth, useful for satellites which observe or stay above a particular point on Earth such as communication satellites; medium Earth orbit (MEO), range of orbits between low Earth orbit and geostationary orbit used by GPS satellites and more communication satellites; low Earth orbit (LEO), an orbit of less than 1000 km, which is home to the ISS; advantages of LEO are that it requires much less energy to put a satellite there, so it is cheaper; disadvantages include the orbital decay and low field of view compared with satellites higher up in MEO and GEO; satellite constellations, groups of satellites that communicate with each other.
Learning outcome 4: Know the achievements of selected pioneers of space exploration
4.1 The first animal in space: Laika the space dog; background and timeline of mission achievements, including the USSR cementing its seemingly superior technological prowess over the USA in 1957, survival of a living creature through launch and lack of gravity on the R7 ICBM converted rocket which carried Laika within its payload Sputnik 2, first demonstration on the potential of human space travel, first animal successfully launched into space and to complete an orbit around the Earth. *4.2 The first woman in space*: Valentina Tereshkova; background and mission highlights, selected because of her parachuting skills, intensive training, more space flight hours than all previous NASA astronauts combined, role model for future generations. *4.3 The first Briton in space*: Helen Sharman; background and mission highlights, becoming the first British citizen and western woman, behind Valentina Tereshkova, to go to space after an unconventional selection process through a television programme, as part of Project Juno, a privately funded campaign to select the first Briton in space. Sharman, who was a chemist, received Russian training and cosmonaut status before travelling to the Mir Space Station where she spent eight days conducting a range of scientific experiments aboard Mir in 1991; legacy after the mission, talks and visits to inspire others about space. *4.4 The first space tourist*: Dennis Tito; background and mission achievements, early career as a NASA engineer and later career outside of the aerospace sector, negotiations with NASA and Russia to travel to space, self-funded mission and training costs, training as a cosmonaut, travel to the International Space Station (ISS) in 2001.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Delivery

This unit can be delivered as part of an integrated training programme for the Air Training Corps (ATC) or Combined Cadet Force (CCF – Royal Air Force section) as part of their bespoke space syllabus.

The delivery of the units that make up the Edexcel BTEC Level 2 Certificate in Space Studies will support and be integral to general cadet training.

The delivery of each unit will follow the structure laid down by Royal Air Force Air Cadets (RAFAC) Instructor Delivery Guides to support and guide the syllabus for each unit. Each guide and associated training material provides a structured learning programme that will aid the delivery of the unit content, and materials that can be used for formative assessment of learning.

Assessment

The unit is internally assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind. All assessment criteria should be assessed and achieved in order to pass the unit.

Unit 3: The Moon Our Nearest Neighbour

Level: 2

Unit type: Mandatory

Guided learning hours: 40

Unit introduction

In this unit you will explore the ways in which the moon influences life on Earth, including the way the Moon affects tides and the varying amount of light it reflects during a complete lunar cycle. The science of the Moon and the experiments that have taken place on it are featured and the current scientific consensus on how it was formed is explored.

The Moon is the Earth's only natural satellite and is much larger than any manmade object launched into space. Its size means many features of the surface can be seen from Earth with the naked eye. The moon has played an important role in folklore, legends and myths and has fascinated humans for thousands of years. It is one of many moons in our Solar System and is vital for life on Earth as we know it.

A colony of people living on the Moon for extended periods has long been science fiction, but recent scientific breakthroughs are bringing this idea closer to reality. The final part of this unit explores how a permanent colony could be set up on the Moon, and how this could be used as a stepping stone for humans to reach Mars.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Know the ways that the Moon influences life on Earth	1.1 Compare and contrast our moon to others found in the Solar System 1.2 Identify and order the eight phases of the lunar cycle 1.3 Identify solar and lunar eclipses 1.4 Outline how the Moon has influenced us in history, myth and legend 1.5 Describe the influence the Moon has on tides and explain why they occur

Learning outcomes	Assessment criteria
2. Know about key lunar experiences	2.1 Describe how the Moon may have been formed 2.2 Describe two key experiments that have taken place on the Moon 2.3 Describe one similarity and one difference between the near side and the far side of the Moon
3. Understand the challenges of setting up a permanent colony on the Moon and outline ways in which these challenges might be overcome	3.1 Describe the environment on the Moon 3.2 Identify two key experiments that have discovered water on the Moon 3.3 Identify the challenges that make building a permanent settlement on the Moon difficult 3.4 Identify two possible ways a permanent lunar settlement could be constructed

Unit content

What needs to be learned
Learning outcome 1: Know the ways that the Moon influences life on Earth
1.1 Key facts about the Moon: diameter, mass, orbital radius, orbital period; lunar cycle.
1.2 Moons in our Solar System: Earth has only one moon but our Solar System has more than 200; discovery of moons by Galileo and later by more modern telescopes and probes; similarities and differences of our moon to others, including the lack of ice compared with moons like Enceladus; size comparison compared to Phobos and Deimos around Mars, which are not spherical, as well as Charon orbiting Pluto, which is large enough comparatively to Pluto that it causes the dwarf planet to wobble; structural composition compared to Jupiter's moon Io, which is smaller than Earth's Moon but retains its volcanicity due to Jupiter's gravity, the Earth's Moon has ceased volcanic activity as it has cooled down; atmosphere compared to Jupiter's Galilean moons, which all have thin atmospheres, whereas Earth's Moon has none.
1.3 The lunar cycle: definition of the lunar cycle; difference between orbit of the Moon and its lunar cycle; description of all eight phases of a lunar cycle, new moon where the Moon's illuminated side is not visible on Earth, waxing crescent where the Moon's illumination is gradually increasing, first quarter occurring around one week after the new moon where half the Moon is visible, waxing gibbous where the Moon is approaching full moon but still has an unlit section, full moon where the Moon is fully illuminated by the Sun, waning gibbous when the Moon starts to diminish its luminosity, last quarter much like the first quarter but the other half is illuminated, waning crescent when the lunar cycle is about to start again. Solar eclipse description and types; total solar eclipse when a new moon passes in front of the Sun, casting a shadow onto the Earth, partial solar eclipse when the Moon doesn't completely cover the Sun, annular solar eclipse is similar to a total solar eclipse, however the Moon is at its furthest point away from Earth, causing a bright ring around the Moon; lunar eclipse description and types, total lunar eclipse occurs when the Moon passes through Earth's umbra, creating a red/orange colour, partial lunar eclipse occurs when part of the Moon passes through Earth's umbral shadow, penumbral lunar eclipse occurs when the Sun, Earth and Moon are not perfectly aligned, causing Earth's penumbral shadow to be cast onto the Moon.
1.4 History, myth and legend: prehistoric lunar calendar found in Scotland; celebration of the Moon in ancient Greece and ancient Rome; the middle ages, the lunacy effect and belief in werewolves and vampires.
1.5 The Moon and the tides: explanation of why tides occur; differences between high tide and low tide which include the Sun and Moons positioning either perpendicular or parallel to Earth, creating neap tides and spring tides respectively, centrifugal force, alignment of Earth–Moon axis; other ways the Moon and its gravity influences life on Earth, Great Barrier Reef spawning, animal migration, tilt of the Earth due to the Moon.

What needs to be learned
Learning outcome 2: Know about key lunar experiences
2.1 The origin of the Moon: how lunar rock samples brought back from the Moon landings helped to estimate the date the Moon was created; description of the giant-impact hypothesis; evidence of the giant-impact hypothesis, composition of Moon rock, composition of lunar meteorites. *2.2 Experiments on the Moon*: manned experiments by astronauts on the Moon, the Hammer-Feather Drop conducted by astronaut David Scott in order to demonstrate the effects of air resistance on Earth, laser ranging retroflectors placed on the Moon by Apollo 11, 14 and 15 in order to measure the distance between the Earth and the Moon, as well as measuring the speed of light; how craters on the Moon were formed and how we can use them to estimate the age of the Moon. *2.3 The far side of the Moon*: explanation of why the Moon has near and far sides, synchronous rotation; similarities and differences between the near and far sides of the Moon, number of craters, composition.
Learning outcome 3: Understand the challenges of setting up a permanent colony on the Moon and outline ways in which these challenges might be overcome
3.1 The environment of the Moon: gravity and its effects; temperature; atmosphere; radiation and meteorites; moonquakes. *3.2 Water on the Moon*: discovery of water on the poles of the Moon and on the lunar surface; overview of the Lunar Crater Observation and Sensing Satellite (LCROSS) mission; overview of the Stratospheric Observatory for Infrared Astronomy (SOFIA) discovery. *3.3 Establishing a permanent lunar settlement*: identifying possible locations for a permanent lunar base; in-situ resource utilisation to reduce costs; 3D printing to build settlements using lunar rock; why astronauts will probably need to live underground; using a moon base for onward travel to Mars.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Delivery

This unit can be delivered as part of an integrated training programme for the Air Training Corps (ATC) or Combined Cadet Force (CCF – Royal Air Force section) as part of their bespoke space syllabus.

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Assessment

The unit is internally assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind. All assessment criteria should be assessed and achieved in order to pass the unit.

Unit 4: Planetary Landscapes

Level: 2

Unit type: Mandatory

Guided learning hours: 40

Unit introduction

In this unit you will explore the typical structures of all bodies that make up our Solar System and compare the inner structure of the Earth, the Moon and Mars.

Our Solar System is formed of one star, eight planets, a dwarf planet and countless other bodies, including moons and meteorites. In our Solar System there are two types of planet: rocky terrestrial planets and larger, gaseous planets with central rocky-metallic cores.

You will learn about the key surface features of the Earth and its nearest neighbours and look at different theories of how the universe was formed and how it is continuously expanding.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand how planets in the Solar System are composed	1.1 Describe the inner structure of the Sun, Moon, Earth and Mars 1.2 Compare the inner structure of the Earth, Moon and Mars 1.3 Describe why the inner Solar System planets are made of rock 1.4 Describe why the outer Solar System planets are made of gas
2. Know about key surface features of selected planets	2.1 Identify six surface features of the Earth 2.2 Identify six surface features of Mars 2.3 Identify six surface features of the Moon

Learning outcomes	Assessment criteria
	2.4 Compare the surface features of Mars and the Earth
3. Understand how the universe may have been formed	3.1 Describe what is meant by the 'Big Bang Theory' 3.2 Describe cosmic microwave background radiation 3.3 Explain the principle of red shift

Unit content

What needs to be learned
Learning outcome 1: Understand how planets in the Solar System are composed
1.1 Planetary bodies: definition of a star, an astronomical object consisting of a luminous spheroid of plasma held together by its own gravity, the Sun (a G2V) G-type main sequence star) is referred to as Yellow Dwarf and is the nearest star to the Earth and the core of our Solar System, radiates energy as visible light, ultraviolet light and infrared radiation, and is the most important source of energy for life on Earth; definition of a planet, a celestial body that is in orbit around a star, has sufficient mass for its own gravity to overcome rigid body forces so that it assumes a round shape/hydrostatic equilibrium; definition of a planetary body; a celestial body that does not produce its own light, is larger than an asteroid, and is illuminated by light from a star, which it orbits, this can include dwarf planets and moons; planetary geology, the study of the physical structure and processes acing on celestial bodies; definition of terrestrial planets, planet comprised of silicate rocks or metals; definition of gaseous planets, planets primarily made of hydrogen or helium, may have a rocky core. *1.2 Internal structure of a terrestrial planet*: typical features of a terrestrial planet including outer core, mantle, crust and metallic core; different regions of the mantle including asthenosphere and lithosphere. *1.3 Inner structure of Earth, Moon and Mars*: comparison of Earth, the Moon and Mars with regards to size of internal structures, including crust, mantle, outer core and metallic core; mass; radius; composition of crust, on Earth only oceanic crust is basaltic, whereas crust is basaltic on the Moon and Mars; tectonic plates, presence of tectonic plates on Mars and Earth and lack of tectonic plates on the Moon; comparison of tectonic activity, between Earth, the Moon and Mars, comparison of Olympus Mons on Mars to Mauna Loa on Earth; magnitude of gravity on each planet. *1.4 Structure of a gaseous planet*: typical features of a gaseous planet, hydrogen, helium and central rocky-metallic core; key characteristics of Saturn and Uranus, radius, atmosphere, rings, volume, magnitude of gravity on each planet. *1.5 Formation of planets in the Solar System:* factors which affected the formation of planets, temperature, density, melting point and gravity; influence of the protostar on formation of the planets; influence of distance from the Sun on planetary composition and size.
Learning outcome 2: Know about key surface features of selected planets
2.1 Surface features of the Earth: radius of the Earth; features including fold mountains, glacial valleys, river valleys, canyons, deserts and volcanoes; characteristics of poles; aeolian processes; formation of the oceans.

What needs to be learned
2.2 Surface features of the Moon: radius of the Moon; features including impact craters, lava flows, dead volcanoes, Maria; characteristics of poles; lack of atmosphere and influence on surface features. *2.3 Surface features of Mars:* radius of Mars; features including impact craters, brain terrain, Medusae Fossae, volcanoes, glaciers, historical evidence of water; characteristics of poles; composition of surface features; thin atmosphere and influence on surface features.
Learning outcome 3: Understand how the universe may have been formed
3.1 Big Bang Theory: estimated age of the universe; stages of the formation of the universe including initial singularity, initial singularity, inflation epoch, nucleosynthesis, expansion phase and structure epoch; density, temperature and energy changes throughout each stage of formation. *3.2 Cosmic microwave background radiation (CMBR):* definition of CMBR, CMBR or 3K radiation or relic radiation is blackbody electromagnetic radiation left over from the original formation of the universe in the Big Bang, with a temperature of approximately 3 Kelvin; age of CMBR; scientific principles behind CMBR including formation; position of CMBR on the electromagnetic spectrum. *3.3 Red shift:* definition of red shift, increase in the wavelength of electromagnetic radiation and corresponding decrease in frequency and energy; principle of red shift, demonstrates that the universe is expanding in relation to all other points, the further away a galaxy is, the faster it is moving; definition of blue shift, decrease in wavelength and increase in frequency in electromagnetic radiation; opposing relationship between red shift and blue shift.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Delivery

This unit can be delivered as part of an integrated training programme for the Air Training Corps (ATC) or Combined Cadet Force (CCF – Royal Air Force section) as part of their bespoke space syllabus.

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Assessment

The unit is internally assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind. All assessment criteria should be assessed and achieved in order to pass the unit.

Unit 5: Life on Mars

Level: 2

Unit type: Mandatory

Guided learning hours: 40

Unit introduction

The Moon landings proved that man could safely travel to another celestial body other than Earth. After this, it was thought that technology would continue to develop rapidly to enable humans to set foot on Mars, but cost, technical challenges and a change in the political climate of the late 20th century meant that this aspiration did not become a reality.

Despite this, several unmanned missions to Mars have taken place successfully and in this unit you will explore missions that have taken place in the past, as well as current and future missions to Mars. The unit also looks at the plans for humans to visit Mars in the future and the role of private companies working in partnership with space agencies to make this a reality.

You will get an introduction to potential developments in space exploration beyond Mars, including the search for life in the Solar System and wider universe, and the potential for mining in space.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Know about unmanned missions to Mars	1.1 List the key mission highlights of five unmanned missions to Mars 1.2 Describe the scientific impact of five unmanned missions to Mars 1.3 Outline three different landing methods spacecraft have used for key unmanned missions to Mars

Learning outcomes	Assessment criteria
2. Know about manned missions to Mars	2.1 Outline NASA's timeline for sending a manned mission to Mars 2.2 Describe the role of space stations in supporting missions to Mars 2.3 Explain the role of commercial space companies in sending a manned mission to Mars
3. Understand potential developments in space exploration beyond Mars	3.1 Describe two regions in space that scientists could explore to detect evidence of life 3.2 Describe three methods scientists could use to determine where life may be in space 3.3 Describe the potential of mining in space

Unit content

What needs to be learned
Learning outcome 1: Know about unmanned missions to Mars
1.1 First successful mission to Mars: key facts about the Mariner 4 mission, including launch date, date of successful flyby of Mars and mission end; major scientific outcomes of mission, first images of another planet other than Earth from orbit, the discovery that Mars has no magnetic field, measurements of surface atmospheric pressure revealed that the Martian atmosphere is a fraction of Earth's, and daytime temperature, use of technology for further missions. After the Mars flyby, Mariner 4 lasted three years in solar orbit and was used by scientists to study the solar wind environment. *1.2 First successful orbiter of Mars*: key facts about the Mariner 9 mission, including launch date, duration of mission and mission end; key components of instrument payload included, ultraviolet spectrometer, interferometer, infrared spectrometer, visual imaging system, each of these instruments was mounted on a movable scan platform underneath the main body to take images of Mars where they scanned 85% of the Martian surface; follow on of studies from Mariner 6 and 7; major scientific outcomes of mission, insight into the geological history of Mars, when the data projected the first insight that there might have been water on the surface, use of technology for further missions. *1.3 First successful soft landing on Mars*: key facts about the Mars 3 mission, including launch date, date of landing on Mars and mission end; images provided from orbiters Mars 2 and 3; overview of landing process, including use of parachutes, 'gunpowder engines', foam, engine burn; potential use of the Prop-M Rover, a robot that was designed to be tethered onto the lander to take measurements on Martian soil; major scientific outcomes of mission from the orbiter, including creation of surface relief maps, information about Martian gravity and magnetic fields, data on composition of the atmosphere, use of technology for further missions; scientific outcomes of the lander, including achieving a soft landing on Mars, and a partial image, which was the last thing sent back before the lander failed, possibly due to a coronal discharge. *1.4 Curiosity (NASA) robotic rover*: key facts about mission including launch date, date of landing, duration of mission and landing site; mission highlights including discovery of ancient stream bed, drilling and discovery of key chemical ingredients for life; overview of landing process. *1.5 ExoMars 2016*: key facts about the mission, including European Space Agency (ESA) involvement, launch date, date of landing, duration of mission and landing site; mission highlights including lander crash, mapping of methane and other gases, possible evidence of biological or geological activity; overview of landing process.

What needs to be learned
Learning outcome 2: Know about manned missions to Mars
2.1 Moon to Mars and the Artemis programme: Earth Reliant phase and mission aims; Proving Ground phase and mission aims; Earth Independent phase and mission aims; timeline of mission; partnership between NASA and external companies. *2.2 Supporting manned missions to space with space stations:* use of International Space Station (ISS) for testing long-term effects on biological organisms in space and validation of technology; development of proposed space stations. *2.3 Commercial space companies exploring the Solar System*: overview of selected private space companies and their involvement with governmental space agencies; independent missions without government involvement.
Learning outcome 3: Understand potential developments in space exploration beyond Mars
3.1 Looking for life in the Solar System: celestial bodies most likely to support life, including Mars, Europa and Enceladus; key facts including temperature, composition and presence of water; missions to study composition and potential for life. *3.2 Looking for life in the universe*: key facts about the Circumstellar Habitable Zone (CHZ); Search for Extra-Terrestrial Intelligence Institute (SETI) and its scientific aims. *3.3 Methods to find life in the universe:* key facts of the 'follow the water' method including detection of trace chemicals and instrumentation used; significant discoveries during the search for exoplanets; overview of why scientists search for radio signals; overview of why scientists are looking for fossilised remains. • *3*.4 Mining in space: benefits of mining in space; negatives of mining in space; overview of potential mining sources; overview of potential mining processes.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Delivery

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Assessment

The unit is internally assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind. All assessment criteria should be assessed and achieved in order to pass the unit.

10 Appeals

Centres must have a policy for dealing with appeals from learners. Appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy is a consideration of the evidence by a Lead Internal Verifier or other member of the programme team. The assessment plan should allow time for potential appeals after learners have been given assessment decisions.

Centres must document all learners' appeals and their resolutions. Further information on the appeals process can be found in the document *Internal assessment in vocational qualifications: Reviews and appeals policy*, available on our website.

11 Malpractice

Dealing with malpractice in assessment

Malpractice refers to acts that undermine the integrity and validity of assessment, the certification of qualifications and/or may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actual or attempted actions of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where malpractice or attempted malpractice has been proven.

Malpractice may occur or be suspected in relation to any unit or type of assessment within a qualification. For further details on malpractice and advice on preventing malpractice by learners, please see Pearson's *Centre Guidance: Dealing with Malpractice*, available on our website.

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The *Centre Guidance: Dealing with Malpractice* document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe a centre is failing to conduct internal assessment according to our policies. The above document gives further information and examples. It details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Learner malpractice

The head of centre is required to report incidents of suspected learner malpractice that occur during Pearson qualifications. We ask centres to complete *JCQ Form M1* (www.jcq.org.uk/malpractice) and email it with any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Processing team at candidatemalpractice@pearson.com. The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Teacher/centre malpractice

The head of centre is required to inform Pearson's Investigations team of any incident of suspected malpractice (which includes maladministration) by centre staff before any investigation is undertaken. The head of centre is requested to inform the Investigations team by submitting a *JCQ M2* Form (downloadable from www.jcq.org.uk/malpractice) with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff, anonymous informants), the Investigations team will conduct the investigation directly or may ask the head of centre to assist.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results/certificates while an investigation is in progress. Depending on the outcome of the investigation, results and/or certificates may not be released or they may be withheld.

You should be aware that Pearson may need to suspend certification when undertaking investigations, audits and quality assurances processes. You will be notified within a reasonable period of time if this occurs.

Sanctions and appeals

Where malpractice is proven, we may impose sanctions or penalties, such as:

- mark reduction for affected external assessments
- disqualification from the qualification
- debarment from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures we may impose sanctions, such as:

- working with centres to create an improvement action plan
- requiring staff members to receive further training
- placing temporary suspensions on certification of learners
- placing temporary suspensions on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from the head of centre (on behalf of learners and/or members or staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in the *JCQ Appeals booklet* (www.jcq.org.uk/exams-office/appeals).

12 Further information and publications

- Edexcel, BTEC and Pearson Work Based Learning contact details: qualifications.pearson.com/en/contact-us.html.
- Books, software and online resources for UK schools and colleges: www.pearsonschoolsandfecolleges.co.uk.
- Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please visit our website.

Further documents that support the information in this specification:

- *Access arrangements and reasonable adjustments* (JCQ)
- *A guide to the special consideration process* (JCQ)
- *UK information manual* (updated annually and available in hard copy) **or** *Entries and information manual* (available online) (Pearson)
- *Distance learning and assessment policy* (Pearson)

Publisher information

Any publisher can seek endorsement for their resources and, if they are successful, we will list their BTEC resources on our website.

13 Glossary

Part A – General terminology used in specification

Term	Description
Level	Units and qualifications have a level assigned to them. The level assigned is informed by the level descriptors defined by Ofqual, the qualifications regulator.
Guided learning hours (GLH)	This indicates the number of hours of activities that directly or immediately involve tutors and assessors in teaching, supervising and invigilating learners, for example lectures, tutorials, online instruction and supervised study. Units may vary in size.
Total qualification time (TQT)	This indicates the total number of hours that a typical learner will take to complete the qualification. This is in terms of guided learning hours but also unguided learning, for example private study, time spent in the workplace to master skills.
Learning outcomes	The learning outcomes of a unit set out what a learner knows, understands or is able to do as the result of a process of learning.
Assessment criteria	The assessment criteria specify the standard the learner is required to meet to achieve a learning outcome.
Unit content	This section sets out the required teaching content of the unit and specifies the knowledge, skills and understanding required for achievement of the unit. It enables centres to design and deliver a programme of learning that will enable learners to achieve each learning outcome and to meet the standard determined by the assessment criteria.

Part B – Terms used in knowledge and understanding criteria

Term	Description
Define	To state or set forth the meaning of a word or phrase. **OR** To explain or identify the nature or essential qualities of an object.
Describe	Give a clear account in their own words, including all the relevant information (e.g. qualities, characteristics or events, etc.). Description shows recall and in some cases application.
Explain	Provide details and give reasons and/or evidence to support an opinion, view or argument. **OR** Provide details and give relevant examples to clarify and extend a point. This would usually be in the context of learners showing their understanding of a technical concept or principle.
Identify	Shows the main features or purpose of something. Can recognise it and/or name characteristics or facts that relate to it.
List	Provide information as an item-by-item record of names or things
Outline	Provide a summary or overview or brief description.
State	Express information in clear and precise terms.

January 2022

For information about Pearson qualifications, including Pearson Edexcel, BTEC and LCCI qualifications visit qualifications.pearson.com

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