SPACE

QUANTITIES FOR THE SPACE UNIT

For this unit copy and complete the table.

Quantity	Symbol	Unit	Unit Symbol	Scalar / Vector
Period	T	second	s	S
Distance	d	metres	m	S
Time	t	second	s	S
Speed	v	metres per seconds	ms^{-1}	S
Light year	ly	metre	m	S
Force	F	Newton	N	V
Mass	m	kilogram	kg	S
Weight	F or W	Newton	N	V
Acceleration	a	metres per second per second metres per second squared	ms^{-2}	V
Gravitational field strength	g	Newtons per kilogram	Nkg-1	V

THE SPACE UNIT IN NUMBERS

Quantity	Value
State the age of the universe.	13.8 billion years
State the distance represented by one light year.	9.45×10^{15} m
State the gravitational field strength on Earth.	9.8 Nkg^{-1}
State the height of a geostationary satellite above the Earth's surface.	36 000 km
State the time for the Earth to spin once on its axis.	1 day or 24 hours
State the time taken for the Earth to orbit the Sun	1 year 365.246 day
State the speed of light in air.	3×10^{8} ms^{-1}

Quantity	Value
State the speed of light across the vacuum of space.	3×10^8 ms^{-1}
State the initial acceleration of an object when dropped close to the Earth's surface.	9.8 ms^{-2}
State the wavelength of red light	≈700 nm
State the wavelength of violet light.	≈400 nm

No.	Content
Space Exploration	
7.1	I have a basic understanding of the Universe https://map.gsfc.nasa.gov/universe/uni_life.html
7.1.1	Write a paragraph explaining our current understanding of the Universe. *Reference correctly any source used-* ***DO NOT COPY, practice referencing and using sources for your assignment.***
7.1.1	Our current understanding of the origin of the Universe is based on the Big Bang theory. The Universe is approximately 13·8 billion ($13{\cdot}8 \times 10^9$) years old and consists of approximately 100 billion galaxies, each containing approximately 100 - 1000 million stars! Before the Universe began, the entire Universe was contained in a singularity. The Big Bang singularity was a point of zero volume, but very high mass, which makes the density infinite. This singularity contained all of the matter and energy in the Universe. At the singularity, all the laws of physics broke down: then it "exploded". Time, space and all of the matter and energy we know today began with the Big Bang. In a fraction of a second, the Universe grew this singularity to bigger than a galaxy. And it kept on growing at a fantastic rate.
7.2	I can use the following terms correctly and in context: planet, dwarf planet, moon, Sun, asteroid, solar system, star, exoplanet, galaxy, and universe.
7.2.1	List the following in order of **decreasing size**: *planet, dwarf planet, moon, sun, asteroid, solar system, star, exoplanet, galaxy, universe.* **Universe ➔ Galaxy ➔ Solar System ➔*star/sun* ➔ *exoplanet* ➔*planet*➔*dwarf planet*➔ *moon*➔ *asteroid (NB some exoplanets are obviously the same size as a planet, but currently we can only detect large planets outside our solar system. Some moons are also as big as some planets)***

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7.2.2	Define each of the following terms: *planet, dwarf planet, moon, sun, asteroid, solar system, star, exoplanet, galaxy, universe.*

Term	Definition
Universe	The Universe consists of the sum total of everything, including ma galaxies separated by empty space.
galaxy	A galaxy is a large cluster of stars (e.g. the Milky Way).
star	A star is a large ball of matter that is undergoing nuclear fusion ar emitting light and other forms of electromagnetic radiation. The sun a star.
sun	A solar system consists of one or more central stars orbited by planet
planet	A planet is a large ball of matter that orbits a star (e.g. Earth Jupiter). Planets do not emit light themselves.
exoplanet	An exoplanet is a planet existing around another star, outside of o solar system
dwarf planet	A dwarf planet is an object that orbits a star but is not large enough roughly spherical enough to be classed as a small planet.
moon	A moon is a natural satellite of a planet. A moon is a lump of matt that orbits a planet e.g. Deimos and Phoebus orbit Mars, so are moo of Mars
asteroid	An asteroid is an orbiting object which is even smaller than a dwa planet.

No.	Content
7.3	I am aware of the benefits of satellites.
7.3.1	Give some uses of satellites placed in orbit above the Earth.
	Weather forecasting, checking natural disasters, checking for hurricanes, spying, GPS location services, communication (TV, phone)

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7.3.2	Explain how the force of gravity keeps a satellite in orbit. The force of gravity pulls all satellites towards the Earth. As the satellite has a horizontal velocity in addition to the vertical velocity it remains in orbit because as the satellite falls the Earth curves away so the satellite remains in orbit and doesn't land. *If the horizontal velocity is reduced too much the satellite would plummet to Earth.*
7.3.3	Two examples of satellites placed in space are the ISS and the Hubble Telescope. For **each** of these satellites: a) State the purpose for it being placed in orbit. b) Describe when the satellite was placed in orbit c) How has our understanding of our Universe altered due to research from the satellite?

Description	ISS	Hubble
a) purpose	A habitable artificial satellite in low Earth Orbit	To take high resolution images in the UV, near IR, visible
b) Date	Launched 1998 to 2011. First residents Nov 2000	April 25th 1990 entered service May 20th 1990
c) understanding	Microgravity and space environment. Lab, observatory and factory in LEO. Loads of new understanding	Understanding of the rate of expansion of the Universe. Massive improvements in astrophysics Age of the Universe, checking for Black Holes, imaging Jupiter's collision with comet Shoemaker Levy

7.4	I know the period and orbital height of a geostationary satellite.
7.4.1	Define the term geostationary or geosynchronous orbit. **A geostationary orbit is one where the satellite stays above the same point on the Earth's surface as it orbits, i.e. it has a period of 24 hours.**
7.4.2	State the height, above the Earth's surface of a satellite placed in geostationary orbit. **36 000 km above the Earth's surface. *This is 36 000 000 m!***
7.4.3	State the time taken for a geostationary satellite to orbit the Earth **A geostationary satellite takes 24 hours to orbit the Earth.**

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7.4.4	State the period of a geostationary satellite. **It has a period of 24 hours**
7.4.5	State above which part of the Earth's surface geostationary satellites are placed. **These satellites are placed above the equator.**
7.5	I know that the period of a satellite changes with altitude.
7.5.1	Explain the term period of a satellite. **The period of a satellite is the time taken for the satellite to orbit the planet.**
7.5.2	Explain how the period of a satellite changes with the height above the Earth's surface. **As height increases the period of the satellite increases**
7.5.3	Does the height of the satellite above any planet affect the period? **Yes, as height increases the period of the satellite increases**
7.6	I am aware of the challenges of space travel.
7.6.1	Describe some of the challenges on space travel, **Manoeuvring in zero friction environment OR Fuel load on take-off OR Potential exposure to radiation OR Pressure differential OR Re-entry through an atmosphere** including the following a) take off **The spacecraft contains huge quantities of highly flammable chemicals which explode on ignition. If this becomes uncontrolled it could burn the astronauts and spacecraft, *this has happened to many a non human rocket flight*. The rockets also have large acceleration which can put strain of human bodies, not designed for such large accelerations.** b) during flight **In emergencies there is no help from base, so everything will need to carried on board and astronauts trained for all medical emergencies. Manoeuvring in zero friction is difficult as small changes in direction will not be opposed by friction. (Read Michael Collin's book "Catching the Fire" for an excellent description of dealing with being in freefall). There is a huge pressure differential between the inside and outside of the spacecraft and space suits. Any hole in either will cause a loss of pressure and a painful death of the crew. The atmosphere above the Earth's surface protects us from high levels of radiation from outer space. The further up in the atmosphere you are the less protection from radiation is achieved. Above the atmosphere the risk increases greatly. This radiation can cause major health problems, and could lead to death.**

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	c) being in "zero gravity" **Bones can absorb calcium and so bones can become fragile as they don't have the forces on them. Swallowing and other human activities are more difficult and dangerous. Manoeuvring in "zero gravity" is difficult due to Newton's 3rd Law of Motion, any small movement causes a reaction force, which causes the astronaut to overcompensate.** d) during re-entry If the re-entry angle on arriving at the atmosphere is too shallow the spacecraft could bounce off the atmosphere; if it is too large the spacecraft could burn up during re-entry. During re-entry the spacecraft has to be slowed, converting kinetic energy to heat energy by friction. If the spacecraft shell is exposed it can cause burn up. (*this happened to the STS Columbia in 2003, with the loss of 7 crew, and nearly happened to Atlantis that lost a couple of black tiles during the flight)* *make sure you answer in terms of PHYSICS*
7.6.2	A meteorite has a mass of 1.45 kg and enters the Earth's atmosphere with a speed of 10 km/s. (i) Calculate the initial kinetic energy of the meteorite $E_k = \frac{1}{2}mv^2$ $E_k = \frac{1}{2} \times 1.45 \times (10 \times 10^3)^2$ $E_k = 7.2 \times 10^7 J$ (ii) A few seconds later its velocity is only 200m/s. State what causes it to slow down. The velocity decreases as the force of friction opposes motion. The force converts the kinetic energy into heat energy. (iii) Determine the new kinetic energy of the meteorite $E_k = \frac{1}{2}mv^2$ $E_k = \frac{1}{2} \times 1.45 \times (200)^2$ $E_k = 2.9 \times 10^4 J$ (iv) The meteorite heats up from -220°C to 3550°C in the process. If it has a specific heat capacity of 800J/kg°C, Calculate the heat energy produced. $\Delta T = T_2 - T_1$ $\Delta T = 3550 - -220$

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	$\Delta T = 3800\ ^\circ C$ $E_H = cm\Delta T$ $E_H = 800 \times 1.45 \times 3800$ $E_H = 4.4 \times 10^6 J$ (v) State what happens to the rest of the kinetic energy as the meteorite passes through the atmosphere. $E_k = 7.2 \times 10^7 - (2.9 \times 10^4 + 4.4 \times 10^6) J$ $E = 6.8 \times 10^6 J$ The remainder of the kinetic energy heats the air around the meteorite and also melts the materials in the meteorite (Fe etc.) turning it into a liquid which sheds in the atmosphere. **Energy lost (as heat and sound) due to friction/air resistance**
7.6.3	During splashdown, the 350 kg Apollo space craft fell 500 m at a steady speed, supported by its parachute. Calculate (i) the loss of gravitational potential energy, $E_p = mgh$ $E_p = 350 \times 9.8 \times 500$ $E_p = 1.7 \times 10^6 J$ (ii) the work done by the parachute, and $W = 1.7 \times 10^6 J$ (iii) The force produced by the parachute. $W = Fd$ $1.7 \times 10^6 = F \times 500$ $F = 3.4 \times 10^3 N$
7.6.4	(a) Why do spacecraft heat up on re-entry? The kinetic energy at the edge of the Earth is reduced due to the frictional forces with the atmosphere; this kinetic energy is converted to heat energy. (b) Where does the energy come from which causes this heating? Kinetic energy of the spacecraft as it is slowed by the atmosphere.
7.7	I am aware of potential space travel across large distances using ion drive.
7.7.1	Explain the term "ion drive" in attaining high velocities in space craft. **Ion thrusters are an example of Newton's Third Law in action.** Xenon atoms accelerate through an electric field, and are ejected from the spacecraft- imparting an equal and opposite force on the spacecraft as it leaves, pushing the spacecraft forward and causing a small acceleration in the spacecraft. As there are no frictional forces on the external spacecraft it is not slowed and can achieve high velocities...

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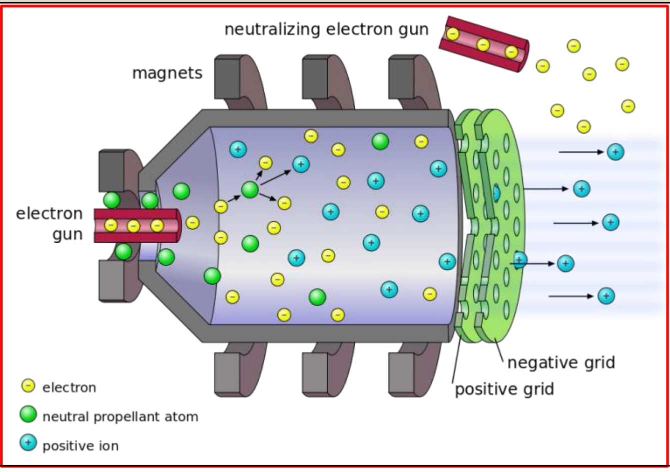
7.7.2	Draw a labelled diagram to show an ion drive used to propel spacecraft over long distances. 
7.7.3	State which of Newton's three laws of motion suggests that ion drive would work. **Ion thrusters are an example of Newton's Third Law in action.**
7.7.4	Summarise the video clip https://www.youtube.com/watch?v=6H0qsqZjLW0 Solid fuel rockets are expensive and have a limited burn time and little flexibility to make manoeuvres. Other methods of propulsion are needed for long flights. E.g. the ion propulsion system. The ion spacecraft acceleration is limited by the maximum lifetime of the thrusters chosen. An ion thruster can eject an individual ion at 90 kms^{-1} (c.f. 5 kms^{-1} for solid fuel). Ion thrusters have an efficiency 90% c.f. 35% for a solid booster rocket. The ions can be directed by a magnetic field to determine the direction of travel. The ions are generated from a plasma inside the spacecraft, and the atoms are bombarded with electrons, the collisions generate more electrons. • Electron and neutral atoms collide • Ionisation occurs (the gaining or loss of electrons) • Positive ions accelerate through electrodes • Electrons are released from the neutralizer • Process repeats • As the electrons are released from the thruster they apply an equal but opposite force on the ion drive pushing it forward. • The whole thing is powered by solar cells so there is no need for batteries to be on board, which are heavy. • Problem is forces are tiny, mN, so the engines are operated for hours or days at a time. • Example of the acceleration, Dawn can go from 0-100 kmh^{-1} in 4 days of continuous thrust. • Can also work with nuclear reactors. *****CHECK
7.8	I have a basic awareness that travelling large distances through space using a 'catapult' method.

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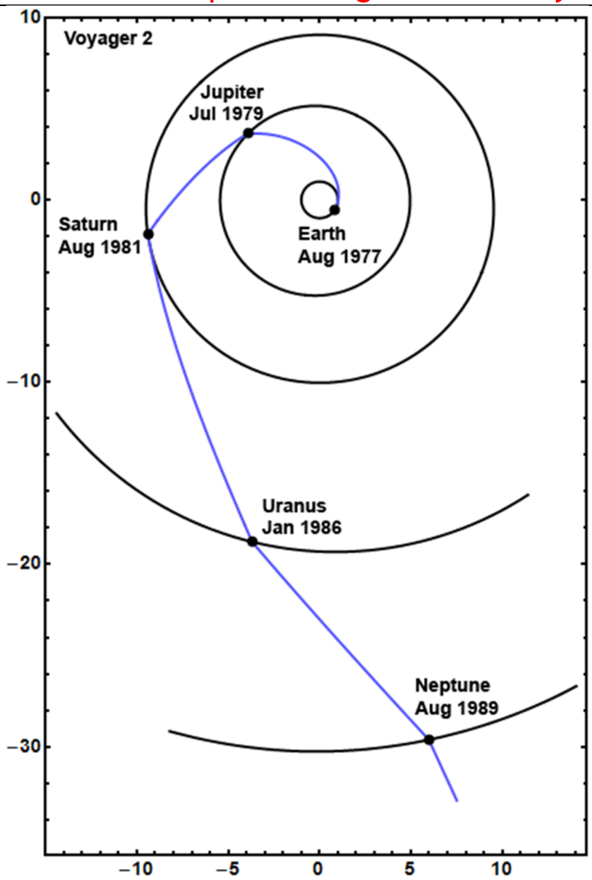
7.8.1	Explain the term "catapult" method in terms of spacecraft. (watch the following to help you https://www.youtube.com/watch?v=xJmD_1kSa3I) Gravity assist uses a planet's gravitational field to provide additional speed and usually a change of direction of the spacecraft; allowing travel to be accomplished with much less fuel ***CHECK
7.8.2	Explain how the catapult method reduced the fuel requirements for the Voyager spacecraft as it left the Earth's surface. The spacecraft's velocity increases during the "slingshot", During the approach, as the spacecraft falls into the gravitational field of the planet, it gains kinetic energy as its speed increases and loses gravitational potential energy, trading one for the other. After the approach it climbs back out and loses whatever kinetic energy it gained during the approach, ending up with the same final speed it started with. The direction of the spacecraft changes during the encounter, so it leaves the planet heading in a different direction. The closer the spacecraft gets to the planet, the greater the deflection. The maximum deflection is 180 degrees, sending the spacecraft back where it came from; this occurs if the spacecraft gets extremely close to the planet.
7.8.3	 Draw a diagram to show a spacecraft using the catapult method to increase velocity.
7.9	I have a basic awareness of how astronauts manoeuvre a spacecraft in a zero friction environment, possibly to dock with the ISS

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7.9.1	Explain why a rocket motor does not necessarily need to be kept on during an interplanetary flight. As there is no air in space frictional forces between the spacecraft and the outside are zero. Therefore Newton stated "an object will remain at rest or move with constant velocity unless acted upon by an unbalanced force". In this instance there is no unbalanced force.
7.9.2	OEQ: A student stated "If there is no friction in space, how do the thrusters work on space shuttle? Don't they have to push against something to move, like air?" Use your knowledge of Physics comment on this statement. ****** This is a possible answer. There are many possible ideas you could mention Newton's Third Law of motion states "For every action there is an equal but opposite reaction" In space there are no frictional force with the outside of the space shuttle so nothing to act as an unbalanced force. Therefore vehicles continue at constant velocity even if there is no force too accelerate the vehicle.
7.9.3	Explain the manoeuvres required by a supply craft docking with the ISS. Docking is the joining of two separate free-flying space vehicles. First the two vehicles must find each other and station-keep in the same orbit. The two vehicles must also reach a very similar speed to avoid a harsh collision.
7.10	I have a basic awareness of maintaining sufficient energy to operate life support systems in a spacecraft.
7.10.1	List uses of energy to operate life with a human crew on a trip to Mars. • Producing oxygen and recycling the carbon dioxide • Producing and heating and cooling system • Generating energy for cooking/ heating/ warming food/ keeping food and experiments are the correct temperature, so fridges/ freezers etc. • Communication system, the computers and systems to be able to communicate with Earth • Energy for the fitness apparatus, astronauts spend much of their day exercising to prevent loss of bone density. • ******

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7.10.2	In the future it is hoped that humans will be able to travel to Mars. One challenge of space travel to Mars is maintaining sufficient energy to operate life support systems. Suggest one solution to this challenge. **Solar cells** Accept: solar panels, Radioisotope Thermoelectric Generator (RTG), nuclear reactors *Solar energy/power alone is insufficient.* *Nuclear energy/power/reactions alone are insufficient.* *(Rechargeable) batteries/cells alone is insufficient.*
7.10.3	Explain the potential difficulties of supporting a crew on a trip to visit Pluto or other astronomical objects further out in our solar system. • Pschycological problems of confinement • Getting on with crew members in a small space for over two years • Communication with home. • Fuel and energy demands See 7.11.1
7.11	I can describe the risks associated with manned space exploration.
7.11.1	State the challenges of space travel to Mars. • Pschycological problems of confinement • Getting on with crew members in a small space for over two years • Communication with home. • Fuel and energy demands • Landing on Mars is difficult 22/45 missions have been successful (2018) *Outer space is a very unpleasant place to be. It is hard to get up there in the first place but once you are there, you have to be protected from all the dangers that surround you. This is largely accomplished through wearing a specially designed space suit.* *What would happen if you left a spacecraft and forgot to put your spacesuit on?* *Space is a vacuum so there is no oxygen there. As a result you would lose consciousness very quickly. Worse will happen however, due to this lack of an atmosphere. As there is no air pressure acting on your body, dissolved gases in your body would come out of solution and your body fluids would start to boil. (fluids boil at lower temperatures at lower pressure). The boiling process also removes energy from the body which cools down very rapidly indeed.* *Tissues in your body and critical organs such as the heart will swell up and expand due to the boiling fluids. Death would be very quick but agonisingly painful.*

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	There would be extremes of temperature. Parts of your body in direct sunlight would experience very high temperatures whilst those in the shade would be extremely cold. *Your body would be bombarded by radiation and charged particles from the Sun. The Earth's atmosphere filters most of the harmful radiation out before it reaches the Earth's surface but there would be no protection in space.* *If all of the above have not already killed you, there is a strong risk that you would be hit by tiny particles of dust or rock that are moving at very high speeds. You might even be hit by debris or 'space junk' from the many satellites and spacecraft that have been abandoned in space.*
7.11.2	Explain some potential solutions to the challenges listed above. • Astronaut training is rigorous and crew train together for many months/years. • Missions can be tested on Earth (HERA missions) to study for potential problems in being away from home for many months. • Different energy solutions are being devised, ion thrusters etc. • All processes have built in redundancy, so that there is a back up if something goes wrong. • 1000's of scientists work on each problem on Earth before completing a mission. • Space suits are specially designed and very expensive. Each piece is carefully designed and built by different scientists. They project against extremes of temperature (good cooling and heating mechanisms), are designed to heal if a small object hits them, and have protection against the high radiation levels.
7.12	I have knowledge of Newton's second and third laws and their application to space travel, rocket launch and landing.
7.12.1	a) State Newton's second law of motion. $F = ma$ b) State Newton's third law of motion. For every action there is an equal but opposite reaction.
7.12.2	Explain, in terms of forces, how a rocket works. A rocket is pushed forward because the "propellant" is pushed back. *When the rocket takes off, the rocket exerts a force downwards on the exhaust gases. The exhaust gases exerts a force on the rocket that is equal in size and opposite in direction.*
7.12.3	In terms of Newton's third law, what is the 'equal and opposite force' in each of these situations:- (i) A ship's propeller pushes on the water, The ship's propeller exerts a force on the water; the water exerts a force on the

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	ship's propeller that is equal in size and opposite in direction. (ii) A rocket pushes on the exhaust gases, The rocket exerts a force downwards on the exhaust gases, the exhaust gases exerts a force on the rocket that is equal in size and opposite in direction. (iii) The Earth's gravity pulls on the moon, The Earth exerts a force on the moon; the moon exerts an equal in size and opposite in direction force on the Earth. (iv) The Earth's gravity pulls on a box sitting on the floor. The Earth exerts a force on the box sitting on the floor; the box exerts an equal in size and opposite in direction force on the Earth.
7.12.4	A rocket has a total mass of 500kg and produces a thrust of 10 000 N. (i) Calculate the initial acceleration of the rocket $F = ma$ $Thrust - Weight = F_{un} = ma$ $10000 - (500 \times 9.8) = 500a$ $a = 10.2\ ms^{-2}$ (ii) State what happens to the mass of the rocket as it burns its fuel. As the rocket burns fuel the mass decreases *(and the weight of the rocket decreases)*. (iii) If the thrust remains constant, state what happens to the acceleration of the rocket. Even if the thrust remains constant the acceleration will increase as fuel is burned as there is less mass to accelerate, and less weight to oppose the thrust.
7.12.5	An astronaut uses a backpack called a Man Manoeuvring Unit, or MMU, to move her around when in space. This produces a thrust of 2.0 N in any direction. If the astronaut and her suit has a mass of 180kg, (i) Calculate the initial acceleration the astronaut using this MMU. $F = ma$ $2.0 = 180 \times a$ $a = 0.011\ ms^{-2}$ (ii) The astronaut is initially at rest, calculate the astronaut's final speed after firing the thruster for 10s. $a = \frac{v - u}{t}$ $0.011 = \frac{v - 0}{10}$ $v = 0.11\ ms^{-1}$

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7.13	I can use **W=mg** to solve problems involving weight, mass and gravitational field strength, in different locations in the universe.
7.13.1	State the weight of each 1kg near the earth. 1kg has a weight of 9.8 N near the surface of the Earth.
7.13.2	Calculate the weight on Earth of (i) a 30kg dog, $W = mg$ $W = 30 \times 9.8$ $\underline{\underline{W = 294\ N}}$ (ii) a ½kg book, $W = mg$ $W = 0.5 \times 9.8$ $\underline{\underline{W = 4.9\ N}}$ (iii) a 23g bag of crisps, $W = mg$ $W = 0.023 \times 9.8$ $\underline{\underline{W = 0.23\ N}}$ (iv) a 2 tonne lorry? (1 tonne = 1000kg) $W = mg$ $W = 2000 \times 9.8$ $\underline{\underline{W = 20\ 000\ N}}$
7.13.3	Calculate the weight of a 10 kg bag of potatoes on Earth. $W = mg$ $W = 10 \times 9.8$ $\underline{\underline{W = 9.8\ N}}$
7.13.4	Calculate the weight of a 250 g bag of sweets. $W = mg$ $W = 0.250 \times 9.8$ $\underline{\underline{W = 2.5\ N}}$

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7.13.5	A girl has a weight of 450 N on Earth, calculate the mass of the girl. $W = mg$ $450 = m \times 9.8$ $\underline{m = 46\ kg}$
7.13.6	Calculate the weight of a 10,000 kg spacecraft on a) Earth b) Mars c) Venus. a) $W = mg$, $W = 10\,000 \times 9.8$, $\underline{W = 98\,000\ N}$ b) $W = mg$, $W = 10\,000 \times 3.7$, $\underline{W = 37\,000\ N}$ c) $W = mg$, $W = 10\,000 \times 8.9$, $\underline{W = 89\,000\ N}$
7.13.7	Calculate the weight of a 60 kg man on Jupiter. $W = mg$ $W = 60 \times 23$ $\underline{W = 1400\ N}$
7.13.8	State the planet's gravitational field strength most similar to our own. Venus
7.13.9	An astronaut who weighs 700 N on Earth goes to a planet where he weighs 266 N. Calculate his mass and state which planet he was on. On Earth: $W = mg$, $700 = m \times 9.8$, $\underline{m = 71.4\ kg}$ Other Planet: $W = mg$, $266 = 71.4 \times g$, $\underline{g = 3.7\ Nkg^{-1}}$ The astronaut is on Mars or Mercury
7.13.10	An astronaut on Venus weighs 528 N. Calculate the weight of this astronaut on Earth. On Venus: $W = mg$, $528 = m \times 8.9$, $\underline{m = 59.3\ kg}$ On Earth: $W = mg$, $W = 59.3 \times 9.8$, $\underline{W = 581\ N}$

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7.13.11	(i) Draw a table showing the mass and weight of a 5.4 kg rock on Earth and Mars. <table><tr><th>Place</th><th>Mass (kg)</th><th>Weight (N)</th></tr><tr><td>Earth</td><td>5.4</td><td>53</td></tr><tr><td>Mars</td><td>5.4</td><td>20</td></tr></table> (ii) If the rock was allowed to fall freely on Mars, state its initial acceleration close to the surface. The rock would accelerate at 3.7 ms^{-2} near the surface of Mars (the value of g)
7.13.12	A lunar rover has a weight of 240N when on the moon Calculate is its mass and weight on the Earth. On Moon: $W = mg$; $240 = m \times 1.6$; $\underline{m = 150\ kg}$ On Earth: $W = mg$; $W = 150 \times 9.8$; $\underline{W = 1500\ N}$ Accept 1470N, 1000N
7.13.13	The weight of a 20 kg mass on Europa, a moon of Jupiter, is 26.4 N. Calculate the gravitational field strength on Europa $W = mg$ $26.4 = 20 \times g$ $\underline{g = 1.3\ Nkg^{-1}}$
7.13.14	State what happens to the weight of a spacecraft as it moves further away from the Earth. *You must justify your answer.* The weight decreases as g is dependant on height.

Cosmology

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8.1	I can correctly use the term light year
8.1.1	Describe the term light year. Light year is the **distance** light travels in one year. distance = speed × time distance = 3.0×10^8 × (seconds in one year) distance = 3.0×10^8 × (60 × 60 ×24 ×365) 1ly = distance = 9.46×10^{15} m

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8.1.2	State the symbol and the unit of a light year. The symbol is ly and it is measured in m
8.1.3	Betelgeuse is 640 light years away, explain what this means. It means that the light that you see from Betelgeuse tonight set off approximately 640 years ago. *For example if it is 2020 the light set off around 1400. (1380)*
8.2	I can convert between light years and metres
8.2.1	The star Proxima Centauri is about 4.5 light years from the sun. Calculate this distance in metres. distance = speed × time $distance = 3.0 \times 10^{8} \times years \times (seconds\ in\ one\ year)$ $distance = 3.0 \times 10^{8} \times 4.5 \times (60 \times 60 \times 24 \times 365)$ $\underline{4.5\ ly = distance = 4.3 \times 10^{16}\ m}$ Or $So\ 4.5\ light\ years = 9.46 \times 10^{15} \times 4.5 = 4.3 \times 10^{16} m$ This would only work if you remembered the correct value for a ly and you MUST NOT use this value in a show that question.
8.2.2	The Milky Way (our galaxy) is 105,700 light years in diameter, calculate this distance in metres. distance = speed × time $distance = 3.0 \times 10^{8} \times years \times (seconds\ in\ one\ year)$ $distance = 3.0 \times 10^{8} \times 105700 \times (60 \times 60 \times 24 \times 365)$ $\underline{distance = 1.0 \times 10^{21} m}$ Or $105700\ light\ years = 9.46 \times 10^{15} \times 105700 = 1.0 \times 10^{21} m$

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8.2.3	The Canis Major Dwarf Galaxy is only 2.36×10^{20} m from the Sun, determine this distance in light years. distance = speed × time $2.36\times 10^{20} = 3.0\times 10^{8} \times years \times (60 \times 60 \times 24 \times 365)$ $light\ years = \frac{2.36\times 10^{20}}{3.0\times 10^{8} \times (60 \times 60 \times 24 \times 365)}$ $\underline{light\ years = 2.49\times 10^{4} ly}$ Or (providing this is not a show that question and you remember the distance for 1ly $light\ years = \frac{2.36\times 10^{20}}{9.46\times 10^{15}} = 2.49\times 10^{4} ly$
8.2.4	Betelgeuse is approximately 640 light-years from the sun. Determine this distance in metres. distance = speed × time $distance = 3.0\times 10^{8} \times 640 \times (60 \times 60 \times 24 \times 365)$ $\underline{distance = 6.1\times 10^{18}\ m}$
8.2.5	Within our solar system distances are often measured in astronomical units (AU).1 AU = $1{\cdot}50 \times 10^{11}$ m. Mars orbits the Sun at an average distance of 1·52 AU. Determine the average distance, in metres, at which Mars orbits the Sun. 1 AU = $1{\cdot}50 \times 10^{11}$ m $1.52\ AU = 1.52 \times 1\cdot 50 \times 10^{11}\ m$ $\underline{1.52\ AU = 2.3 \times 10^{11}\ m}$
8.3	I can give a basic description of the Big Bang theory of the origin of the Universe.
8.3.1	The term Big Bang has been use to described the origin of the Universe. Explain why this term appears appropriate. The Universe came into existence as a singularity and rapidly expanded from an extremely hot dense state to what exists today. So it appeared from a tiny space into a massive and vast space like an explosion.
8.3.2	Summarise the following video clip. https://www.youtube.com/watch?v=wNDGgL73ihY

No.	Content
8.4	I know the estimated age of the Universe.
8.4.1	State the approximate age of the Universe. **13.8 or 14 billion years old**
8.4.2	List and explain the evidence to support the age of the Universe? • Cosmic Microwave Background Radiation has been detected in space as evidence of this cooling. The average temperature of the Universe is currently around 2.7K or -270.5 °C. • Red shift- if the galaxies are moving further apart then we can trace this back (extrapolate) to a time when the galaxies were all at one point.
8.5	I can describe how different parts of the electromagnetic spectrum are used to obtain information about astronomical objects.
8.5.1	List the parts of the electromagnetic spectrum in order of increasing wavelength Gamma ⇒X-rays⇒UV⇒Visible⇒IR⇒Microwaves⇒Radio
8.5.2	State a detector for each part of the electromagnetic spectrum

EM Waveband	Emitted by	Detected by
Radio	Astronomical Objects Radio Station transmitters	Ground based radio telescopes Radio Aerials
Microwaves	Gas clouds collapsing into stars Microwave Ovens Radar Stations Cell Phones (mobiles)	Aerials Microwave Telescopes Cell phones aerials Radar systems
Infra-Red	Sun and stars (Near) TV Remote Controls Everything at room temp or above	(black bulb) thermometer, photodiode, phototransistor, thermistor, thermocouple, CCD, thermochromic film
Visible	The sun and other astronomical objects Laser pointers Light bulbs	Retina Photographic film CCD Refracting / reflecting Telescopes
UV	The sun (A) Tanning booths (A) Black light bulbs (B) UV lamps	Space based UV detectors ~~UV Cameras~~
X-rays	Astronomical objects X-ray machines CAT scan machines Older televisions Radioactive minerals Airport luggage scanners	Space based X-ray detectors X-ray film (photographic film) CCD detectors

No.	Content

Gamma	Astronomical objects X-ray machines CAT scan machines Older televisions Radioactive minerals Airport luggage scanners	Space based X-ray detectors X-ray film (photographic film) CCD detectors

8.5.3

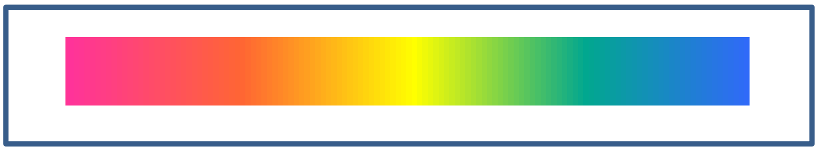
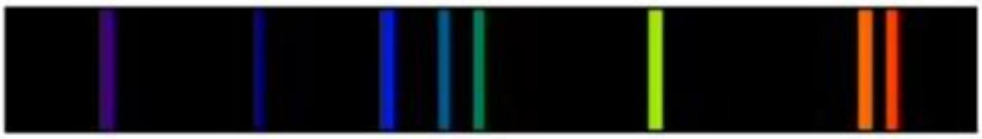
State what happens to the frequency of the radiation as the wavelength increases.

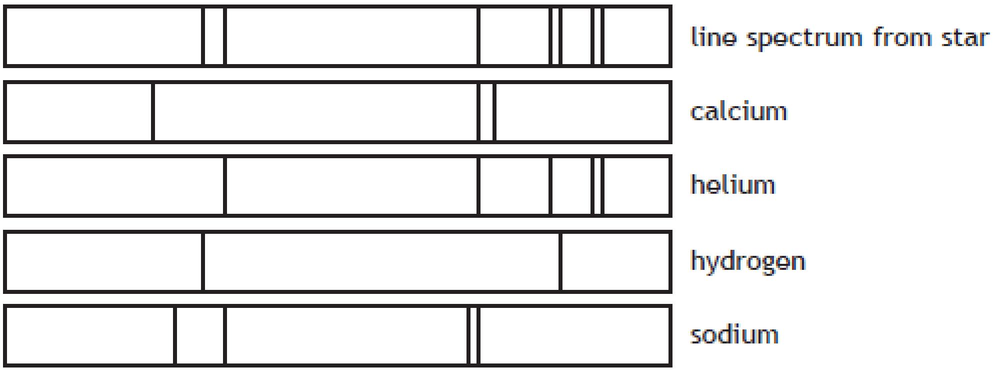
As the wavelength of the e-m radiation increases, the frequency decreases as $v = f\lambda$ and $3 \times 10^8 = f\lambda$

8.5.4

State how each part of the electromagnetic spectrum can be used to learn about space, complete the following table

Type of Radiation	Detector	Use
Radio	Radio Telescope	Used to study naturally occurring radio light from stars, galaxies, black holes, and other astronomical objects. They can also be used to transmit and reflect radio light off of planetary bodies in our solar system.
Microwave		• Molecular clouds • Star formation • Studies chemical abundance and cooling mechanisms • Formation and evolution of galaxies.
IR	e.g. Spritzer	First to capture direct "light" from exoplanets. Information from IR telescopes increased our understanding of how planets formed. In 2004 detected the youngest star ever seen.
Visible	Hubble Telescope/ James Webb Telescope	• Imaging various celestial objects in our solar system. • Kepler telescope detected exoplanets. • Detecting sunspots, • Studying nebulae
UV	e.g GALEX	Needs to be above the atmosphere as most UV is absorbed by the atmosphere. Can be used to study young hot stars
X-rays	E.g. Chandra an X-ray observatory	Chandra is designed to observe X-rays from high energy regions of the universe, such as the remnants of exploded stars.
Gamma	X-rays and	Used to study

No.	Content
	Gamma ray observatories • Black holes • Active Galaxies • Pulsars • Supernovae • Gamma-ray bursts
8.6	I can identify continuous and line spectra.
8.6.1	State the type of spectrum shown in diagram below  Continuous Spectrum
8.6.2	State the type of spectra shown in diagrams below. (A)  Line Spectrum /Emission spectrum
8.6.3	 (B) Line Spectrum/ Emission spectrum
8.6.4	 (C) Continous spectrum
8.6.5	 (D) Line Spectrum /Absorption spectrum
8.7	I can use spectral data for known elements, to identify the elements present in stars.

No.	Content
8.7.1	Light from a star is split into a line spectrum of different colours. The line spectrum from the star is shown, along with the line spectra of the elements calcium, helium, hydrogen and sodium. State what elements are present in the star.  Hydrogen and Helium