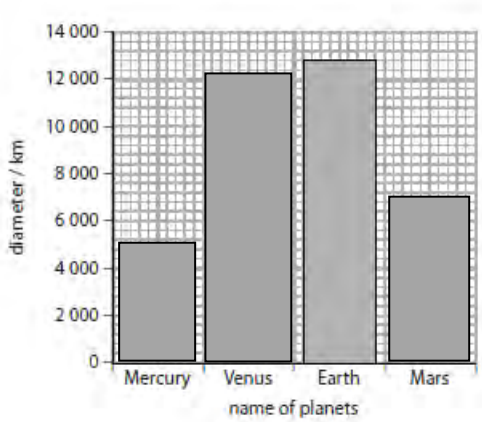
Question Number	Answer	Acceptable answers	Mark
1(a)(i)	Milky Way	Accept any spelling	**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	☒ **D** white dwarf		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)(i)	 Mercury 4 900 km Venus 12 100 km Mars 6 800 km Three correct (2) One or two correct (1) + or – one square Judge by eye		**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)(ii)	Correct information from table 1.52 (1) Conversion to kilometres (1.52) x 150 000 000 (1)	Seen anywhere in the answer Incorrect information shown to be used correctly (1) Correct answer, no working scores full marks 228 000 000 / 2.28×10^8 (km) 228 to any power of 10, allow 1 mark if no other mark awarded. 225 000 000 / 2.25×10^8 (km), allow max 1 mark if no working shown.	**(2)**

Question Number		Indicative Content	Mark
QWC	*)	A description including some of the following points In Solar System • Use of telescopes • Search for evidence of conditions needed for life e.g. water/oxygen/bacteria on other planets • Manned missions (to the Moon) • Unmanned missions/probes to other planets e.g. Mars, Jupiter, Saturn, Mercury • Landers / robots / rovers sample soil • Information transmitted back to Earth Throughout the Universe • Search for extra-terrestrial intelligence (SETI) • Use radio telescopes • Search for (regular pattern of) radio signals • Search for other planetary systems • Discovery of other planetary systems (capable of supporting life) • Broadcasting signals/ sending out messages (to extra terrestrial intelligences)	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• A limited description giving a (named) way of searching for evidence e.g. SETI **OR** using telescopes **OR** send messages to space **OR** spacecraft • The answer communicates ideas using simple language and uses limited scientific terminology • Spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• A simple description of any TWO of the searches for evidence e.g space probes go to other planets and telescopes are used **OR** radio telescopes and looking for radio waves from space. • The answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • Spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• A detailed description of searches for evidence within **AND** outside the solar system e.g. Unmanned space probes go to other planets and radio telescopes search for radio signals from space. • The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • Spelling, punctuation and grammar are used with few errors	

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	cosmic microwave background (radiation) all three words needed		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	(the) Big Bang (theory)		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	change in the (observed) frequency **or** wavelength of light/radiation (received from a distant galaxy)	light/absorption lines is/are shifted toward red end of spectrum light/radiation has longer wavelength/lower frequency waves are more spread out/stretched Ignore references to sound or colour of light eg galaxies/light appear(s) red(er)	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iv)	An explanation linking the following:- It/the Universe is expanding (1) some galaxies are (moving)faster (than others) (1)	they/ galaxies are moving further/away (from the Earth/us) the further away the galaxy is the greater the red-shift/the faster the galaxy is moving (some galaxies) are moving away faster (than others) gains 2 marks IGNORE references to planets/stars	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)(i)	D red giant then white dwarf		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(ii)	an explanation linking **two** of the following: • Different/more wave(length)s/frequencies (now) detected/collected (1) • because telescopes positioned above Earth's atmosphere or by radio telescopes (1) OR • weaker signal(s) (now) detected/collected (1) • because modern telescopes are more powerful/have greater magnification **or** positioned above Earth's atmosphere/ on top of mountains (1) If no other marks awarded allow 1 mark for idea that: Electronic(s)/computers can process/improve the data/signal information/waves/radiation	named type of em radiation accept CMB for microwave space telescope or named space telescope (because) less or no light/radiation is absorbed by Earth's atmosphere Accept named space telescope eg Hubble/Planck/Compton etc Ignore references to clearer images/more detail/can see further/photographs	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	Universe		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	Milky Way		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(b)(i)	A description including: • change in wavelength / frequency (1) • Correct change(s) (1)	wavelength increases (2) frequency decreases (2)	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)(ii)	An explanation linking **two** of the following points • red shift (1) • universe expanding (1) • (cosmic) microwave (background)(radiation) (1)	Accept initials (eg CMB)	**(2)**

Question Number			
QWC	***3(c)**	A description including some of the following points Life cycle of a star similar of mass similar to that of our sun a. nebu / stellar nursery • clouds of dust and gas • pulled together or collapsed by gravitational forces b. Ou sun / main sequence • stable state • hydrogen being converted to helium, nuclear fusion • huge amounts of heat and light produced • continues for many millions of years c. r giant • hydrogen runs out • star expands • star gets colder • uses up all its helium • outward forces decrease d. white dwarf • eventually collapses • due to own gravity • becomes much smaller and very dense e. Sequ ce: • Nebula / stellar nursery • (Protostar) • Star (main sequence) • Red Giant • White Dwarf • (Black Dwarf) ignore references to planetary nebula) Credit is given for correctly labelled diagrams.	**(6)**
Level	**0**	no rewardable material	
1	**1-**	• a limited description including naming one of the stages (star alone is insufficient) e.g. A star can be a red giant • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3-**	• a simple description including two consecutive stages in the correct sequence OR a description of one of the stages e.g. a nebula forms a (main sequence) star / Nebulae are clouds of dust and gas • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description including naming three consecutive stages in the correct order AND a description of one stage e.g. A nebula is a cloud of gas and dust that forms a star which then becomes a red giant. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Question Number	Answer		Mark
4(a)(i)	the explosion of a massive star		**(1)**

Question Number	Answer	Mark
4(a)(ii)	<table><tr><td colspan="3">**longest wavelength** ⟶ **shortest wavelength**</td></tr><tr><td>infrared</td><td>visible light</td><td>X-rays</td></tr></table> All three must be correct	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	An explanation linking **three** of the following points • discovery of objects not detectable by visible light (1) • more information / data can be collected (1) • different (electromagnetic) waves can give different types of information (1) • produce magnified images (1) • (space telescopes) produce clearer images / images unaffected by Earth's atmosphere (1)	allow specific examples e.g. (discovery of) black holes/CMB / pulsars different telescopes provide different data/ images brighter/more detailed images ignore idea 'can see further' unless qualified	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(b)	Any **two** of the following points • Spitzer observes /uses infrared (1) • infrared is heat (1) • Sun produces (large amounts of) heat / infrared (1) • small amount of heat from distant galaxies would not be detected (amongst radiation from the Sun) (1)	ignore idea 'to protect telescope from heat/damage' infrared (waves)/heat from the Sun would interfere with/swamp/ruin image (of distant galaxies)	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(c)(i)	calculate **one** distance (1) e.g. 1.49×10^8 or 3.96×10^{13} evaluation (1) e.g. $(3.96 \times 10^{13} \div 1.49 \times 10^8)$ = 265 000 e.g. inverse $(1.49 \times 10^8 \div 3.96 \times 10^{13})$ 3.77×10^{-6} e.g. from comparison of times (2 200 000 ÷ 8.3) = 265 000	accept 149 400 000 or 39 600 000 000 000 265 060 265 771.18 Give 2 marks for a correct evaluation with no working shown or no distance calculation Give 2 marks for two correct distances and a correct comparative statement	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(c)(ii)	the stars are so distant that a large unit of distance is needed	the numbers (of km or miles) would be too big (to understand)/ too long (to write down) (numbers of) light years are more manageable/ easier to understand	**(1)**