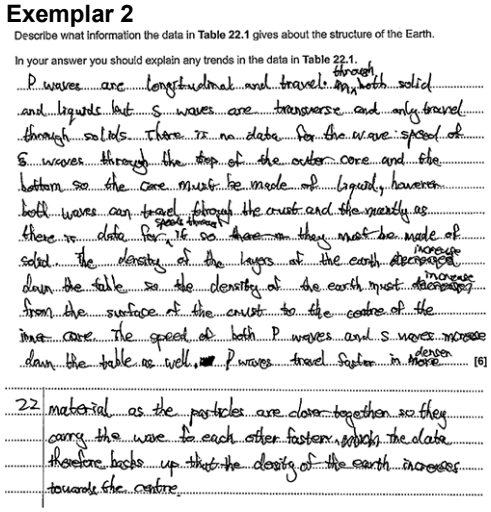
Mark scheme – Beyond Earth (H)

Question			Answer/Indicative content	Marks	Guidance
1			**C** ✓	1 (AO1.1)	
			Total	**1**	
2			**A** ✓	1 (AO1.1)	
			Total	**1**	
3			**A** ✓	1 (AO1.1)	
			Total	**1**	
4			**A** ✓	1 (AO1.1)	
			Total	**1**	
5			D ✓	1 (AO1.1)	**Examiner's Comments** This was generally well answered. Candidates who did not gain the correct answer often chose C indicating that the direction of the electric field was not fully understood.
			Total	**1**	
6			**C** ✓	1 (AO 1.1)	**Examiner's Comments** This question assessed candidates' knowledge of how the force of gravity can change the velocity of a planet but its speed stays the same. Most candidates correctly chose option C.
			Total	**1**	
7			**B** ✓	1 (AO 2.1)	**Examiner's Comments** A number of candidates struggled with this question about satellite orbits. A common error was option C as candidates incorrectly thought that the speed of the satellite in orbit would increase as it is moved further from Earth.
			Total	**1**	

8			**B** ✓	1 (AO 1.1)	**Examiner's Comments** Candidates were mainly able to apply their knowledge to link correctly the amount of red-shift to the movement of galaxies.
			Total	**1**	
9			**A** ✓	1 (AO 1.1)	
			Total	**1**	
10			**C** ✓	**1 (AO2.1)**	**Examiner's Comments** Most candidates demonstrated a good knowledge about the orbits of artificial satellites at different heights (P8.3f and P8.3g). Most other candidates correctly identified that the force of gravity would be less when the satellite is moved to a higher orbit, but also predicted that the speed would increase (distractor D).
			Total	**1**	
11			**C** ✓	**1 (AO1.1)**	
			Total	**1**	
12			**D** ✓	**1 (AO1.1)**	
			Total	**1**	
13			B	1	
			Total	**1**	
14			* Please refer to point 10 of the marking instructions of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** **Interpretation of the diagram and how it provides evidence for an expanding universe and the Big Bang model** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated*. **Level 2 (3–4 marks)** **Description of red shift AND recognition**	6	**AO3.2b: Analyse the diagram to conclude how it provides evidence for an expanding universe and the Big Bang model** • The further away a galaxy is the more red shifted it is indicating an expanding universe • If galaxies are moving away then the universe must be expanding • If whole universe is expanding then it must have started from a certain point – the singular point where the Big Bang occurred • More distant galaxies are more red shifted than stars that are closer

			of what the red shift diagram indicates relating to the Big Bang model *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence*. **Level 1 (1–2 marks)** **Simple description of the Big Bang model OR redshift** *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*. **0 marks** *No response or no response worthy of credit*.		• Distant galaxies show the lines moving towards the red end of the spectrum • Dark bands are moving towards the red end of the spectrum **AO1.1: Description of evidence linking red shift to the Big Bang model** • Red shift is caused by a change in frequency / wavelength of light • Description of the changes in frequency and wavelength of light from distant galaxies • Red shift shows galaxies moving away.
			Total	**6**	
15			Any two features from: Polar orbit travels over both poles (1) Travels faster than a geostationary satellite (1) Multiple orbits in a day (1) Lower orbit than geostationary satellites(1) Any one use from: Mapping / weather / surveillance (1)	3	
			Total	**3**	
16		i	Neutron(s) ✓	1 (AO 1.1)	**IGNORE** gamma **<u>Examiner's Comments</u>** About two thirds of the candidates did not know that neutrons were also produced in a fusion reaction. Common misconceptions included water, carbon dioxide and protons.
		ii	**Any one from:** Gravity ✓ (very) high temperatures ✓	1 (AO 1.1)	**ALLOW** (high) gravitational field strength **ALLOW** hot (temperatures) / lots of heat **IGNORE** just heat

			high pressure ✓		**Examiner's Comments** The majority of candidates answered this correctly.
			Total	**2**	
17			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed description of the structure of the Earth **AND** Detailed explanation of the trends in **Table 22.1.** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Description of the structure of the Earth. **AND** Explanation of the trends in **Table 22.1.** **OR** Detailed description of the structure of the Earth. **OR** Detailed explanation of the trends in **Table 22.1.** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** **A basic description of the structure of the Earth.** **OR** A basic description of the trends in **Table 22.1.** *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO 2×3.1a) (AO 2×3.2a) (AO 2×2.1)	**AO3.1a Analyse information and ideas to interpret some basic trends in data** • density increases as depth increases • speed (of P/S waves) increases as density increases • speed (of P/S waves) increases as depth increases **AO2.1 Apply knowledge and understanding of scientific ideas to explain trends in the data** • Earth contains layers • velocity changes at a boundary • as density changes at a boundary • particles more tightly packed • P is longitudinal, S is transverse **AO3.2a Analyse information and ideas to make judgements about the structure of the Earth** • core has highest density • core has highest speed for P waves • S waves do not travel through the core • so the outer core is a liquid • pressure highest in core / P = ρgh • pressure and so density increase with depth • large change in density between mantle and outer core **Examiner's Comments** This was the Level of Response question, targeted up to Grade 9, and assessed AO2 and AO3. There was a wide range of marks achieved and the question discriminated well. Very few candidates did not achieve any credit.

					The majority of candidates were able to describe some basic trends in the table for density and speed of P and S waves. More detailed responses also included a description of the structure of the Earth for Level 2. Many excellent responses from the more able candidates at Level 3 included: ● trends in the data identified and explained ● linking facts about P and S waves to an explanation of why the outer core is liquid. Poor quality of communication, including contradictions or the same facts repeated a number of times, prevented some candidates from achieving a higher mark. **Exemplar 2** Describe what information the data in **Table 22.1** gives about the structure of the Earth. In your answer you should explain any trends in the data in **Table 22.1**.  P waves are longitudinal and travel through both solid and liquids but S waves are transverse and only travel through solids. There is no data for the wave speed of S waves through the top of the outer core and the bottom so the core must be made of liquid, however both waves can travel through the crust and the mantle as there is data for it so these must be made of solid. The density of the layers of the earth decreases down the table so the density of the earth must increase from the surface of the crust to the centre of the inner core. The speed of both P waves and S waves increase down the table as well. P waves travel faster in denser material as the particles are close together so they carry the wave to each other faster, which the data therefore backs up that the density of the earth increases towards the centre. [6] This response achieved Level 3, 6 marks. The candidates included a detailed description of the structure of the Earth, including ideas about density and the liquid outer core. There is also a detailed explanation of the trends shown in the table.
			Total	**6**	
18	a		(All galaxies) showed <u>red-shift</u> ✓ (Hubble measured the) wavelength/frequency of <u>light</u> (from the galaxy) ✓	2 (AO2 × 1.1)	**ALLOW** (all galaxies) showed <u>light</u> with a longer wavelength/lower frequency for 2 marks
	b	i	Readings of speed taken for two different values of distance ✓ Working to show that the factor increase in speed is the same as distance ✓	2 (AO2 × 3.1a)	**ALLOW** +/- ½ a small square **ALLOW** a statement for the second mark e.g. as the distance doubles so does the speed.

					Example: At 20 Mpc, speed = 1400 km/s At 40 Mpc, speed = 2800 km/s 40/20 = 2 = 2800/1400 **ALLOW** 1 mark maximum for it is a (straight) line of best fit through the origin (therefore it is proportional)
		ii	**Any one from:** The more distant galaxies are travelling faster ✓ The evidence suggests the universe is expanding ✓ The universe was smaller in the past ✓	1 (AO1.1)	**ALLOW** galaxies are moving away from each other
	c		To ensure results are reproducible / check the work is of high enough quality / claims are not false / for new theories to be accepted / to develop theories / AW ✓	1 (AO1.1)	**ALLOW** check validity / for mistakes/anomalies / AW **ALLOW** check that it's not biased / AW
	d	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5 800 000 (m/s) award 2 marks** (Reads off speed from graph =) 5800 (km/s) ✓ Speed = 5800 × 1000 = 5 800 000 (m/s) ✓	2 (AO2.2) (AO1.2)	**ALLOW** 5.8×10^6 (m/s) **ALLOW** ecf for their speed from graph x 1000
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.36×10^{17} (s) award 3 marks** time = distance / speed ✓ (time =) 2.53×10^{24} / 5 800 000 ✓ (time =) 4.36×10^{17} (s) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**ALLOW** ecf from **(i)** **ALLOW** 4.4×10^{17} (s) **ALLOW** equation in any form
			Total	**11**	