Selected Questions – Set 5 - Answers

1.

Question	Answers	Marks	Guidance
(a)	$V = \frac{4}{3}\pi \times (6\times10^3)^3$ or $V = 9.05 \times 10^{11}$ (m^3) density = $\frac{2.0\times10^{30}}{\frac{4}{3}\pi\times(6\times10^3)^3}$ density = 2.2×10^{18} kg m^{-3}	C1 C1 A1	**Note**: An incorrect equation here for V prevents this and any subsequent marks. The correct unit must also be included to score this A1 mark. **Allow** 2 marks for 2.76.... $\times 10^{17}$ kg m^{-3} – 12 km used instead of 6 km for the radius.
(b)	$g \propto 1/r^2$ ratio = $\left(\frac{1.4\times10^9}{12\times10^3}\right)^2$ or ratio = $\left(\frac{0.7\times10^9}{6\times10^3}\right)^2$ ratio = 1.4×10^{10}	C1 A1	**Note**: The answer to 3 sf is 1.36×10^{10}. **Allow** 1 mark for 7.3×10^{-11} – inverse of the ratio.
(c)	($p = 1/d$) $d = \frac{8.6\times9.5\times10^{15}}{3.1\times10^{16}}$ (pc) or $d = 2.64$ (pc) $p = 0.38$ (arc seconds)	C1 A1	**Allow** full credit for alternative methods.
(d)	$(\frac{\Delta\lambda}{\lambda} = \frac{v}{c})$ fractional change = $\frac{7600}{3.0\times10^8}$ percentage change = 2.5×10^{-3} %	C1 A1	**Allow** 1 mark for 2.5×10^{-5} (factor of 100 missed out).
(e)	The suggestion is incorrect because Hubble's law applies to (distant receding) galaxies. or The suggestion is incorrect because Hubble's law does not apply to stars in our own galaxy.	B1	Do **not** allow this mark if 'Sirius / star is moving towards us' is also included.

2.

Question			Answer	Marks	Guidance
	(a)		$F = \frac{GMm}{r^2}$ force = $\frac{6.67\times10^{-11}\times(10^{41})^2}{(4\times10^{22})^2}$ force = 4.2×10^{26} (N)	C1 C1 A1	**Allow**: 4×10^{26} (N) or 10^{26} since this is an estimation **Allow**: 2 marks for 4.2×10^{n}; $n \neq 26$ (POT error)
	(b)		Allow any <u>one</u> from: • The galaxies are receding / moving away from each other (because of the big bang) • Other galaxies may be pulling them in opposite direction • The acceleration is too small to collapse (other than over a very long period of time)	B1	
	(c)	(i)	Dark lines / bands against a background of <u>continuous</u> <u>spectrum</u>	M1 A1	
		(ii)	$\frac{v}{c} = \frac{\Delta\lambda}{\lambda}$ speed = $\frac{86.6}{393.4}\times3.0\times10^{8}$ (Any subject) speed = 6.6×10^{7} (m s^{-1}) or 66000 (km s^{-1}) $v = H_0 d$ $66000 = 50 \times d$ distance = 1300 (Mpc)	C1 C1 A1	**Allow**: 1 mark for $\frac{86.6}{480.0}\times3.0\times10^{8} = 5.41\times10^{7}$ (m s^{-1}) **Allow**: 2 marks for 1.3×10^{n}; $n \neq 3$ (POT error) **Note**: Answer is 1080 (Mpc) if 5.4×10^{7} (m s^{-1}) is used; this value will score 2 marks