Question number	Answer	Notes	Marks
2 (a) (i)	any orbit around Earth; circular orbit centred on Earth;		2
(ii)	any elliptical orbit around Sun; with focus at Sun;	accept incomplete or full orbit; accept parabolic/hyperbolic path with Sun at focus for 2 marks	2
(b)	evidence of correct conversion from days to seconds; substitution into given formula; correct evaluation; Correct answer: 30 km/s e.g. $365 \times 24 \times 60 \times 60 = 31.5 \times 10^6$ s Orbital speed = $(2\ \pi\ r) \div T$ Orbital speed = $(2 \times \pi \times 150\ 000\ 000) / 31.5\ldots. \times 10^6$ s Orbital speed = 29.9 km/s		3
(c)	B – gravitational; A, C and D cannot be correct as only the gravitational force is responsible for keeping planets in orbit around their star.		1
(d)	starts as nebula/cloud (of gas); reference to main sequence; finishes as white dwarf; PLUS at least ONE, in the correct place, from protostar/red (super) giant/planetary nebula; e.g. nebula → protostar → main sequence → red giant → white dwarf and planetary nebula	 ignore black dwarf reject supernova for this mark	4

Total for Question 2 = 12 marks

Question number	Answer	Notes	Marks
3 (a) (i)	8.2 (m/s) ;		1
(ii)	any TWO from: MP1. reference to weight and drag; MP2. weight greater than drag; MP3. resultant force causes acceleration; MP4. drag increases with speed; PLUS weight = drag at terminal velocity/eq;	ignore reference to upthrust accept water friction or water resistance for "drag" accept 'gravitational force' for 'weight' "F=ma" is insufficient by itself	3
(b) (i)	pressure difference = height × density × g ;	accept depth for height accept accepted symbols e.g. p, h, d (for height), d or ρ (for density), accept any correct rearrangement reject 'gravity' for 'g'	1
(ii)	substitution; evaluation; correct answer: 250 000 (Pa) e.g. pressure difference = height × density × g pressure difference = 25 × 1000 × 10 pressure difference = 250 000 (Pa)	accept use of 9.8(1) for 'g' giving 245 000 (Pa) POT error gives −1 except if no evidence of use of 'g'	2
(iii)	addition of 1.0×10^5 to candidate's answer to (ii); correct answer: 3.5×10^5 (Pa)	accept answer not given in standard form	1
(iv)	substitution into given equation; rearrangement; correct evaluation; correct answer: 0.13(14) (m^3) e.g. $p_1 \times V_1 = p_2 \times V_2$ $1.0 \times 10^5 \times 0.46 = 3.5 \times 10^5 \times V_2$ $V_2 = (1.0 \times 10^5 \times 0.46) \div (3.5 \times 10^5)$ $V_2 = 0.1314$ (m^3)	subs and rearrange can be in either order; condone use of 2.5×10^5 Pa giving V = 0.18… (m^3) for 2 marks condone use of 2.45×10^5 Pa giving V = 0.188… (m3) for 2 marks	3

Total for Question 3 = 11 marks

Question number	Answer	Notes	Marks
7 (a) (i)	C – 51°; Angle should be measured and cannot be either A, B or D.		1
(ii)	refractive index = sin (i)/sin (r);	allow n, η for refractive index	1
(iii)	substitution; rearrangement; correct evaluation; correct answer: 31 degrees e.g refractive index = sin (i)/sin (r) 1.52 = sin(51)/sin(r) sin(r) = sin(51)/1.52 sin(r) = 0.511… r = $\sin^{-1}$(0.511…) = 30.7… degrees	allow ECF from (i) answers of 26.66…, 28.76…, 32.06… all score 3 marks ECF	3
(b) (i)	use of formula sin c = 1/n; substitution; correct evaluation; correct answer: 41 (degrees) e.g. sin c = 1/n sin c = 1/1.52 c = $\sin^{-1}$(1/1.52) = 41.1 (degrees)		3
(ii)	total internal reflection (TIR) / angle of incidence is above the critical angle and so reflects;		1

Total for Question 7 = 9 marks

Question number	Answer	Notes	Marks
10 (a) (i)	26(.4) (N) ;		1
(ii)	(resultant) force = mass × acceleration;	allow acceptable symbols e.g. F, f, m, M, a, A allow any correct rearrangement;	1
(iii)	conversion of 160 g to 0.16 kg; rearrangement or substitution; correct evaluation; correct answer: 165 (m/s^2) e.g. acceleration = resultant force ÷ mass acceleration = 26.4 ÷ 0.16 acceleration = 165 (m/s^2)	 allow ECF for incorrect resultant force Condone rounding to 160 or 170.	3
(iv)	any THREE from: MP1. weight decreases; MP2. air resistance increases; MP3. consistent inference of changing resultant force; MP4. (therefore) changing acceleration;	ignore references to running out of fuel reducing thrust/eq ignore references to energy DOP consistent with MP3	3
(b)	any FOUR from: MP1. (observed) frequency decreases; MP2. speed of **waves** constant; MP3. wavefronts behind firework spread out/eq; MP4. causing an increased wavelength (at the observer); MP5. reference to f = speed ÷ wavelength;	ignore references to region in front of rocket or an approaching rocket allow any rearrangement	4

Total for Question 10 = 12 marks