

Question number	Answer	Notes	Marks
1 (c) (i)	<p>Working;; e.</p> $300\,000 = \frac{170\,000\,000}{t}$ <p>1 working mark (sub ONLY)</p> $t = \frac{170\,000\,000}{300\,000}$ <p>AND rearrange)</p> <p>Calculation; e.</p> $= 570\ (566.7)\ (s)$ <p>1 mark (ans to > 1 SF)</p>	<p>'show that' question, working must be shown for full marks</p> <p>REVERSE CALCS: maximum mark =2 (correct calc plus a comparison statement e.g. $283\,333 \equiv 300\,000$ $180\,000\,000 \equiv 170\,000\,000$)</p> <p>Allow (without the subject of the equation) for 2 marks, <u>170 000 000</u> 300 000</p>	3

Question number	Answer	Notes	Marks
1 (c) (ii)	<p>Any two of</p> <ol style="list-style-type: none"> 1. IDEA of HOW THE LOW SPEED AFFECTS DRIVING; low speed reduces stopping distance low speed helps to avoid obstacle 2. IDEA of THE EFFECT OF LOW SPEED ON COLLISION; momentum /low speed / low (kinetic) energy reduces damage if in collision 3. IDEA of WHAT THE TIME DELAY DOES; time delay affecting reaction time / stopping distance / steering 4. IDEA of WHAT THE TIME (DELAY) IS; it takes a long time to get the signal (the communication delay is) ≈ 1200 (s) (we see images which are) 600s delayed light and radio waves travel at the same speed in a vacuum 	<p>Allow idea that rover could travel up to 48 m between commands RA</p> <p>ignore better photos/detail of the planet /eq</p>	2
		Total	10

Question number	Answer			Notes	Marks
2 (a) (i)	Isotope	Proton number	Neutron number		2
	Uranium-234	2	142		
	Uranium-235	92	143		
	Uranium-238	2	146		
	92 as shown; 146 as show;			Reject for the relevant mark 'half the time' particles molecules 'break down' 'reactivity' nucleus halve in mass to completely/fully decay	2
	(ii) Time taken; and either of <ul style="list-style-type: none"> For half of (radioactive) nuclei / atoms /isotope to decay; For (radio)activity to halve;			Allow how long it takes	1
	(iii) any one from: <ul style="list-style-type: none"> Other isotopes have decayed more quickly; It has the longest half-life; 			Allow <ul style="list-style-type: none"> reverse arguments comparative e.g. longer rather than longest Ignore <ul style="list-style-type: none"> number of neutrons purity /concentration	

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2 (b)	any three from 1. Neutrons; 2. (product) nuclei/a named nucleus; 3. Appropriate qualification of either term above(DOP); 4. gamma (radiation)/thermal energy e.g. of MP3 neutrons - 2, 3, fast, high energy nuclei – daughter, lighter, e.g. for M allowed nuclei include : krypton, barium, xenon,	Allow two correct named nuclei as MP2 & MP3 Ignore extra as a qualifier for neutrons helium alpha beta atoms daughter atoms/cells	3
(c) (i)	Any one of to slow down neutrons/eq; to increase rate of fission; to increase absorption of neutrons by uranium/fuel;	allow reduce the (kinetic) energy of neutrons	1
(ii)	Any two of 1. rate of reaction increases; 2. fewer neutrons absorbed by control rod OR more neutrons collide with uranium; 3. temperature <u>increases</u> ;	allow rate of fission increases control rods absorb neutrons <u>more</u> heat released (need for comparative) ignore risk of explosion	2

Question number	Answer	Notes	Marks
2 (d)	<p>Any five of the following ideas</p> <p><i>facts about radioactivity</i></p> <ol style="list-style-type: none"> 1. idea of harmful nature of radiation / danger to life; 2. high (activity) levels; 3. long half-life / half-lives; <p><i>consequences</i></p> <ol style="list-style-type: none"> 4. difficulties for (emergency) workers to access the area, e.g. short safe working times / need for protective clothing; 5. (requirement for) special handling equipment OR difficulty in removing material; 6. idea of extensive time OR distance (exclusion/hazardous) zone; <p><i>environmental effects local and distant</i></p> <ol style="list-style-type: none"> 7. idea of radioactive material mixing with the local environment e.g. soil, plants, water, air; <p>idea of further /more distant spreading of material e.g. by fire, wind, water;</p>	<p>Ignore repeat of the stem, i.e. radioactive material has been spread into the surrounding area can't be seen</p> <p>allow MP1 toxic, can kill, causes mutation, ionises cells</p> <p>MP5 a lot of (contaminated) material to deal with</p> <p>MP6 still radioactive after a long time takes a long time to go away</p>	5
		Total	16

Question number	Answer	Notes	Marks
3 (a)	C the Solar System;		(1)
(b)	small circle centred on Q;		(1)
(c)	correct shape; correct orbit, star is clearly not at the centre of the orbit;	accept <ul style="list-style-type: none"> • 'open' ellipse /eq • oval • hyperbola it is not necessary that perihelion < orbital radius of S	(2)
(d) (i)	Any one comparison from: MP1. smaller {orbital path/ distance travelled} for close planets; MP2. larger speed for close planets;	Allow reverse arguments accept smaller orbital radius ignore lack of gravity all refs to time	(1)
(ii)	C planet S makes more orbits than P;		(1)
(e) (i)	250 (million km);		(1)
(ii)	150 (million km);		(1)

Total for Question 3 = 8 marks

Question number	Answer	Notes	Marks
4 (a)	(speed = $2\pi r/T$ is given) use of equation; final value; matching unit; e. Speed = $(2 \times \pi \times 58\,000\,000) / (88 \times 24 \times 60 \times 60)$ Speed = $(2 \times \pi \times 58\,000\,000) / (88 \times 24 \times 60 \times 60) = 47.9$ km/s	alternatives - 88 days, 2112 hours, 126720 minutes, 7603200 seconds 47930 m/s, 172439596 m/hr, 172548.596 km/hr, 4138560 km/day	3
(b) (i)	Gravitational;	ALLOW 'gravity'	1
(ii)	Ellipse added to diagram with Sun nearer one focus of the ellipse;	DO NOT ALLOW symmetrical ellipse with Sun at the centre ALLOW incomplete ellipse (i.e. path around the Sun shown with orbit extending beyond the diagram space)	1
(iii)	Point closest Sun labelled X / ecf from the ellipse drawn	Should ideally extend from outside Mercury orbit to inside Mercury orbit ALLOW a tolerance on the position of X in line with the drawing skill	1
(iv)	Close / closest / closer to Sun; Gravitational force strongest;	ALLOW '(force of) gravity greater' ALLOW Answer based on gpe/ke	1 1
		Total	8

Question number	Answer	Notes	Marks
5 (a)	gravity		1
(b) (i)	6960 (km)		1
(ii)	equation quoted (NO MARK) conversion of km OR min; $v = (2 \times \pi \times 6\,960\,000) / (96 \times 60)$; 7600;	ECF on (i) Allow for rounding errors	3
(c)	EITHER grav pe reduces when closer; (so) ke increases; because total energy conserved; OR gravitational attraction / field strength increases when closer; mass remains constant; so accelerates;	Grav force increases so ke increases = 1 (mixing arguments) REJECT 'gravity higher' 'gravity stronger' ACCEPT 'pull of gravity' 'force of gravity'	3
(d) (i)	electromagnetic (spectrum)	Accept transverse (waves)	1
(ii)	Any two from X-rays have shorter wavelength; ORA X-rays have higher frequency; ORA X-rays have higher energy; ORA X-rays have greater penetration range; ORA X-rays have greater effects on living tissue; ORA	Idea of comparison must be there REJECT 'visible light can be seen' / eq	2