Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Physics

Standard level

Paper 2

12 pages

	Question		Answers	Notes	Total
1.	**a**		change in momentum each second $= 6.6 \times 10^{-6} \times 5.2 \times 10^{4}$ «$= 3.4 \times 10^{-1}$ kg m s^{-1}» ✔ acceleration $=$ «$\dfrac{3.4 \times 10^{-1}}{740} =$» 4.6×10^{-4} «m s^{-2}» ✔		**2**
1.	**b**	**i**	***ALTERNATIVE 1***: (considering the acceleration of the spacecraft) time for acceleration $= \dfrac{30}{6.6 \times 10^{-6}} =$ «4.6×10^{6}» «s» ✔ max speed $=$ «answer to (a) $\times 4.6 \times 10^{6} =$» 2.1×10^{3} «m s^{-1}» ✔ ***ALTERNATIVE 2***: (considering the conservation of momentum) (momentum of 30 kg of fuel ions $=$ change of momentum of spacecraft) $30 \times 5.2 \times 10^{4} = 710 \times$ max speed ✔ max speed $= 2.2 \times 10^{3}$ «m s^{-1}» ✔		**2**
1.	**b**	**ii**	problem may be too complicated for exact treatment ✔ to make equations/calculations simpler ✔ when precision of the calculations is not important ✔ some quantities in the problem may not be known exactly ✔		**1 max**

(Question 1 continued)

Question			Answers	Notes	Total
1.	**c**	**i**	ions have same (sign of) charge ✔ ions repel each other ✔		**1.** **2**
1.	**c**	**ii**	the forces between the ions do not affect the force on the spacecraft. ✔ there is no effect on the acceleration of the spacecraft. ✔		**1.** **2**
1.	**d**	**i**	force per unit mass ✔ acting on a small/test/point mass «placed at the point in the field» ✔		**1.** **2**
1.	**d**	**ii**	satellite has a much smaller mass/diameter/size than the planet «so approximates to a point mass» ✔		**1.** **1**

Question			Answers	Notes	Total
2.	a		**ALTERNATIVE 1:** $r = \sqrt{\dfrac{\rho l}{\pi R}}$ **O** $\sqrt{\dfrac{7.2 \times 10^{-7} \times 12.5}{\pi \times 0.1}}$ ✔ $r = 5.352 \times 10^{-3}$ ✔ 5.4×10^{-3} «m» ✔ **ALTERNATIVE 2:** $A = \dfrac{7.2 \times 10^{-7} \times 12.5}{0.1}$ ✔ $r = 5.352 \times 10^{-3}$ ✔ 5.4×10^{-3} «m» ✔		**3**
2.	b		current in lamp $= \dfrac{5}{24}$ «$= 0.21$» «A» **OR** $n = 24 \times \dfrac{8}{5}$ ✔ so «38.4 and therefore» 38 lamps ✔		**2**

(Question 2 continued)

Question			Answers	Notes	Total
2.	**c**			*Accept converse arguments for adding lamps in series:*	
			when adding more lamps in parallel the brightness stays the same ✔	*when adding more lamps in series the brightness decreases*	
			when adding more lamps in parallel the pd across each remains the same/at the operating value/24 V ✔	*when adding more lamps in series the pd decreases*	
			when adding more lamps in parallel the current through each remains the same ✔	*when adding more lamps in series the current decreases*	
			lamps can be controlled independently ✔	*lamps can't be controlled independently*	**1 max**
			the pd across each bulb is larger in parallel ✔	*the pd across each bulb is smaller in series*	
			the current in each bulb is greater in parallel ✔	*the current in each bulb is smaller in series*	
			lamps will be brighter in parallel than in series ✔		
			In parallel the pd across the lamps will be the operating value/24 V ✔	*in series the pd across the lamps will less than the operating value/24 V*	
				Do not accept statements that only compare the overall resistance of the combination of bulbs.	

Question			Answers	Notes	Total
3.	a		**ALTERNATIVE 1:** initial momentum $= mv = \sqrt{2 \times 0.058 \times 0.63}$ «$= 0.27$ kg m s^{-1}» **OR** $mv = 0.058 \times \sqrt{2 \times 9.81 \times 1.1}$ «$= 0.27$ kg m s^{-1}» ✔ force $= $«$\dfrac{\text{change in momentum}}{\text{time}} =$» $\dfrac{0.27}{0.055}$ ✔ 4.9 «N» ✔ $F - mg = 4.9$ so $F = 5.5$ «N» ✔ **ALTERNATIVE 2:** «$E_k = \dfrac{1}{2} mv^2 = 0.63$ J» $v = 4.7$ m s^{-1} ✔ acceleration $= $«$\dfrac{\Delta v}{\Delta t} =$» $\dfrac{4.7}{55 x 10^{-3}} = $«85 m s^{-2}»✔ 4.9 «N» ✔ $F - mg = 4.9$ so $F = 5.5$ «N» ✔		**4**

(continued…)

(Question 3 continued)

Question			Answers	Notes	Total
3.	b		*ALTERNATIVE 1:* concrete reduces the stopping time/distance ✔ impulse/change in momentum same so force greater ***OR*** work done same so force greater ✔ *ALTERNATIVE 2:* concrete reduces the stopping time ✔ deceleration is greater so force is greater ✔	*Allow reverse argument for grass.*	**2**

Question			Answers	Notes	Total
4.	a		«air molecule» moves to the right and then back to the left ✔ returns to X/original position ✔		2
4.	b		wavelength $= 2 \times 1.4$ «$= 2.8\,\mathrm{m}$» ✔ $c =$ « $f\lambda =$ » 120×2.8 «$= 340\,\mathrm{m\,s}^{-1}$» ✔ $K =$ « $\rho c^2 = 1.3 \times 340^2 =$ » 1.5×10^5 ✔		3
4.	c	i	construction showing formation of image ✔	*Another straight line/ray from image through the wall with line/ray from intersection at wall back to transmitter. Reflected ray must intersect boat.*	1
4.	c	ii	interference pattern is observed ***OR*** interference/superposition mentioned ✔ maximum when two waves occur in phase/path difference is nλ ***OR*** minimum when two waves occur $180°$ out of phase/path difference is $(n + \tfrac{1}{2})\,\lambda$ ✔		2

Question			Answers	Notes	Total
5.	**a**		identifies $\lambda = 435\,nm$ ✓ $$E = «\frac{hc}{\lambda} =» \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{4.35 \times 10^{-7}}$$ ✓ 4.6×10^{-19} «J» ✓		
5.	**b**		–0.605 **OR** –0.870 **OR** –1.36 to –5.44 **AND** arrow pointing downwards ✓	*Arrow **MUST** match calculation in (a)(i)* *Allow ECF from (a)(i)*	**1**
5.	**c**		Difference in energy levels is equal to the energy of the photon ✓ Downward arrow as energy is lost by hydrogen/energy is given out in the photon/the electron falls from a higher energy level to a lower one ✓	*Allow ECF from (a)(i)*	**2** **3**

Question			Answers	Notes	Total
6.	**a**		use of $I \propto \dfrac{1}{r^2}$ «$1.36 \times 10^3 \times \dfrac{1}{1.5^2}$» ✔ 604 «$\text{W m}^{-2}$» ✔		**2**
6.	**b**		use of $\dfrac{600}{4}$ for mean intensity ✔ temperature/K = «$\sqrt[4]{\dfrac{600}{4 \times 5.67 \times 10^{-8}}}$ =» 230 ✔		**2**
6.	**c**		recognize the link between molecular density/concentration and pressure ✔ low pressure means too few molecules to produce a significant heating effect ***OR*** low pressure means too little radiation re-radiated back to Mars ✔		**2**

Question			Answers	Notes	Total
7.	a		Internal energy is the sum of all the PEs and KEs of the molecules (of the oxygen) ✔ PE of molecules in gaseous state is zero ✔ (At boiling point) average KE of molecules in gas and liquid is the same ✔ gases have a higher internal energy ✔	*Molecules/particles/atoms must be included once, if not, award [1 max]*	**2 max**
7.	b	i	**ALTERNATIVE 1:** flow rate of oxygen $= 8$ «g s^{-1}» ✔ « $2.1 \times 10^5 \times 8 \times 10^{-3}$ » $= 1.7$ «kW» ✔ **ALTERNATIVE 2:** $Q =$ « $0.25 \times 32 \times 10^{-3} \times 2.1 \times 10^5 =$ » 1680 «J» ✔ power $=$ « $1680\,\text{W} =$ » 1.7 «kW» ✔		**2**
7.	b	ii	$V =$ « $\dfrac{nRT}{p} =$ » 4.9×10^{-3} «m^3» ✔		**1**
7.	c		ideal gas has point objects ✔ no intermolecular forces ✔ non liquefaction ✔ ideal gas assumes monatomic particles ✔ the collisions between particles are elastic ✔	*Allow the opposite statements if they are clearly made about oxygen eg oxygen/this can be liquified*	**1 max**