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 $= 6.6\times10^{-6}\times5.2\times10^{4}$ «$= 3.4\times10^{-1}$ kg m s^{-1}» ✓ acceleration $=$ «$\frac{3.4\times10^{-1}}{740}$ =» 4.6×10^{-4} «m s^{-2}» ✓		2
1.	b	i	***ALTERNATIVE 1***: (considering the acceleration of the spacecraft) time for acceleration $= \frac{30}{6.6\times10^{-6}} =$ «4.6×10^{6}» «s» ✓ max speed = «answer to (a) $\times 4.6\times10^{6} =$» 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) $30\times5.2\times10^{4} = 710\times$ max speed ✓ max speed $= 2.2\times10^{3}$ «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

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**c**	**i**	ions have same (sign of) charge ✓ ions repel each other ✓		**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. ✓		**2**
1.	**d**	**i**	force per unit mass ✓ acting on a small/test/point mass **«**placed at the point in the field**»** ✓		**2**
1.	**d**	**ii**	satellite has a much smaller mass/diameter/size than the planet **«**so approximates to a point mass**»** ✓		**1**

Question			Answers	Notes	Total
2.	a		***ALTERNATIVE 1*:** $r = \sqrt{\frac{\rho l}{\pi R}}$ **O** $\sqrt{\frac{7.2\times10^{-7}\times12.5}{\pi\times0.1}}$ ✓ $r = 5.352\times10^{-3}$ ✓ 5.4×10^{-3} **«**m**»** ✓ ***ALTERNATIVE 2*:** $A = \frac{7.2\times10^{-7}\times12.5}{0.1}$ ✓ $r = 5.352\times10^{-3}$ ✓ 5.4×10^{-3} **«**m**»** ✓		**3**
2.	b		current in lamp $= \frac{5}{24}$ **«**= 0.21**»** **«**A**»** ***OR*** $n = 24\times\frac{8}{5}$ ✓ so **«**38.4 and therefore**»** 38 lamps ✓		**2**

(continued…)

(Question 2 continued)

Question			Answers	Notes	Total
2.	**c**			*Accept converse arguments for adding lamps in series:*	**1 max**
			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*	
			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 $= mv = \sqrt{2 \times 0.058 \times 0.63}$ **«** $= 0.27\ \text{kg m s}^{-1}$ **»** ***OR*** $mv = 0.058 \times \sqrt{2 \times 9.81 \times 1.1}$ **«** $= 0.27\ \text{kg m s}^{-1}$ **»** ✓ force $=$ **«** $\frac{\text{change in momentum}}{\text{time}} =$ **»** $\frac{0.27}{0.055}$ ✓ 4.9 **«**N**»** ✓ $F - mg = 4.9$ so $F = 5.5$ **«**N**»** ✓ ***ALTERNATIVE 2:*** **«**$E_k = \frac{1}{2}mv^2 = 0.63$ J**»** v = 4.7 m s^{-1} ✓ acceleration $=$ **«** $\frac{\Delta v}{\Delta t} =$ **»** $\frac{4.7}{55x10^{-3}} =$ **«**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 $= 2 \times 1.4$ « $= 2.8$ m» ✓ $c =$ « $f\lambda =$» 120×2.8 « $= 340\ \text{m s}^{-1}$» ✓ $K =$ « $\rho c^2 = 1.3 \times 340^2 =$» 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 + ½) λ ✓		2

Question			Answers	Notes	Total
5.	a		identifies $\lambda = 435\,\text{nm}$ ✓ $E = \text{«}\frac{hc}{\lambda} = \text{»}\frac{6.63\times10^{-34}\times3\times10^{8}}{4.35\times10^{-7}}$ ✓ 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 $I \propto \frac{1}{r^2}$ «$1.36 \times 10^3 \times \frac{1}{1.5^2}$» ✓ 604 «W m^{-2}» ✓		2
6.	b		use of $\frac{600}{4}$ for mean intensity ✓ temperature/K = «$\sqrt[4]{\frac{600}{4 \times 5.67 \times 10^{-8}}}$ =» 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}» ✓ «$2.1\times10^{5}\times8\times10^{-3}$» $= 1.7$ «kW» ✓ ***ALTERNATIVE 2***: $Q =$ «$0.25\times32\times10^{-3}\times2.1\times10^{5}$ =» 1680 «J» ✓ power = «1680 W =» 1.7 «kW» ✓		**2**
7.	b	ii	$V =$ «$\frac{nRT}{p}$ =» 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**