

# Markscheme

November 2018

Physics

Standard level

Paper 2

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Question			Answers	Notes	Total
1.	a		change in momentum each second = $6.6 \times 10^{-6} \times 5.2 \times 10^4$ « $3.4 \times 10^{-1} \text{ kg m s}^{-1}$ » ✓ acceleration = « $\frac{3.4 \times 10^{-1}}{740} = 4.6 \times 10^{-4} \text{ m s}^{-2}$ » ✓		2
1.	b	i	<p><b>ALTERNATIVE 1:</b>                      (considering the acceleration of the spacecraft)                      time for acceleration = <math>\frac{30}{6.6 \times 10^{-6}} = 4.6 \times 10^6</math> « s » ✓</p> <p>max speed = « answer to (a) <math>\times 4.6 \times 10^6 = 2.1 \times 10^3 \text{ m s}^{-1}</math> » ✓</p> <p><b>ALTERNATIVE 2:</b>                      (considering the conservation of momentum)                      (momentum of 30 kg of fuel ions = change of momentum of spacecraft)  <math>30 \times 5.2 \times 10^4 = 710 \times \text{max speed}</math> ✓                      max speed = <math>2.2 \times 10^3 \text{ m s}^{-1}</math> » ✓</p>		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	<p><b>ALTERNATIVE 1:</b></p> $r = \sqrt{\frac{\rho l}{\pi R}} \quad \text{O} \quad \sqrt{\frac{7.2 \times 10^{-7} \times 12.5}{\pi \times 0.1}} \quad \checkmark$ $r = 5.352 \times 10^{-3} \quad \checkmark$ $5.4 \times 10^{-3} \text{ «m»} \quad \checkmark$ <p><b>ALTERNATIVE 2:</b></p> $A = \frac{7.2 \times 10^{-7} \times 12.5}{0.1} \quad \checkmark$ $r = 5.352 \times 10^{-3} \quad \checkmark$ $5.4 \times 10^{-3} \text{ «m»} \quad \checkmark$		3
2.	b	<p>current in lamp = <math>\frac{5}{24}</math> «= 0.21» «A»</p> <p><b>OR</b></p> $n = 24 \times \frac{8}{5} \quad \checkmark$ <p>so «38.4 and therefore» 38 lamps <math>\checkmark</math></p>		2

(continued...)

(Question 2 continued)

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

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

(continued...)

(Question 3 continued)

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



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 » ✓ $c = \ll f \lambda = \gg 120 \times 2.8$ « = $340 \text{ m s}^{-1}$ » ✓ $K = \ll \rho c^2 = 1.3 \times 340^2 = \gg 1.5 \times 10^5$ ✓		3
4.	c	i	construction showing formation of image ✓	<i>Another straight line/ray from image through the wall with line/ray from intersection at wall back to transmitter. Reflected ray must intersect boat.</i>	1
4.	c	ii	interference pattern is observed <b>OR</b> interference/superposition mentioned ✓  maximum when two waves occur in phase/path difference is $n\lambda$ <b>OR</b> minimum when two waves occur $180^\circ$ out of phase/path difference is $(n + \frac{1}{2}) \lambda$ ✓		2

Question		Answers	Notes	Total
5.	a	identifies $\lambda = 435 \text{ nm}$ ✓  $E = \left\langle \frac{hc}{\lambda} \right\rangle = \left\langle \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{4.35 \times 10^{-7}} \right\rangle$ ✓  $4.6 \times 10^{-19} \text{ «J»}$ ✓		
5.	b	-0.605 <b>OR</b> -0.870 <b>OR</b> -1.36 to -5.44 <b>AND</b> arrow pointing downwards ✓	Arrow <b>MUST</b> 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 <sup>-2</sup> » ✓		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 <b>OR</b> 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 ✓	<i>Molecules/particles/atoms must be included once, if not, award [1 max]</i>	2 max
7.	b	i	<b>ALTERNATIVE 1:</b> flow rate of oxygen = $8 \text{ g s}^{-1}$ ✓ $\ll 2.1 \times 10^5 \times 8 \times 10^{-3} \gg = 1.7 \text{ kW}$ ✓ <b>ALTERNATIVE 2:</b> $Q = \ll 0.25 \times 32 \times 10^{-3} \times 2.1 \times 10^5 \gg = 1680 \text{ J}$ ✓ power = $\ll 1680 \text{ W} \gg = 1.7 \text{ kW}$ ✓		2
7.	b	ii	$V = \ll \frac{nRT}{p} \gg = 4.9 \times 10^{-3} \text{ m}^3$ ✓		1
7.	c		ideal gas has point objects ✓ no intermolecular forces ✓ non liquefaction ✓ ideal gas assumes monatomic particles ✓ the collisions between particles are elastic ✓	<i>Allow the opposite statements if they are clearly made about oxygen eg oxygen/this can be liquified</i>	1 max