

# Markscheme

November 2020

Physics

Standard level

Paper 2

11 pages

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Question			Answers	Notes	Total
1.	a	i	zero ✓		1
1	a	ii	Blades exert a downward force on the air ✓  air exerts an equal and opposite force on the blades «by Newton's third law» <b>OR</b> air exerts a reaction force on the blades «by Newton's third law» ✓	<i>Downward direction required for MP1.</i>	2
1	a	iii	«lift force/change of momentum in one second» = $1.7v$ ✓ $1.7v = (0.95 + 0.45) \times 9.81$ ✓ $v = 8.1$ «ms <sup>-1</sup> » <b>AND</b> answer expressed to 2 sf only ✓	<i>Allow 8.2 from <math>g = 10 \text{ ms}^{-2}</math>.</i>	3
1	b		vertical force = lift force – weight <b>OR</b> $0.45 \times 9.81$ <b>OR</b> $4.4$ «N» ✓  acceleration = $\frac{0.45 \times 9.81}{0.95} = 4.6$ «ms <sup>-2</sup> » ✓		2

Question		Answers	Notes	Total
2.	a	<p>arrow downwards labelled weight/<math>W/mg</math> and arrow upwards labelled friction/<math>F</math> ✓                      arrow horizontally to the left labelled «normal» reaction/<math>N</math> ✓</p> 	<p><i>Ignore point of application of the forces but do not allow arrows that do not touch the object.</i></p> <p><i>Do not allow horizontal force to be labelled 'centripetal' or <math>R</math>.</i></p>	2
2	b	<p>See <math>F = \mu N</math> <b>AND</b> <math>N = mR\omega^2</math> ✓</p> <p>«substituting for <math>N</math>» <math>\mu m\omega^2 R = mg</math> ✓</p>		2

Question		Answers	Notes	Total
2	c	<p><b>ALTERNATIVE 1</b></p> <p>minimum required angular velocity « = <math>\sqrt{\frac{9.81}{0.40 \times 3.5}}</math> » = 2.6 « rad s<sup>-1</sup> » ✓</p> <p>actual angular velocity « = <math>\frac{2\pi}{\left(\frac{60}{28}\right)}</math> » = 2.9 « rad s<sup>-1</sup> » ✓</p> <p>actual angular velocity is greater than the minimum, so the person does not slide ✓</p> <p><b>ALTERNATIVE 2</b></p> <p>Minimum friction force = <math>mg = \text{« } 9.81m \text{ »}</math> ✓</p> <p>Actual friction force « = <math>\mu m R \omega^2 = 0.40 m \times 3.5 \left( 2\pi \frac{28}{60} \right)^2</math> » = 12.0 m ✓</p> <p>Actual friction force is greater than the minimum frictional force so the person does not slide ✓</p>	<p>Allow 2.7 from <math>g = 10 \text{ ms}^{-2}</math>.</p>	3

Question			Answers	Notes	Total
3.	a	i	« $15 \times 30 \times 60$ » = 27000 «J» ✓		1
3	a	ii	$27 \times 10^3 = 0.32 \times c \times (290 - 250)$ <b>OR</b> 2100 ✓ J kg <sup>-1</sup> K <sup>-1</sup> <b>OR</b> J kg <sup>-1</sup> °C <sup>-1</sup> ✓	Allow any appropriate unit that is $\frac{\text{energy}}{\text{mass} \times \text{temperature}}$	2
3	b		«intermolecular» bonds are formed during freezing ✓  bond-forming process releases energy <b>OR</b> «intermolecular» PE decreases «and the difference is transferred as heat» ✓  «average random» KE of the molecules does not decrease/change ✓ temperature is related to «average» KE of the molecules «hence unchanged» ✓	To award MP3 or MP4 molecules/particles/atoms must be mentioned.	3 max
3	c		mass of frozen oil « $= \frac{27 \times 10^3}{130 \times 10^3}$ » = 0.21 «kg» ✓ unfrozen mass « $= 0.32 - 0.21$ » = 0.11 «kg» ✓		2

Question		Answers	Notes	Total
4.	a	wavelength = $\frac{340}{850} = 0.40 \text{ «m»} \checkmark$ path difference = $1.8 \text{ «m»} \checkmark$ $1.8 \text{ «m»} = 4.5\lambda$ <b>OR</b> $\frac{1.8}{0.20} = 9 \text{ «half-wavelengths»} \checkmark$  waves meet in antiphase «at P» <b>OR</b> destructive interference/superposition «at P» $\checkmark$	Allow approach where path length is calculated in terms of number of wavelengths; along path A (56.25) and path B (60.75) for MP2, hence path difference 4.5 wavelengths for MP3	4
4	b	«equally spaced» maxima and minima $\checkmark$  a maximum at Q $\checkmark$  four «additional» maxima «between P and Q» $\checkmark$		2 max
4	c	the amplitude of sound at Q is halved $\checkmark$ «intensity is proportional to amplitude squared hence» $\frac{I_A}{I_0} = \frac{1}{4} \checkmark$		2

Question			Answers	Notes	Total
5.	a		current is not «directly» proportional to the potential difference <b>OR</b> resistance of X is not constant <b>OR</b> resistance of X changes «with current/voltage» ✓		1
5	b	i	<b>ALTERNATIVE 1</b> voltage across X = 2.3 «V» ✓ voltage across R «= 4.0 – 2.3» = 1.7 «V» ✓ resistance of variable resistor «= $\frac{1.7}{0.020}$ » = 85 «Ω» ✓  <b>ALTERNATIVE 2</b> overall resistance «= $\frac{4.0}{0.020}$ » = 200«Ω» ✓ resistance of X «= $\frac{2.3}{0.020}$ » = 115 «Ω» ✓ resistance of variable resistor «= 200 – 115» = 85 «Ω» ✓		3
5	b	ii	power «= 4.0 × 0.020» = 0.080 «W» ✓		1

Question			Answers	Notes	Total
5	c	i	from 0 to 60 mA ✓		1
5	c	ii	allows zero current through component X / potential divider arrangement ✓ provides greater range «of current through component X» ✓		2

Question			Answers	Notes	Total
6.	a	i	energy required to «completely» separate the nucleons <b>OR</b> energy released when a nucleus is formed from its constituent nucleons ✓	<i>Allow protons AND neutrons.</i>	1
6	a	ii	the values «in SI units» would be very small ✓		1
6	a	iii	$140 \times 8.29 + 94 \times 8.59 - 235 \times 7.59$ <b>OR</b> 184 «MeV» ✓		1
6	b	i	see «energy $\Rightarrow$ » $180 \times 10^6 \times 1.60 \times 10^{-19}$ <b>AND</b> «mass $\Rightarrow$ » $235 \times 1.66 \times 10^{-27}$ ✓ $7.4 \times 10^{13}$ «J kg <sup>-1</sup> » ✓		2
6	b	ii	energy produced in one day = $\frac{1.2 \times 10^9 \times 24 \times 3600}{0.36} = 2.9 \times 10^{14}$ «J» ✓ mass = $\frac{2.9 \times 10^{14}}{7.4 \times 10^{13}} = 3.9$ «kg» ✓		2
6	c	i	39 ✓	<i>Do not allow <math>{}_{39}^{94}\text{X}</math> unless the proton number is indicated.</i>	1
6	c	ii	75 «s» ✓		1

Question			Answers	Notes	Total
6	c	iii	<p><b>ALTERNATIVE 1</b></p> <p>10 min = 8 <math>t_{1/2}</math> ✓</p> <p>mass remaining = <math>1.0 \times \left(\frac{1}{2}\right)^8 = 3.9 \times 10^{-3}</math> « kg » ✓</p> <p><b>ALTERNATIVE 2</b></p> <p>decay constant = « <math>\frac{\ln 2}{75} = 9.24 \times 10^{-3}</math> « s<sup>-1</sup> » ✓</p> <p>mass remaining = <math>1.0 \times e^{-9.24 \times 10^{-3} \times 600} = 3.9 \times 10^{-3}</math> « kg » ✓</p>		2