Markscheme

November 2020

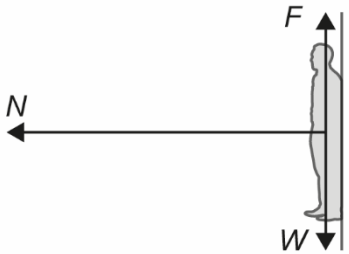
Physics

Standard level

Paper 2

11 pages

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**»** ***OR*** air exerts a reaction force on the blades **«**by Newton's third law**»** ✓	*Downward direction required for **MP1**.*	**2**
1	**a**	**iii**	**«**lift force/change of momentum in one second**»** $= 1.7\,\text{v}$ ✓ $1.7v = (0.95 + 0.45) \times 9.81$ ✓ $v = 8.1\,\text{«ms}^{-1}\text{»}$ ***AND*** answer expressed to 2 sf only ✓	*Allow 8.2 from g = 10 ms^{-2}.*	**3**
1	**b**		vertical force= lift force – weight ***OR*** $= 0.45 \times 9.81$ ***OR*** $= 4.4$ **«**N**»** ✓ acceleration $= \frac{0.45 \times 9.81}{0.95} = 4.6\ \text{«ms}^{-2}\text{»}$ ✓		**2**

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

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

Question			Answers	Notes	Total
3.	a	i	«$15 \times 30 \times 60$» $= 27000$ «J» ✓		1
3	a	ii	$27 \times 10^3 = 0.32 \times c \times (290 - 250)$ ***OR*** 2100 ✓ J kg^{-1} K^{-1} ***OR*** J kg^{-1} ^{0}C^{-1} ✓	*Allow any appropriate unit that is* $\frac{energy}{mass \times temperature}$	2
3	b		«intermolecular» bonds are formed during freezing ✓ bond-forming process releases energy ***OR*** «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 = $\frac{340}{850} = 0.40$ **«**m**»** ✓ path difference = 1.8 **«**m**»** ✓ 1.8 **«**m**»** = 4.5λ ***OR*** $\frac{1.8}{0.20} = 9$ **«**half-wavelengths**»** ✓ waves meet in antiphase **«**at P**»** ***OR*** destructive interference/superposition **«**at P**»** ✓	*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 ✓ a maximum at Q ✓ four **«**additional**»** maxima **«**between P and Q**»** ✓		**2 max**
4	**c**		the amplitude of sound at Q is halved ✓ **«**intensity is proportional to amplitude squared hence**»** $\frac{I_A}{I_0} = \frac{1}{4}$ ✓		**2**

Question			Answers	Notes	Total
5.	**a**		current is not «directly» proportional to the potential difference ***OR*** resistance of X is not constant ***OR*** resistance of X changes «with current/voltage» ✓		**1**
5	**b**	**i**	***ALTERNATIVE 1*** 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» ✓ ***ALTERNATIVE 2*** 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 «$= 4.0 \times 0.020$» $= 0.080$ «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 ***OR*** energy released when a nucleus is formed from its constituent nucleons ✓	*Allow protons **AND** neutrons.*	**1**
6	a	ii	the values «in SI units» would be very small ✓		**1**
6	a	iii	$140 \times 8.29 + 94 \times 8.59 - 235 \times 7.59$ ***OR*** 184 «MeV» ✓		**1**
6	b	i	see «energy =» $180 \times 10^{6} \times 1.60 \times 10^{-19}$ ***AND*** «mass =» $235 \times 1.66 \times 10^{-27}$ ✓ 7.4×10^{13} «J kg^{-1}» ✓		**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 ✓	*Do not allow* $^{94}_{39}X$ *unless the proton number is indicated.*	**1**
6	c	ii	75 «s» ✓		**1**

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