

Markscheme

November 2017

Physics

Standard level

Paper 2

12 pages

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Question			Answers	Notes	Total
1.	a		arrow vertically downwards labelled weight «of sledge and/or girl»/W/mg/gravitational force/F_g/$F_{\text{gravitational}}$ AND arrow perpendicular to the snow slope labelled reaction force/R/normal contact force/N/F_N ✓ friction force/F/f acting up slope «perpendicular to reaction force» ✓	<i>Do not allow G/g/“gravity”.</i> <i>Do not award MP1 if a “driving force” is included. Allow components of weight if correctly labelled. Ignore point of application or shape of object.</i> <i>Ignore “air resistance”.</i> <i>Ignore any reference to “push of feet on sledge”.</i> <i>Do not award MP2 for forces on sledge on horizontal ground</i> <i>The arrows should contact the object</i>	2
1.	b		gravitational force/weight from the Earth «downwards» ✓ reaction force from the sledge/snow/ground «upwards» ✓ no vertical acceleration/remains in contact with the ground/does not move vertically as there is no resultant vertical force ✓	<i>Allow naming of forces as in (a)</i> <i>Allow vertical forces are balanced/equal in magnitude/cancel out</i>	3
1.	c		mention of conservation of momentum OR $5.5 \times 4.2 = (55 + 5.5)$ «v» ✓ 0.38 «m s⁻¹» ✓	<i>Allow $p = p'$ or other algebraically equivalent statement</i> <i>Award [0] for answers based on energy</i>	2

(continued...)

(Question 1 continued)

Question			Answers	Notes	Total
1.	d		same change in momentum/impulse ✓ the time taken «to stop» would be greater «with the snow» ✓ $F = \frac{\Delta p}{\Delta t}$ therefore F is smaller «with the snow» OR force is proportional to rate of change of momentum therefore F is smaller «with the snow» ✓	Allow reverse argument for ice	3
1.	e	i	«friction force down slope» = $\mu mg \cos(6.5)$ = «5.9N» ✓ «component of weight down slope» = $mg \sin(6.5)$ «= 6.1N» ✓ «so $a = \frac{F}{m}$ » acceleration = $\frac{12}{5.5} = 2.2$ «ms⁻²» ✓	Ignore negative signs Allow use of $g = 10 \text{ ms}^{-2}$	3
1.	e	ii	correct use of kinematics equation ✓ distance = 4.4 or 4.0 «m» ✓ Alternative 2 KE lost = work done against friction + GPE ✓ distance = 4.4 or 4.0 «m» ✓	Allow ECF from (e)(i) Allow [1 max] for GPE missing leading to 8.2 «m»	2

(continued...)

(Question 1 continued)

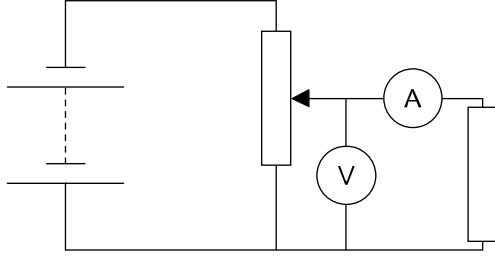
Question			Answers	Notes	Total
1.	f		calculates a maximum value for the frictional force = « μR = » 7.5 «N» ✓ sledge will not move as the maximum static friction force is greater than the component of weight down the slope ✓	Allow correct conclusion from incorrect MP1 Allow $7.5 > 6.1$ so will not move	2

Question			Answers	Notes	Total
2.	a		it has a lepton number of 1 «as lepton number is conserved» ✓ it has a charge of zero/is neutral «as charge is conserved» OR it has a baryon number of 0 «as baryon number is conserved» ✓	<i>Do not credit answers referring to energy</i>	2
2.	b		hadrons experience strong force OR leptons do not experience the strong force ✓ hadrons made of quarks/not fundamental OR leptons are not made of quarks/are fundamental ✓ hadrons decay «eventually» into protons OR leptons do not decay into protons ✓	<i>Accept leptons experience the weak force</i> <i>Allow “interaction” for “force”</i>	2 max

Question			Answers	Notes	Total
3.	a	i	$\llcorner l = \frac{RA}{\rho} = \frac{82 \times 8 \times 10^{-3} \times 2 \times 10^{-6}}{4.1 \times 10^{-5}} \llcorner$ 0.032 «m» ✓		1
3.	a	ii	power = $1500 \times 8 \times 10^{-3} \times 0.032$ «= 0.384» ✓ $\llcorner \text{current} \leq \sqrt{\frac{\text{power}}{\text{resistance}}} = \sqrt{\frac{0.384}{82}} \llcorner$ 0.068 «A» ✓	Award [1] for 4.3 «A» where candidate has not calculated area	2
3.	a	iii	quantities such as resistivity depend on the material OR they allow the selection of the correct material OR they allow scientists to compare properties of materials ✓		1
3.	b		as area is larger and length is smaller ✓ resistance is «very much» smaller ✓	Award [1 max] for answers that involve a calculation	2

(continued...)

(Question 3 continued)

Question			Answers	Notes	Total
3.	c		complete functional circuit with ammeter in series with resistor and voltmeter across it ✓ potential divider arrangement correct ✓	eg: 	2

Question			Answers	Notes	Total
4.	a	i	$v = c \frac{\sin i}{\sin r} = \frac{3 \times 10^8 \times \sin(33)}{\sin(46)} \checkmark$ $2.3 \times 10^8 \text{ «ms}^{-1}\text{» } \checkmark$		2
4.	a	ii	light strikes AB at an angle of $57^\circ \checkmark$ critical angle is $\sin^{-1}\left(\frac{2.3}{3}\right) = 50.1^\circ \checkmark$ angle of incidence is greater than critical angle so total internal reflection OR light strikes AB at an angle of $57^\circ \checkmark$ calculation showing $\sin$ of “refracted angle” = 1.1 $\checkmark$ statement that since $1.1 > 1$ the angle does not exist and the light does not emerge $\checkmark$	49.2° from unrounded value	3 max
4.	a	iii	total internal reflection shown $\checkmark$ ray emerges at opposite face to incidence $\checkmark$	Judge angle of incidence = angle of reflection by eye or accept correctly labelled angles With sensible refraction in correct direction	2

(continued...)

(Question 4 continued)

Question			Answers	Notes	Total
4.	b	i	mass = «<i>volume</i> × <i>density</i>» $(0.75)^3 \times 920$ «= 388 kg» ✓ energy required to raise temperature = $388 \times 2100 \times 20$ «= 1.63×10^7 J» ✓ energy required to melt = $388 \times 330 \times 10^3$ «= 1.28×10^8 J» ✓ 1.4×10^8 «J» OR 1.4×10^5 «kJ» ✓	Accept any consistent units Award [3 max] for answer which uses density as 1000 kg^{-3} (1.5×10^8 «J»)	4
4.	b	ii	in solid state, nearest neighbour molecules cannot exchange places/have fixed positions/are closer to each other/have regular pattern/have stronger forces of attraction ✓ in liquid, bonds between molecules can be broken and re-form ✓	OWTTE Accept converse argument for liquids	1 max

Question			Answers	Notes	Total
5.	a		$\frac{mv^2}{r} = G \frac{Mm}{r^2} \checkmark$ $\text{leading to } T^2 = \frac{4\pi^2 r^3}{GM} \checkmark$ $T = 5320 \text{ «s» } \checkmark$ Alternative 2 $\text{«}v = \sqrt{\frac{Gm_E}{r}} \text{»} = \sqrt{\frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24}}{6600 \times 10^3}} \text{ OR } 7800 \text{ «ms}^{-1}\text{» } \checkmark$ $\text{distance} = 2\pi r = 2\pi \times 6600 \times 10^3 \text{ «m» OR } 4.15 \times 10^7 \text{ «m»}$ $\text{«}T = \frac{d}{v} = \frac{4.15 \times 10^7}{7800} \text{»} = 5300 \text{ «s»}$	Accept use of ω instead of v	3

(continued...)

(Question 5 continued)

Question			Answers	Notes	Total
5.	b	i	$T = \left\langle \frac{2.90 \times 10^{-3}}{\lambda_{\max}} \right\rangle = \left\langle \frac{2.90 \times 10^{-3}}{10.1 \times 10^{-6}} \right\rangle \checkmark$ $= 287 \text{ «K» or } 14 \text{ « } ^\circ\text{C} \text{ » } \checkmark$	<i>Award [0] for any use of wavelength from Sun</i> <i>Do not accept 287 °C</i>	2
5.	b	ii	wavelength of radiation from the Sun is shorter than that emitted from Earth «and is not absorbed by the atmosphere» ✓ infrared radiation emitted from Earth is absorbed by greenhouse gases in the atmosphere ✓ this radiation is re-emitted in all directions «including back to Earth» ✓		3
5.	c		peer review ✓ international collaboration ✓ full details of experiments published so that experiments can repeated ✓		1 max