N17/4/PHYSI/SP2/ENG/TZ0/XX/M

Markscheme

November 2017

Physics

Standard level

Paper 2

12 pages

Question			Answers	Notes	Total
1.	**a**		arrow vertically downwards labelled weight **«**of sledge and/or girl**»**/*W*/mg/gravitational force/F_g/$F_{gravitational}$ ***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**»** ✓	*Do not allow G/g/“gravity”.* *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.* *Ignore “air resistance”.* *Ignore any reference to “push of feet on sledge”.* *Do not award MP2 for forces on sledge on horizontal ground* *The arrows should contact the object*	**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 ✓	*Allow naming of forces as in (a)* *Allow vertical forces are balanced/equal in magnitude/cancel out*	**3**
1.	**c**		mention of conservation of momentum ***OR*** $5.5 \times 4.2 = (55 + 5.5)$ **«** v **»** ✓ 0.38 **«** m s^{-1} **»** ✓	*Allow* $p = p'$ *or other algebraically equivalent statement* *Award* ***[0]*** *for answers based on energy*	**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» $= \mu mg\cos(6.5) =$ «$5.9\,\text{N}$» ✓ «component of weight down slope» $= mg\sin(6.5)$ «$= 6.1\,\text{N}$» ✓ «so $a = \frac{F}{m}$ » acceleration $= \frac{12}{5.5} = 2.2$ «m s^{-2}» ✓	*Ignore negative signs* *Allow use of $g = 10\,\text{m s}^{-2}$*	**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)

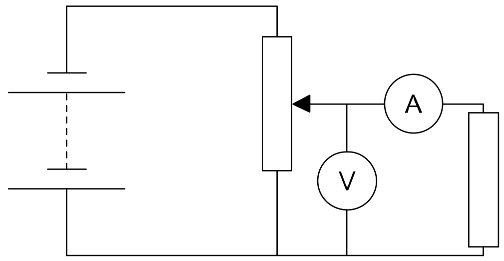
Question			Answers	Notes	Total
1.	**f**		calculates a maximum value for the frictional force = **«** μR = **»** 7.5 **«**N**»** ✓ sledge will not move as the maximum static friction force is greater than the component of weight down the slope ✓	 *Allow correct conclusion from incorrect MP1* *Allow 7.5 > 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**»** ✓	*Do not credit answers referring to energy*	**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 ✓	*Accept leptons experience the weak force* *Allow "interaction" for "force"*	**2 max**

Question			Answers	Notes	Total
3.	a	i	« $l = \frac{RA}{\rho} = \frac{82 \times 8 \times 10^{-3} \times 2 \times 10^{-6}}{4.1 \times 10^{-5}}$ » 0.032 «m» ✓		**1**
3.	a	ii	power $= 1500 \times 8 \times 10^{-3} \times 0.032$ «$= 0.384$» ✓ «current $\le \sqrt{\frac{\text{power}}{\text{resistance}}} = \sqrt{\frac{0.384}{82}}$ » 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	«$v = c\frac{\sin i}{\sin r} =$» $\frac{3\times 10^8 \times \sin(33)}{\sin(46)}$ ✓ 2.3×10^8 «$\mathrm{m\,s^{-1}}$» ✓		**2**
4.	a	ii	light strikes AB at an angle of 57° ✓ critical angle is «$\sin^{-1}\left(\frac{2.3}{3}\right) =$» 50.1° ✓ angle of incidence is greater than critical angle so total internal reflection ***OR*** light strikes AB at an angle of 57° ✓ calculation showing sin of "refracted angle" $= 1.1$ ✓ statement that since $1.1 > 1$ the angle does not exist and the light does not emerge ✓	*49.2° from unrounded value*	**3 max**
4.	a	iii	total internal reflection shown ✓ ray emerges at opposite face to incidence ✓	*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 $=$ **«** *volume* $\times$ *density* **»** $(0.75)^3 \times 920$ **«** $= 388\,\text{kg}$ **»** ✓ energy required to raise temperature $= 388 \times 2100 \times 20$ **«** $= 1.63 \times 10^7$ J **»** ✓ energy required to melt $= 388 \times 330 \times 10^3$ **«** $= 1.28 \times 10^8$ 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**		$\frac{mv^2}{r} = G\frac{Mm}{r^2}$ ✓ leading to $T^2 = \frac{4\pi^2 r^3}{GM}$ ✓ $T = 5320$ «s» ✓ ***Alternative 2*** «$v = \sqrt{\frac{Gm_E}{r}}$» $= \sqrt{\frac{6.67\times10^{-11}\times6.0\times10^{24}}{6600\times10^{3}}}$ ***OR*** 7800 «$\mathrm{m\,s^{-1}}$» ✓ distance $= 2\pi r = 2\pi\times6600\times10^{3}$ «m» ***or*** 4.15×10^{7} «m» «$T = \frac{d}{v} = \frac{4.15\times10^{7}}{7800}$» $= 5300$ «s»	*Accept use of ω instead of v*	**3**

(continued…)

(Question 5 continued)

Question			Answers	Notes	Total
5.	**b**	**i**	$T = «\frac{2.90\times10^{-3}}{\lambda_{\max}} =» \frac{2.90\times10^{-3}}{10.1\times10^{-6}}$ ✓ $= 287$ «K» ***or*** 14 «°C» ✓	*Award **[0]** for any use of wavelength from Sun* *Do not accept 287 °C*	**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**