Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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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» $= \mu mg\cos(6.5) =$ «5.9N» ✓ «component of weight down slope» $= mg\sin(6.5)$ «$= 6.1$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)

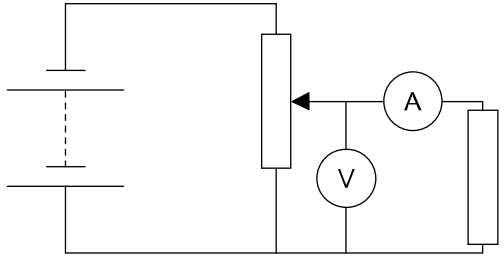
Question			Answers	Notes	Total
1.	**f**		calculates a maximum value for the frictional force = « μR =» 7.5 «N» ✓ sledge will not move as the maximum static friction force is greater than the component of weight down the slope ✓	*Allow correct conclusion from incorrect MP1* *Allow 7.5 > 6.1 so will not 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 $\leq \sqrt{\frac{\text{power}}{\text{resistance}}} = \sqrt{\frac{0.384}{82}}$ » 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	« $v = c\frac{\sin i}{\sin r} =$ » $\frac{3\times10^8\times\sin(33)}{\sin(46)}$ ✓ 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* × *density* » $(0.75)^3 \times 920$ « = 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		$\frac{mv^2}{r} = G\frac{Mm}{r^2}$ ✓ 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 «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**	$T = \text{«}\frac{2.90\times10^{-3}}{\lambda_{max}} = \text{»}\frac{2.90\times10^{-3}}{10.1\times10^{-6}}$ ✓ $= 287$ «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**