Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

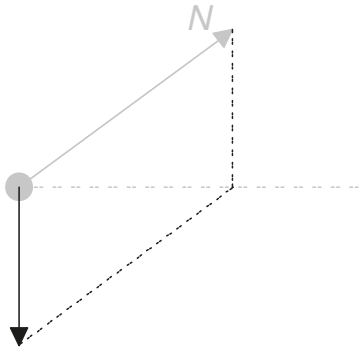
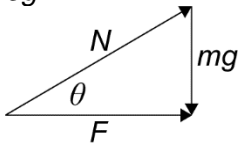
May 2018

Physics

Standard level

Paper 2

8 pages

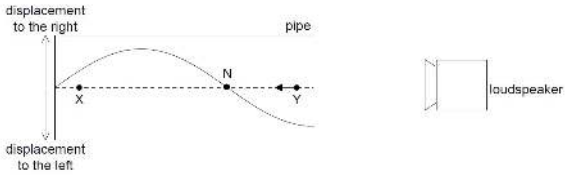
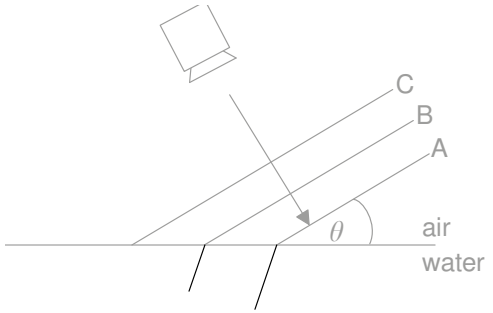
Question			Answers	Notes	Total
1.	a	i	towards the centre «of the circle» / horizontally to the right ✓	*Do not accept towards the centre of the bowl*	1
1.	a	ii	downward vertical arrow of any length ✓ arrow of correct length ✓	*Judge the length of the vertical arrow by eye. The construction lines are not required. A label is not required* *eg*: 	2
1.	a	iii	***ALTERNATIVE 1*** $F = N\cos\theta$ ✓ $mg = N\sin\theta$ ✓ dividing/substituting to get result ✓ ***ALTERNATIVE 2*** right angle triangle drawn with *F*, *N* and *W/mg* labelled ✓ angle correctly labelled and arrows on forces in correct directions ✓ correct use of trigonometry leading to the required relationship ✓	*eg:*  $tan\theta = \frac{O}{A} = \frac{mg}{F}$ $F = \frac{mg}{tan\theta}$	3

(continued…)

(Question 1 continued)

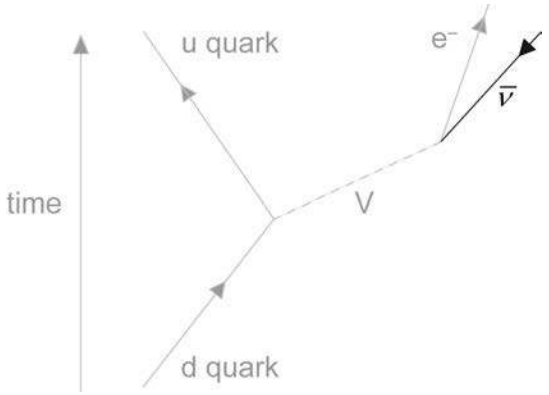
1.	**b**		$\frac{mg}{\tan\theta} = m\frac{v^2}{r}$ ✓ $r = R\cos\theta$ ✓ $v = \sqrt{\frac{gR\cos^2\theta}{\sin\theta}} / \sqrt{\frac{gR\cos\theta}{\tan\theta}} / \sqrt{\frac{9.81\times 8.0\cos 22}{\tan 22}}$ ✓ $v = 13.4 / 13$ «m s^{-1}» ✓	*Award **[4]** for a bald correct answer* *Award **[3]** for an answer of 13.9/14 «ms^{-1}». MP2 omitted*	**4**
1.	**c**		there is no force to balance the weight/N is horizontal ✓ so no / it is not possible ✓	*Must see correct justification to award MP2*	**2**
1.	**d**		speed $v =$ «$\sqrt{2gR}$ =» 12.5 «m s^{-1}» ✓ «from conservation of momentum» common speed after collision is $\frac{1}{2}$ initial speed «$v_c = \frac{12.5}{2} = 6.25\,\text{m s}^{-1}$» ✓ $h =$ «$\frac{v_c^{\,2}}{2g} = \frac{6.25^2}{2\times 9.81}$» 2.0 «m» ✓	*Allow 12.5 from incorrect use of kinematics equations* *Award **[3]** for a bald correct answer* *Award **[0]** for $mg(8) = 2mgh$ leading to $h = 4\,m$ if done in one step.* *Allow ECF from MP1* *Allow ECF from MP2*	**3**

Question			Answers	Notes	Total
2.	a	i	a gas in which there are no intermolecular forces ***OR*** a gas that obeys the ideal gas law/all gas laws at all pressures, volumes and temperatures ***OR*** molecules have zero PE/only KE ✓	*Accept atoms/particles.*	**1**
2.	a	ii	$N = \text{«}\frac{pV}{kT} = \frac{5.3\times10^{5}\times2.1\times10^{-4}}{1.38\times10^{-23}\times310}\text{»}\ 2.6\times10^{22}$ ✓		**1**
2.	a	iii	«For one atom $U = \frac{3}{2}kT$» $\frac{3}{2}$ ă 1.38 ă 10^{-23} ă 310 / 6.4 ă 10^{-21} «J» ✓ $U = \text{«}2.6\times10^{22}\times\frac{3}{2}\times1.38\times10^{-23}\times310\text{»}\ 170$ «J» ✓	*Allow ECF from (a)(ii)* *Award **[2]** for a bald correct answer* *Allow use of* $U = \frac{3}{2}pV$	**2**
2.	b	i	$p_2 = \text{«}5.3\times10^{5}\times\frac{2.1\times10^{-4}}{6.8\times10^{-4}}\text{»}\ 1.6\times10^{5}$ «Pa» ✓		**1**
2.	b	ii	«volume has increased and» average velocity/KE remains unchanged ✓ «so» molecules collide with the walls less frequently/longer time between collisions with the walls ✓ «hence» rate of change of momentum at wall has decreased ✓ «and so pressure has decreased»	*The idea of average must be included* *Decrease in number of collisions is not sufficient for MP2. Time must be included.* *Accept atoms/particles.*	**2 max**

3.	**a**	**i**	the incident wave «from the speaker» and the reflected wave «from the closed end» superpose/combine/interfere ✓	*Allow superimpose/add up* *Do not allow meet/interact*	**1**
3.	**a**	**ii**	Horizontal arrow from X to the right ✓	*MP2 is dependent on MP1* *Ignore length of arrow*	**1**
3.	**a**	**iii**	P at a node ✓		**1**
3.	**a**	**iv**	wavelength is $\lambda = «\frac{4 \times 0.30}{3} =» 0.40 «\text{m}»$ ✓ $f = «\frac{340}{0.40} =» 850 «\text{Hz}»$ ✓	*Award **[2]** for a bald correct answer* *Allow ECF from MP1*	**2**
3.	**b**	**i**	$\frac{\sin\theta_C}{340} = \frac{1}{1500}$ ✓ $\theta_C = 13 «^\circ»$ ✓	*Award **[2]** for a bald correct answer* *Award **[2]** for a bald answer of 13.1* *Answer must be to 2/3 significant figures to award MP2* *Allow 0.23 radians*	**2**
3.	**b**	**ii**	correct orientation ✓ greater separation ✓	*Do not penalize the lengths of A and B in the water* *Do not penalize a wavefront for C if it is consistent with A and B* *MP1 must be awarded for MP2 to be awarded* *eg*: 	**2**

Question			Answers	Notes	Total
4.	a		the work done per unit charge ✓ in moving charge from one terminal of a cell to the other / all the way round the circuit ✓	*Award **[1]** for "energy per unit charge provided by the cell"/"power per unit current"* *Award **[1]** for "potential difference across the terminals of the cell when no current is flowing"* *Do not accept "potential difference across terminals of cell"*	**2**
4.	b	i	the resistance is proportional to length / see 0.35 ***AND*** 1«.00»✓ so it equals 0.35×80 ✓ « $= 28\,\Omega$»		**2**
4.	b	ii	current leaving 12 V cell is $\frac{12}{80} = 0.15$ « A » ***OR*** $E = \frac{12}{80} \times 28$ ✓ $E =$ « $0.15 \times 28 =$ » 4.2 « V » ✓	*Award **[2]** for a bald correct answer* *Allow a 1sf answer of 4 if it comes from a calculation.* *Do not allow a bald answer of 4 «V»* *Allow ECF from incorrect current*	**2**

Question			Answers	Notes	Total
5.	a	i	Average height = 127 «m» ✓ Specific energy $«= \frac{mg\bar{h}}{m} = g\bar{h} = 9.81 \times 127» = 1.2 \times 10^3\ \text{J kg}^{-1}$ ✓	*Unit is essential* *Allow $g = 10$ gives $1.3 \times 10^3\ \text{J kg}^{-1}$* *Allow ECF from 110 m $(1.1 \times 10^3\ \text{J kg}^{-1})$ or 144 m $(1.4 \times 10^3\ \text{J kg}^{-1})$*	**2**
5.	a	ii	mass per second leaving dam is $\frac{1.2 \times 10^5}{60} \times 10^3 = «2.0 \times 10^6\ \text{kg s}^{-1}»$ ✓ rate of decrease of GPE is $= 2.0 \times 10^6 \times 9.81 \times 127$ ✓ $= 2.49 \times 10^9$ «*W*» / 2.49«*GW*» ✓	*Do not award ECF for the use of 110 m or 144 m* *Allow 2.4 GW if rounded value used from (a)(i) or 2.6 GW if $g = 10$ is used*	**3**
5.	a	iii	efficiency is $«\frac{1.8}{2.5} =» 0.72 / 72\%$ ✓		
5.	b		water is pumped back up at times when the demand for/price of electricity is low ✓		**1**

6.	**a**		«most of» the mass of the atom is confined within a very small volume/nucleus ✓ «all» the positive charge is confined within a very small volume/nucleus ✓ electrons orbit the nucleus «in circular orbits» ✓		**2 max**
6.	**b**	**i**	the energy needed to separate the nucleons of a nucleus ***OR*** energy released when a nucleus is formed from its nucleons ✓	*Allow neutrons **AND** protons for nucleons* *Don't allow constituent parts*	**1**
6.	**b**	**ii**	$Q = 106 \times 8.550 - 106 \times 8.521 = 3.07$ «MeV» ✓ «$Q \approx 3$ MeV»		**1**
6.	**c**	**i**	line <u>with arrow</u> as shown labelled anti-neutrino/$\overline{\nu}$ ✓	*Correct direction of the "arrow" is essential* *The line drawn must be "upwards" from the vertex in the time direction i.e. above the horizontal* *eg*: 	**1**
6.	**c**	**ii**	$V = W^-$ ✓		**1**