

# Markscheme

May 2018

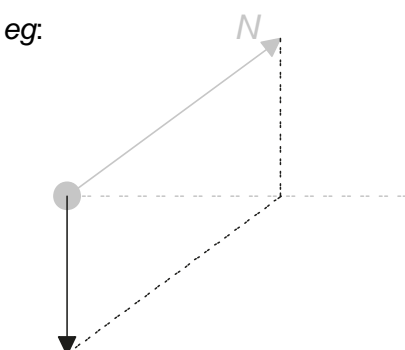
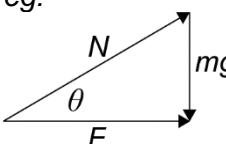
Physics

Standard level

Paper 2

8 pages

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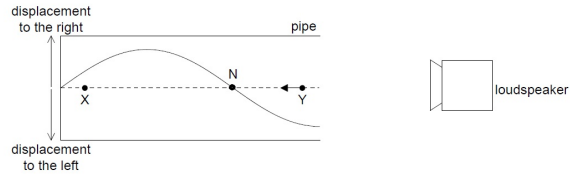
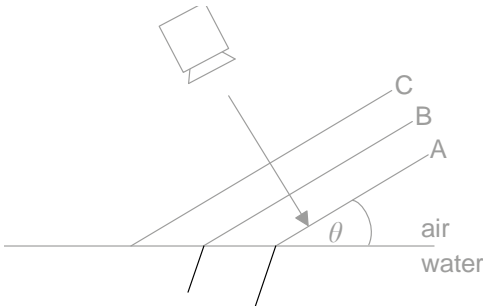
Question			Answers	Notes	Total
1.	a	i	towards the centre «of the circle» / horizontally to the right ✓	<i>Do not accept towards the centre of the bowl</i>	1
1.	a	ii	downward vertical arrow of any length ✓ arrow of correct length ✓	<i>Judge the length of the vertical arrow by eye. The construction lines are not required. A label is not required</i>  eg: 	2
1.	a	iii	<b>ALTERNATIVE 1</b> $F = N \cos \theta$ ✓ $mg = N \sin \theta$ ✓ dividing/substituting to get result ✓ <b>ALTERNATIVE 2</b> 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	$\frac{mg}{\tan\theta} = m\frac{v^2}{r} \checkmark$ $r = R\cos\theta \checkmark$ $v = \sqrt{\frac{gR\cos^2\theta}{\sin\theta}} / \sqrt{\frac{gR\cos\theta}{\tan\theta}} / \sqrt{\frac{9.81 \times 8.0 \cos 22}{\tan 22}} \checkmark$ $v = 13.4 / 13 \text{ «ms}^{-1}\text{»} \checkmark$	<p>Award <b>[4]</b> for a bald correct answer                  Award <b>[3]</b> for an answer of 13.9/14 «ms<sup>-1</sup>». MP2 omitted</p>	4
1.	c	<p>there is no force to balance the weight/N is horizontal <math>\checkmark</math>                  so no / it is not possible <math>\checkmark</math></p>	<p>Must see correct justification to award MP2</p>	2
1.	d	<p>speed before collision <math>v = \sqrt{2gR} = 12.5 \text{ «ms}^{-1}\text{»} \checkmark</math></p> <p>«from conservation of momentum» common speed after collision is <math>\frac{1}{2}</math> initial</p> <p>speed «<math>v_c = \frac{12.5}{2} = 6.25 \text{ ms}^{-1}</math>» <math>\checkmark</math></p> <p><math>h = \frac{v_c^2}{2g} = \frac{6.25^2}{2 \times 9.81} = 2.0 \text{ «m»} \checkmark</math></p>	<p>Allow 12.5 from incorrect use of kinematics equations                  Award <b>[3]</b> for a bald correct answer                  Award <b>[0]</b> for <math>mg(8) = 2mgh</math> leading to <math>h = 4 \text{ m}</math> if done in one step.</p> <p>Allow ECF from MP1</p> <p>Allow ECF from MP2</p>	3

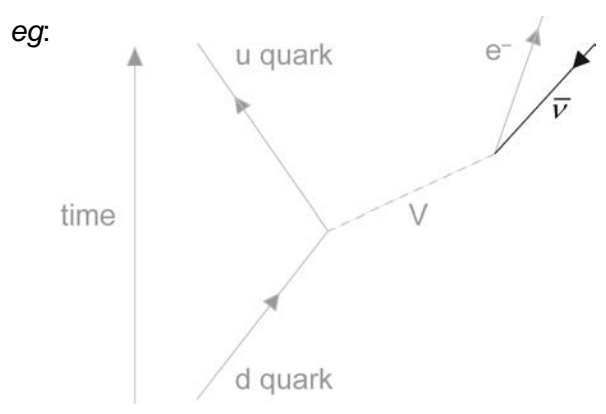
Question			Answers	Notes	Total
2.	a	i	a gas in which there are no intermolecular forces <b>OR</b> a gas that obeys the ideal gas law/all gas laws at all pressures, volumes and temperatures <b>OR</b> molecules have zero PE/only KE ✓	Accept atoms/particles.	1
2.	a	ii	$N = \left\langle \frac{pV}{kT} = \frac{5.3 \times 10^5 \times 2.1 \times 10^{-4}}{1.38 \times 10^{-23} \times 310} \right\rangle 2.6 \times 10^{22} \checkmark$		1
2.	a	iii	«For one atom $U = \frac{3}{2} kT$ » <del>1.38</del> $\hat{A} 1.38 \hat{A} 10^{-23} \hat{A} 310 / 6.4 \hat{A} 10^{-21}$ «J» ✓  $U = \left\langle 2.6 \times 10^{22} \times \frac{3}{2} \times 1.38 \times 10^{-23} \times 310 \right\rangle 170$ «J» ✓	Allow ECF from (a)(ii) Award <b>[2]</b> for a bald correct answer  Allow use of $U = \frac{3}{2} pV$	2
2.	b	i	$p_2 = \left\langle 5.3 \times 10^5 \times \frac{2.1 \times 10^{-4}}{6.8 \times 10^{-4}} \right\rangle 1.6 \times 10^5$ «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 <i>superimpose/add up</i> Do not allow <i>meet/interact</i>	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	$\frac{\sin \theta_c}{340} = \frac{1}{1500}$ ✓  $\theta_c = 13 \text{ «°»}$ ✓	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		<p>the work done per unit charge ✓</p> <p>in moving charge from one terminal of a cell to the other / all the way round the circuit ✓</p>	<p>Award <b>[1]</b> for “energy per unit charge provided by the cell”/“power per unit current”</p> <p>Award <b>[1]</b> for “potential difference across the terminals of the cell when no current is flowing”</p> <p>Do not accept “potential difference across terminals of cell”</p>	2
4.	b	i	<p>the resistance is proportional to length / see 0.35 <b>AND</b> 1«.00»✓</p> <p>so it equals <math>0.35 \times 80</math> ✓</p> <p>« = 28 Ω »</p>		2
4.	b	ii	<p>current leaving 12 V cell is <math>\frac{12}{80} = 0.15</math> « A »</p> <p><b>OR</b></p> <p><math>E = \frac{12}{80} \times 28</math> ✓</p> <p><math>E = \text{«} 0.15 \times 28 = \text{»} 4.2</math> « V » ✓</p>	<p>Award <b>[2]</b> for a bald correct answer</p> <p>Allow a 1sf answer of 4 if it comes from a calculation.</p> <p>Do not allow a bald answer of 4 « V »</p> <p>Allow ECF from incorrect current</p>	2

Question			Answers	Notes	Total
5.	a	i	Average height = 127 «m» ✓ Specific energy « $= \frac{mgh}{m} = gh = 9.81 \times 127$ » = $1.2 \times 10^3 \text{ J kg}^{-1}$ ✓	Unit is essential Allow $g = 10$ gives $1.3 \times 10^3 \text{ J kg}^{-1}$ Allow ECF from 110m ( $1.1 \times 10^3 \text{ J kg}^{-1}$ ) or 144m ( $1.4 \times 10^3 \text{ J kg}^{-1}$ )	2
5.	a	ii	mass per second leaving dam is $\frac{1.2 \times 10^5}{60} \times 10^3 = \text{«}2.0 \times 10^6 \text{ kg s}^{-1}\text{»}$ ✓ rate of decrease of GPE is $= 2.0 \times 10^6 \times 9.81 \times 127$ ✓ $= 2.49 \times 10^9 \text{ «W»} / 2.49 \text{ «GW»}$ ✓	Do not award ECF for the use of 110m or 144m Allow 2.4GW if rounded value used from (a)(i) or 2.6GW 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		<p>«most of» the mass of the atom is confined within a very small volume/nucleus ✓</p> <p>«all» the positive charge is confined within a very small volume/nucleus ✓</p> <p>electrons orbit the nucleus «in circular orbits» ✓</p>		2 max
6.	b	i	<p>the energy needed to separate the nucleons of a nucleus</p> <p><b>OR</b></p> <p>energy released when a nucleus is formed from its nucleons ✓</p>	<p>Allow neutrons <b>AND</b> protons for nucleons</p> <p>Don't allow constituent parts</p>	1
6.	b	ii	<p><math>Q = 106 \times 8.550 - 106 \times 8.521 = 3.07</math> «MeV» ✓</p> <p>«<math>Q \approx 3</math> MeV»</p>		1
6.	c	i	<p>line <u>with arrow</u> as shown labelled anti-neutrino/<math>\bar{\nu}</math> ✓</p>	<p>Correct direction of the “arrow” is essential</p> <p>The line drawn must be “upwards” from the vertex in the time direction i.e. above the horizontal</p> <p>eg:</p> 	1
6.	c	ii	<p><math>V = W^-</math> ✓</p>		1