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# Physics

Standard level paper 2 markscheme



May 2017

# Markscheme

**May 2017**

**Physics**

**Standard level**

**Paper 2**

12 pages

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Question		Answers	Notes	Total
1.	a	correct use of kinematic equation/equations ✓ 148.5 <b>or</b> 149 <b>or</b> 150 «m» ✓	<i>Substitution(s) must be correct.</i>	2
	b	$a = \frac{27}{11}$ <b>or</b> 2.45 «m s <sup>-2</sup> » ✓ $F - 160 = 492 \times 2.45$ ✓ 1370 «N» ✓	<i>Could be seen in part (a).</i> Award <b>[0]</b> for solution that uses $a = 9.81 \text{ m s}^{-2}$	3

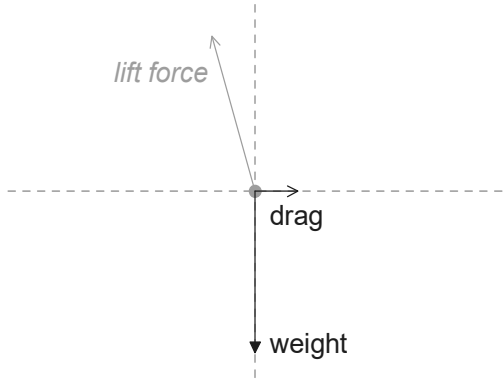
(continued...)

(Question 1 continued)

Question	Answers	Notes	Total
c	<p><b>ALTERNATIVE 1</b></p> <p>«work done to launch glider» = <math>1370 \times 149</math> « = 204 kJ» ✓</p> <p>«work done by motor» = <math>\frac{204 \times 100}{23}</math> ✓</p> <p>«power input to motor» = <math>\frac{204 \times 100}{23} \times \frac{1}{11} = 80</math> <b>or</b> 80.4 <b>or</b> 81 k«W» ✓</p> <p><b>ALTERNATIVE 2</b></p> <p>use of average speed <math>13.5 \text{ m s}^{-1}</math> ✓</p> <p>«useful power output» = force <math>\times</math> average speed « = <math>1370 \times 13.5</math> » ✓</p> <p>power input = « <math>1370 \times 13.5 \times \frac{100}{23} = \text{» } 80</math> <b>or</b> 80.4 <b>or</b> 81 k«W» ✓</p> <p><b>ALTERNATIVE 3</b></p> <p>work required from motor = KE + work done against friction « = <math>0.5 \times 492 \times 27^2 + (160 \times 148.5)</math> » = 204 «kJ» ✓</p> <p>«energy input» = <math>\frac{\text{work required from motor} \times 100}{23}</math> ✓</p> <p>power input = <math>\frac{883000}{11} = 80.3</math> k«W» ✓</p>	<p>Award [2 max] for an answer of 160 k«W».</p>	<p>3</p>

(continued...)

(Question 1 continued)

Question	Answers	Notes	Total
d	$\omega = \left\langle \frac{v}{r} \right\rangle = \frac{27}{0.6} = 45 \checkmark$ <p>rad s<sup>-1</sup> ✓</p>	<p>Do not accept Hz.</p> <p>Award [1 max] if unit is missing.</p>	2
e	<p>direction of motion ←</p>  <p>drag correctly labelled and in correct direction ✓</p> <p>weight correctly labelled and in correct direction <b>AND</b> no other incorrect force shown ✓</p>	<p>Award [1 max] if forces do not touch the dot, but are otherwise OK.</p>	2

(continued...)

(Question 1 continued)

Question		Answers	Notes	Total
	<b>f</b>	name Newton's first law ✓  vertical/all forces are in equilibrium/balanced/add to zero <b>OR</b> vertical component of lift mentioned ✓  as equal to weight ✓		<b>2 max</b>
	<b>g</b>	any speed and any direction quoted together as the answer ✓ quotes their answer(s) to 3 significant figures ✓  speed = $12.7 \text{ m s}^{-1}$ <b>or</b> direction = $9.46^\circ$ <b>or</b> $0.165 \text{ rad}$ «below the horizontal» <b>or</b> gradient of $-\frac{1}{6}$ ✓		<b>3</b>

Question		Answers	Notes	Total
2.	a	<p>PE of water is converted to KE of moving water/turbine to electrical energy «in generator/turbine/dynamo» ✓</p> <p>idea of pumped storage, ie: pump water back during night/when energy cheap to buy/when energy not in demand/when there is a surplus of energy ✓</p>		2
	b	<p>total energy = «<math>2.7 \times 10^3 \times 1.5 \times 10^{10} = 4.05 \times 10^{13}</math> J» ✓</p> <p>time = «<math>\frac{4.0 \times 10^{13}}{4 \times 2.5 \times 10^8} = 11.1 \text{ h}</math> or <math>4.0 \times 10^4 \text{ s}</math>» ✓</p>	<i>For MP2 the unit <b>must</b> be present.</i>	2
	c	<p>friction/resistive losses in walls of pipe/air resistance/turbulence/turbine and generator bearings ✓</p> <p>thermal energy losses, in electrical resistance of components ✓</p> <p>water requires kinetic energy to leave system so not all can be transferred ✓</p>	<i>Must see “seat of friction” to award the mark. Do not allow “friction” bald.</i>	1 max
	d	<p>area required = <math>\frac{1 \times 10^9}{0.22 \times 180}</math> «<math>= 2.5 \times 10^7 \text{ m}^2</math>» ✓</p> <p>length of one side = <math>\sqrt{\text{area}} = 5.0 \text{ km}</math> ✓</p>		2



Question		Answers	Notes	Total	
3.	a	<p>«light» superposes/interferes ✓</p> <p>pattern consists of «intensity» maxima and minima</p> <p><b>OR</b></p> <p>consisting of constructive and destructive «interference» ✓</p> <p>voltage peaks correspond to interference maxima ✓</p>		3	
	b	i	$s = \frac{\lambda D}{d} = \frac{6.3 \times 10^{-7} \times 5.0}{1.5 \times 10^{-3}} = 2.1 \times 10^{-3} \text{ «m» } \checkmark$	<p><i>If no unit assume m.</i></p> <p><i>Correct answer only.</i></p>	1
	b	ii	<p>correct read-off from graph of 25 m s ✓</p> $v = \frac{x}{t} = \frac{2.1 \times 10^{-3}}{25 \times 10^{-3}} = 8.4 \times 10^{-2} \text{ «m s}^{-1}\text{» } \checkmark$	<p><i>Allow ECF from (b)(i)</i></p>	2

(continued...)

(Question 3 continued)

Question		Answers	Notes	Total
	c	<p><b>ALTERNATIVE 1</b></p> <p>«reflection at barrier» leads to two waves travelling in opposite directions ✓</p> <p>mention of formation of standing wave ✓</p> <p>maximum corresponds to antinode/maximum displacement «of air molecules»</p> <p><b>OR</b></p> <p>complete cancellation at node position ✓</p>		<b>2 max</b>

Question		Answers	Notes	Total
4.	a	222 <b>AND</b> 4 ✓	<i>Both needed.</i>	1
	b	alpha particles highly ionizing <b>OR</b> alpha particles have a low penetration power <b>OR</b> thin glass increases probability of alpha crossing glass <b>OR</b> decreases probability of alpha striking atom/nucleus/molecule ✓		1
	c	conversion of temperature to 291 K ✓  $p = 4.5 \times 10^{-9} \times 8.31 \times \left\langle \frac{291}{1.3 \times 10^{-5}} \right\rangle$ <b>OR</b> $p = 2.7 \times 10^{15} \times 1.38 \times 10^{-23} \times \left\langle \frac{291}{1.3 \times 10^{-5}} \right\rangle \checkmark$ 0.83 <b>or</b> 0.84 «Pa» ✓	<i>Allow ECF for <math>2.7 \times 10^{15}</math> from (b)(ii).</i>	3

(continued...)

(Question 4 continued)

Question		Answers	Notes	Total
	<b>d</b>	electron/atom drops from high energy state/level to low state ✓ energy levels are discrete ✓ wavelength/frequency of photon is related to energy change <b>or</b> quotes $E = hf$ <b>or</b> $E = \frac{hc}{\lambda}$ and is therefore also discrete ✓		<b>3</b>
	<b>e</b>	peer review guarantees the validity of the work <b>OR</b> means that readers have confidence in the validity of work ✓	OWTTE	<b>1</b>

Question		Answers	Notes	Total	
5.	a	<p>when an electric field is applied to any material «using a cell etc» it acts to accelerate any free electrons ✓</p> <p>electrons are the charge carriers «in copper» ✓</p> <p>metals/copper have many free electrons whereas insulators have few/no free electrons/charge carriers ✓</p>	<p><i>Accept "free/valence/delocalised electrons".</i></p>	3	
	b	i	$\text{area} = \frac{1.7 \times 10^{-3} \times 35 \times 10^3}{64} \llcorner = 9.3 \times 10^{-6} \text{ m}^2 \llcorner \checkmark$	2	
	b	ii	<p>«resistance of cable = <math>2\Omega</math>»</p> <p>power dissipated in cable = <math>730^2 \times 2 \llcorner = 1.07 \text{ MW} \llcorner \checkmark</math></p> <p>power loss per meter = <math>\frac{1.07 \times 10^6}{35 \times 10^3}</math> <b>or</b> <math>30.6 \llcorner \text{ W m}^{-1} \llcorner \checkmark</math></p>	<p><i>Allow [2] for a solution where the resistance per unit metre is calculated using resistivity and answer to (b)(i) (resistance per unit length of cable = <math>5.7 \times 10^{-5} \text{ m}</math>)</i></p>	2
	b	iii	<p><math>30 = m \times 390 \times 3.5 \times 10^{-2} \llcorner \checkmark</math></p> <p><math>2.2 \text{ k} \llcorner \text{ g} \llcorner \checkmark</math></p>	<p><i>Correct answer only.</i></p>	2