

# Markscheme

May 2017

Physics

Standard level

Paper 2

9 pages

This markscheme is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Global Centre, Cardiff.

Question			Answers	Notes	Total
1	a	i	$\frac{1}{2}v^2 = 0.24gh$ ✓ $v = 11.9 \text{ «ms}^{-1}\text{»}$ ✓	Award GPE lost $= 65 \times 9.81 \times 30 = \text{«19130 J»}$ . Must see the 11.9 value for MP2, not simply 12. Allow $g = 9.8 \text{ ms}^{-2}$ .	2
	a	ii	internal energy is the total KE «and PE» of the molecules/particles/atoms in an object ✓ temperature is a measure of the average KE of the molecules/particles/atoms ✓	Award <b>[1 max]</b> if there is no mention of molecules/particles/atoms.	2
	b	i	arrow vertically downwards from dot labelled weight/W/mg/gravitational force/ $F_g$ / $F_{\text{gravitational}}$ <b>AND</b> arrow vertically upwards from dot labelled reaction force/R/normal contact force/N/ $F_N$ ✓ $W > R$ ✓	Do not allow gravity. Do not award MP1 if additional 'centripetal' force arrow is added. Arrows must connect to dot. Ignore any horizontal arrow labelled friction. Judge by eye for MP2. Arrows do not have to be correctly labelled or connect to dot for MP2.	2

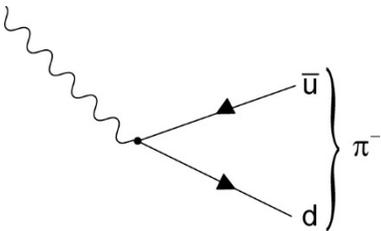
Question			Answers	Notes	Total
1	b	ii	<p><b>ALTERNATIVE 1</b></p> <p>recognition that centripetal force is required / <math>\frac{mv^2}{r}</math> seen ✓</p> <p>= 468 «N» ✓</p> <p>W/640 N (weight) is larger than the centripetal force required, so the skier does not lose contact with the ground ✓</p> <p><b>ALTERNATIVE 2</b></p> <p>recognition that centripetal acceleration is required / <math>\frac{v^2}{r}</math> seen ✓</p> <p>a = 7.2 «ms<sup>-2</sup>» ✓</p> <p>g is larger than the centripetal acceleration required, so the skier does not lose contact with the ground ✓</p> <p><b>ALTERNATIVE 3</b></p> <p>recognition that to lose contact with the ground centripetal force ≥ weight ✓</p> <p>calculation that v ≥ 14 «ms<sup>-1</sup>» ✓</p> <p>comment that 12 «ms<sup>-1</sup>» is less than 14 «ms<sup>-1</sup>» so the skier does not lose contact with the ground ✓</p> <p><b>ALTERNATIVE 4</b></p> <p>recognition that centripetal force is required / <math>\frac{mv^2}{r}</math> seen ✓</p> <p>calculation that reaction force = 172 «N» ✓</p> <p>reaction force &gt; 0 so the skier does not lose contact with the ground ✓</p>	<p><i>Do not award a mark for the bald statement that the skier does not lose contact with the ground.</i></p>	3

Question		Answers	Notes	Total	
1	c	<p><b>ALTERNATIVE 1</b></p> <p><math>0 = 8.2^2 + 2 \times a \times 24</math> therefore <math>a = \llcorner - \gg 1.40 \llcorner \text{ms}^{-2} \gg \checkmark</math></p> <p>friction force = <math>ma = 65 \times 1.4 = 91 \llcorner \text{N} \gg \checkmark</math></p> <p>coefficient of friction = <math>\frac{91}{65 \times 9.81} = 0.14 \checkmark</math></p> <p><b>ALTERNATIVE 2</b></p> <p><math>KE = \frac{1}{2}mv^2 = 0.5 \times 65 \times 8.2^2 = 2185 \llcorner \text{J} \gg \checkmark</math></p> <p>friction force = <math>KE/\text{distance} = 2185/24 = 91 \llcorner \text{N} \gg \checkmark</math></p> <p>coefficient of friction = <math>\frac{91}{65 \times 9.81} = 0.14 \checkmark</math></p>	<p><i>Allow ECF from MP1.</i></p>	3	
	d	i	<p><math>\llcorner 76 \times 9.6 \gg = 730 \checkmark</math></p> <p>Ns <b>OR</b> <math>\text{kg ms}^{-1} \checkmark</math></p>		2
	d	ii	<p>safety net extends stopping time <math>\checkmark</math></p> <p><math>F = \frac{\Delta p}{\Delta t}</math> therefore <math>F</math> is smaller <math>\llcorner \text{with safety net} \gg \checkmark</math></p> <p><b>OR</b></p> <p>force is proportional to rate of change of momentum therefore <math>F</math> is smaller <math>\llcorner \text{with safety net} \gg \checkmark</math></p>	<p><i>Accept reverse argument.</i></p>	2

Question		Answers	Notes	Total
2	a	when 2 waves meet the resultant displacement ✓ is the «vector» sum of their individual displacements ✓	<i>Displacement should be mentioned at least once in MP 1 or 2.</i>	2
	b	$\lambda = \frac{4.7 \times 10^{-3} \times 0.35 \times 10^{-3}}{2.4} \checkmark$ $= 6.9 \times 10^{-7} \text{ «m»} \checkmark$ answer to 2 SF ✓	<i>Allow missed powers of 10 for MP1.</i>	3
	c	green wavelength smaller than red ✓ fringe separation / distance between maxima decreases ✓	<i>Allow ECF from MP1.</i>	2
	d	bright central maximum ✓ subsidiary maxima «on either side» ✓  the width of the central fringe is twice / larger than the width of the subsidiary/secondary fringes/maxima  <b>OR</b> intensity of pattern is decreased ✓	<i>Allow marks from a suitably labelled intensity graph for single slit diffraction.</i>	2 max

Question		Answers	Notes	Total
3	a	solar heating panel converts solar/radiation/photon/light energy into thermal <b>energy AND</b> photovoltaic cell converts solar/radiation/photon/light energy into electrical <b>energy</b> ✓	Accept <i>internal energy</i> of water.	1
	b	power received = $240 \times 25000 = \text{«6.0 MW»}$ ✓  efficiency $\text{«} = \frac{1.6}{6.0} \text{»} = 0.27 / 27\%$ ✓		2
	c	i area = $\pi \times 17^2 \text{ «} = 908\text{m}^2 \text{»}$ ✓  power = $\frac{1}{2} \times 908 \times 1.3 \times 7.5^3 \text{ «} = 0.249\text{MW} \text{»}$ ✓  number of turbines $\text{«} = \frac{1.6}{0.249} = 6.4 \text{»} = 7$ ✓	Only allow integer value for MP3.  Award <b>[2 max]</b> for <b>25 turbines</b> (ECF from incorrect power)  Award <b>[2 max]</b> for <b>26 turbines</b> (ECF from incorrect radius)	3
		ii «efficiency is less than 100 % as» not all KE of air can be converted to KE of blades <b>OR</b> air needs to retain KE to escape ✓ thermal energy is lost due to friction in turbine/dynamo/generator ✓	Allow velocity of air after turbine is not zero.	2

Question			Answers	Notes	Total
4	a	i	$I = \frac{8.5 \times 10^3}{240} = 35 \text{ «A» } \checkmark$		1
	a	ii	$R = \frac{1.7 \times 10^{-8} \times 10}{6.0 \times 10^{-6}} \checkmark$ $= 0.028 \text{ «}\Omega\text{» } \checkmark$	Allow missed powers of 10 for MP1.	2
	b		«as temperature increases» there is greater vibration of the metal atoms/lattice/lattice ions <b>OR</b> increased collisions of electrons $\checkmark$ drift velocity decreases «so current decreases» $\checkmark$ «as V constant so» R increases $\checkmark$	Award [0] for suggestions that the speed of electrons increases so resistance decreases.	3
	c		recognition that power = flow rate $\times c\Delta T$ $\checkmark$ flow rate « $= \frac{\text{power}}{c\Delta T} = \frac{8.5 \times 10^3}{4200 \times 35} \checkmark$ » $= 0.058 \text{ «kgs}^{-1}\text{» } \checkmark$ $\text{kg s}^{-1} / \text{g s}^{-1} / \text{l s}^{-1} / \text{ml s}^{-1} / \text{m}^3 \text{ s}^{-1} \checkmark$	Allow MP4 if a bald flow rate unit is stated. Do not allow imperial units.	4

Question		Answers	Notes	Total
5	a	<p>Meson: quark-antiquark pair ✓</p> <p>Baryon: 3 quarks ✓</p>		2
	b	<p><b>i</b></p> <p><b>Alternative 1</b></p> <p>strange quark changes «flavour» to an up quark ✓</p> <p>changes in quarks/strangeness happen only by the weak interaction ✓</p> <p><b>Alternative 2</b></p> <p>Strangeness is not conserved in this decay «because the strange quark changes to an up quark» ✓</p> <p>Strangeness is not conserved during the weak interaction ✓</p>	Do not allow a bald answer of weak interaction.	2
		<p><b>ii</b></p> <p>arrows drawn in the direction shown ✓</p> 	Both needed for [1] mark.	1
		<p><b>iii</b></p> <p><math>W^-</math> ✓</p>	Do not allow $W$ or $W^+$ .	1
	c	<p>it lowers the cost to individual nations, as the costs are shared ✓</p> <p>international co-operation leads to international understanding <b>OR</b> historical example of co-operation <b>OR</b> co-operation always allows science to proceed ✓</p> <p>large quantities of data are produced that are more than one institution/research group can handle ✓</p> <p>co-operation allows effective analysis ✓</p>	Any one.	1 max