

Question number	Answer	Additional guidance	Mark
2(a)	<ul style="list-style-type: none"> downward arrow labelled 'weight' (1) upward arrow labelled 'reaction' (1) both arrows of approximately equal length and drawn in line within ball (1) 	ignore 'gravity' allow 'gravitational force', 'force due to gravity' allow 'normal reaction force', 'normal contact force'	3

Question number	Answer	Additional guidance	Mark
2(b)	Process should include: <ul style="list-style-type: none"> substitution rearrangement evaluation to at least 2 significant figures (s.f.) e.g. $v^2 = 0 + (2 \times 10 \times 1.3)$ (1) $v = \sqrt{2 \times 10 \times 1.3}$ (1) $v = 5.1$ (m/s) (1)	allow 5.10, 5.099, 5.09	3

Question number	Answer	Additional guidance	Mark
2(c)(i)	0.51 (seconds)	allow value in range 0.50–0.52 (seconds)	1

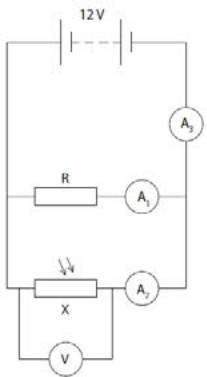
Question number	Answer	Additional guidance	Mark
2(c)(ii)	Average speed = distance moved/time taken	allow in accepted symbols or rearranged.	1

Question number	Answer	Additional guidance	Mark
2(c)(iii)	(Speed =) 2.0 (m/s)	accept 2	1

Question number	Answer	Mark
2(c)(iv)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> gradient is equal to the {speed/velocity} of the ball (1) gradient is increasing over time (1) (therefore) the {speed/velocity} is increasing with time (1) 	3

Total for Question 2 = 12 marks

Question number	Answer	Mark
3(a)(i)	An LDR (light-dependent resistor)	1

Question number	Answer	Mark
3(a)(ii)	<ul style="list-style-type: none"> correct symbol (1) correct position in parallel with X (1) 	2

Question number	Answer	Additional guidance	Mark
3(b)	rearrangement <ul style="list-style-type: none"> $I = V/R$ (1) substitution <ul style="list-style-type: none"> $I = 12/840 (= 0.014 \text{ (A)})$ (1) 	0.01429 (A) some evidence of working required for two marks	2

Question number	Answer	Additional guidance	Mark
3(c)(i)	correct addition of current in A_1 with current in A_2 $= 0.021 \text{ (A)}$ (1)	ecf from 3(b) 0.025 (A) award full marks for correct numerical answer without working	1

Question number	Answer	Mark
3(c)(ii)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> resistance of LDR increases (1) hence current in A_2/A_3 decreases (1) 	2

Total for Question 3 = 8 marks

Question number	Answer	Mark
4(a)(i)	A	1

Question number	Answer	Mark
4(a)(ii)	B	1

Question number	Answer	Mark
4(b)(i)	C	1

Question number	Answer	Additional guidance	Mark
4(b)(ii)	<p>2 marks max. available for each named part of the spectrum for each use:</p> <ul style="list-style-type: none"> • 1 mark for a simple use • 1 mark for a supporting description <p>e.g.</p> <p>for gamma rays:</p> <ul style="list-style-type: none"> • used to sterilise medical tools (1) • (because) gamma kill bacteria (1) <p>for x-rays:</p> <ul style="list-style-type: none"> • used to photograph bones (1) • (because) x-rays can penetrate soft tissues but not bone (1) <p>for ultraviolet:</p> <ul style="list-style-type: none"> • used for detecting security ink (1) • (because) it fluoresces with ultraviolet lighting (1) <p>for infrared:</p> <ul style="list-style-type: none"> • used for optical fibre communications (1) • (because) they can undergo total internal reflection (1) <p>for micro waves:</p> <ul style="list-style-type: none"> • used for satellite communications (1) • (because) microwaves can penetrate Earth's atmosphere (1) <p>for radio waves:</p> <ul style="list-style-type: none"> • used for long-range communications (1) • (because) they can be reflected from the Earth's atmosphere (1) 	no mark for simply naming a part of the spectrum	6

Total for Question 4 = 9 marks

Question number	Answer	Mark
5(a)(i)	Process should include: <ul style="list-style-type: none"> substitution rearrangement evaluation e.g. $100 \times 7.5 = p_2 \times 5.0$ (1) $p_2 = (100 \times 7.5)/5.0$ (1) $(p_2 =) 150$ (kPa) (1)	3

Question number	Answer	Additional guidance	Mark
5(a)(ii)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> particles collide with walls (of container) (1) And any two from: <ul style="list-style-type: none"> more frequently/time between collisions is less (1) (resulting in) larger force (1) (over a) smaller surface area (1) 	allow 'more often'	3

Question number	Answer	Additional guidance	Mark
5(b)(i)	A description that makes reference to the following points: <ul style="list-style-type: none"> (average kinetic energy) increases (1) in (direct) proportion to (1) Kelvin temperature (1) 	dependent on point 1 dependent on point 1	3

Question number	Answer	Additional guidance	Mark
5(b)(ii)	Process should include: <ul style="list-style-type: none"> conversion of temperatures to Kelvin scale (1) rearrangement (1) substitution (1) evaluation (1) e.g. $20^\circ\text{C} = 293\text{ K}$ OR $65^\circ\text{C} = 338\text{ K}$ (1) $(p_1/T_1)/T_2 = p_2$ (1) $p_2 = (100 \times 338)/293$ (1) $(p_2 =) 115$ (kPa) (1)	not converting to Kelvin gains 2 marks max. $100/293 = p_2/338$ allow 115.358...	4

Total for Question 5 = 13 marks

Question number	Answer	Additional guidance	Mark
6(a)	Any two control variables (2) e.g. <ul style="list-style-type: none"> distance between fan and turbine fan speed number of turbine blades turbine angle fan angle orientation of fan with respect to turbine 	ignore type of fan/turbine	2

Question number	Answer	Additional guidance	Mark
6(b)(i)	Scale (1) Axes (1) Plotting (1)	both axes should occupy at least 50% of the grid both axes should be labelled with quantity and unit orientation unimportant points should be accurate within 1mm. -1 mark for each error	3

Question number	Answer	Additional guidance	Mark
6(b)(ii)	<ul style="list-style-type: none"> curve starting at (0,0) (1) smooth curve to a peak at (20, 2.2) (1) 	curve should be smooth with roughly equal distribution of points either side	2

Question number	Answer	Additional guidance	Mark
6(b)(iii)	A description containing any two from: <ul style="list-style-type: none"> voltage increases, then decreases as blade angle is increased (1) maximum voltage when blade angle is 20° (1) non-linear relationship (1) 	allow range of 15°–25°	2

Question number	Answer	Mark
6(c)(i)	Bar chart	1

Question number	Answer	Mark
6(c)(ii)	(Number of blades) is a discrete/discontinuous variable	1

Total for Question 6 = 11 marks

Question number	Answer	Mark
7(a)	<ul style="list-style-type: none"> • Axes shown with either voltage or current against time AND more than one wavelength shown (1) • Continuous curve drawn that alternates to + and –, and has approximately equal displacement on either side of x-axis (1) 	2

Question number	Answer	Additional guidance	Mark
7(b)	A diode only allows current in one direction	allow answers which describe what would happen to a battery with a.c.	1

Question number	Answer	Additional guidance	Mark
7(c)(i)	<ul style="list-style-type: none"> • All circuit symbols correct (1) • Bulbs shown in series (1) 	allow cell for battery reject power supply symbol	2

Question number	Answer	Additional guidance	Mark
7(c)(ii)	Power = current \times voltage	allow rearrangement and correct symbols, e.g. $P = I \times V$	1

Question number	Answer	Additional guidance	Mark
7(c)(iii)	Process includes: <ul style="list-style-type: none"> • rearrangement • evaluation e.g. $I = P/V$ (1) $= 0.33/6.0$ $= 0.055$ (A) (1)	1 mark max if incorrect V is used	2

Total for Question 7 = 8 marks

Question number	Answer	Mark
8(a)	B	1

Question number	Answer	Additional guidance	Mark
8(b)(i)	Transverse	allow any recognisable spelling	1

Question number	Answer	Additional guidance	Mark
8(b)(ii)	Any transverse wave e.g. electromagnetic named part of EM spectrum (surface) water waves waves on a rope seismic S waves	ignore waves on a slinky unless correctly clarified	1

Question number	Answer	Additional guidance	Mark
8(c)(i)	wave speed = frequency \times wavelength	equation can be given in words or symbols	1

Question number	Answer	Additional guidance	Mark
8(c)(ii)	<ul style="list-style-type: none"> • Conversion of kHz to Hz OR cm to m • Substitution • Evaluation e.g. 2.9 kHz = 2900 Hz (1) ($v =$) 2900 \times 0.12 (1) ($v =$) 350 (m/s) (1)	seen anywhere allow 348 (m/s) 0.348, 0.35, 34800, 35000 gains 2 marks 34.8, 35 gains 1 mark	3

Question number	Answer	Additional guidance	Mark
8(d)	An explanation including: <ul style="list-style-type: none">• frequency decreases (1)• wavelength increases (1)• (because) wave speed is constant (1)	Ignore references to volume or loudness Allow 'pitch' for frequency	3

Total for Question 8 = 10 marks

Question number	Answer	Mark
9(a)(i)	4 (1) 0 (1) $ \begin{array}{ccccccc} & 2 & & 3 & & & \\ & \text{H} & + & \text{H} & \longrightarrow & & \\ & 1 & & 1 & & & \\ & & & & & \boxed{4} & & & & 1 \\ & & & & & 2 & \text{He} & + & & \text{n} \\ & & & & & & & & & \boxed{0} \end{array} $	2

Question number	Answer	Additional guidance	Mark
9(a)(ii)	(Centre of) stars	allow the Sun	1

Question number	Answer	Mark
9(a)(iii)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> hydrogen nuclei repel (1) need a high speed/kinetic energy (1) to get close enough to fuse together (1) 	3

Question number	Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> when fission occurs a large nucleus splits into smaller nuclei (1) but when fusion occurs small nuclei fuse together to form a larger nucleus (1) 	allow 'heavier', 'lighter' allow specific correct named isotopes	2

Total for Question 9 = 8 marks

Question number	Answer	Mark
10(a)(i)	Process includes: <ul style="list-style-type: none"> • rearrangement (1) • substitution (1) • evaluation of orbital radius (1) • answer to 3 s.f. (1) e.g. $r = v \times T/2\pi$ (1) $r = (7.66 \times 92.7 \times 60)2\pi$ (1) $r = 6781$ (km) (1) $r = 6780$ (km) (1)	4

Question number	Answer	Additional guidance	Mark
10(a)(ii)	Earth radius = $r - 409$ = 6370 (km)	Allow ecf Allow 6 371 (km) Allow 6 372 (km)	1

Total for Question 10 = 5 marks

Question number	Answer	Additional guidance	Mark
11	<p>A description that makes reference to six of the following points:</p> <ul style="list-style-type: none"> • all main sequence stars fuse H into He (1) • lower mass stars stay on the MS line for longer (1) • lower mass stars become red giants (1) • higher mass stars become red super giants (1) • red giant becomes a white dwarf (1) • supergiant becomes a supernova (1) • supernova becomes a neutron star (1) • supernova becomes a black hole (1) 	<p>accept numerical values</p> <p>allow red giant to planetary nebula</p>	6

Total for Question 11 = 6 marks

Question number	Answer	Mark																		
12(a)(i)	<ul style="list-style-type: none"> answer 3 correct (1) answers 4 and 5 in either order (1) answers 6 and 7 in either order (1) <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Statements</th> <th>Order</th> </tr> </thead> <tbody> <tr> <td>record the data in a table</td> <td>8</td> </tr> <tr> <td>take the temperature of the two test tubes</td> <td>5</td> </tr> <tr> <td>tie 7 test tubes together</td> <td>1</td> </tr> <tr> <td>heat the water to 90 °C</td> <td>2</td> </tr> <tr> <td>take the temperatures every minute</td> <td>6</td> </tr> <tr> <td>place equal volumes of water in all test tubes</td> <td>3</td> </tr> <tr> <td>put thermometers into the middle test tube and single test tube</td> <td>4</td> </tr> <tr> <td>record data for 15 minutes</td> <td>7</td> </tr> </tbody> </table>	Statements	Order	record the data in a table	8	take the temperature of the two test tubes	5	tie 7 test tubes together	1	heat the water to 90 °C	2	take the temperatures every minute	6	place equal volumes of water in all test tubes	3	put thermometers into the middle test tube and single test tube	4	record data for 15 minutes	7	3
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Question number	Answer	Mark
12(a)(ii)	<ul style="list-style-type: none"> correct units shown (1) temperature and indication of two different thermometers' readings (1) 	2

Question number	Answer	Mark
12(a)(iii)	The single test tube will cool faster/RA	1

Question number	Answer	Mark
12(a)(iv)	<ul style="list-style-type: none"> correct labels on axes ($x = \text{time}$, $y = \text{temperature}$) (1) both lines start on y-axis at the same temperature (1) both lines show that temperature decreases with time (1) line for single tt thermometer is below other line at all points (1) 	4

Question number	Answer	Additional guidance	Mark
12(a)(v)	<p>An explanation that makes reference to the following three points:</p> <ul style="list-style-type: none"> • thermal energy loss by convection is reduced because of the air pockets in the 7 tt (1) • causes the single tt to lose more thermal energy/RA (1) • radiation loss is the same for both (1) • conduction losses for 7 tt are not high/layer of tt acts as an insulator (1) 	<p>allow heat for thermal energy accept alternative descriptions of 7 tt e.g. huddle</p>	3

Question number	Answer	Mark
12(b)	<p>Fat Acts as an insulator so keeps penguins warm(1)</p> <p>Feathers Feathers trap pockets of air (1) and either reduce thermal energy loss by convection (1) or air is a poor conductor so thermal energy loss is reduced (1)</p>	3

Total for Question 12 = 16 marks

TOTAL FOR PAPER = 110 MARKS

