



Mark Scheme (Results)

November 2024

Pearson Edexcel International GCSE
In Physics (4PH1) Paper 2P

Question number	Answer	Notes	Marks
1 (a)	B - electron; A cannot be correct as a beta particle is not an EM wave C cannot be correct as a helium nucleus is the same as an alpha particle D cannot be correct as a beta particle is not a neutron		1
(b)	B - helium nucleus; A cannot be correct as an alpha particle is not an EM wave C cannot be correct as a neutron is merely a constituent particle of an alpha particle D cannot be correct as a proton is merely a constituent particle of an alpha particle		1
(c)	top line: 4; bottom left box: 93 bottom right box: 2;		3

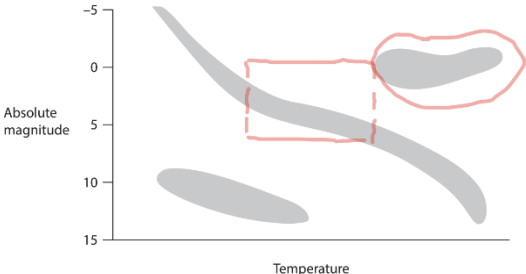
Total for question 1= 5 marks

Question number	Answer	Notes	Marks
2 (a)	idea of negative charge transfer; cloth loses electrons;	this statement alone scores 2 marks. allow rod takes electrons off the cloth for 2 marks	2
(b) (i)	electrons flow (through metal/towards Earth)/eq ; then stop flowing / eq;	accept 'charge(s)' for 'electrons' accept idea that rod has discharged or has been neutralised	2
(ii)	charge = current $\times$ time;	allow standard symbols and rearrangements e.g. 'Q=It' ignore 'C' for current or charge	1
(iii)	conversion of ms to s; substitution; correct evaluation; eg. charge = current $\times$ time charge = $6.8 \times 10^{-6} \times 3.7 \times 10^{-3}$ charge = 2.516×10^{-8} (C) correct answer = 2.5×10^{-8} (C)	mark independently allow ECF from missing or wrong conversion accept answer in either decimal or standard form reject evaluation of answer expressed as a fraction allow any incorrect answer that rounds to 2.5×10^{-8} for 2 marks	3

Total for question 2 = 8 marks

Question number	Answer	Notes	Marks
3 (a)	(total) momentum before (collision) = (total) momentum after (collision) / eq;	ignore equation i.e. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$	1
(b)	(i) 39 (kg m/s);	ignore sign	1
	(ii) momentum = mass $\times$ velocity;	allow standard symbols and rearrangements e.g. $v = p \div m$	1
	(iii) substitution or rearrangement; correct evaluation; eg. $39 = 8.1 \times \text{speed}$ $\text{speed} = 39 \div 8.1$ $\text{speed} = 4.814\dots$ (m/s) correct answer: 4.8 (m/s)	accept any answer that rounds to 4.8 allow 5 (m/s)	2
	(iv) substitution of time and change in momentum into given formula; correct evaluation; eg. force = (change in momentum) $\div$ time taken force = $39 \div 0.56$ force = 69.6.... (N) correct answer = 70 (N)	accept use of $F = ma$ AND $a = (v-u) \div t$ with ECF from (iii) ignore sign accept any answer that rounds to 70 (N) for 2 marks	2
	(v) magnitude: candidate's answer to (iv); direction: right / eq;		2

Total for question 3 = 9 marks

Question number	Answer	Notes	Marks
4 (a) (i)	X drawn anywhere in rectangle on main sequence as shown below;	by eye and use extreme left edge of red giant blob as a guide	1
(ii)	red giants in top right encircled as shown below; 	allow any loop that overlaps correct area only	1
(b)	any two from: • hot / high (surface) temperature; • bright/ high luminosity / high power; • white/blue-white/blue; • high mass;	ignore reference to absolute magnitude	2
(c)	(i)	any attempt at an average over more than one period; answer in range 150 000 - 160 000 (s);	2
	(ii)	candidate's answer to (i) substituted into given formula; correct evaluation; eg. frequency = $1 \div 155\,000$ frequency = $6.45... \times 10^{-6}$ (Hz) frequency = 6.5×10^{-6} (Hz)	2 ignore POT for this MP -1 POT penalty i.e. answer in range $6.25 - 6.67 \times 10^{-6}$ (Hz) for correct answer to (i) accept any answer that rounds to 6 or 7×10^{-6} (Hz) for 2 marks
	(iii)	brightness of an object at a standard distance (from the Earth) / eq;	1
	(iv)	idea that the stars are not the same distance away; {star A/ brighter star} is nearer / eq;	2

Total for question 4 = 11 marks

Question number	Answer	Notes	Marks
5 (a)	MP1 Mass found on balance; MP2 Time determined using timer/stopwatch/stopclock; MP3 temperature change determined; i.e. temperature change= final temp - initial temp MP4 rearrangement of formula sheet equation; i.e. $c = \text{energy} / (m \times \text{temp change})$ PLUS ONE from MP5 Energy supplied = voltmeter reading x ammeter reading x time; MP6 Mass of liquid = mass of water + cup - mass of cup; MP7 Entire experiment repeated and averaged; MP8 Liquid stirred (throughout); MP9 Keep taking temperature after heater switched off for max temp;	accept "scales" reject "scale" allow 'determined time for a given temp change' accept "$E = VIt$" for 'energy supplied' and for MP5 also accept SHC found using method involving calculating the gradient of a temperature-time graph can be awarded if seen for MP4 allow use of joulemeter to determine energy however expressed i.e. zero balance when empty cup on balance not just unqualified 'repeat and average' ignore reference to insulation or lid	5
(b) (i)	C - boiling;		1

	A cannot be correct because the substance is already a liquid B cannot be correct because the substance is being heated D cannot be correct because the substance is being heated and is not a gas		
(ii)	35 (°C);		1
(iii)	energy supplied = $48 \times$ appropriate time taken in seconds; rearrangement with SHC as subject; correct evaluation; eg.: energy supplied = $48 \times 15 \times 60 = 43200 \text{ J}$ energy supplied = $m \times c \times (\text{temp change})$ $43200 = 0.53 \times c \times 35$ $c = 43200 \div (0.53 \times 35)$ $c = 43200 \div 18.55$ $c = 2328.84... \text{ (J/kg } ^\circ\text{C)}$ Correct answer = $2300 \text{ (J/kg } ^\circ\text{C)}$	ECF candidate's time taken and temp change accept dimensionally correct substitution into formula for this mark condone wrong power of ten for any substitution allow 39 (J/kg °C) for 2 marks (missed conversion from minutes to seconds) allow answer that rounds to 2.6 for 1 mark allow answer that rounds to 1300 for 3 marks allow answer that rounds to 4700 for 2 marks	3

Total for question 5 = 10 marks

Question number	Answer	Notes	Marks
6 (a) (i)	moment = force $\times$ (perpendicular) distance	allow standard symbols and rearrangements e.g. 'F = moment/d' condone 'M = F $\times$ d'	1
(ii)	substitution into correct formula for one force; attempt to combine two moments ; correct evaluation; eg. moment of one force = 8.1×2.6 (cm) moment of one force = 21.06 (N cm) total moment = $21.06 \times 2 = 42.12$ (N cm) correct answer = 42 (N cm)	accept however expressed -1 POT error allow answers that round to 84 for 2 marks	3
(b)	arrangement: at least one from closely packed /eq; random/irregular (arrangement); motion: at least one from random (motion); idea of flow of particles;	mark can be scored from a diagram e.g. 'all touching', 'not as closely packed as the solid' e.g. "particles slide over each other" ignore 'move freely'	3

Total for question 6 = 7 marks

Question number	Answer	Notes	Marks
7 (a) (i)	kinetic energy (store); increases;	accept thermal store reject 'heat' accept 'KE (store) of air/wind to KE (store) of turbine for 2 marks accept '...to KE (store) of turbine for 1 mark	2
(ii)	thermal (store); increases;	ignore 'heat' DOP	2
(b) (i)	efficiency = useful energy (output) ÷ total energy(output) x100%	accept omission of 100% accept power for energy condone input for output in denominator	1
(ii)	KE = $\frac{1}{2} m v^2$ seen; evaluation of KE of blades; substitution of candidate's value for blades' KE and wind KE into efficiency equation; evaluation of efficiency; e.g. KE of blades = $\frac{1}{2} \times 16\,000 \times (7.6)^2$ KE of blades = 462 080 (J) efficiency = (KE of blades/KE of wind) x 100% efficiency = $(462\,080 \div 1\,200\,000) \times 100\%$ efficiency = 38.506... % correct answer = 39%	accept substitution correct KE is 462 080 (J) allow correct decimal expression allow correct % expression with % sign ignore fractional final answer	4

Total for question 7 = 9 marks

Question number	Answer	Notes	Marks
8 (a)	suitable instrument e.g. metre wheel, trundle wheel, tape measure, laser (range-finder); repeat and take an average;	ignore any attempt at using speed of sound condone ruler allow idea of a straight/flat tape measure allow idea of measuring perpendicular to wall allow ensuring use of trundle wheel in a straight line	2
(b)	use of average speed = distance $\div$ time taken; substitution; evaluation; eg.: speed = distance $\div$ time taken speed = 130 (m) $\div$ 0.35 (s) speed = 371.428... (m/s) speed = 370 m/s	scores first two MP accept answer that rounds to 190 (m/s) for 2 marks (use of 65 m) accept answer that rounds to 370 (m/s) for 3 marks	3
(c)	any four from: MP1 idea of original method did not repeat (and average) MP2 mention of (human) reaction time; MP3 critique of accuracy of distance measurement; MP4 reference to sound becoming inaudible because of distance; MP5 reference to large distance reducing effect of timing errors; MP6 reference to uncontrolled variables; e.g. temperature, humidity, wind, noise	need to repeat (and average) repeating (and averaging) would improve experiment allow RA	4
(d)		ignore 'repeat and average' ignore use of oscilloscope to	2

	any two from: reduction of timing inaccuracy: MP1 idea of datalogging (with a microphone/sound meter); MP2 idea of electronic start and/or stop timing (with a microphone/sound meter); MP3 larger distance (gives larger time); MP4 idea of longer time may reduce effect of reaction time; MP5 produce a regular sound that coincides with echo; improvement of distance measurement: MP6 use a laser-based distance measure/use a map (and scale) to pinpoint start and finish; other: MP7 idea of removing noise/wind; e.g. do the experiment indoors, shielding a microphone, wait for a windless time MP8 drawing a distance-time graph for different distances and finding gradient;	measure wavelength or period ignore unqualified use of microphone	
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Total for question 8 = 11 marks



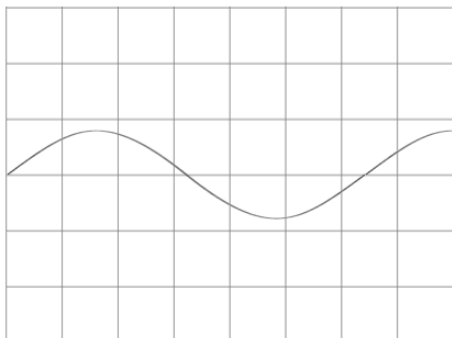
Mark Scheme (Results)

Summer 2025

Pearson Edexcel International GCSE
In Physics (4PH1) Paper 2P

Question number	Answer	Notes	Marks
1 (a)	use of a balance; PLUS any ONE from - idea that balance should be zeroed; - idea that there should be no draughts; - idea that balance should be level;	ignore scale allow weighing scale condone scales allow 'tare' for 'zero' allow idea that balance is placed on a flat/level surface ignore idea of 'repeat and average' ignore references to sig figs or decimal places	2
(b) (i)	either reading correctly measured; both readings correctly measured and subtracted;	allow 30 or 37 seen in working final answer of 7 (cm³) scores both marks	2
(b) (ii)	substitution; evaluation; any dimensionally correct unit that matches candidate's evaluation; e.g. density = $9.2 \div 7$ (density =) 1.3 g/cm³	allow ecf from (i) allow any value which would round to 1.3×10^n e.g. the following would score full marks: 1300 kg/m³ 1.3 g/cm³ 1300 g / litre 1.3×10^{-3} kg/cm³ allow 1.31...	3

Total for Question 1 = 7 marks

Question number	Answer	Notes	Marks										
2 (a)	C (20 Hz to 20 000 Hz); A is incorrect because the lower range is too low B is incorrect because both the lower and upper ranges are incorrect D is incorrect because the upper range is too high		1										
(b)	1 mark for each correctly ticked row;; <table><tr><th>Statement</th><th>Correct (✓)</th></tr><tr><td>sound waves are longitudinal</td><td>✓</td></tr><tr><td>sound waves can travel through a vacuum</td><td></td></tr><tr><td>sound waves are part of the electromagnetic spectrum</td><td></td></tr><tr><td>sound waves can be reflected and refracted</td><td>✓</td></tr></table>	Statement	Correct (✓)	sound waves are longitudinal	✓	sound waves can travel through a vacuum		sound waves are part of the electromagnetic spectrum		sound waves can be reflected and refracted	✓	if more than two ticks then -1 for each incorrect tick	2
Statement	Correct (✓)												
sound waves are longitudinal	✓												
sound waves can travel through a vacuum													
sound waves are part of the electromagnetic spectrum													
sound waves can be reflected and refracted	✓												
(c) (i)	time;	ignore any unit given reject time base reject time period accept lower case 't' reject upper case 'T'	1										
(ii)	trace has lower amplitude throughout; trace has larger time period throughout; e.g. 		2										

Total for Question 2 = 6 marks

Question number	Answer	Notes	Marks
3 (a)	any three from: MP1. idea of reduction of nuclear store of Sun; MP2. (transferred) by radiation (to the solar panel); MP3. energy absorbed by solar panel; MP4. energy transferred (from panel to battery) electrically; MP5. idea of increase of chemical store of battery;	allow by light/ by IR/ by infrared NOT by electricity alternate description MP1 nuclear energy of sun transferred to light energy MP2 light energy from sun transferred to electrical energy of panel MP3 electrical energy of panel transferred to chemical energy of battery NOTE: marks can be scored from either the answer column scheme or the alternate description but not from both	3
(b)	any one from: • solar power is renewable; • solar panel does not produce CO₂; • idea of using less petrol; • idea that it can be used if petrol runs out;	allow it won't run out etc. ignore 'greenhouse gas(es)'	1
(c)	black is a good absorber; of radiation;	allow light allow infra-red / IR condone heat ignore reference to emission ignore reference to conduction or insulation	2
(d)	substitution; rearrangement; evaluation; e.g. 360 000 = 15 × time time = 360 000 ÷ 15 (time =) 24 000 (s)	-1 POT error	3

Total for Question 3 = 9 marks

Question number	Answer	Notes	Marks
4 (a)	(i) use of moment = force $\times$ distance; substitution; evaluation to 2 s.f. or more; e.g. moment = force $\times$ distance moment = $5.2 \times (0.)22$ moment = 1.14(4) (N m)	may be implied by substitution ignore units i.e. answer of 1.14(4) (N m) or 114(.4) N cm is acceptable RA scores one mark max i.e. attempt to find force or distance from a moment of 1 N m	3
	(ii) idea that (sum of) clockwise moment(s) = (sum of) anti-clockwise moment(s);		1
	(iii) substitution into principle of moments; rearrangement; evaluation; e.g. $F \times (0.)70 = 1.14$ $F = 1.14 \div (0.)70$ (F =) 1.63 (N)	allow ECF from (i) ignore units allow any answer that rounds to 1.4 (N) by using 1 N m as the moment or rounds to 1.6 by using 1.14(4) N m as the moment	3
(b)	any two from: MP1. longer handle/eq; MP2. weaker spring/eq; MP3. spring closer to pivot point/eq; MP4. lubricate pivot or lubricate spring /eq;	ignore changes to force applied accept 'lower spring constant' allow bolt for spring ignore unqualified 'longer coil', 'more coils', 'longer spring', 'less coils' etc	2

Total for Question 4 = 9 marks

Question number	Answer	Notes	Marks
5 (a)	metal;	allow any named conductor e.g., aluminium, graphite, copper, iron	1
(b)	idea of transfer of electrons or transfer of negative charge; electrons are lost from the ball / eq;	reject whole response motion of protons or motion of positive charge scores both marks	2
(c) (i)	ball moves towards rod; must be <u>opposite</u> (ly) charged;	allow rod and ball attract 'opposite charges attract' scores 2 marks	2
(ii)	any value greater than 5.0 and less than 7.2 (cm);	i.e. reject 5.0 (cm) reject 7.2 (cm)	1
(d)	any two from: MP1. distance between rod and ball; MP2. (initial) charge on ball; MP3. dimensions of rod;	accept 'rub rod with same force' or 'rub rod for the same amount of time' e.g. same length, thickness, size etc. condone 'shape of rod'	2
(e) (i)	idea that material is a categoric variable;	allow not continuous, discontinuous condone discrete	1
(ii)	any three from: MP1. wood has no charge; MP2. ebonite and/or polythene are negatively charged; MP3. glass and/or nylon are positively charged; MP4. ebonite has the most charge; MP5. (of those that have charge) nylon is the least charged; MP6. glass has the biggest positive charge; MP7. ebonite has the biggest negative charge;	nylon has the least positive charge polythene has the least negative charge	3

Total for Question 5 = 12 marks

Question number	Answer	Notes	Marks																		
6 (a)	D (gamma radiation is less ionising than alpha radiation); A is incorrect because gamma radiation has a high penetrating ability B is incorrect because gamma radiation is emitted by nuclei C is incorrect because gamma radiation has no charge		1																		
(b) (i)	any one from: - to calculate a mean; - anomalies can be identified or can be removed or can be checked; - to minimise the effect of random errors or of anomalies;	allow ‘average’ for ‘mean’	1																		
(ii)	calculation of one constant from a point on the curve; calculation of a second constant from a second point on the curve; comparison of the constants AND conclusion that is valid from the candidate’s values for the ‘constant’; Sample data: <table><tr><th>Count</th><th>Distance</th><th>Constant</th></tr><tr><td>13 600</td><td>6</td><td>489 600</td></tr><tr><td>3300</td><td>12</td><td>475 200</td></tr><tr><td>1600</td><td>18</td><td>518 400</td></tr><tr><td>800</td><td>24</td><td>460 800</td></tr><tr><td>600</td><td>30</td><td>540 000</td></tr></table>	Count	Distance	Constant	13 600	6	489 600	3300	12	475 200	1600	18	518 400	800	24	460 800	600	30	540 000	roughly, the constant for any count-distance pair is in range 460 000-540 000 reject this mark if there are any miscalculated constants i.e. are the constants ‘the same’ or not NB: ignore consistent PoT errors	3
Count	Distance	Constant																			
13 600	6	489 600																			
3300	12	475 200																			
1600	18	518 400																			
800	24	460 800																			
600	30	540 000																			

Total for Question 6 = 5 marks

Question number	Answer	Notes	Marks
7 (a)	(i) input (primary) voltage / output (secondary) voltage = primary turns / secondary turns;	allow recognisable symbols and rearrangements e.g. $V_2 = (N_2/N_1) \times V_1$ condone coils for turns condone T for turns allow 1 and 2 for input and output	1
	(ii) substitution; rearrangement; evaluation; e.g. $230 \div V_2 = 1000 \div 300$ $V_2 = 300 \times 230 \div 1000$ ($V_2 =$) 69 (V)	accept in either order substitution into an incorrectly arranged formula scores zero	3
	(iii) use of power = current $\times$ voltage; evaluation of input power; evaluation of output power; substitution into given formula; evaluation of efficiency; e.g. power = current $\times$ voltage input power = $(1.3 \times 230 =)$ 299 (W) output power = $(4.0 \times 69 =)$ 276 (W) efficiency = $276 \div 299 (\times 100\%)$ (efficiency =) 92 (%)	e.g. a correct substitution allow ECF from (ii) allow ECF from incorrect power values if clear from working allow 92.3... (%)	5
(b)	any five from: MP1. step-up transformer used before transmission; MP2. voltage is increased before transmission; MP3. current is reduced before transmission; MP4. less heating in transmission wires / cables; MP5. less energy wasted; MP6. step-down transformer used after transmission; MP7. voltage is decreased after transmission for safety ;	allow ideas seen/expressed in a diagram allow larger current required for some household devices	5

Total for Question 7 = 14 marks

Question number	Answer	Notes	Marks
8 (a)	cosmic microwave background radiation; red-shift of galaxies ;	allow CMBR condone one missing word or one missing letter from the acronym accept cosmological red-shift accept quasars for galaxies	2
(b)	substitution into $\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$; rearrangement; evaluation of λ ; evaluation of λ to 5s.f.; e.g. $\frac{\lambda - 4.3405 \times 10^{-7}}{4.3405 \times 10^{-7}} = \frac{1.44 \times 10^5}{3.00 \times 10^8}$ $\lambda = (0.0048 \times 4.3405 \times 10^{-7}) + 4.3405 \times 10^{-7}$ $\lambda = 4.34258344 \times 10^{-7} \text{ (m)}$ $\lambda = 4.3426 \times 10^{-7} \text{ (m)}$	take evaluation of the change in wavelength as evidence of MP1 and MP2 regardless of PoT NB correct change in wavelength is $2.0834... \times 10^{-10} \text{ (m)}$ accept any value that would round to $4.3426 \times 10^{-7} \text{ (m)}$ mark independently	4
(c)	 Centaurus A will have a greater red-shift; (so) wavelength from Centaurus A will be longer /eq;	allow idea of “further galaxies” for “Centaurus A” allow RA allow RA	2

Total for Question 8 = 8 mark



Mark Scheme (Results)

Summer 2025

Pearson Edexcel International GCSE
In Physics (4PH1) Paper 2PR

Question number	Answer	Notes	Marks
1 (a) (i)	idea of rubbing / friction; (causing) transfer of <u>electrons</u> ;	condone rubbing between particles reject transfer of protons/positive charge	2
(ii)	like / identical / (the) same / similar; repulsive / repelling / repulsion;	allow equivalent phrases e.g. <u>both</u> have negative (charges) ignore unqualified negative, positive allow equivalent phrases ignore opposite	2
(b)	idea that earthing prevents the metal channels / particles from becoming charged; prevents a spark from occurring;	allow idea that {charge/electrons/current} can pass {through the earth wire / to earth / ground} allow idea that channel/particles remain neutral/become discharged allow idea that risk of spark is reduced ignore references to explosions	2

Total for Question 1 = 6 marks

Question number	Answer	Notes	Marks
2 (a)	(nuclei with) same number of protons; different number of neutrons;	ignore references to electrons allow same atomic number ignore same element allow different (atomic) mass, nucleon/mass number	2
(b) (i)	A (92); <i>B is incorrect because this is the number of neutrons</i> <i>C is incorrect because this is the number of nucleons</i> <i>D is incorrect because this is the nucleon number and proton number added together</i>		1
(ii)	neutron;	ignore n condone spelling mistakes	1
(c) (i)	recognition that 46 minutes is 2 half-lives; correct final evaluation; e.g. $46 \div 23 = 2$ OR $60 \times \frac{1}{2} \times \frac{1}{2}$ (mass =) 15 (g)	allow attempt to halve twice in calculation allow 2 half-lives seen explicitly in working	2
(ii)	C ($^{239}_{93}\text{Np}$); <i>A is incorrect because neither the number of neutrons or protons has changed</i> <i>B is incorrect because a neutron has been added with no change to the number of protons</i> <i>D is incorrect because a proton has been added with no change to the number of neutrons</i>		1

Total for Question 2 = 7 marks

Question number	Answer	Notes	Marks
3 (a)	any two from: MP1. idea that it is renewable; MP2. does not produce carbon dioxide / greenhouse gases; MP3. does not produce sulfur dioxide / oxides of nitrogen / acid rain; MP4. idea that it is reliable / tides are dependable; MP5. does not produce radioactive waste;	ignore references to cost allow idea that resource will not run out allow does not contribute to global warming ignore toxic/polluting gases ignore toxic/polluting gases allow doesn't depend on sunlight, wind etc. condone can be used at any time	2
(b)	any two from: MP1. potential impact on wildlife; MP2. idea that it cannot (always) provide electricity when needed (e.g. at high tide); MP3. changes shipping routes; MP4. idea that tides may vary (over time); MP5. idea that not suitable in all locations;	ignore references to cost allow idea that it blocks migration routes, wading bird habitats etc. allow idea that (electrical) output varies allow idea that it doesn't work if not near the sea	2
(c) (i)	substitution; evaluation; e.g. energy transferred = $1 \times 10 \times (8.0)$ (energy transferred =) 80 (J)	allow use of $g = 9.8, 9.81$ (N/kg) condone substitution of mass in grams for this mark only allow 78, 78.4, 78.5, 78.48 (J)	2
(ii)	conversion of kW to W; setting up calculation; evaluation; e.g. $240\,000\text{ kW} = 240\,000\,000\text{ W}$ $240\,000\,000 = \text{mass} \times 10 \times 8(.0) (\div 1)$ (mass of water =) 3 000 000 (kg)	allow ecf from (i) and from incorrect power conversion answers between 3000 and 3100 (kg) scores 2 marks allow use of ratio e.g. $\text{mass} = 240\,000\,000 / 80$ allow $3(.0) \times 10^6$ (kg) allow answers between 3 000 000 and 3 100 000 (kg)	3

Total for Question 3 = 9 marks

Question number	Answer	Notes	Marks
4 (a)	two coils (of wire); secondary coil has more turns than primary coil; iron core (linking the coils);	all marking points can be awarded from labelled diagram allow two coils drawn in diagram even if not labelled as “coils” allow RA condone more coils on secondary relative numbers of turns can be inferred from diagram allow “magnetically soft” for iron allow both coils wound round a single iron core	3
(b) (i)	input power = output power;	allow if expressed in terms of voltages and currents e.g. $V_p I_p = V_s I_s$ allow p/s, 1/2, in/out, i/o for subscripts	1
(ii)	substitution; rearrangement; evaluation; e.g. $230 \times 4.5 = V \times 0.21$ $V = 230 \times 4.5 / 0.21$ $(V =) 4900 \text{ (V)}$	allow 5000, 4930, 4929, 4928.6, 4928.57... (V) condone 4928, 4928.5 (V)	3

Total for Question 4 = 7 marks

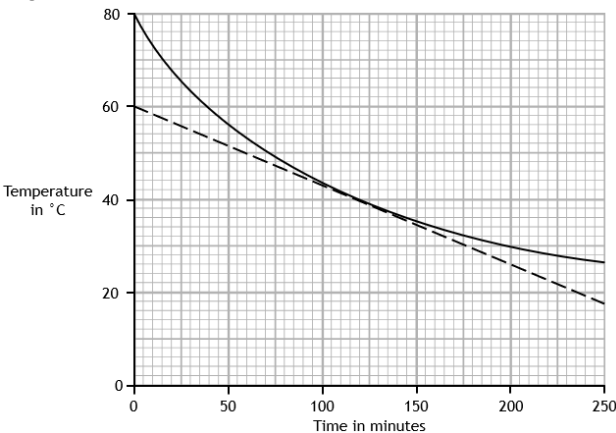
Question number	Answer	Notes	Marks
5 (a)	arrow drawn vertically downwards such that its line of action passes through the centre of the ball; arrow labelled “weight”;	ignore any additional arrows judge by eye ignore starting position of arrow allow force due to gravity, gravitational force ignore gravity	2
(b) (i)	initial momentum calculated; final momentum calculated; evaluation of change in momentum; consistent unit; e.g. $(\text{initial momentum} = 0.057 \times 2.5 =) 0.14$ $(\text{final momentum} = 0.057 \times 1.9 =) 0.11$ $(\text{change in momentum} = 0.14 + 0.11 =) 0.25$ kg m/s	ignore any minus signs allow if calculated in kg m/s or g m/s change in momentum of 0.034(2) scores first two marks allow 0.142, 0.143, 0.1425 allow 0.108, 0.1083 allow 0.251, 0.2508 allow Ns allow g m/s only if consistent with values	4
(ii)	substitution into given formula; evaluation; direction of force = upwards; e.g. $(\text{force} =) 0.25 / 0.0060$ $(\text{force} =) 42 \text{ (N)}$ direction = upwards	allow ecf from (i) ignore units allow upwards arrow ignore north allow 41-42 (N)	3
(c)	any two marks max. from: MP1. independent variable is type of ball; MP2. dependent variable is height of bounce; MP3. any named control variable; any two marks max. from: MP4. ensure distances are measured vertically; MP5. use of set square; MP6. measure at eye level;	related to variables allow material of ball allow coefficient of restitution e.g. drop height, surface used, temperature of ball, released from rest related to accuracy allow ruler/tape measure perpendicular to ground can be awarded from well-drawn diagram ignore unqualified “avoid parallax”	6

	MP7. use of (slow motion) camera to measure height; any two marks max. from: MP8. repeats taken for each ball; MP9. identify anomalies; MP10. calculate mean values;	ignore use of light gates related to reliability allow repeat investigation allow average for mean	
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Total for Question 5 = 15 marks

Question number	Answer	Notes	Marks
6 (a) (i)	(wave) speed = frequency $\times$ wavelength;	allow standard symbols and rearrangements i.e. $\lambda = v / f$ allow v, c and s for speed	1
(ii)	substitution; rearrangement; evaluation in mm to at least 2s.f.; e.g. $3.0 \times 10^8 = 1.6 \times 10^{11} \times \lambda$ $\lambda = 3.0 \times 10^8 / 1.6 \times 10^{11}$ $\lambda = (0.0019 \text{ (m)}) = 1.9 \text{ (mm)}$	allow 1.88, 1.875 (mm) condone 1.87 (mm)	3
(b)	idea that wavelength has increased (over time); because <u>Universe</u> is expanding;	allow wavelength has stretched ignore wavelength has expanded ignore red-shift	2
(c)	(most galaxies show a) red-shift because they are moving away (from Earth / each other); further galaxies show a greater red-shift; further galaxies are travelling (away from Earth) faster; idea that all matter must have originated from a single point;	condone use of stars, planets, objects for galaxies for this marking point only allow faster galaxies have greater red-shift	4

Total for Question 6 = 10 marks

Question number	Answer	Notes	Marks
7 (a)	mention of infrared (radiation); idea that surface is a poor absorber (of infrared);	allow IR for infrared allow idea that surface is a (good) reflector condone surface reflects heat	2
(b)	lid traps air; which reduces/stops convection (currents);	allow steam/gas for air ignore traps heat/energy allow reduces evaporation	2
(c) (i)	suitable tangent drawn at point on curve corresponding to a temperature of 40 °C; e.g. 	if extrapolated, line should intersect temperature axis between 56 and 64 °C	1
(ii)	attempt at gradient calculation; gradient evaluated correctly; minus sign included in answer; e.g. $\text{gradient} = (18 - 60) / (250 - 0)$ $\text{gradient} = (-)0.17 \text{ (}^{\circ}\text{C/minute)}$ $\text{gradient} = -0.17 \text{ (}^{\circ}\text{C/minute)}$	allow ecf from (i) allow any clear change in temperature divided by a change in time allow range of 0.14 - 0.21 mark independently	3
(iii)	curve drawn consistently below existing curve; curve starts at same initial temperature and does not decrease below 20 °C;	curve may start at 80 °C, but does not have to for this mark DOP	2

Total for Question 7 = 10 marks

Question number	Answer	Notes	Marks
8 (a)	20 000 (Hz);	allow if full range given i.e. 20 - 20 000 (Hz) allow 20 kHz but matching unit needed	1
(b)	evaluation of time period; use of $f = 1/T$; evaluation of frequency; consistent conclusion comparing calculated frequency to answer in (a); e.g. $T = 4 \times 20 \times 10^{-6} = 8 \times 10^{-5} \text{ (s)}$ $f = 1 / 8 \times 10^{-5}$ $f = 12\,500 \text{ (Hz)}$ this is within human hearing range so can be heard	allow ecf from incorrect T for this mark only this mark can only be awarded if a frequency calculation has been attempted allow ecf from (a)	4
(c)	A (10×10^{-6} seconds per square, 5 mV per square); <i>B is incorrect because this will cause the amplitude to decrease</i> <i>C is incorrect because this will cause there to be four waves on the screen</i> <i>D is incorrect because this will cause there to be four waves on the screen and the amplitude to decrease</i>		1

Total for Question 8 = 6 marks