PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 4: ENERGY RESOURCES AND ENERGY TRANSFERS (PACK 1)

SCORE	PERCENTAGE
/325	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a) (i)	GPE = mass × g × height;	allow standard symbols and rearrangements e.g. GPE = m × g × h	1
(ii)	substitution; evaluation; e.g. (GPE =) 0.52 × 10 × 0.82 (GPE =) 4.3 (J)	allow use of g = 9.8, 9.81 -1 for clear POT error allow 4.2, 4.26, 4.264, 4.17872, 4.18...	2
(iii)	identical answer to (ii);	allow ecf from (ii) expect 4.3 (J)	1
(iv)	selection of KE = ½ × mass × speed^2; substitution; rearrangement; evaluation; e.g. KE = ½ × m × v^2 4.3 = ½ × 0.52 × v^2 v = √[2 × 4.3 / 0.52] (v =) 4.1 (m/s)	seen or implied allow ecf from (iii) allow alternative method using v^2 = u^2 + 2as allow 4.0-4.1 (m/s)	4
(b)	any three from: MP1. oil is more dense / viscous (than air); MP2. force of friction now present / greater (than before); MP3. ball now does work against friction; MP4. decrease in GPE same as before; MP5. idea that energy is conserved; MP6. some energy transferred to thermal store (of air/ball); MP7. means less energy transferred to KE;	 allow oil is thicker allow drag, fluid/liquid resistance for friction allow upthrust is greater ignore resistance	3
		Total for question = 11 marks	

Q2.

Question number	Answer	Notes	Marks
(a)	use of u=0 (m/s); correct substitution into '$v^2 = u^2 + 2aS$'; correct evaluation of v^2; correct evaluation of v; correct answer = 160 (m/s) e.g. $v^2 = u^2 + 2aS$ $v^2 = 0^2 + (2 \times 10 \times 1300)$ $v^2 = 26000$ v = 161.245... (m/s)	accept loss of GPE = gain in KE reject use of v=0 for this MP $v^2 = 26000$ accept 25506, 25480 reject $v^2 = 2600$ if no a=10 seen. ignore sign accept 159.7059..,159.62....	4
(b) (i)	any THREE from: MP1. reference to weight **and** air resistance; MP2. air resistance larger than weight (when parachute opens); MP3. reference to 'F = ma'; MP4. acceleration is upwards; MP5. air resistance decreases as parachutist slows down;	ignore 'upthrust' accept drag for AR accept 'resultant or unbalanced force is upwards ' allow idea of increased AR ignore 'decelerates' or 'slows down'	3
(ii)	any THREE from: MP1. GPE reduces as height above ground reduces; MP2. KE reduces as speed reduces; MP3. friction force does mechanical work on parachutist; MP4. thermal store of parachutist increases; MP5. thermal transfer between (warm) parachutist and (cold) air; MP6. thermal transfer happens by conduction or radiation;	 accept 'works mechanically' accept 'energy lost to the surroundings' accept idea of conversion to heat energy via friction	3
		(Total for Question = 10 marks)	

Q3.

Question number	Answer	Notes	Marks
(a)	calculation of energy transferred by battery; efficiency formula stated; correct substitution; evaluation; e.g. energy supplied = VIt = 12 × 0.25 × 12 = 36 (J) efficiency = <u>useful energy output</u> total energy output efficiency = 25 / 36 (×100%) efficiency = 69 (%)	36 (J) seen seen or implied anywhere in working allow ecf from battery energy if clear 25/36 (×100) seen allow 70, 69.4...(%)	4
(b) (i)	current / coil has a magnetic field; interaction between fields; resulting in a force; forces on opposite sides of the coil are in opposite directions;	 ignore references to attraction / repulsion	4
(ii)	C - YZ; A is incorrect because WX moves downwards B is incorrect because part of XY moves downwards D is incorrect because part of ZW moves downwards		1

Q4.

Question number	Answer	Additional guidance	Mark
	• Conversion of hours to seconds • Evaluation of output power • Rearrangement and substitution into P=W/t • Evaluation of light energy output e.g. 9 hours = 32 400 seconds (1) Output power = 2.6 (W) (1) (light energy output =) 2.6 x 32 400 (1) (light energy output =) 84 000 (J) (1)	allow 32 400 seen anywhere allow 84 240 (J) 23.4 (J) gains 3 marks (not changing time to seconds) 1 684 800 (J) gains 3 marks (not factoring in efficiency) 468 (J) gains 2 marks (not changing time to seconds and not factoring in efficiency) in the absence of any other marks, allow efficiency equation stated for 1 mark	**4**

Q5.

Question number	Answer	Notes	Marks
	any six from: MP1. cat X loses more energy by conduction / convection than cat Y; MP2. cat Y loses more energy by radiation than cat X; MP3. fur traps air; MP4. larger surface area increases conduction (losses); MP5. air is a (good) insulator/ poor conductor; MP6. fur is a (good) insulator / poor conductor; MP7. trapped air cannot move around; MP8. trapped air reduces convection; MP9. black surfaces are better emitters / emit radiation faster;	allow RA throughout ignore black surfaces being better absorbers	6

Q6.

	Answer	Notes	Marks
(a)	any four from: MP1. water near heater is heated; MP2. (heated) water expands; MP3. density of (heated) water decreases; MP4. lower density / warm water rises; MP5. cooler / denser water sinks; MP6. process repeats / is continuous;	allow clear annotations on diagram accept 'particles move apart from each other'/'particles spread out' reject particles expand	4
(b) (i)	temperature increases with time; idea that rate of temperature increase reduces;	 allow 'temperature increases at a decreasing rate'/ EQ for 2 marks	2
(ii)	temperature rise is quicker when container is empty; with any two explanations from: • particles move around quicker/have more KE in gases; • convection current is faster in gases; • energy transfer (by convection) is quicker; • mass of air in empty container less than mass of water in full container; • specific heat capacity of air is lower than water;	allow empty container reaches higher temperature ignore comments about conduction allow particles in gases are more free to move allow less particles in empty container allow RA	3
		Total for Question = 9 marks	

Q7.

Question number	Answer	Notes	Marks
(a)	idea that 15% of **total** energy; is transferred **usefully**;	allow reverse argument e.g. 85% of total energy is wasted	2
(b)	correct efficiency read from graph; substitution into efficiency formula; rearrangement; evaluation; e.g. 90% or 0.9 seen in working 0.9 = 6.0 / total energy input total energy input = useful energy / efficiency (total energy input =) 6.7 (kJ)	 allow ecf from incorrect efficiency allow working in J or kJ allow any correctly rounded value for 4 marks allow 6.6 or 6.6 recurring (kJ) for 3 marks	4
(c) (i)	uranium or plutonium;	allow specifically named fuel e.g. uranium-235, plutonium-239 condone incorrect isotope number	1
(ii)	neutron; unstable; daughter; neutrons; kinetic;		5

Q8.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><th>thermometer</th><th>part of spectrum</th></tr>
<tr><td>P</td><td>infrared;</td></tr>
<tr><td>Q</td><td>red</td></tr>
<tr><td>R</td><td>green / yellow;</td></tr>
<tr><td>S</td><td>violet</td></tr>
<tr><td>T</td><td>ultraviolet;</td></tr>
</table>
</td><td>allow all valid colours/ visible</td><td>3</td></tr>
<tr><td>(b)</td><td>any reference to absorption;

black is the better/best/good absorber;</td><td>allow reference to reflection
allow reference to ‘poor reflector’</td><td>2</td></tr>
<tr><td>(c)</td><td>infrared/IR;</td><td></td><td>1</td></tr>
<tr><td colspan="4">(Total for Question = 6 marks)</td></tr>
</table>

Q9.

Question number	Answer	Mark
(a)	5.5×10^4 J	1

Question number	Answer	Additional guidance	Mark
(b)(i)	work done = force × distance moved in the direction of the force	equation can be given in words or symbols	1

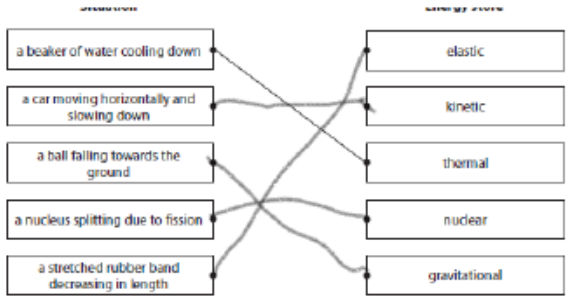
Question number	Answer	Additional guidance	Mark
(b)(ii)	• Rearrangement (1) • Substitution (1) • Evaluation (1) e.g. F= W/d = (5.5 × 10^4) ÷ 73 = 750 (N)	seen anywhere accept 753.4(.....)	3

Q10.

Question number	Answer	Notes	Marks
(a) (i)	idea that kinetic store increases;	e.g. chemical transferred to kinetic	1
(ii)	idea that gravitational store increases;		1
(b)	two correct statements ticked;; Statement / Correct (✓) gravitational store increases ✓ gravitational store stays the same gravitational store decreases kinetic store increases kinetic store stays the same kinetic store decreases ✓	3 ticks scores 1 max 4 or more ticks scores 0	2
(c) (i)	gravitational (force);	allow weight, gravity	1
(ii)	substitution into given formula; evaluation; e.g. orbital speed = (2 × π × 7100) / 5800 (orbital speed =) 7.7 (km/s)	 allow 7.69... (km/s)	2

(d)	any four from: MP1. bars increase in temperature when facing towards Sun / decrease in temperature when facing away from Sun; MP2. (when pointed at the Sun,) black bar increases temperature faster than white bar; MP3. (because) black is a better absorber of radiation than white; MP4. (so) black bar reaches a higher temperature than white bar; MP5. (when pointed away from the Sun,) black bar decreases temperature faster than white bar; MP6. (because) black is a better emitter of radiation than white; MP7. convection/conduction plays no part in heat transfer (outside the spacecraft); MP8. (because) there are no particles outside the spacecraft;	accept any clear reverse argument allow energy, heat, IR for radiation allow energy, heat, IR for radiation	4

Q11.

Question number	Answer	Notes	Marks
(a)		-1 for each additional line	4
(b) (i)	A - electrical;		1
(ii)	B - light radiation;		1
		(Total for Question = 6 marks)	

Q12.

Question number	Answer	Notes	Marks
(a) (i)	B (gravitational); A is incorrect because any fuel burned in this process would decrease the chemical store C is incorrect because the speed of the elevators is constant D is incorrect because magnets are not involved in raising the elevators		1
(ii)	D (mechanically); A is incorrect because the motor and elevator are not in thermal contact B is incorrect because any transfer by radiation would not be useful C is incorrect because there is no electrical circuit between the motor and elevators		1
(b) (i)	D (the rate of energy transferred); A is incorrect because it does not include the amount per unit time B is incorrect because it does not include the amount per unit time C is incorrect because it refers to charge, not energy		1
(ii)	D (2200 W); A is incorrect because this is the correct conversion for mW B is incorrect because this is the correct conversion for cW C is incorrect because this involves multiplying by 100, not 1000		1
(iii)	C (3600 s); A is incorrect because this is the number of hours in one day B is incorrect because this is the number of seconds in one minute D is incorrect because this is the number of seconds in one day		1

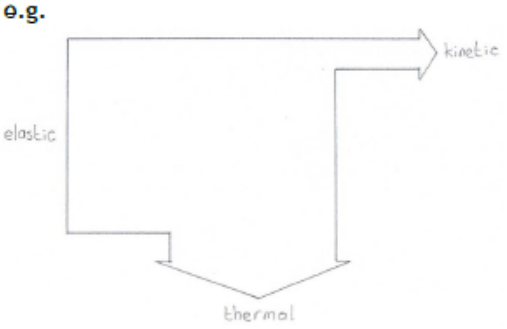
Q13.

Question number	Answer	Notes	Marks
(a)	D - mechanically; A is incorrect because this energy transfer is wasted B is incorrect because this energy transfer is wasted C is incorrect because there is no electrical circuit between the engine and wheels		1
(b) (i)	conversion of minutes to seconds OR kW to W; dimensionally correct substitution into P = W / t; (rearrangement leading to) correct evaluation; e.g. 900 seconds OR 47000 W 47000 = W / 900 (useful output energy =) 42 000 000 (J)	seen anywhere allow 42 300 000 (J) 42300 (J), 705000 (J) gains 2 marks 705 (J), 710 (J) gains 1 mark	3
(ii)	efficiency = useful (energy) output / total (energy) output;	allow rearrangements allow total (energy) input ignore x100(%) added to formula	1
(iii)	substitution; evaluation; e.g. (efficiency =) 42000000 / 2.0×10^8 (efficiency =) 0.21 OR 21%	allow ecf from (b)(i) allow decimal or % answers allow 0.2115, 21.15%	2

(c)	any four from: MP1. as power increases, maximum speed increases; MP2. use of data to justify MP1; MP3. (generally) as mass increases, maximum speed increases; MP4. use of data to justify MP3; MP5. (generally) as power increases, mass increases; MP6. use of data to justify MP5; MP7. data for Car R does not fit either of these trends; MP8. any other relevant use of data e.g. power to mass ratios;	allow reverse arguments condone use of energy for power DOP DOP condone use of energy for power DOP allow idea that car R is an anomaly	4
		Total for question 6 = 11 marks	

Q14.

Question number	Answer	Notes	Marks
(a)	idea that energy can't be created or destroyed;	both created and destroyed / eq need to be seen ignore lost, removed for destroyed	1

(b)	(i)	efficiency = $\frac{\text{useful (energy) output}}{\text{total (energy) output}}$;	ignore ×100(%) allow rearrangements allow total (energy) input for total (energy) output	1
	(ii)	substitution; rearrangement; evaluation of useful energy output; subtraction from total to find wasted energy output; e.g. 0.15 = E_{useful} / 165 E_{useful} = 0.15 × 165 (E_{useful} =) 25 (J) (E_{wasted} =) 165 - 25 = 140 (J)	 allow 24.75 (J) allow 140.25 (J) allow alternative method of determining 85% of energy wasted, leading to correct final answer e.g. % wasted = 100 - 15 = 85 0.85 = E_{wasted} / 165 (E_{wasted} =) 0.85 × 165 (E_{wasted} =) 140 (J)	4
	(iii)	diagram to show standard single input with two output arrows; input and output arrows labelled correctly; scale approximately correct; e.g.  	arrows can be in any orientation e.g. both useful and wasted arrows drawn horizontally allow elastic, input, total for initial arrow kinetic, useful (output) for narrower output thermal/heat, wasted (output) for wider output but apply ECF from (b)(ii) allow ECF from (b)(ii) judge by eye - wasted arrow should be at least 4× wider than useful arrow and they should sum to approximately the width of the input	3

(c)	(i)	45 (J);		1
	(ii)	substitution into work done = force × distance; rearrangement; evaluation; e.g. 45 = force × 7.5 force = 45 / 7.5 (force =) 6.0 (N)	 allow 6 (N)	3
			Total for Question = 13 marks	

Q15.

Question number	Answer	Notes	Marks
(a)	idea that the **temperature** outside the box is greater than the **temperature** inside the box;	however described e.g. "it is hotter outside the box than inside the box"	1
(b)	any two from: MP1. air / cardboard is a poor conductor / (good) insulator; MP2. air is a gas (which are poor conductors); MP3. particles in air are far apart / collide with each other rarely; MP4. idea that thicker objects (of the same material) conduct slower;	ignore idea of trapped air condone idea of 'non-conductor'	2
(c)	idea that air (particles) cannot move around; lid stops or reduces convection currents forming;	e.g. air cannot flow or air trapped accept idea that box is a solid and convection is impossible in solids for 1 mark	2
(d)	white / silver ; (because) these are poor emitters of infrared / radiation;	accept 'radiators' for emitters ignore references to absorption or reflection	2

Q16.

Question number	Answer	Notes	Marks
(a)	live / L;	allow red / brown wire	1
(b)	any two from: MP1. earth wire; MP2. circuit breaker; MP3. double insulation; MP4. insulated cables;	 allow RCD, trip switch, surge protector allow any mention of insulated wires	2
(c) (i)	power = current × voltage;	allow standard symbols e.g. P = I × V ignore C, c for current	1
(ii)	substitution; evaluation; unit; e.g. (P =) 9.6 × 230 (P =) 2200 watts / W	 mark independently 2.2 kW = full marks allow 2208, 2210 allow J/s	3
(iii)	 coil has resistance; electrons transfer/lose energy (as they flow through coil); (due to) electron collisions with (lattice) ions in the coil;	allow wire for coil throughout allow atoms, particles for ions	3
(d)	idea of excessive current; melts the fuse (wire); breaking the **circuit**;	e.g. "current becomes too high" allow breaking the fuse condone "blows the fuse" allow "stops the current" / eq	3

Q17.

Question number	Answer	Notes	Marks
(a)	substitution into GPE = mass × *g* × height; at least one quantity correctly converted to SI units; correct evaluation; e.g. GPE = 0.580 × 10 × 0.92 mass = 0.580 (kg) OR height = 0.92 (m) (GPE =) 5.3 (J)	allow substitution with no unit conversions allow *g* = 9.8, 9.81 allow 5.2, 5.34, 5.336, 5.23...	3
(b)	any four from: MP1. mention of energy being transferred <u>mechanically</u> at any stage in the response; MP2. (before it is dropped) dough initially has energy in its gravitational store (and no energy in its kinetic store); MP3. (just before it hits the floor) energy is in the dough's kinetic store (and less energy in its gravitational store); MP4. (as the dough falls / after the dough has hit the floor) the thermal store **of the air / floor / surroundings** has increased; MP5. (after the dough has hit the floor) the thermal/elastic store **of the dough** has increased (and the kinetic store of the dough is zero); MP6. energy has been transferred to the surroundings (mechanically and) by radiation;	 condone the ball initially having GPE condone energy transferred to KE condone energy transferred to heat energy of the surroundings ignore references to sound energy condone energy transferred to elastic/heat energy of the dough	4

Q18.

Question number	Answer	Notes	Marks
	any six from: MP1. cup slows down/stops energy transfer to surroundings; **relating to conduction:** MP2. vacuum contains no particles; MP3. reducing/stopping conduction (through the sides); MP4. plastic (lid) is a poor conductor / good insulator; **relating to convection:** MP5. air is trapped by the lid; MP6. reducing/stopping convection (from the surface); **relating to radiation:** MP7. (inner) shiny surface is poor absorber of infrared / radiation; MP8. (outer) shiny surface is poor emitter of infrared / radiation; MP9. energy transfer by radiation reduced/stopped;	allow idea that energy is trapped ignore 'heat is trapped' allow reducing/stopping evaporation allow idea that inner surface reflects heat	6

Q19.

Question number	Answer	Notes	Marks
(a)	D (by radiation); A is incorrect because conduction cannot take place through the vacuum of space B is incorrect because convection cannot take place through the vacuum of space C is incorrect because evaporation cannot take place through the vacuum of space		1
(b)	air (inside external pipe) is heated; air expands; air decreases in density (and therefore rises);	 allow particles move further apart reject particles become less dense	3
(c)	idea that air entering tube is hotter than the ground; energy is transferred from air (to ground/surroundings); by conduction;	allow RA e.g. ground is cooler than air	3
(d)	black / other dark colour; (because) dark colours are better/good **absorbers** of radiation; air inside pipe becomes hotter / convection increases;	 allow infrared / IR for radiation ignore heat	3
		Total for Question = 10 marks	

Q20.

Question number	Answer	Notes	Marks
(a) (i)	idea that extension is (directly) proportional to force or load; up to limit of proportionality;	condone 'mass' for force allow up to elastic limit	2
(ii)	line is not straight / eq; so, force and extension cannot be (directly) proportional;	allow line is curved	2
(b)	mechanical; elastic; kinetic / gravitational;	 allow elastic potential allow gravitational potential	3

(c)	drag force drawn horizontally left;
	
	drag force = thrust force;
	
	weight force drawn vertically downwards;
	
	weight force = lift force;
		judge by eye
		allow air resistance, friction
		judge by eye
		ignore force labels
		judge by eye
		allow gravitational force
		ignore gravity
		judge by eye
		ignore force labels
			4

		Total for Question = 11 marks	

Q21.

Question number	Answer	Notes	Marks
(a)	use of p = h × density × *g*; conversion of 57 cm into 0.57 m; evaluation; e.g. pressure difference = 57 × 820 × 10 pressure difference = 0.57 × 820 × 10 (pressure difference =) 4700 (Pa)	allow mark if formula on its own is seen in working allow use of *g* = 9.8, 9.81 470 000, 467 000, 467 400, 458 052, 458 519.4 etc. score 2 marks allow 4670, 4674, 4580.52, 4585.194 etc.	3
(b) (i)	substitution into W = m × g; evaluation; correct unit; e.g. W = 24 × 10 (W =) 240 newtons / N	no mark for formula on its own allow use of *g* = 9.8, 9.81 -1 for POT error e.g. incorrectly changing kg to g mark independently allow 235.2, 235.44	3
(ii)	substitution into p = F/A; evaluation; e.g. p = 240 / 1.2 (p =) 200 (Pa)	no mark for formula on its own allow ecf from (i)	2
(iii)	substitution into p = F/A; rearrangement; evaluation; e.g. 200 = F / 4.8 F = 200 × 4.8 (F =) 960 (N)	no mark for formula on its own allow ecf from (ii)	3

(c)	GPE of piston X = decrease; GPE of piston Y = increase; chemical energy of piston Y = no change; kinetic energy of piston Y = no change;	allow marks if the meaning is clear e.g. allow +, ↑ for increase etc.	4
		Total for Question = 15 marks	

Q22.

Question number	Answer	Notes	Marks
(a)	substitution; rearrangement; evaluation; correct answer: 23 (m/s) e.g. $3.2 \times 10^5 = ½ \times 1.25 \times 10^3 \times v^2$ $v = \sqrt{2 \times 3.2 \times 10^5 / 1.25 \times 10^3}$ $v = 22.6(3)$ m/s	ACCEPT substitution and re-arrangement in either order. ACCEPT correct rearrangement in symbols ALLOW 512(.1) for 2 marks	3
(b) (i)	Evidence of "GPE = mass x *g* x height"; Substitution; Evaluation; Correct answer: 560 000 (J) e.g. GPE = mgh GPE = $1.25 \times 10^3 \times 10 \times 45$ GPE = 562500 J		3
(ii)	560 000 J	ACCEPT any number that is the same as (i)	1
(iii)	mechanical(ly);		1

Question number	Answer	Notes	Marks
(c) (i)	efficiency = useful output energy/total output energy (x 100%)	ALLOW a correct rearrangement	1
(ii)	B - (the useful output energy transfer is 270 kJ, out of a total output energy transfer of 320 kJ); A is incorrect as 270 kJ is not the total output energy C is incorrect as the mechanically transferred energy is not useful D is incorrect as 320 kJ is the total output energy not the useful output energy		1

Q23.

Question number	Answer	Notes	Marks
(a)	one mark for each correct row;;; Energy store in magnet B: gravitational — Decreases ✓; magnetic — Increases ✓; kinetic — Stays the same ✓		3
(b)	downward arrow labelled "weight"; arrow same length as upward force arrow;	ignore gravity allow gravitational force, gravitational pull ignore arrows associated with magnet A judge by eye	2
(c)	any five from: MP1. caliper (to measure distance); MP2. balance (to check mass is 10g); MP3. use of set square to ensure vertical distance; MP4. independent variable identified as the mass added; MP5. dependent variable identified as the distance; MP6. repeat readings and find mean (average); MP7. plot graph of results; MP8. (identify and) remove / ignore anomalies;	allow any marking point if clear from diagram allow ruler, measuring tape allow scales	5
(d)	any three from: MP1. idea of magnet C providing a downward force on magnet B; MP2. idea that total downward force on magnet B is greater (than before); MP3. (creating) resultant downward force on magnet B; MP4. idea that (upward) force of magnet A on magnet B increases (when B moves down the shaft); MP5. (because) idea that decreased distance gives stronger magnetic field (between A and B);	ignore any references to magnets having different strengths allow "B is repelled by C" / eq allow idea that total downward force greater than upward force allow A repels B more strongly	3 Exp
		Total for question 4 = 13 marks	

Q24.

Question number	Answer	Notes	Marks
(a) (i)	any FOUR from: MP1. measure mass; MP2. use (mass) balance; MP3. measure diameter; MP4. use ruler/callipers/micrometer; MP5. further experimental detail e.g. use set square against ruler/use callipers in different orientations/fully submerged/avoid splashing; MP6. repeat readings and take average; MP7. use formula to find volume of a sphere e.g. $V = 4/3\ \pi r^3$; MP8. use density = mass ÷ volume;	condone reference to letting the ice melt allow scales reject scale allow use of displacement method and measuring cylinder for MP3, MP4, MP7	4
(ii)	substitution into equation density = mass ÷ volume; evaluation; unit i.e g/cm^3;	allow use of standard symbols e.g. D = M ÷ V accept ρ for density -1 for POT error independently marked accept unit matching calculation i.e. if mass converted into kg	3
	correct answer = $0.85\ g/cm^3$ e.g. density = mass ÷ volume density = 0.94 ÷ 1.1 density = 0.8545... density = $0.85\ g/cm^3$	accept 0.854 or 0.855	
(b)	any TWO from: MP1. warm air rises; MP2. warm air expands; MP3. warm air is less dense than cold air; MP4. a convection <u>current</u> is formed;	allow 'cloud' for 'air' allow air particles spread out reject 'particles expand'	2
		(Total for Question = 9 marks)	

Q25.

Question number	Answer	Notes	Marks
(a)	any one from: • idea that there is no data at the value of 0; • idea that {pressure of gas / speed of particles} cannot be zero; • idea that all data would be bunched together at the top of the axis / eq;		1
(b)	for either graph: MP1. as temperature increases, pressure/speed increases; for graph 1: MP2. relationship is linear; for graph 2: MP3. relationship is non-linear; MP4. idea of decreasing gradient of curve;	ignore positive correlation accept proportional only if there is a clear link to the temperature being measured in kelvin	3
(c)	any two from: MP1. this temperature is <u>absolute zero</u>; MP2. pressure/speed/kinetic energy of gas particles would be 0 at this temperature; MP3. idea that it is impossible to have a temperature lower than this;	allow idea that negative pressure/speed/KE is impossible	2

(d)	(i)	answer in range 520-525 (m/s);	ignore 515	1
	(ii)	recall of KE formula; substitution; evaluation; e.g. KE = ½ × mass × speed^2 (KE =) 0.5 × 5.3 × 10^{-26} × 520^2 (KE =) 7.2 × 10^{-21} (J)	can be implied from working ECF from (i) -1 for POT error allow 7.16×10^{-21} - 7.31×10^{-21}	3
	(iii)	373 (K);		1
	(iv)	straight line with positive gradient; line passes through origin;	judge straightness by eye	2

Q26.

Question number	Answer	Notes	Marks
(a)	take repeats and find the mean;	allow 'average' for 'mean'	1
(b)	any two from: MP1. mass (being lifted); MP2. height (lifted) / distance; MP3. power supply / circuit being used; MP4. temperature (of motor);	ignore 'same motor' condone weight	2
(c)	conversion of cm to m; substitution into GPE = mass × g × height; e.g. 50 cm = 0.5 m GPE = 1 × 10 × 0.5 (= 5 J)	 allow 0.5 seen anywhere allow use of g = 9.8(1) (m/s^2)	2
(d) (i)	efficiency formula seen; substitution; evaluation; e.g. efficiency = useful energy output / total energy input efficiency = 5 / 12.7 (×100%) efficiency = 39.4 (%)	 ignore s.f. allow 39, 39.37... reject unsupported incorrect answer	3
(ii)	suitable linear scale chosen (>50% of grid used); axes labelled with quantities and unit; all plotting correct to nearest half square;	ignore orientation ignore plotting at 10V	3
(iii)	acceptable curve of best fit drawn up to a voltage of 6V; straight horizontal line of best fit drawn from 6V onwards;	i.e. curved line with even distribution of points either side by eye	2
(iv)	correctly read voltage from graph consistent with candidate's curve of best fit;	allow range 5.4V - 6.6V allow ecf from (iii)	1

Q27.

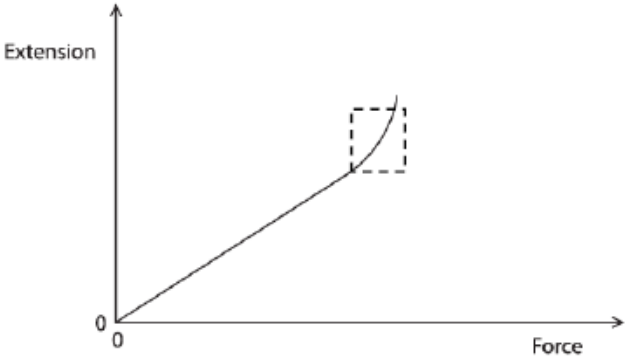
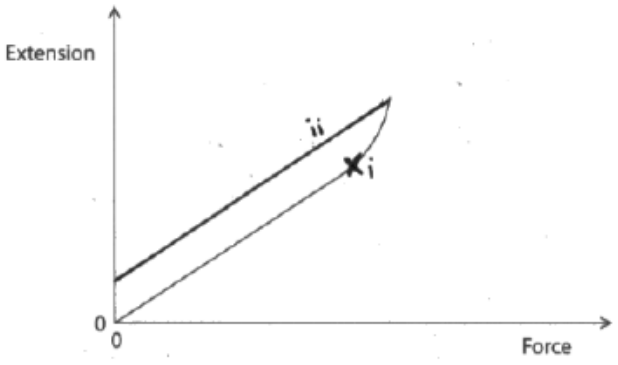
Question number	Answer	Notes	Marks
(a) (i)	(average) speed = distance / time;	allow standard symbols and rearrangements e.g. v = s/t allow s for speed and d for distance	1
(ii)	substitution; evaluation; e.g. (speed =) 1860 / 5.6 (speed =) 330(m/s)	 allow 332.14...(m/s)	2
(iii)	light travels faster than sound; he sees explosion before hearing it;	allow idea that they travel at different speeds but not that sound travels faster Allow RA	2
(b)	vibrations (of particles) are parallel; to direction the wave travels;	allow oscillations for vibrations DOP allow direction of energy transfer	2
(c) (i)	kinetic energy = ½ × mass × speed^2;	allow standard symbols and rearrangements e.g. KE = ½ × m × v^2	1
(ii)	substitution; evaluation; e.g. (KE =) $0.5 \times 1.25 \times 10^7 \times 19200^2$ (KE =) 2.30×10^{15} (J)	 -1 for POT error allow 2.304×10^{15} (J)	2

Q28.

Question number	Answer	Notes	Marks
(a)	substitution into $v^2 = u^2 + 2as$; rearrangement; evaluation; e.g. $v^2 = 0 + (2 \times 10 \times 18)$ $v = \sqrt{360}$ (v =) 19 (m/s)	allow alternative method involving changing GPE lost = KE gained e.g. sub into mgh = ½mv² allow use of 9.8, 9.81 for *g* allow 18.8, 18.78..., 18.79...,18.97... (m/s)	3
(b) (i)	kinetic energy = ½ × mass × speed²;	allow rearrangements and standard symbols e.g. KE = ½ × m × v²	1
(ii)	substitution; evaluation; e.g. (KE =) 0.5 × 2100 × 19² (KE =) 380 000 (J)	allow ECF from (a) allow alternative method involving changing GPE lost = KE gain allow 370 000-372 000 from *g* = 9.8, 9.81 allow 400 000, 378 000, 379 000 1 mark only for not converting tonnes to kg e.g. KE = 380 (J), 378 (J)	2

(c)	idea that energy is transferred from a gravitational (store) to a kinetic (store); idea that energy is transferred to a thermal (store) of {car / shaft / surroundings}; idea that energy is transferred mechanically; idea that energy is transferred by radiation / by heating;	allow answers in terms of types of energy rather than stores and transfers allow GPE to KE allow heat for thermal allow energy transferred due to a named force e.g. gravity, friction allow energy transferred as sound	4
		Total for Question = 10 marks	

Q29.

Question number	Answer	Notes	Marks
(a) (i)	cross drawn on line in region shown;  	cross cannot be drawn at the extreme upper end of the curved line	1
(ii)	any line drawn above and starting at the end of the original that shows a reduction in extension as the force is decreased; line drawn is straight and returns to the extension axis above the origin;  	DOP judge straightness by eye	2

(b)	(i)	elastic (potential);	1
	(ii)	C (mechanically); A is incorrect because there is no electrical circuit B is incorrect because there is no temperature difference D is incorrect because transfers by radiation do not involve forces	1

Q30.

Question number	Answer	Notes	Marks
(a)	black because it is a better/good absorber; of radiation (from the Sun);	ignore references to emission allow IR, infrared for radiation	2
(b)	any four from: MP1. temperature of air increases; MP2. air expands / air particles move further apart; MP3. density of air decreases; MP4. warm/heated air rises; MP5. cool air replaces warmed air; MP6. process repeats;	 allow air particles gain KE reject particles expand reject particles become less dense ignore heat rises allow cool air sinks	4

Q31.

Question number	Answer	Mark
(a)(i)	• answer 3 correct (1) • answers 4 and 5 in either order (1) • answers 6 and 7 in either order (1)	3

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

Question number	Answer	Mark
(a)(ii)	• correct units shown (1) • temperature and indication of two different thermometers' readings (1)	2

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

Question number	Answer	Mark
(a)(iv)	• correct labels on axes (x = time, y = 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
(a)(v)	An explanation that makes reference to the following three points: • 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)	allow heat for thermal energy accept alternative descriptions of 7 tt e.g. huddle	3

Question number	Answer	Mark
(b)	**Fat** Acts as an insulator so keeps penguins warm(1) **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)	3

(Total for question = 16 marks)

Q32.

Question number	Answer	Notes	Marks
(a) (i)	travel at the same speed (in a vacuum) / can travel in a vacuum;	allow both transverse waves, both transfer energy, both microwaves	1
(ii)	wavelength;	allow idea of different range / penetration ignore amplitude	1
(b) (i)	speed = frequency × wavelength;	allow standard symbols and rearrangements e.g. $\lambda = v / f$ allow c for speed ignore s for speed	1
(ii)	substitution OR rearrangement; evaluation; e.g. $3.0 \times 10^8 = 5.2 \times 10^9 \times \lambda$ OR $\lambda = v / f$ (wavelength =) 0.058 (m)	-1 for POT error allow 0.06, 0.0576...(m)	2
(c) (i)	D; A is incorrect because electromagnetic waves are not longitudinal B is incorrect because electromagnetic waves are not mechanical waves C is incorrect because sound waves are not electromagnetic waves		1
(ii)	vibrations / oscillations; correct relationship between direction of travel/energy transfer and direction of vibration for both transverse and longitudinal waves;	both marks can be scored from a suitable diagram allow movement of particles / eq for vibrations for this mark	2

Q33.

Question number	Answer	Notes	Marks
(a) (i)	work (done) = force × distance (moved);	allow rearrangements and standard symbols e.g. W = F × d allow E or W for work and d or s for distance	1
(ii)	substitution; evaluation; unit; e.g. (W =) 8750 × 2.3 (W =) 20000 joules / J	-1 if cm not converted to m 2012500 Ncm scores full marks allow 20125 condone Nm	3
(iii)	substitution into power formula; evaluation; e.g. (P =) 20125 / 7.0 (P =) 2900 (W)	allow ecf from (ii) allow 2880, 2875, 2860, 2857.14...	2
(b) (i)	idea of reducing pressure on ground;	allow idea of preventing damage to the ground / stopping leg sinking into the ground	1
(ii)	pressure = force / area;	allow rearrangements and standard symbols e.g. F = p × A	1
(iii)	evaluation of area; substitution into pressure formula; rearrangement; evaluation; e.g. area = 0.50 × 0.50 OR area = 0.25 (m^2) 148000 = F / 0.25 (F =) 148000 × 0.25 (F =) 37000 (N)	allow ecf from incorrect area / use of 0.50 as area -1 for POT error 74000, 37 gets 3 marks 74 gets 2 marks	4
		Total for question = 12 marks	

Q34.

Question number	Answer	Notes	Marks
(a) (i)	work done = force × distance (travelled);	allow accepted symbols	1
(ii)	substitution; evaluation; e.g work done = 0.89 × 26 work done = 23.1(4 J)		2
(iii)	evidence of recall of formula GPE = mgh; substitution; evaluation; e.g. GPE = mgh GPE = 1.3 × 10 × 0.11 GPE = 1.4(3 J)	allow g = 9.8(1) (N/kg) -1 for POT error providing use of *g* seen	3
(iv)	any TWO from: any reference to friction/air resistance; energy transferred to the surroundings (by mechanical work); block not necessarily at constant speed;	allow 'heat/thermal energy transferred to air/ramp by friction for 2 marks	2
(b)	any TWO from: lower force required; to prevent block from slipping down required / to move block; any TWO from: longer distance required (with a lower force); more inefficient; greater proportion of energy transferred to the surroundings;	allow 'to overcome friction' allow 'easier to move block' for 2 marks Allow idea of more work required (for same increase in GPE)	4
		(Total for Question = 12 marks)	