Mark Scheme

Q1.

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**

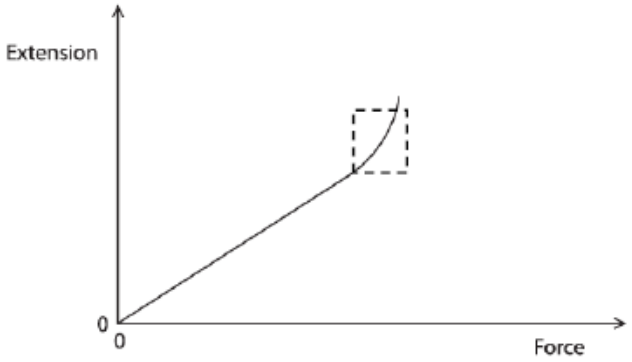
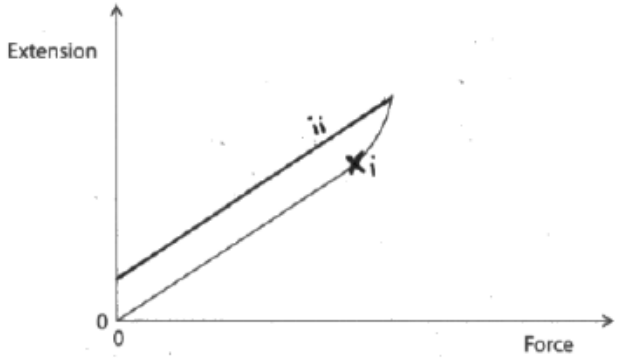
Q2.

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

Q3.

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

Q4.

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

Q5.

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

Q6.

Question number	Answer	Notes	Marks
(a)	1 mark for each correct tick;;; Methods of generating electricity / Uses a renewable energy resource coal power station diesel generator geothermal power station ✓ hydroelectric power station ✓ natural gas turbine nuclear power station solar cell (✓) wind turbine ✓	4 candidate ticks = 2 marks max. 5-6 candidate ticks = 1 mark max. 7 candidate ticks = 0 marks	3
(b) (i)	B (by radiation); A is incorrect because transfers by heating cannot take place through space C is incorrect because there are no electrical conductors between the Sun and the panel D is incorrect because it requires particles that are not present in the vacuum of space		1
(ii)	any 1 of: MP1. only generates electricity when it is sunny / eq;	allow not generating electricity at night ignore 'depends on the weather'	1
	MP2. idea of visual pollution;	Condone 'ugly'	
	MP3. idea that solar panels take up a lot of space;		

Q7.

Question number	Answer	Additional guidance	Mark
(a)(i)	Advantage: any suitable (1) e.g. • does not contribute to global warming • wind available in all parts of Earth • can be used on a large or small scale Disadvantage: any suitable (1) e.g. • noisy • visual pollution • harm to (migratory flocks of) birds	ignore renewable as given in the stem	2

Question number	Answer	Additional guidance	Mark
(a)(ii)	A description that makes reference to the following three points: • no output until 5 m/s (1) • linear increase of output from 5 m/s to 15 m/s (1) • output constant at 0.6 MW for speeds over 15 m/s (1)	data points must be referenced allow 1 mark for correct trend without any data references.	3

Question number	Answer	Additional guidance	Mark
(b)	A description that includes reference to five of the following points: construction: • soft iron core (1) • primary coils (1) • secondary coils (1) operation: • lower voltage applied to the primary coils/RA (1) • must be a.c. (1) • number of primary coils< secondary coils (1) • turns ratio of 220 (1)	may be shown on a labelled diagram	5

(Total for question = 10 marks)

Q8.

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	

Q9.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>one mark for each correct row;;;

<table><tr><th>Energy store in magnet B</th><th>Increases</th><th>Decreases</th><th>Stays the same</th></tr><tr><td>gravitational</td><td></td><td>✓</td><td></td></tr><tr><td>magnetic</td><td>✓</td><td></td><td></td></tr><tr><td>kinetic</td><td></td><td></td><td>✓</td></tr></table></td><td></td><td>3</td></tr>
<tr><td>(b)</td><td>downward arrow labelled “weight”;

arrow same length as upward force arrow;</td><td>ignore gravity
allow gravitational force, gravitational pull
ignore arrows associated with magnet A
judge by eye</td><td>2</td></tr>
<tr><td>(c)</td><td>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;</td><td>allow any marking point if clear from diagram
allow ruler, measuring tape
allow scales</td><td>5</td></tr>
<tr><td>(d)</td><td>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);</td><td>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</td><td>3

Exp</td></tr>
<tr><td colspan="4">Total for question 4 = 13 marks</td></tr>
</table>

Q10.

Question number	Answer	Notes	Marks
(a) (i)	Substitution (including conversion of time to seconds); Re-arrangement of given equation P = W/t; Evaluation; e.g. Energy = 75 x (22 x 60) = 99 000 (J)	 Allow W or E for energy or work. Can be implied from their working. Accept 1650 or 5.9 million for 2 marks.	3
(ii)	Any ONE assumption from • dog does not change temperature • dog does not change power output • rate of transfer is constant (despite increase in temp of water) • no heating of outside world/surroundings/material of bag • no heating from the surroundings	 Ignore unqualified '100% efficient' or 'no energy lost'	1
(iii)	Use of Q = m x c x $\Delta\theta$; Substitution of their energy, mass, c; Evaluation of temp change; Calculation of final temp = temp change + 16; e.g. 99 000 = 8.7 x 4200 x $\Delta\theta$ temp rise = 99 000/(8.7 x 4200) = 2.7 final temp = 19 (°C);	 Allow ECF from (a)(i) Allow ECF from evaluation of temp change. Accept 16.04... for all marks (ecf E without min->s conversion) Accept answer to 3 or more sf i.e 18.7	4

(b)	Any THREE from MP1 Dog and water are at different temperatures; MP2 Dog and water in physical contact so likely to be conduction; MP3 No movement of particles from dog to water, so not convection / EQ; MP4 Dog and bag are both solids, so convection impossible; MP5 Not much radiation as dog and water similar temperatures;	 Allow "no gap between dog and bag so no convection"	3

Q11.

Question number	Answer	Mark
(a)	A description that makes reference to three of the following points. For a liquid: • molecules closely spaced (1) • molecules slide over one another (1) For a gas: • molecules spread out (1) • molecules move with random motion (1)	3

Question number	Answer	Additional guidance	Mark
(b)(i)	Process includes: • Conversion of time into seconds substitution into or rearrangement of • $P = W/t$ • Evaluation e.g. time = 120 seconds (1) 2200 = W/120 (1) W = 260 000 (joules) (1)	seen anywhere in working allow 264 000 answer of 4400 (joules) gains 2 marks max	3

Question number	Answer	Additional guidance	Mark
(b)(ii)	Energy transferred = mass × specific heat capacity × change in temperature	equation can be given in words or symbols e.g. $\Delta Q = m \times c \times \Delta\theta$ allow E for Q, T for θ	1

Question number	Answer	Additional guidance	Mark
(b)(iii)	Process includes: • rearrangement of equation (1) • substitution into correct equation (1) • evaluation of temperature difference (1) • calculation of final temperature (1) e.g. 264 000 = 1.1 × 4200 × $\Delta\theta$ (1) $\Delta\theta = \frac{264\,000}{1.1 \times 4200}$ (1) ($\Delta\theta$ =) 57 (°C) (1) final temperature = 77 (°C) (1)	allow ecf from (b)(i)	4

Question number	Answer	Additional guidance	Mark
(c)(i)	Thermometer	allow temperature sensor AND data logger	1

Question number	Answer	Mark
(c)(ii)	An explanation that makes reference to the following points: • actual temperature lower than calculated (1) • energy is lost to the surroundings not all the energy is transferred to the water (1)	2

(Total for question = 14 marks)

Q12.

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)