

Mark Scheme

Q1.

Question Number:	Answer	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative (example) content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content • Description of an experiment which will allow work done over a given time to be measured. • E.g. running upstairs, step-ups, lifting weights • Apparatus to be used, weighing scales, known weights ruler, stop clock • Measurements to be made • E.g. weight of person/weights lifted, vertical distance moved, time taken. • Calculation of work done for each student using $\text{work done} = \text{force} \times \text{distance moved in direction of force}$ • Calculation of power for each student using $\text{power} = \text{work done} / \text{time taken}$ Comparison of powers by lifting same weights, in a constant time and comparing the distance moved	(6) AO 2 2

Level	Mark	Descriptor
	0	No awardable content
Level 1	1–2	- The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) - Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	- The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) - Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	- The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) - Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Q2.

Question number	Answer	Additional guidance	Mark
(i)	joule(s)	J j Nm newton metre(s) $\text{kg m}^2 \text{s}^{-2}$ $\text{kg m}^2/\text{s}^2$ Ignore SI prefixes do not accept nm	(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	selection of and substitution into $E = F \times d$ (1) 1960 = weight $\times$ 4.0 rearrangement and evaluation (1) (weight =) 490 (N)	accept $P \times t = F \times d$ 436 $\times$ 4.5 = weight $\times$ 4.0 490.5 or 491 award full marks for the correct answer without working 530 scores 1 mark (used data to calculate median value)	(2) A02

Question number	Answer	Additional guidance	Mark
(iii)	selection of and substitution into $P = E \div t$ (1) $425 = 2040 \div t$ rearrangement and evaluation (1) (time =) 4.8 (s)	0.208 scores 1 mark 867000 scores 1 mark award full marks for the correct answer without working	(2) A02

Question number	Answer	Additional guidance	Mark
(iv)	values for power selected and added (1) $\frac{440 + 436 + 425}{(3)}$ evaluation (1) 434 (W)	$\frac{1301}{(3)}$ accept values that round to 434 e.g. 433.667 accept 436 (median average) for 2 marks 1301 scores 1 mark 1017(.666) scores 1 mark award full marks for the correct answer without working	(2) AO2

Q3.

Question Number:	Answer	Additional guidance	Mark
	recall and substitution (1) $1600 = \text{force} \times 28$ rearrangement (1) $(\text{force}) = \frac{1600}{28}$ evaluation (1) 57 (N)	substitution and rearrangement in either order accept f, F or ? for force accept values that round down to 57 e.g. 57.14 award full marks for correct answer without working award 1 mark for answers of 44800 or 0.0175 and a correct expression relating work, force and distance	(3) AO 2 1

Q4.

	Answer	Acceptable answers	Mark
	C when the bungee cord is stretched the most		(1)

Q5.

	Answer	Acceptable answers	Mark
(a)	C when the bungee cord is stretched the most		(1)
(b)	A 600 kg m/s		(1)
(c)(i)	Substitution: (1) $60 \times 10 \times 50$ or 600×50 Evaluation: (1)	give two marks for correct answer no	(3)

	30 000 Unit: (1) J / Nm	working j / joule 30 kJ for full marks	
(c)(ii)	After falling 50 m / when the cord becomes straight/when cord starts to stretch	tension starting to increase at terminal velocity ignore maximum velocity/speed	(1)
(c)(iii)	An explanation linking any two of not all GPE is transferred to KE (1) some {of the GPE transfers to thermal energy /work is done} (1) due to drag (1)	not all GPE goes to KE maximum energy is same (value) as GPE before falling /speed does not reach the speed at which he should fall some lost as heat/sound (of rope or movement through air) (air) resistance / friction ignore wind	(2)

Q6.

Question number	Answer	Additional guidance	Mark
i	substitution (1) $(\Delta GPE) = 72 \times 10 \times 7.0$ evaluation (1) 5040 (J)	do not penalise any power of ten error (p.o.t.e.) at this stage do not accept an answer without value for g (10 being used) award full marks for correct answer without working	(2) A02

Question number	Answer	Additional guidance	Mark
ii	an explanation to include (potential / kinetic) energy is transferred / dissipated (1) to surroundings / water / air / slide (1)	accept lost / decreases accept friction / air resistance acts accept to thermal (store)	(2) AO3

Q7.

Question number	Answer	Additional guidance	Mark
(i)	rearrangement of work = force $\times$ distance (1) $d = W \div F$ substitution and evaluation (1) 18 (m)	$d = 2700 \div 150$ Award full marks for correct answer without working	(2)

Question number	Answer	Mark
(ii)	2700 (J)	(1)

Question number	Answer	Additional guidance	Mark
(iii)	rearrangement of $KE = \frac{1}{2}mv^2$ (1) $v = \sqrt{2 \times KE \div m}$ substitution and evaluation (1) 19 (m/s)	$v = \sqrt{2 \times 2700 \div 15}$ $v^2 = (2 \times 2700 \div 15)$ allow answers that round to 19 award full marks for correct answer without working allow alternative route using $v^2 - u^2 = 2ax$ for full marks	(2)

Q8.

Question Number	Answer	Additional guidance	Mark
(i)	substitution (1) $(\Delta GPE =) (0.0)46 \times 10 \times 2.05$ evaluation (1) 0.94(3) (J)	allow $g=9.8(1) \text{ m/s}^2$ 0.9 (J) values that round to 0.92 or 0.93 (from using $g = 9.8$ or 9.81) do not award for 1(J) no POT error in evaluation award full marks for the correct answer without working.	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	recall (1) $(KE =) \frac{1}{2} \times m \times v^2$ substitution (1) $(KE =) \frac{1}{2} \times (0.0)46 \times 3.5^2$ evaluation (1) 0.28 (J)	allow answers that round to 0.28 e.g. 0.28175 (J) allow max 2 marks for POT error e.g. 0.00028 award full marks for the correct answer without working	(3)

Question Number	Answer	Additional guidance	Mark
(iii)	Any value between 0.8 (m) and 0.95 (m) inclusive		(1)

Question Number	Answer	Additional guidance	Mark
(iv)	An explanation linking (the ball) has lost energy (1) identification of what has happened to that energy (1)	accept (energy) dissipated or (transferred to) surroundings / ground or thermal energy or heat / sound or system is not 100% efficient or bounce is not (100%) elastic or squashing (the ball or the ground)	(2)

Q9.

Question number	Answer	Additional guidance	Mark
(i)	recall and substitution into (1) $gpe = m \times g \times h$ $(gpe) = 4.5 \times 10 \times 20$ evaluation (1) 900(J)	allow 90(J) for 1 mark award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
ii	900(J)	allow ecf from bi	(1)

Question number	Answer	Additional guidance	Mark
iii	recall and substitution (1) power = work done / time taken (power =) 900 / 4 evaluation (1) 200 (W)	allow ecf from bi or bii 230(W) 225(W) award full marks for the correct answer without working	(2)

Q10.

Question number	Answer	Additional guidance	Mark
i	substitution (1) $(I = \frac{P}{V}) = \frac{1.9 \times 10^3}{230} \text{ (1)}$ evaluation (1) 8.3 (A)	8.3 / 8.26 (A) award full marks for correct answer without working award one mark for $8.26 \times 10^{-3} / 0.0083$	(2) AO2

Question number	Answer	Additional guidance	Mark
ii	choice and substitution (1) $E = I \times V \times t$ $= 7.4 \times 230 \times 120$ evaluation (1) 200000 (J)	accept 204000 / 204240 award full marks for correct answer without working award 1 mark for 3400 / 3404 (J) (using 2 minutes as time)	(2) AO2

Q11.

Question number	Answer	Additional guidance	Mark
	substitution (1) $KE = \frac{1}{2} \times 58 (\times 10^{-3}) \times 28^2$ conversion (1) uses 58×10^{-3} or 0.058 evaluation (1) 23 (J)	do not penalise p.o.t.e. at this stage award full marks for any answer that rounds to 23 (e.g. 22.736) (J) award max two marks for any answer that rounds to 2.3 to any other power of 10 consolation mark for not squaring 28 (8.1(2) to any p.o.t.) (maximum 1 mark)	(3) AO2

Q12.

Question number	Answer	Additional guidance	Mark
i	substitution (1) $(E =) \frac{1}{2} \times 20 \times 0.09^{(2)}$ evaluation (1) 0.08(1) (J)	allow 1 mark for $\frac{1}{2} \times 20 \times 9^2$ or answer of 810 (J) or answer of 90 (J) award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
ii	a description including mention of one relevant energy store (1) correct transfer in context (1)	potential/ PE/ kinetic/ KE/ thermal/ heat/ elastic potential energy stored in the spring transferred to kinetic energy of the ball/rod scores 2 marks kinetic energy of rod is transferred to kinetic energy of ball scores 2 marks idea of energy transferred to the surroundings/ thermal scores 2 marks	(2)

Question number	Answer	Additional guidance	Mark
iii	an explanation linking two from (controls the maximum) extension (1) idea of keeping below the elastic limit (1) (which would result in) spring being permanently stretched (1)	ignore <u>damaging</u> the spring (given in stem) stretch prevents spring being over-stretched / extended too far scores 2 marks allow distorted/ break	(2)

Q13.

Question number	Answer	Additional guidance	Mark
(a)(i)	substitution (1) $(KE =) \frac{1}{2} \times 85 \times 1.5^2$ answer (1) 96 (J)	award full marks for correct numerical answer without working allow 95.625 (J)	(2)

Question number	Answer	Additional guidance	Mark
(a)(ii)	rearrange (1) force = work done ÷ distance answer (1) (force) = 15 (N)	accept rearrangement with values subst., i.e. (force) = $1200 \div 80$ award full marks for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): - the work done is the same for walking and running (1) - because work done depends on force and distance only, not time (1)	allow energy for work done because work done $\div$ time is power	(2)

Question number	Answer	Additional guidance	Mark
(c)	rearrangement (1) $(\text{height}) = \text{change in GPE} \div (\text{mass} \times g)$ answer (1) 2.2 (m)	accept rearrangement with values, i.e. $(h) = 264 \div (12 \times 10)$ or $= 264 \div 120$ award full marks for correct numerical answer without working	(2)

Q14.

Question Number:	Answer	Additional guidance	Mark
	substitution (1) $(KE =) \frac{1}{2} \times 68 \times 12^2$ evaluation (1) 4900 (J)	$\frac{1}{2} \times 68000 \times 12^2$ scores 1 mark accept values that round to 4900(J) e.g. 4896(J) award full marks for correct answer without working	(2) AO 2 1

Q15.

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	Answer	Acceptable answers	Mark
	substitution: 0.6×20 (1) evaluation 12 (1) J (1)	give 2 marks for correct answer no working unit is an independent mark joules, Nm, kgm^2/s^2 , Ws	(3)

Q16.

			Indicative Content	
QWC		*	A discussion including some of the following points - improved lighting levels for LEDs - energy savings per year for LEDs or calculation time - calculation of energy savings over lifetime of L - calculation of monetary savings by using LEDs - link to savings in fossil fuels for LEDs or link to LEDs and reduced global warming - comparison of lifetimes and maintenance cost	
Level	0	No rewardable content		
1	1 - 2	- a limited discussion of benefits using some pieces of the information provided, e.g. LEDs last 40 000 hours longer and the lighting levels are 200% brighter. - the answer communicates ideas using simple language and uses limited scientific terminology - spelling, punctuation and grammar are used with limited accuracy		
2	3 - 4	- a simple discussion of benefits using some pieces of the information and processing one of them OR 2 processed pieces of information. e.g. LEDs save 3000 kW h of energy each year and are much brighter. The money they save each year compared to fluorescents is £420. OR The payback time for the LEDs is about 5 years and in that time they would have to pay for the fluorescent lights to be replaced 5 times. - the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately - spelling, punctuation and grammar are used with some accuracy		
3	5 - 6	- a detailed discussion of benefits using processed information covering more than half of the data points in the table e.g. LEDs use less energy each year and this means that fossil fuel reserves are not used up as quickly. The LEDs save £420 each year and have a payback time of about 5 years. - the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately - spelling, punctuation and grammar are used with few errors		

Q17.

Question number	Answer	Additional guidance	Mark
	An answer that combines points of interpretation/evaluation to provide a logical description: efficiency increases (at first) (1) to maximum efficiency (for mass of about 25 kg) (1)	e.g. decreases for larger masses	(2)

Q18.

Question Number	Answer	Additional guidance	Mark
	A description to include: as the bounce number increases the height decreases/negative correlation (1) non-linear (1)	allow not in even steps / not proportional / not a straight line height/it (nearly) halves each time scores 2 marks	(2)

Q19.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Chemical energy stored in battery • Transferred to KE in motors • Transferred to GPE as it rises • Thermal energy wasted (at each stage) • Energy transferred to surroundings (at each stage)	(6)

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Summary for guidance			
Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Isolated fact e.g. a description of least one energy store or interpretation of diagram without mentioning energy stores or types	<u>Possible candidate responses</u> Chemical energy stored in the battery or energy transferred from the battery to the motors and then to the blades. Some energy is lost at each stage.
Level 2	3–4	<u>Additional guidance</u> Description of at least one energy transfer	<u>Possible candidate responses</u> KE (of blades) is transferred to GPE (as the drone rises) or (thermal) energy is transferred to the surroundings
Level 3	5–6	<u>Additional guidance</u> Description of two or more energy transfers	<u>Possible candidate responses</u> Chemical energy in the battery is transferred to KE of the blades AND Thermal energy is wasted in the motors when they turn.

Q20.

	Answer	Acceptable answers	Mark
(i)	A line connecting a train part with a useful energy transfer as shown below (1)	Lines need not be straight Ignore any arrow heads drawn Note: if more than one line is drawn from a train part then zero mark for that train part.	(3)

	Train part transfer useful energy diesel engine generator motor chemical to electrical chemical to kinetic electrical to kinetic kinetic to chemical kinetic to electrical		
(ii)	(transfer of energy to) thermal (1)	heat/sound	(1)

Q21.

	Answer	Acceptable answers	Mark
	☒ B conservation of energy		(1)

Q22.

	Answer	Acceptable answers	Mark
(a)(i)	B it decreases		(1)
(a)(ii)	C it does not change		(1)
(b)(i)	horizontal arrow (judge by eye), pointing to the right anywhere on the diagram 		(1)
(b)(ii)	substitution: (1) $130\,000 \times 75$ evaluation: (1) $9\,750\,000 \text{ (kgm/s) (Ns)}$	give full marks for correct answer, no working Ignore minus sign $9.75 \times 10^6 \text{ (kgm/s) (Ns)}$	(2)
(b)(iii)	$9\,750\,000 \text{ kgm/s}$	same value as answer to (b)(ii)	

		Ignore minus sign	(1)
(c)(i)	An explanation linking two of the following: • force is smaller/less (1) • momentum changes more slowly (1) • lower deceleration (1) • use of the formula (1)	pressure is smaller/less slower deceleration force is proportional to rate of change of momentum/ $F = (mv - mu)/t$	(2)
(c)(ii)	Any two from: (for loaded aircraft) • has more mass (1) • has more momentum (1) • has more k.e. (1) • higher velocity • brakes need to do more work (1)	accept reverse argument for empty aircraft heavier/more passengers/more cargo higher speed/moving faster	(2) expert

Total marks for question = 10 marks

Q23.

	Answer	Acceptable answers	Mark
(a)	kinetic (energy)	Movement (energy) KE	(1)
(b)	substitution: 0.6×20 (1) evaluation 12 (1) J (1)	give 2 marks for correct answer no working unit is an independent mark joules, Nm, kgm^2/s^2 , Ws	(3)
(c)	substitution: 0.5×18 (1) evaluation 9.0 (1)	9 give full marks for correct answer no working	(2)

QWC	* (d)	Indicative Content	
		a description including some of the following points: • chemical to kinetic while in his hand • kinetic (gradually) to potential while rising / from	

		• eventually all potential at 10 m with a little thermal energy • some mention of conservation of energy • potential (gradually) to kinetic as falls / 10 m-0 • with a little more thermal (heat) energy • at 0 m sound energy • at 0 m thermal (heat) energy	
Level	0	No rewardable content	
1	1 - 2	• a limited description which identifies a change in one relevant type energy or a transfer of energy from one form to another e.g. kinetic energy increases OR kinetic energy changes to sound. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	3 - 4	• a simple description giving detail of a relevant energy change/transfer e.g. kinetic energy changes into potential energy as it moves upwards OR kinetic energy increases as it falls. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	5 - 6	• a detailed description of a sequence of relevant energy changes /transfers e.g. kinetic energy is transferred into potential energy as it rises. This then changes back into kinetic energy as it falls back down. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Q24.

	Answer	Acceptable answers	Mark
	Description including 3 of the following: • (Gravitational) potential energy (transferred) to KE(1) • Idea of energy transfer to heat/sound whilst descending (1) • Chemical energy is transferred to heat energy in Andrew (1) • Idea of energy dissipated on stopping (1)	(G)PE (transferred) to KE Allow gravitational energy for GPE Energy transferred to heat because of air resistance/ friction The energy goes to heat as he stops. Energy is transferred to the surroundings	(3)

Q25.

Question Number:	Answer	Mark
(i)	efficiency = $\frac{\text{useful (energy transferred by the device)}}{\text{total (energy supplied to the device)}} \times 100$	(1) AO 1 1

Question Number:	Answer	Additional guidance	Mark
(ii)	determine useful energy (1) $7500 - 3200 = 4300$		(1) AO 2 1

Question Number:	Answer	Additional guidance	Mark
(iii)	substitution (1) efficiency = $\frac{4300}{7500}$ evaluation (1) 0.57	allow ECF from (i) and/ or (ii) for 1 mark maximum accept 57(.33)(%), 0.6, 60(%) award full marks for the correct answer without working	(2) AO 2 1

Q26.

	Answer	Acceptable answers	Mark
(i)	an explanation linking two of the following points • electric(al)(energy) (1) • (is converted) to heat / thermal (energy) (1) • (is converted) to light (1)	electricity	(2)

Q27.

	Answer	Acceptable answers	Mark
(i)	350 (J)	400 - 50 (J)	(1)
(ii)	Substitution $50 \div 400$ (1) or $50 \times 100 / 400$ (%) Evaluation 13(%) (1)	 12.5(%), 0.125, 0.13 or 1/8 Give full marks for correct answer, no working	(2)

Q28.

Question Number:	Answer	Additional guidance	Mark
	a description to include: kinetic energy (store) (of cyclist and /or bicycle) decreases / is transferred into(1) thermal energy (store) (of brakes / surroundings) increases (1)	 KE for kinetic energy allow heat for thermal allow brakes get hotter ignore sound energy accept kinetic (energy) to heat (energy) for 2 marks in this context	(2) AO 1 1

Q29.

Question Number	Answer	Acceptable answers	Mark
(i)	20 (J)	200 – 180 (even if calculated value from this is incorrect)	(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	(changed to) {thermal energy / heat}	dissipated (lost) to {surroundings / motor / air / atmosphere} sound / noise reject if kinetic, light or chemical is mentioned	(1)

Question Number	Answer	Acceptable answers	Mark
(iii)	$\frac{180}{200} \times 100$ (1) 90 (%) (1)	award full marks for correct answer with no working $\frac{180}{200}$ 0.9, 9/10 Or [100 – (20/200)] % not needed but if a unit is given then maximum score is 1	(2)

Q30.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking energy has been dissipated /wasted / lost (1) as thermal energy (1)	energy has been transferred mechanically useful energy is less than total energy supplied identifies difference of 600(J) heat to the surroundings ignore sound accept (some) energy has been transferred to thermal store for 2 marks	(2) A03

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) (efficiency =) $\frac{8400}{9000}$ evaluation (1) (efficiency =) 0.93	0.9 93(%) allow values that round to 0.93 or 93(%) award full marks for the correct answer without working	(2) A02

Question number	Answer	Additional guidance	Mark
	Explanation linking two from: choice of distance (1) 6.3 m (calculations of work done need) the distance moved in the direction of the force (1) (friction acts) along the slope / hypotenuse (1)	accept pushed up the slope	(2) AO3

Q32.

Question Number	Answer	Acceptable answers	Mark
(a)	D driving for a long time without taking a break		(1)

Question Number	Answer	Acceptable answers	Mark
(b)(i)	substitution $1200 \times 8(.0)$ (1) evaluation 9600 (J) OR 9.6×10^3 (J) (1)	Give full marks for correct answer with no working. 9.6 x any other power of 10 = 1 mark	(2)

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	substitution $0.5 \times 1400 \times 25^2$ (1) evaluation of v squared $0.5 \times 1400 \times 625$ (1) evaluation 4.4×10^5 (J) (1) OR 440 000	Give full marks for correct answer with no working. accept 625 seen anywhere for this mark e.g. 875 000 gets 1 mark (forgot ½) 437 500 (J) 4.4 x any other power of 10 = 2 marks	(3)

Q33.

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	Answer	Acceptable answers	Mark
(ai)	Model A because Model A (can produce up to)7200kWh per year (at 13mph) / will produce 6000 kWh (with given wind speed). (1)	Model B produces less than 6000kWh per year at 13mph /requires wind speed of more than 13mph to produce 6000kWh	(1)
(aii)	Substitution (1) 0.14 × 6000 Evaluation (1) (£)840	Allow incorrect conversion of p to £ such as 0.014 × 6000 for 1 mark only 84 000 p correct answer with no working shown gains both marks	(2)
(aiii)	Divide the installation cost by the annual saving (to find the time in years) (1)	£840 for annual saving	(1)
(aiv)	A suggestion linking (energy saving lamps) would not transfer so much thermal energy (1) he may have to use additional heating / lights (which would cost money to run/ purchase) (1)	not get hot / produce so much heat reverse argument such as insufficient heat for chicks to thrive (Ignore references to light output.)	(2)

		Indicative Content	
QWC		*(b)	A discussion including some of the following points • Both HEP and Solar power are renewable • Both HEP and Solar power would save fossil fuel • HEP only possible in some locations • HEP requires reservoirs and damming of rivers • This can damage environment /takes a lot of land • Energy from solar power installation is currently less than energy from fossil fuel powered station • Solar power only suitable in certain locations • Solar power reliability dependent on constant weather • Neither of them cause atmospheric pollution
Level	0	No rewardable content	
1	1 - 2	• a limited description such as at least one relevant detail of each resource eg: Solar power doesn't give off atmospheric pollution. HEP generates more power than solar power. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	3 - 4	• a simple discussion such as one which gives comparisons between the two or at least an advantage and disadvantage of both. eg: HEP does not use fossil fuels but it can damage the environment where is	

		it located. Solar power will never run out but it requires lots of light/land. - the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately - spelling, punctuation and grammar are used with some accuracy
3	5 - 6	- a detailed comparison such as one which relates advantages and disadvantages of both HEP and solar power to a particular situation for possible large scale use e.g.: Solar power uses a renewable energy source but it currently does not produce as much energy as fossil fuel station where there is little sunlight. HEP can produce a lot more energy where there are hills and water but only possible in certain geographical locations. - the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately - spelling, punctuation and grammar are used with few errors

Q34.

	Answer	Acceptable answers	Mark
(i)	Model A because Model A (can produce up to)7200kWh per year (at 13mph) / will produce 6000 kWh (with given wind speed). (1)	Model B produces less than 6000kWh per year at 13mph /requires wind speed of more than 13mph to produce 6000kWh	(1)
(ii)	Substitution (1) 0.14 × 6000 Evaluation (1) (£)840	Allow incorrect conversion of p to £ such as 0.014 × 6000 for 1 mark only 84 000 p correct answer with no working shown gains both marks	(2)
(iii)	Divide the installation cost by the annual saving (to find the time in years) (1)	£840 for annual saving	(1)
(iv)	A suggestion linking (energy saving lamps) would not transfer so much thermal energy (1) he may have to use additional heating / lights (which would cost money to run/ purchase) (1)	not get hot / produce so much heat reverse argument such as insufficient heat for chicks to thrive (Ignore references to light output.)	(2)

Q35.

	Answer	Acceptable answers	Mark
(a)	Description including 3 of the following: • (Gravitational) potential energy (transferred) to KE(1) • Idea of energy transfer to heat/sound whilst descending (1) • Chemical energy is transferred to heat energy in Andrew (1) • Idea of energy dissipated on stopping (1)	(G)PE (transferred) to KE Allow gravitational energy for GPE Energy transferred to heat because of air resistance/ friction The energy goes to heat as he stops. Energy is transferred to the surroundings	(3)
(b)(i)	substitution (1) 67×31 evaluation (1) 2077 (kg m/s)	2080, 2100 working backwards using 2000 (v=) 29.85, 30 (m=) 64.52, 65 67 X 31=2000 scores only one mark	(2)
(b)(ii)	substitution (1) $2000 \div 2.3$ evaluation (1) 870 (N)	answer to (b)(i)) $\div 2.3$ 900, 869.6, 869.5 903	(2)
(b)(iii)	an explanation linking two of the following • Force on Andrew is quite small (1) • Because impact time is long (1) • The acceleration/deceleration is quite small (1) • Because impact distance is far (1)	force is reduced/ less /not as strong slows down/changes momentum gradually acceleration = 1.35 'g' or 13.5 m/s^2 slows down (rate of) change of momentum scores 2 marks	(2)

Total question = 8 marks

Q36.

	Answer	Acceptable answers	Mark
(i)	Substitution: (1) $60 \times 10 \times 50$ or 600×50 Evaluation: (1) 30 000 Unit: (1) J / Nm	give two marks for correct answer no working J / joule 30 kJ for full marks	(3)
(ii)	After falling 50 m / when the cord becomes straight/when cord starts to stretch	tension starting to increase at terminal velocity ignore maximum velocity/speed	(1)
(iii)	An explanation linking any two of not all GPE is transferred to KE (1) some {of the GPE transfers to thermal energy /work is done} (1) due to drag (1)	not all GPE goes to KE maximum energy is same (value) as GPE before falling /speed does not reach the speed at which he should fall some lost as heat/sound (of rope or movement through air) (air) resistance / friction ignore wind	(2)

Q37.

	Answer	Acceptable answers	Mark
(i)	B it decreases		(1)
(ii)	C it does not change		(1)

Q38.

Question number	Answer	Additional guidance	Mark
	estimate of weight (1)	ignore reaction time	(2) A03
	measure (actual) weight (1)	use scales ignore repeating measurements	

Q39.

Question Number	Answer	Mark
	The only correct answer is B: work done= force x distance moved in direction of force A is incorrect because the equation would be dimensionally inconsistent C is incorrect because the equation would be dimensionally inconsistent D is incorrect because the direction of the distance moved is incorrect	(1)

Q40.

	Answer	Acceptable answers	Mark
(a)(i)	An explanation linking • 60 % of	Accept reverse argument ie 40 % of {total/electrical/input/output}	(2)

	{total/electrical/input/output} energy (is used/transferred) (1) • into/is kinetic/useful energy (1) If no other marks scored accept: 60% (of the energy produced by the motor) is useful/40% is wasted for 1 mark	energy (is/transferred) into/lost as/thermal (heat)/waste energy	
(a)(ii)	☒ B energy		(1)
(a)(iii)	substitution 20×15 (1) evaluation 300 (J) (1) If no other mark scored award 1 mark for correct transposition ie $E = P \times t$ Ignore any unit given by candidate	Power of 10 error maximum of 1 mark eg 300 000 (J) gains 1 mark Give full marks for correct answer, no working	(2)
(a)(iv)	substitution $18 \div 24 (\times 100)$ (1) evaluation 0.75 or 75% (1) Ignore any unit given by candidate	Power of 10 error maximum of 1 mark give full marks for correct answer, no working	(2)
(b)	☒ B conservation of energy		(1)

Q41.

Question Number	Answer	Acceptable answers	Mark
(ai)	B momentum (1)		(1)

Question Number	Answer	Acceptable answers	Mark
(aii)	power (1)		(1)

Question Number	Answer	Acceptable answers	Mark
(bi)	Substitution: $\frac{1}{2} \times 0.8 \times 25^2$ (1) Evaluation 250 (1) 0.25 <u>kJ</u> scores 3 marks J bod j (1)	Allow both marks for correct answer with no method shown. Ignore power of 10 until evaluation e.g. 2 marks for 25 J 1mark for 25 W Nm ignore kg (m/s) ² Unit mark is independent of numerical answer.	(3)

Question Number	Answer	Acceptable answers	Mark
(bii)	250 (1) Ignore any unit given by the candidate	Allow ecf from 1(bi)	(1)

Question Number	Answer	Acceptable answers	Mark
(biii)	A suggestion to include: work done = force x distance (1) (force) used over a longer distance (1)	ignore references to more power, greater speed, longer time, larger force, momentum and how far javelin travels. the longer they are pushing (it/the javelin) [bod distance] they can push the javelin (forward) for longer [bod distance] the arm can move further	(2)

(Total for Question =8 marks)

Q42.

Question Number:	Answer	Additional guidance	Mark
(i)	an explanation linking: wheel rubs on axle (as it rotates) OR friction (between the wheel and the axle) (1) causes heating/transfer of (thermal) energy/ work being done (1)	allow generates heat	(2) AO 1 1

Question Number:	Answer	Additional guidance	Mark
(ii)	any one from: lubrication/oil (1) (ball) bearings / ball-race (1) go slower (1)	anything that lubricates – grease etc.	(1) AO 1 1

Q43.

	Answer	Acceptable answers	Mark
(i)	An explanation linking 60 % of {total/electrical/input/output} energy (is used/transferred) (1) - into/is kinetic/useful energy (1) If no other marks scored accept: 60% (of the energy produced by the motor) is useful/40% is wasted for 1 mark	Accept reverse argument ie 40 % of {total/electrical/input/output} energy (is/transferred) into/lost as/thermal (heat)/waste energy	(2)
(ii)	☒ B energy		(1)
(iii)	substitution 20 × 15 (1) evaluation 300 (J) (1)	Power of 10 error maximum of 1 mark eg 300 000 (J) gains 1 mark	(2)

	If no other mark scored award 1 mark for correct transposition ie $E = P \times t$ Ignore any unit given by candidate	Give full marks for correct answer, no working	
(iv)	substitution $18 \div 24 (\times 100) (1)$ evaluation 0.75 or 75% (1) Ignore any unit given by candidate	Power of 10 error maximum of 1 mark give full marks for correct answer, no working	(2)

Q44.

	Answer	Acceptable answers	Mark
(i)	$1400 - 1300 (= 100) (kj) (1)$		(1)
(ii)	Substitution (1) $1300 / 1400 \times 100$ Evaluation (1) 93(%) or 0.93	A value which rounds to 93(%) or 0.93 Correct answer with no working scores 2 marks	(2)

Q45.

Question number	Answer	Mark
(a)	A	(1)

Question number	Answer	Additional guidance	Mark
(b)	rearrangement (1) (useful energy transferred) = efficiency $\times$ total energy supplied substitution (1) = $(70 \times 170) \div 100$ answer (1) 119 (J)	award full marks for correct numerical answer without working accept (useful energy transferred) = 170×0.7 OR = 171×0.7 accept alternative answer from 171 (J) i.e. 120 (J)	(3)

Q46.

Question number	Answer	Mark
(i)	A	(1)

Question number	Answer	Additional guidance	Mark
(ii)	An answer that provides a description by making reference to: - thermal/heat energy (1) - dissipated in/transferred to air/surroundings (1)	allow heat 'lost' to surroundings	(2)

Q47.

Question number	Answer	Additional guidance	Mark
	B A, C and D are incorrect because these do not measure the vertical change in height above the earth's surface.		(1) A01

