Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(i)	substitution (1) 371 = (64.5+ m) x 3.5 rearrangement (1) m+64.5 = 371 / 3.5 evaluation of total mass (1) m+64.5 = 106 (kg) evaluation of woman's mass (1) m = 106-64.5 = 41.5 (kg)	full marks will be awarded for correct numerical answer without working	(4)

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) KE = ½ x 64.5 x 3.5^2 evaluation (1) 395 (J)	allow answers which round to 395 e.g. 395.0625 full marks will be awarded for correct numerical answer without working	(2)

Q2.

	Answer	Additional guidance	Mark
(i)	selection and substitution (1) $(KE) = \frac{1}{2} \times 3.6 \times 10^5 \times 71^2$ evaluation (1) 9.1×10^8 (J)	 accept 9.07×10^8 (J) accept 907 380 000 (J) award full marks for correct answer without working do not award a power of ten error	(2) AO2

	Answer	Additional guidance	Mark
(ii)	any **one** from: mechanically (to the thermal store) (1) (heating) due to air resistance / friction (1) thermally (1)	 allow dissipated thermal (store) / heat (energy)	(1) AO2

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	selection and substitution (1) $3(.00) \times 10^8 = 2.45 (\times 10^9) \times \lambda$ rearrangement (1) $(\lambda=) \dfrac{3(.00) \times 10^8}{2.45 (\times 10^9)}$ evaluation (1) 0.12 (m)	allow substitution and rearrangement in either order $2.45 (\times 10^9) = \dfrac{3(.00) \times 10^8}{\lambda}$ $\lambda = \dfrac{v}{f}$ accept 0.122(m) power of ten error gains 2 marks award full marks for the correct answer without working	**(3)** **AO2**

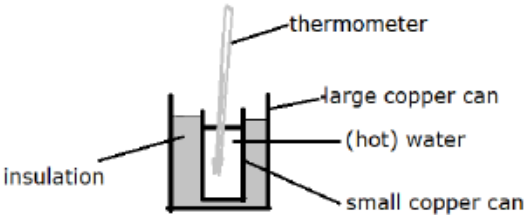| Question Number	Answer	Additional guidance	Mark
(ii)	selection and substitution (1) $(0.)55 = \dfrac{42\ 000}{\text{total energy supplied (to device)}}$ rearrangement (1) $(\text{total energy supplied to device=}) \dfrac{42\ 000}{(0.)55}$ evaluation (1) 76 000(J)	allow substitution and rearrangement in either order $(0.)55 = \dfrac{42\ 000}{x}$ accept any value that rounds to 76 000(J) 760/764/763(J) gains 2 marks any other power of ten error gains 1 mark award full marks for the correct answer without working	(3) AO2

Q4.

Question number	Answer	Additional guidance	Mark
	A description to include: mention relevant energy store such as GPE or chemical (1)	allow KE or mechanical or thermal or heat	(2)
	'correct' transfer in context (1)	chemical to (G)PE or chemical to KE (in lifting) allow misread GPE to KE/thermal on <u>slope</u> Allow KE to GPE in lifting	

Q5.

	Answer	Additional guidance	Mark
	a description giving as the density (of expanded polystyrene) increases the (thermal) conductivity decreases (1)	ORA	(2) AO2
	non-linear / gradient decreases / at a decreasing rate / levels off / plateaus / becomes (almost) constant (1)	allow inversely proportional / exponential for non-linear in this context ignore negative correlation unqualified quoted values are insufficient	

Q6.

Question Number	Answer	Additional guidance	Mark

(i)	a diagram showing:
	
	apparatus labelled to include **three** from
	  • thermometer
	  • water
	  • insulator / sand / sawdust / material
	  • (copper) can
	                                        (1)
	
	thermometer in the **water** (1)
	
	arrangement for water and insulator in and between copper cans (e.g. as in diagram below) (1)
		independent of arrangement
		
		ignore kettle and stop clock
		
		accept reverse positions for water and insulator
			(3) AO2

thermometer
large copper can
(hot) water
insulation
small copper can

Question Number	Answer	Additional guidance	Mark
(ii)	any **three** factors from: {mass / volume} of water (1) {volume / thickness / mass} of insulators / materials (1) {starting / initial} temperature of water (1) time interval / temperature change (1)	 accept amount / specified values / "how much" accept amount / specified values / "how much" accept temperature of hot / boiling water / specified values accept specified values of interval or change unqualified "same time" is insufficient	(3) AO3

Q7.

	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)**

			Indicative Content	
QWC		***(d)***	a description including some of the following points: - chemical to kinetic while in his hand - kinetic (gradually) to potential while rising / fr⌷ - eventually all potential at 10 m with a little the⌷ 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		

Q8.

Question number	Answer		Additional guidance	Mark
(a)(i)	0.45 (s)	(1)	Allow any value ≥ 0.4 and ≤ 0.5	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that combines improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark) • take pictures more frequently (1) • in order to determine exact time of the release. (1)	other responses may be acceptable	(2)

Question number	Answer	Additional guidance	Mark
(a)(iii)	Substitution (1) F = 7.26 x 20.6 Evaluation (1) 150 (N)	Accept 149.6 (N) full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(a)(iv)	Rearrangement (1) v = a x t Substitution (1) v = 23 x 0.48 Evaluation (1) 11 m/s	Accept 11.04(m/s) full marks will be awarded for correct numerical answer without working	(3)

Question number	Answer	Additional guidance	Mark
(b)	Substitution (1) PE = 7.26 x 10 x 1.3 Evaluation (1) 94.4 (J)		(2)

Q9.

	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 ÷ 2.3 evaluation (1) 870 (N)	answer to (b)(i)) ÷ 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	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)

is quite small (1)

- Because impact distance is far (1)

Total question = 8 marks

Q10.

Question number	Answer	Additional guidance	Mark
(a)	An answer that combines the following points of understanding to provide a logical description: • measurement of time between(or at) two positions using suitable timing equipment (1) • measurement of suitable distance along the runway with metre rule (1) • measurement of vertical height to starting position (1) • repeats AND averages AND use of a correct equation (1)	allow stopwatch, light gates minimum is 0.5 m metal tape measure average speed = distance/time OR average speed = (speed at A − speed at B)/2	(4)

Question number	Answer	Additional guidance	Mark
(b)(i)	Substitution of correct data from graph and mass conversion (1) $0.5 \times 0.65 \times (0.61)^2$ Answer (1) 0.12 (J)	maximum of 1 mark if mass in g used allow tolerance of ±0.2 for speed	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	• Tangent to the graph at $h = 0.1$ (1) • Answer in the region 3.5 to 3.6	either seen on graph or suitable pairs of values of Δv and Δh	(2)

Question number	Answer	Mark
(b)(iii)	An answer that combines points of interpretation/evaluation to provide a logical description: • for each change in height, as the height increases the speed of the trolley increases • the greatest change in speed is between the change in height from 0.04 m to 0.9 m	(2)

Question number	Answer	Additional guidance	Mark
(c)	An answer that combines the following points to provide a logical description of the plan/method/experiment: • identifies control variables (1) • uses at least 3 different surfaces (1) • calculates average speed for each surface and repeats (1)	constant height, constant slope, constant starting points and same length of surface	(3)

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	recall (1) (ΔPE) = mgh substitution and rearrangement (1) h = $\dfrac{1300}{7 \times 10}$ evaluation (1) 19 (m)	1300 = 7 x 10 x h work done = force x distance accept answers that round up to 19 (m) (e.g. 18.57 (m)) award full marks for the correct answer with no working	**(3)** AO 1 1 AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	recall (1) KE = ½ m v² substitution and rearrangement (1) v =√(2 x 1100÷8) evaluation (1) 17 (m/s)	 v² = $\dfrac{2 \times 1100}{8}$ accept answers that round up to 17 (m/s) (e.g. 16.58 (m/s)) award full marks for the correct answer with no working	**(3)** AO 1 1 AO 2 1

Q12.

Question Number	Answer	Additional guidance	Mark
	reading energies from graph (1) 5.2 and 3.9 (kJ) substitution (1) e.g. $\frac{1.3 \times (100)}{5.2}$ evaluation (1) 25(%)	accept 5.0 to 5.4 and 3.7 to 4.1 0.18 to 0.32 18 to 32 (%) award full marks for the correct answer with no working	(3) AO 2 1

Q13.

Question Number	Answer	Mark
	B natural gas **is the only correct answer** A *geothermal is not a non-renewable source of energy* C *tidal is not a non-renewable source of energy* D *solar is not a non-renewable source of energy*	(1) AO 1 1

Q14.

Question Number	Answer	Additional guidance	Mark
	an explanation linking: increased use of renewables/decrease use of nonrenewables (1) reason (1)	accept "them" as renewable accept reason why renewables are beneficial accept reason why non-renewable(s) are not beneficial	(2) AO 1 1

Q15.

Question number	Answer	Additional guidance	Mark
	(original) GPE – KE (at bottom) (1)	allow (idea of) input – output allow wrong way round (eg output-input)	(1)

Q16.

Question Number	Answer	Additional guidance	Mark
	An answer that includes:		(4)
	(measure) mass of the trolley (1)	weigh the trolley	
	(measure) (vertical) height / h (1)	NOT measure height of ramp	
	repeat for a range of masses (1)		
	plus **any one** from:		
	method of identifying / measuring h (1)	e.g. use of reference mark	
	OR		
	repeat firing with same mass (1)	accept "use ruler to measure height/h" for 2 marks	
		NOT "use ruler to measure height of ramp"	

Q17.

Question number	Answer	Additional guidance	Mark
	(vertical) height of slope (1)		(2)
	mass (of the toy car) (1)	allow (in this context) weight	
		if no other mark scored allow 1 mark for quoting either equation $(\Delta)GPE = mgh$ OR $KE = \frac{1}{2}mv^2$	

Q18.

Question Number	Answer	Additional guidance	Mark
	reference to $\Delta PE = mg(\Delta)h$ (1) relevant values from graph and one calculation to find energy (1) repeated with 2nd set of values (1)	can be seen in calculations e.g. 0.6 x 10 x 0.230 ≈ 1.4 (J) e.g. 1.0 x (10) x 0.138 ≈ 1.4 (J) must see calculations for mp2 and 3 1 mark for 2 calculations of mh with 'g' omitted (MP3)	(3)

Q19.

Question Number	Answer	Mark
	B. when there are energy transfers, the total energy does not change *A is not correct because the total energy does not reduce* *C is not correct because the total energy does not reduce* *D is not correct because the total energy does not increase*	(1) AO1