

Mark Scheme

Q1.

Question Number:	Answer	Additional Guidance	Mark
	an explanation linking: over the same time / in 300s, more work done / energy transferred in session 1 than in session 2 (1) (therefore) more power (developed) in session 1 (1)	allow reverse argument power in session 1 = $\frac{45.2}{300} = 0.15 \text{ (kW) or } 150\text{(W)}$ allow statement that power = $\frac{\text{work}}{\text{time}}$ or power = $\frac{\text{energy(transferred)}}{\text{time}}$ for MP1 power in session 2 = $\frac{37.9}{300} = 0.13 \text{ (kW) or } 126\text{(W)}$	(2) AO 3 2a AO 3 2b

Q2.

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

Q3.

Question number	Answer	Additional guidance	Mark
(i)	rearrangement of work = force $\times$ distance to give distance = work $\div$ force (1) substitution and evaluation (1) 18 (m)	seeing $2700 \div 150$ 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 $KE = \frac{1}{2}mv^2$ $v = \sqrt{2 \times KE \div m}$ (1) 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)

Q4.

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) $(KE =) \frac{1}{2} \times (0.046 \times 3.5^2$ 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)

Q5.

Question number	Answer	Additional guidance	Mark
(i)	select and substitute (1) $(\Delta GPE = m \times g \times \Delta h)$ $= 1100 \times 3.7 \times 1.8 (\times 10^3)$ evaluation (1) 7 326 000 (J) evaluation to 2 s.f. (1) 7 300 000 (J)	any number rounding to 7 300 000 7326 scores 1 mark independent mark -any final answer stated to 2 s.f.	(3) A02.1

Question number	Answer	Additional guidance	Mark
(ii)	select and substitute (1) $(\Delta KE = \frac{1}{2} m \times v^2)$ $= \frac{1}{2} 1100 \times 88^2$ evaluation (1) 4 300 000 (J)	ignore minus signs accept numbers that round to 4 300 000 (J) e.g. 4 259 200 (J) award full marks for the correct answer without working	(2) A02.1

Question number	Answer	Additional guidance	Mark
iii	A description linking three from: 1. work is done against / by gravity (1) 2. idea of work done by the thrusters / jets (on the rover) (1) 3. (work done) by air/atmospheric resistance on the parachute (and rover) (1) 4. this reduces the kinetic energy (store) (1) 5. (there is a) decrease in the gravitational potential energy (store) of the rover (1) 6. (there is a) transfer of chemical energy from the thrusters (1) 7. energy transferred to thermal energy (store) (1) 8. (transfer) mechanically (to the thermal store) (1)	KEY: attempt to explain <u>how work done</u> contributes towards the energy changes / conservation of energy if no other mark scored allow one mark for work = force x distance	(3) AO2.1

Q6.

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 accept 230(W), 225(W) award full marks for the correct answer without working	(2)

Q7.

Question Number	Answer	Additional guidance	Mark
(i)	recall (1) $(P =) \frac{E}{t}$ substitution and evaluation (1) (P=) 75 (W)	$P = \text{work done} \div \text{time}$ $P = \frac{45}{0.6}$ award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	substitution into $E = \frac{1}{2} \times k \times x^2$ (1) $45 = \frac{1}{2} \times 140 \times x^2$ rearrangement (1) $(x =) \sqrt{\frac{2 \times 45}{140}}$ evaluation (1) 0.8(0) (m)	allow substitution and rearrangement in either order $x^2 = (\frac{E}{0.5k} =) \frac{2 \times 45}{140}$ $x^2 = 0.64(28571)$ accept values that round to 0.80 e.g. 0.80178 award full marks for the correct answer without working	(3)

Q8.

Question number	Answer	Additional guidance	Mark
	substitution (1) $2,800 = \frac{1}{2} \times 85 \times v^2$ rearrangement (1) $(v^2 =) \frac{2800 \times 2}{85}$ evaluation (1) $v = 8.1$ (m/s)	allow substitution and rearrangement in either order 66 or 65.88 seen allow values that round to 8.1 e.g. 8.1168 award full marks for the correct answer without working	(3) AO2

Q9.

Question number	Answer	Mark
(a)	C	(1)

Question number	Answer	Mark
(b)(i)	change in GPE = mass $\times$ gravitational field strength $\times$ change in vertical height	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	transformation (1) $h = \Delta E \div mg$ substitution (1) $h = 39\,000 \div (580 \times 10)$ evaluation (1) 6.7(m)	accept use of $g = 9.81$ accept 6.72 accept 6.85 (from $g = 9.81$)	(3)

Q10.

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

Q11.

Question number	Answer	Mark
(i)	An answer that combines the following points of understanding to provide a logical description: - when steam condenses, its molecules move closer together, so the internal energy decreases (1) - when the water from the condensed steam cools, its molecules move more slowly, therefore storing less kinetic energy (1)	allow as water cools, the distance between the particles decreases which increases the intermolecular forces (2)

Question number	Answer	Additional guidance	Mark
(ii)	equating the variables in the three equations/principle of conservation of energy (1) $(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w) = (m_m \times c_m \times \Delta\theta_m)$ rearrangement (1) $m_m = \frac{(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w)}{(c_m \times \Delta\theta_m)}$ substitution of correctly calculated quantities (1) $= \frac{\left(\left(\frac{25}{1000} \right) \times 2260000 \right) + \left(\left(\frac{25}{1000} \right) \times 4200 \times 35 \right)}{3840 \times 60}$ evaluation (1) 0.26 (kg)	allow in words or with suitable alternative subscripts temperature changes and l_w must be correct allow maximum of 3 marks for calculations that omit the energy from cooling of water	(4)

Question number	Answer	Mark
(iii)	Any two of the following reasons: • more steam must condense and transfer the energy that is dissipated to the jug during the process (1) • more steam must condense and transfer the energy that is dissipated to the surroundings during the process (1) • more steam must condense and transfer the energy needed to cause the milk to froth (1) • more steam must condense to replace any steam that might leave the milk without condensing (1)	(2)

Q12.

Question number	Answer	Additional guidance	Mark
(i)	Recall GPE = $m \times g \times \Delta h$ (1) Substitution = $400 \times 9.8 \times 1.5$ (1) Evaluation = 5900 (J) (1) (which is nearly 6000 J)	accept 5880 (J)	(3)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that combines identification – knowledge (1 mark) and reasoning (1 mark) - energy is dissipated/scattered (1) - into the surroundings (1)	energy from a loss of ball's PE / its gain in KE ends up as (kinetic) energy of molecules (of ball / wall / air)	(2)

Question number	Answer	Mark
(iii)	B velocity	(1)

Q13.

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)

Q14.

Question number	Answer	Additional guidance	Mark
	An answer that combines the following points of application of knowledge and understanding to provide a logical description: - work is done against friction (1) - energy is stored in another specified way (1)	ignore references to friction as energy store acceptable stores are: - KE of water - thermal energy of water - thermal energy of air (G)PE of water	(2)

Q15.

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

Q16.

Question Number	Answer	Acceptable answers	Mark
(a)	A transverse and electromagnetic		(1)

Question Number	Answer	Acceptable answers	Mark
(b)	Evaluation 171.5 (1) Substitution (34.3/171.5) x 100 (1) Evaluation 20 (%) (1)	award full marks for correct answer with no working 34.3 x 5 [34.3 / (34.3 x 5)] x 100 [34.3 / (34.3 x 5)] [34.3 / 171.5] Allow 0.2 or 1/5 for 3 marks	(3)

Question Number	Answer	Acceptable answers	Mark
(c)	rate of {energy/heat} (from the Sun){absorbed/taken in} (1) equals rate of {energy/heat} {radiated/emitted/given out}(1)	Allow 'energy in = energy out' for 1 mark 'power in = power out' for 2 marks	(2)

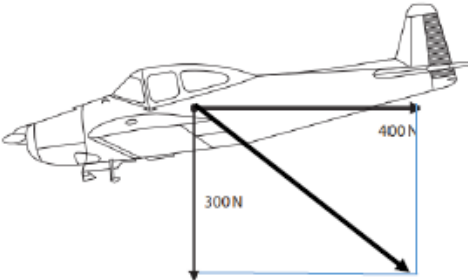
Q17.

Question number	Indicative content	Mark
	Answers will be credited according to the 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 of the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. A03 (6 marks) · the varying height shows a varying gravitational potential energy(gpe) during the swings · when the height is a maximum the gpe is a maximum-at top of swing · when the height is a minimum the gpe is a minimum-at bottom of swing · kinetic energy varies during swing · kinetic energy maximum at bottom of swing · kinetic energy minimum at top of swing · (continuous) interchange of KE and gpe · total amount of energy is constant during one swing · over a number of swings max KE and max PE decreases · energy is dissipated/'lost' to surroundings · because of air resistance / friction · amplitude/size of swings decrease (as energy 'lost' to surroundings) ignore references to momentum	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	- Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. - Judgements are supported by limited evidence. (AO3)
Level 2	3-4	- Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently. - Judgements are supported by evidence occasionally. (AO3)
Level 3	5-6	- Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. - Judgements are supported by evidence throughout. (AO3)

Q18.

Question Number:	Answer	Additional guidance	Mark
(i)	0.9 (k N) (1) up / upwards / ascending (1)	accept .9 or 0.90 north N ↑	(2) AO 3 2a AO 3 2b

Question Number:	Answer	Additional guidance	Mark
(ii)		judge length and direction by eye construction lines need not be shown magnitude need not be stated allow missing arrowhead if direction and length are correct reject answers which have any additional vectors drawn	(1) AO 3 2b

Question Number:	Answer	Additional Guidance	Mark
(iii)	recall and substitution (1) $GPE = 750 \times 10 \times 1300$ evaluation (1) (energy =) 9 800 000 (J)	no POT error (could have missed out g) allow answers in standard form 9.8×10^6 allow answers that round to 9 800 000 e.g. 9 750 000 J allow 9800 kJ or 9.8MJ allow 9 555 000 J allow negative values award full marks for correct answer without working	(2) AO 2 1

Q19.

Question number	Answer	Additional guidance	Mark
(i)	D R and S A, B and C are incorrect because the difference in vertical positions are all less than that shown by R and S		(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	recall (1) work done = force x distance substitution and evaluation (1) (work done =) 14,000 (J)	(work done) = 700 x 20 award full marks for the correct answer without working	(2) AO1

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $11250 = m \times 10 \times 15$ rearrangement and evaluation (1) (mass=) 75 (kg)	 award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers of 0.013 (substitution mark using $h = 15$)	(2) AO2

Question number	Answer	Additional guidance	Mark
(iv)	An explanation linking some work is done to overcome friction/air resistance (1) energy is dissipated /transferred to the environment (1)	 allow energy is lost thermal energy	(2) AO1

Question number	Answer	Additional guidance	Mark
(v)	C increase the efficiency of the cyclist and bicycle A is incorrect because lubrication has no effect on work done against gravity B is incorrect because lubrication will increase efficiency D is incorrect because the overall energy transfer will not increase		(1) AO1

Q20.

Question Number	Answer	Mark
	The only correct answer is B: work done= force $\times$ 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)

Q21.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	C - power		(1)

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	energy work	Must be in correct order	(1)

Question Number	Answer	Acceptable answers	Mark
a(iii)	Substitution 50 x 4 (1)		
	Evaluation 200 (kg m/s) (1)	Allow full marks for correct answer with no working shown	(2)

Question Number	Answer	Acceptable answers	Mark
a(iv)	Substitution 450 / 1.5 (1)		
	Evaluation 300 (N) (1)	Allow full marks for correct answer with no working shown Allow (1) for 167 (N) obtained by 450-200 / 1.5	(2)

Question Number	Answer	Acceptable answers	Mark
(a)(v)	An explanation to include (quantity has) a size and a direction	ignore any named examples	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation which uses conservation of momentum to link three from Mother and daughter have different mass (1) Momentum is conserved / is zero to start with (1) Both have same size momentum (after the push) (1) so speed of the daughter is greater than that of the mother (1)	An explanation based on Newton's laws and linking three from Each have a different mass (1) Each experience the same size force / action and reaction are equal (1) Each experiences a different acceleration (1) so speed of the daughter is greater than that of the mother (1)	(3)

(Total for Question = 10 marks)

Q22.

Question Number:	Answer	Additional Guidance	Mark
(i)	recall efficiency equation (1) $\text{efficiency} = \frac{\text{useful output}}{\text{input}}$ rearrangement (1) output energy = 0.70 x 6500 recall power equation (1) $\text{power} = \frac{\text{energy}}{\text{time}}$ evaluation (1) (power =) 76 (kW)	efficiency = $\frac{\text{power output}}{\text{power input}}$ 4550 (kJ) seen scores 2 marks (from 0.7 x 6500 (kJ)) $\frac{4550}{60}$ accept ecf from output energy accept values that round up to 76 (kW) e.g. 75.8 award full marks for correct answer without working	(4) AO 1 1 AO 2 1

Question Number:	Answer	Additional Guidance	Mark
(ii)	an explanation linking: (useful) output energy is less than input energy (1) some energy is transferred to less useful forms (1)	input energy is greater than output energy (only) 70% of the input energy is useful energy is dissipated / wasted / lost (to surroundings) energy is lost / transferred as thermal / heat 30% is lost /dissipated / wasted / lost for 2 marks	(2) AO 1 1

Q23.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	A		(1)

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	A description to include any two of • Gravitational / potential energy reduces (1) • kinetic energy increases (1) • total energy remains constant (1)	Ignore energy changes resulting from impact with sand GPE reduces KE increases Allow GPE is transferred to KE for 2 mark	(2)

Question Number	Answer	Acceptable answers	Mark
(b)	A explanation linking • (work is done) displacing the sand (1) with EITHER • (as) <u>kinetic</u> energy of the ball(s) has been transferred (1) OR • by the force between the ball and the sand (1)	sand moving/ pushing/ blowing upwards OWTTE or ball sinking into sand	(2)

Question Number	Answer	Acceptable answers	Mark
(c)(i)	transposition mass = momentum / velocity (1) substitution mass = 0.46 / 6.2 (1) evaluation 0.074 (kg) / 74g (1)	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition. Give full marks for correct answer with no working. Answers that round to 0.074 (kg) 0.07 (kg)	(3)

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	substitution (impact) force = 0.46 / 0.17 (1) evaluation 2.7 (N) (1)	Give full marks for correct answer with no working. Ignore power of ten error until evaluation Answers which round to 2.7 Allow ECF if candidate has used mass from part (i) in $F = m(v-u) / T$ $F = \frac{6.2 - 0}{0.17} \times 0.074$ (1) = 2.7 (N) (1)	(2)