Question number	Answer	Notes	Marks
1 (a) (i)	sub into E = I x V x t; evaluation; rounding to 2SF; e.g. (E=) 2.1 x 1.5 x 12 37.8 (J) 38 (J)	 Correct answer without working gains 3 marks	3
(ii)	GPE = m x g x h ;	accept: • word equations and rearrangements do not accept: • gravity for g • 10 for g • a 'units' only eqn	1
(iii)	sub into eqn; evaluation; e.g. (GPE=) 0.13 x10 x 0.63 0.82 (J)	no POT error as eqn has 'g' 0.819 (J) allow 0.802 (J) (g as 9.81)	2
(iv)	any TWO from: MP1 energy 'lost' as heat and/or sound; MP2 mass has gained KE; MP3 mass of string has been ignored / eq; MP4 motor not 100% efficient;	 allow eqn	2

Question number	Answer	Notes	Marks
1 (b)	Any FOUR from: MP1. Current in <u>coil</u> ; MP2. (Creates) magnetic field (around the wires of the coil); MP3. Interaction of (this) field with that of (permanent) magnets; MP4. There is a force on the wire(of coil); MP5. Reference to left hand rule; MP6. force up on one side and down on other side; MP7. Idea that commutator reverses current (every half turn);	allow credit for points shown labelled diagram current in circuit is not enough coil becomes an electromagnet can be shown on diagram idea of catapult field reference to moment/turning effect on the coil	4

(Total for Question 1 = 12 marks)

Question number	Answer	Notes	Marks
2 (a) I	0.45;	no unit penalty	1
ii	Power = current × voltage;	Allow P = I × V and rearrangements	1
iii	Substitution; Evaluation; e.g. 1.5= I x 0.45 I = 3.3 (A) (answer to at least 2 s.f.)	Allow reverse argument yielding 1.35 (W) for 1mark	2
(b) i	conversion of time to seconds; substitution into correct equation (E = I × V × t); evaluation; e.g. time = 7 × 5 × 60 × 60 (= 126 000) E = 3.3 x 9 x 7 x 5 x 60 x 60 3 742 000 (J)	Allow solution in stages i.e. from P=IV and P =E/t Allow for full marks 3 402 000 (J) (from use of 3 A given above) 3 780 000 (J) (from 1.5 x 20 x 7 x 5 x 60 x 60) Allow max of 1 if time not in seconds, e.g. 1040 (J) (from 3.3 x 9 x 7 x 5, time in hours) 62400 (J) (from 3.3 x 9 x 7 x 5 x 60, time in minutes)	3
ii	A description to include electrical; to **light** (and heat);	Reject "electricity" for the first mark Allow chemical to electrical to light for 1 mark only	2
		Total	9

Question number	Answer	Notes	Marks
3 (a) i	GPE = mass × *g* × height ;	Allow GPE = m × *g* × h and rearrangements	1
ii	Substitution into correct equation; Evaluation; e.g. 0.25 x 10 x 1.75 4.375 (J)	Reject "gravity" for *g* in 11(a)(i) 4.4, 4.38 Allow use of 9.81 (or 9.8) → 4.29 for full marks	2
(b)	Value given in 11(a)(ii);		1
(c) i	KE = ½ × mass × speed^2 ;	Allow KE = ½ × m × v^2 and rearrangements	1
ii	Substitution into correct equation; Transformation; Evaluation; e.g. 3.1 = ½ × 0.25 × v^2 v^2 = 3.1 ÷ ½ × 0.25 v = 4.98 (m/s)	Substitution and transposition either order Accept 5.0, 5 and allow truncation e.g. 4.97 m/s	3
		Total	8

Question number	Answer	Notes	Marks
4 (a)	Any 4 of: heat loss is reduced / traps heat; <u>relating to the air being an insulator –</u> air is a (good) insulator / air insulates / air is insulation / air is a bad conductor /air reduces conduction; <u>relating to the blanket / fibres being an insulator –</u> blanket is a (good) insulator / blanket insulates / blanket is insulation / blanket is a bad conductor / blanket reduces conduction; <u>relating to convection –</u> air is trapped / blanket traps air / air movement reduced; convection (currents) reduced / convection (currents) stopped; <u>relating to sweating –</u> sweat cannot evaporate; (so) less cooling effect from sweating;	seen anywhere in the answer ACCEPT ‘air stops conduction / air does not conduct’ ACCEPT ‘blanket’, ‘fibres’, ‘cloth’, ‘fabric’, etc as the same thing – ‘it’ refers to the blanket ACCEPT ‘blanket stops conduction / blanket does not conduct’ ACCEPT ‘air cannot move’ IGNORE ‘keeps out cold air’ NOT ACCEPT ‘stops sweating’	4
(b)	Mark is for the reason and must match yes / no statement Any ONE of - <u>Yes / right</u> (Al / foil / heat) reflects; Al is a poor absorber/emitter (of radiation); <u>No / wrong</u> (Al / foil) is a (good) conductor / bad insulator;	IGNORE shiny ACCEPT answers that refer to the blanket if they imply a relevant point, e.g. ‘no, because the blanket would conduct away less heat’	1

Total 5 Marks

Question number	Answer	Notes	Marks
5 (a)	A (chemical → electrical → kinetic)		1
(b) (i)	KE = ½ x m x v^2 ;		1
(ii)	substitution into correct equation; Calculation; e.g. ½ x 600 x 28^2 ; 240000 (J);	correct answer = 2 marks ACCEPT 235200 (J);	2
(c) (i)	gpe = mass x *g* x height;	ACCEPT GPE = mgh ACCEPT gravitational field strength/acceleration due to gravity for g	1
(ii)	substitution into correct equation; Calculation; e.g. 600 x 10 x 1000 6 000 000 (J) or 6000 k(J) or 6 M(J)	correct answer = 2 marks ALLOW 5 880 000 (from *g* = 9.8)	2
(iii)	EITHER <u>Calculation of energy supplied (by fuel cells)</u> 24 kW x 180 s OR 4 320 000 (J); <u>Comparison with energy required</u> 4 320 000 < 6 000 000; OR <u>Calculation of power required</u> 6 000 000 J ÷ 180 s OR 33.3 kW; <u>Comparision with fuel cells</u> 33.3 kW > 24 kW;	 ALLOW ECF if 6 000 000 not seen ALLOW ECF if 6 000 000 not seen	2

Question number	Answer	Notes	Marks
5 (c) (iv)	use of P= I x V for one cell ; e.g. 30 x 0.6 OR 18(W) calculation; e.g 24 000 ÷ 18 = 1333 (> 1300) OR 1300 x 18 = 23400 (< 24000) ALTERNATIVE Using E= IVt for one cell; e.g. 30 x 0.6 x180 OR 3240(J) calculation; e.g. 4 320 000 ÷ 3240 = 1333 (> 1300) OR 1300 x 3240 = 4 212 000 (< 4 320 000)	First Marking Point can be credited if '18' or '30 x 0.6' seen in calculation	2

Total 11 Marks

Question number	Answer	Notes	Marks
6 (a) (i)	gravitational potential energy = mass x g x height	Allow symbols and rearrangements, e.g. GPE = m x g x h	1
(ii)	Substitution into correct equation; Calculation; e.g. GPE = 2.75 x 10 x 0.61 = 17 (J)	16.8, 16.775, 16.78 (J) allow calculation with g = 9.81 =16.46 (J)	2
(iii)	Any two of- MP1. idea that system is inefficient OR not 100% efficient; MP2. idea that energy is lost / wasted / dissipated ; MP3. explanation /detail of fate of energy; e.g. used when working against {friction / drag / air resistance} as thermal energy to parts of the apparatus or surroundings transferred to surroundings by sound converted into KE as mass fell	condone used / transferred elsewhere Need mention of 'object' Ignore light allow to overcome friction allow heat for thermal energy	2
(iv)	Substitution into correct equation; Calculation; e.g. Energy transferred = 0.46 x 12.7 x 1.3 7.6 (J)	allow answer without working or equation seen (7.5946)	2
(b)	three of the following ideas- MP1. water has (initial) GPE; MP2. KE of (moving) water; MP3. Work done on turbine / generator; MP4. Work done against magnetic force; MP5. Electrical energy/power/current/voltage (produced);	allow KE in turbine / generator	3

Total 10 marks

Question number			Answer	Notes	Marks
7	(a)		C (the walls)		1
	(b)		D (40%)		1
	(c)	(i)	Any **two** of – • Fibres are good insulators / bad conductors; • Air is a bad conductor / good insulator; • Because air particles are widely spaced; • conduction requires solids/does not occur in gases;	no marks for • 'air is trapped' as is given in stem • conduction/convection mechanism described e.**g. air can't convect up through layers**	2
		(ii)	stopping /reducing (formation of) convection <u>currents</u>; air in the insulation can't move/eq;	allow air is trapped fibres prevent movement of air	2

Total 6 marks

Question number			Answer	Notes	Marks
8	(a)		Substitution into **correct** equation; Calculation; e.g. 1.3 x 10.3 x 4.7; 63 (J);	No credit for merely quoting the equation as $E = IVt$ is given on p2. 62.9 (J)	2
	(b)	(i)	Work done = force x distance moved (in the direction of the force);	Accept rearrangements and symbols e.g. force = $\frac{\text{work}}{\text{distance}}$ W = F x d F=W/d	1
		(ii)	Substitution into **correct** equation; Calculation; e.g. Work done = 20 x 0.85; 17 (J);		2
		(iii)	Value given in 8(b)(ii);	Allow GP(E)	1
	(c)	(i)	Efficiency = useful energy output divided by total energy input;	Accept efficiency in terms of work or power and percentage e.g. Efficiency = (work out / work in) x 100 %	1
		(ii)	17 divided by 63; 0.27;	Allow ecf answer from b(ii) [or (b)(iii)] divided by answer from (a) Allow 27%	2

Total 9 marks