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

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 1 (b) | Any FOUR from:<br><br>MP1. Current in <u>coil</u> ;<br><br>MP2. (Creates) magnetic field (around the wires of the coil);<br><br>MP3. Interaction of (this) field with that of (permanent) magnets;<br><br>MP4. There is a force on the wire(of coil);<br><br>MP5. Reference to left hand rule;<br><br>MP6. force up on one side and down on other side;<br><br>MP7. Idea that commutator reverses current (every half turn); | allow credit for points shown labelled diagram<br><br>current in circuit is not enough<br>coil becomes an electromagnet<br><br>can be shown on diagram<br>idea of catapult field<br><br>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;<br>Evaluation;<br>e.g. 1.5= I x 0.45<br>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;<br>substitution into correct equation (E = I × V × t);<br>evaluation;<br>e.g. time = 7 × 5 × 60 × 60 ( = 126 000 )<br>E = 3.3 x 9 x 7 x 5 x 60 x 60<br>3 742 000 (J ) | Allow solution in stages i.e. from P=IV and P =E/t<br>Allow for full marks<br>3 402 000 (J) (from use of 3 A given above)<br>3 780 000 (J) (from 1.5 x 20 x 7 x 5 x 60 x 60)<br>Allow max of 1 if time not in seconds, e.g.<br>1040 (J) (from 3.3 x 9 x 7 x 5, time in hours)<br>62400 (J) (from 3.3 x 9 x 7 x 5 x 60, time in minutes) | 3 |
| ii | A description to include<br>electrical;<br>to light (and heat); | Reject "electricity" for the first mark<br>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;<br>Evaluation;<br>e.g. 0.25 x 10 x 1.75<br>4.375 (J) | Reject "gravity" for *g* in 11(a)(i)<br><br>4.4, 4.38<br>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;<br>Transformation;<br>Evaluation;<br><br>e.g. 3.1 = ½ × 0.25 × v$^2$<br>v$^2$ = 3.1 ÷ ½ × 0.25<br>v = 4.98 (m/s) | Substitution and transposition either order<br><br>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:<br>heat loss is reduced / traps heat;<br><br><u>relating to the air being an insulator –</u><br>air is a (good) insulator / air insulates / air is insulation / air is a bad conductor /air reduces conduction;<br><br><u>relating to the blanket / fibres being an insulator –</u><br>blanket is a (good) insulator / blanket insulates / blanket is insulation / blanket is a bad conductor / blanket reduces conduction;<br><br><u>relating to convection –</u><br>air is trapped / blanket traps air / air movement reduced;<br><br>convection (currents) reduced / convection (currents) stopped;<br><br><u>relating to sweating –</u><br>sweat cannot evaporate;<br><br>(so) less cooling effect from sweating; | seen anywhere in the answer<br><br>ACCEPT 'air stops conduction / air does not conduct'<br><br>ACCEPT 'blanket', 'fibres', 'cloth', 'fabric', etc as the same thing – 'it' refers to the blanket<br>ACCEPT 'blanket stops conduction / blanket does not conduct'<br><br>ACCEPT 'air cannot move'<br>IGNORE 'keeps out cold air'<br><br>NOT ACCEPT 'stops sweating' | 4 |
| (b) | Mark is for the reason and must match yes / no statement<br>Any ONE of -<br><u>Yes / right</u><br>(Al / foil / heat) reflects;<br>Al is a poor absorber/emitter (of radiation);<br><br><u>No / wrong</u><br>(Al / foil) is a (good) conductor / bad insulator; | IGNORE shiny<br><br>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;<br>Calculation;<br>e.g. ½ x 600 x $28^2$ ;<br>240000 (J); | correct answer = 2 marks<br><br><br>ACCEPT 235200 (J); | 2 |
| (c) (i) | gpe = mass x *g* x height; | ACCEPT GPE = mgh<br>ACCEPT gravitational field strength/acceleration due to gravity for g | 1 |
| (ii) | substitution into correct equation;<br>Calculation;<br>e.g. 600 x 10 x 1000<br>6 000 000 (J) or 6000 k(J) or 6 M(J) | correct answer = 2 marks<br><br>ALLOW 5 880 000 (from *g* = 9.8) | 2 |
| (iii) | EITHER<br><br><u>Calculation of energy supplied (by fuel cells)</u><br>24 kW x 180 s OR 4 320 000 (J);<br><br><u>Comparison with energy required</u><br>4 320 000 < 6 000 000;<br><br>OR<br><br><u>Calculation of power required</u><br>6 000 000 J ÷ 180 s OR 33.3 kW;<br><br><u>Comparision with fuel cells</u><br>33.3 kW > 24 kW; | <br><br><br><br><br>ALLOW ECF if 6 000 000 not seen<br><br><br><br>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 ;<br>e.g. 30 x 0.6 OR 18(W)<br><br>calculation;<br>e.g 24 000 ÷ 18 = 1333 (> 1300)<br>OR<br>1300 x 18 = 23400 (< 24000)<br><br>ALTERNATIVE<br><br>Using E= IVt for one cell;<br>e.g. 30 x 0.6 x180 OR 3240(J)<br><br>calculation;<br>e.g. 4 320 000 ÷ 3240 = 1333 (> 1300)<br>OR<br>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;<br>Calculation;<br>e.g.<br>GPE = 2.75 x 10 x 0.61<br>= 17 (J) | <br><br><br><br>16.8, 16.775, 16.78 (J)<br>allow calculation with g = 9.81<br>=16.46 (J) | 2 |
| (iii) | Any two of-<br>MP1. idea that system is inefficient OR not 100% efficient;<br>MP2. idea that energy is lost / wasted / dissipated ;<br>MP3. explanation /detail of fate of energy;<br>e.g.<br>used when working against {friction / drag / air resistance}<br>as thermal energy to parts of the apparatus or surroundings<br>transferred to surroundings by sound<br>converted into KE as mass fell | <br><br>condone<br>used / transferred elsewhere<br>Need mention of 'object'<br>Ignore light<br><br>allow to overcome friction<br>allow heat for thermal energy | 2 |
| (iv) | Substitution into correct equation;<br><br>Calculation;<br>e.g.<br>Energy transferred = 0.46 x 12.7 x 1.3<br>7.6 (J) | <br><br><br>allow answer without working or equation seen<br>(7.5946) | 2 |
| (b) | three of the following ideas-<br>MP1. water has (initial) GPE;<br>MP2. KE of (moving) water;<br>MP3. Work done on turbine / generator;<br>MP4. Work done against magnetic force;<br>MP5. Electrical energy/power/current/voltage (produced); | <br><br><br>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 –<br>• Fibres are good insulators / bad conductors;<br>• Air is a bad conductor / good insulator;<br>• Because air particles are widely spaced;<br>• conduction requires solids/does not occur in gases; | no marks for<br>• 'air is trapped' as is given in stem<br>• conduction/convection mechanism described<br>e.**g. air can't convect up through layers** | 2 |
| | | (ii) | stopping /reducing (formation of) convection <u>currents</u>;<br>air in the insulation can't move/eq; | allow<br>air is trapped<br>fibres prevent movement of air | 2 |

Total 6 marks

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

Total 9 marks