# Mark scheme – Power and Efficiency (F)

| Question | | | Answer/Indicative content | Marks | Guidance |
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| 1 | | | **C** ✓ | **1 (AO 2.1)** | |
| | | | **Total** | **1** | |
| 2 | | | C | 1 | |
| | | | **Total** | **1** | |
| 3 | | | C | 1 | |
| | | | **Total** | **1** | |
| 4 | a | | 59 (anomalous result should be left out of calculation) (1) | 1 | |
| | b | | 28 (1) | 1 | |
| | c | | Green results unreliable / large variation / anomalous result (1)<br><br>Should have repeated 31 (green) reading / other results (red, blue, white, yellow) are reliable (1)<br><br>A sensible suggested improvement (1) | 3 | e.g. use camera to measure bounce heights (1) |
| | d | i | bounce height / drop height × 100% = 85% useful, therefore 15% wasted. (1)<br><br>transferred to heat and sound (1) | 2 | |
| | | ii | If the bounce height was greater then the efficiency would be higher / **ORA** (1) | 1 | |
| | | | **Total** | **8** | |
| 5 | a | | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 89 (%) award 3 marks**<br><br>48 000 ÷ 54 000 (× 100) ✓<br><br>= 88.88888….etc ✓<br><br>= 89(%) (2 sig figs) ✓ | **3**<br><br>**(AO 2.1)**<br><br>**(AO 2.1)**<br><br>**(AO 1.2)** | **ALLOW** two marks for 0.89 or 88(%)<br>**ALLOW** one mark for 0.88<br><br>**Examiner's Comments**<br>Two thirds of candidates were credited with some marks for this question. Candidates needed to use the equation provided and |

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| | | | | | give their final answer as a percentage. Many candidates did not show any working so could only be credited with any marks if their final answer was correctly given as a percentage. There was a compensatory mark for showing 48000 divided by 54000 in a candidate's workings which almost every candidate could have accessed.<br><br>**OCR support**<br><br>The answer to two significant figures is 89%. Many candidates gave their final answer to two significant figures as 0.8/ 80% or 0.9/90% or 0.88 /88%. .The Mathematical Skills Handbook provides support on the use of significant figures and other required mathematical skills.<br><br>http:/www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf |
| | b | i | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 60 000 (J) award 2 marks**<br><br>48 000 + 12 000 ✓<br><br>= 60 000 (J) ✓ | **2**<br><br>**(AO 2.2)**<br><br>**(AO 2.2)** | Check table<br><br>**Examiner's Comments**<br>Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings. |
| | | ii | C ✓ | **1 (AO 3.2b)** | **Examiner's Comments**<br>Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings. |
| | | iii | B ✓ | **1 (AO 3.2b)** | **Examiner's Comments**<br>Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect |

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| | | | | | responses. Most of these candidates had nether completed the table nor shown any workings. |
| | | iv | Heat / sound / KE of particles passed to other particles / AW ✓ | **1 (AO 1.1)** | **ALLOW** (energy) transferred to surroundings / by friction<br><br>**Examiner's Comments**<br>A large number of candidates correctly stated that the motor would produce heat and/or sound or indicated that the energy was 'wasted' through friction. Some candidates wrote out all the energy transfers in an electric motor (e.g. "heat, sound and kinetic energy") which could not gain credit as it did not describe how energy is 'wasted'. Credit was given when it was clear that the 'waste' resulted from the transfer of the kinetic energy store of particles passed on to other particles or to the surroundings but not a vague transfer of 'kinetic energy to the atmosphere'. |
| | | v | Lubrication / oil ✓ | **1 (AO 2.1)** | **ALLOW** reduce friction<br><br>**Examiner's Comments**<br>Candidates found this question extremely challenging. There were very few suggestions of specific improvements to the electric motor such as lubricating it or applying oil to the moving parts. Many candidates suggested general energy efficiency tips such as switching it off when it not in use, running the motor at a slower speed or putting insulation around the motor. |
| | | | **Total** | **9** | |
| 6 | | i | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 2.8 (kW) award 4 marks**<br><br>(P =) $I^2 \times R$ ✓<br><br>11 × 11 × 23 or 112 × 23 or 121 × 23 ✓<br><br>= 2783 ✓<br><br>Conversion to kW = 2.8 (kW) ✓ | **4**<br><br>**(AO 1.2)**<br><br>**(AO 2.1)**<br><br>**(AO 2.1)**<br><br>**(AO 2.1)** | **ALLOW** 2.78 kW or 2.783 kW ✓✓✓✓<br><br>**ALLOW** equation in any form<br><br>**ALLOW** ecf candidates answer to 3rd marking point converted to kW<br><br>**Examiner's Comments**<br>Q23 is an overlap question with J249/04 and candidates found it very challenging |

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| | | | | | with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11 × 23 or 23 ÷ 11, rather than 112 × 23 = 2.78kW. . |
| | | ii | Wind speed varies / AW ✓ | **1 (AO 2.1)** | **ALLOW** it depends on the strength of the wind / how windy it is / AW<br><br>**IGNORE** there might not be any wind / wind changes direction / AW<br><br>**Examiner's Comments**<br>Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'. |
| | | iii | (Idea of) not always enough wind / demand may exceed supply / AW ✓ | **1 (AO 2.1)** | **ALLOW** (it) may not generate enough power / energy / AW<br><br>**Examiner's Comments**<br>Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.<br><br>**AfL**<br><br>It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house. |
| | | | **Total** | **6** | |
| 7 | | | **B** ✓ | 1 (AO2.1) | **Examiner's Comments**<br><br>This question was well answered. Higher ability candidates used the space around |

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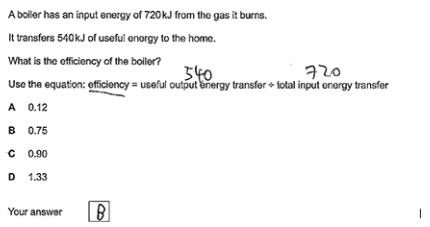
| | | | | | the question for their working.<br><br>**Exemplar 1**<br>  <br>5 A boiler has an input energy of 720 kJ from the gas it burns.<br>It transfers 540 kJ of useful energy to the home.<br>What is the efficiency of the boiler?<br>Use the equation: efficiency = useful output energy transfer ÷ total input energy transfer<br>A 0.12<br>B 0.75<br>C 0.90<br>D 1.33<br>Your answer B<br><br>This exemplar shows the candidate identifying the correct numbers for the given equation. |
| | | | **Total** | **1** | |
| 8 | a | i | 40 (°C) ✓ | 1 (AO2.2) | **Examiner's Comments**<br><br>The majority of the candidates calculated the difference correctly.<br><br>Higher ability candidates often wrote 100 – 60 = 40 |
| | | ii | **Any one from:**<br>Difference is much too high / difference should be lower than the previous result AW ✓<br><br>End temperature is too low ✓ | 1 (AO3.2a) | **ALLOW** does not follow the trend/pattern<br><br>**IGNORE** not stirring/thermometer touching the bottom / start temperature / boiling temperature<br><br>**Examiner's Comments**<br><br>This question required candidates to identify that the last difference did not follow the pattern. The start temperature in this case was irrelevant and was not credited. Many candidates correctly identified that the end temperature was too low or that the temperature difference was too large. Candidates should be encouraged to include a comparison in this type of question. |
| | b | | All points plotted correctly ✓<br><br>Appropriate straight line of best fit ✓ | 2 (AO 2×2.2) | **ALLOW** tolerance of ± half a square<br><br>**DO NOT ALLOW** straight line from top to bottom<br>**ALLOW** ECF for mis-plotted data points<br><br>**Examiner's Comments**<br><br>Many data points and lines were too thick. The second and fourth data points were often incorrectly plotted. |

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| | | | | | It was expected that a straight line of best fit would be drawn. A large number of candidates drew lines dot-to-dot.<br><br>  **AfL**<br><br>Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. Straight lines should be drawn with a ruler.<br><br>Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern.<br><br>The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit. |
| | c | | (As thickness of the insulation increases) temperature difference falls / ORA ✓ | 1 (AO3.1a) | **Examiner's Comments**<br><br>The majority of candidates correctly stated that the temperature difference falls as the thickness of the insulation increases.<br><br>Higher ability candidates included in their answer "as the thickness of the insulation increases". |
| | d | | As thickness increases rate decreases / AW / ORA ✓ | 1 (AO3.2b) | **ALLOW** as thickness increases tea cools slower / takes longer to cool ORA<br><br>**Examiner's Comments**<br><br>Many candidates omitted to indicate a direction of change for the thickness of the insulation. Other candidates did not understand the meaning of the term 'rate'.<br><br>  **AfL**<br><br>Candidates should be encouraged to practise explaining equations in terms of the effect of increasing a quantity on another quantity. |

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| | e | | **Any two from:**<br>Keep starting temperatures the same ✓<br><br>Keep room temperature the same ✓<br><br>Stir tea before taking measurements ✓<br><br>Use a lid / add (same) insulation underneath the cup / cover whole cup in (same) thickness insulation ✓<br><br>Repeat <u>and</u> average | 2<br>(AO2×3.3b) | **<u>Examiner's Comments</u>**<br><br>In this type of question, candidates need to give detailed ways of improving the experiment. Many candidates stated add insulation without being specific that the insulation should be either under the tea or as a lid. A number of candidates stated correctly that the start temperature should be the same and the room temperature should also be the same. |
| | | | **Total** | **8** | |
| 9 | a | i | **Any one from:**<br>Ratio of 1:1 at a height of 40 cm ✓<br><br>ratio (seems to) increase by 0.1 when height decreases by 20 cm (until ratio is 1:1) / AW ✓ | 1 (AO3.2a) | **ALLOW** when drop height was 40 cm, bounce height was the same / bounce ratio coming closer to 1:1 each time / bounce height cannot be higher than drop height<br><br>**<u>Examiner's Comments</u>**<br><br>Many candidates answered this question correctly by referring to the previous bounce height being the same. This question again required candidates to interpret data from a table. |
| | | ii | Some of the energy from the KE store is transferred to other energy stores as ball hits the ground AW ✓ | 1 (AO2.1) | **ALLOW** ball will lose energy (when it hits the ground)<br><br>**<u>Examiner's Comments</u>**<br><br>There was a clue in the question regarding energy. It was anticipated that candidates would understand that there is likely to be energy losses both as the ball travels through the air and as it bounces. It was hoped that there would be reference to energy being transferred from the kinetic energy store to other energy stores as the ball bounces. |
| | b | | **Any two from:**<br>Lower head to read bounce height / take bounce height readings at eye level / AW ✓<br><br>Take multiple readings and <u>average</u> them ✓<br><br>Take readings at other intervals (eg. 90, 70, 50) ✓ | 2<br>(AO2×3.3b) | **ALLOW** second person to read bounce height / idea of video camera and play back<br><br>**ALLOW** drop from greater heights<br><br>**<u>Examiner's Comments</u>** |

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| | | | | | This was another question which required candidates to consider experimental procedures. Many candidates suggested taking other readings. Some candidates tried to suggest methods of improving the measurement of the bounce height but often the explanations were vague and lacked the necessary detail.<br><br>  **AfL**<br><br>Candidates should be encouraged to consider improvements to experiments that are carried out as part of their practical course. |
| | | | **Total** | **4** | |
| 10 | | | As speed increases, (thinking) distance increases / ORA ✓<br><br>**BUT**<br>(thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓ | 2 (AO 3.1a)<br>(AO 3.2b) | **ALLOW** numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m).<br><br>**ALLOW** numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = 2×10 = 20 (m) for 2 marks<br><br>**Examiner's Comments**<br><br>Most candidates stated that the thinking distance increased with increasing speed. Few candidates stated that the thinking distance was directly proportional to the speed.<br><br>The question does indicate that candidates should use data from the graph. In this case, candidates could easily see that the thinking distance line is a straight line through the origin. Alternatively, they could have read the thinking distance at a speed of 15 m / s and 30 m / s to see that the thinking distances are 10 m and 20 m. This means that as the speed doubles the thinking distance doubles.<br><br>  **AfL**<br><br>Understand how to test from a graph |

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| | | | | | whether two quantities are directly proportional.<br><br>1. Take a quantity on the x-axis and double it and read off the y-axis values and see whether they double as well<br><br>2. See whether there is a straight line through the origin. |
| | | | **Total** | **2** | |
| 11 | a | i | 5 or 4 points correctly plotted to within ½ small square ✓✓ | 2<br>(AO2 × 2.2) | 3 or 2 correctly plotted points gains 1 mark<br>**IGNORE** 'blobs' more than ½ square diameter |
| | | ii | Smooth curved line of best fit through most points ✓ | 1<br>(AO1.2) | **DO NOT ALLOW** a straight line of best fit |
| | | iii | Temperature decreases (with time) ✓<br><br>At a decreasing rate / by a smaller change in temperature for each increase in time ✓ | 2<br>(AO2 × 3.1a) | **IGNORE** non-linear relationship / positive/negative correlation<br><br>**ALLOW** inverse proportion for this mark only<br><br>**ALLOW** gradient decreases / temperature decreases more quickly at the start (than at the end)<br><br>**ALLOW** use of data from the graph to show decreasing rate |
| | | iv | Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓ | 2<br>(AO3.2b) | **IGNORE** shape of the line but no mark for a horizontal line<br>**ALLOW** 90 +/- 2 °C |
| | | v | **Any one from:**<br>Repeat (and find a mean) / check reproducibility/repeatability ✓<br><br>Use smaller time intervals ✓<br><br>Use more precise timer/thermometer ✓ | 1<br>(AO3.3b) | **ALLOW** any sensible suggestion<br>**IGNORE** a longer time / use more thicknesses<br><br>**ALLOW** use equipment with higher resolution / data logger **IGNORE** better equipment unless qualified |
| | b | | Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓ | 1<br>(AO3.2a) | **ALLOW** metal is a (better thermal) conductor / ORA |
| | c | | Change the thickness of the cardboard (and repeat) ✓<br><br>**Any 2 from:**<br><br>(Control variable) Same volume of water / same starting temperature of water ✓ | 3<br>(AO3 × 3.3a) | **ALLOW** use different boxes with different thicknesses / line the box with an insulator<br><br>**ALLOW** same beaker / both beakers (don't) have a lid / same room temperature |

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| | | | Measure temperature with thermometer / time with stopwatch ✓<br><br>Calculate the rate using change in temperature / time ✓<br><br>Repeat results (and calculate the mean) ✓ | | **ALLOW** a specified amount of water in the beaker / a specified starting temperature |
| | | | **Total** | **11** | |