Mark scheme – Energetics (F)

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td></td><td></td><td>D</td><td>1
(AO 1.1)</td><td><u>Examiner's Comments</u>

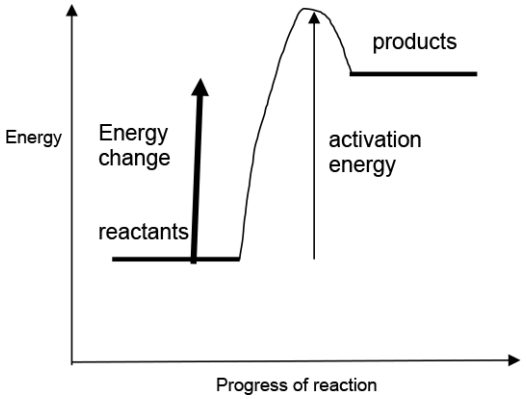
A and C were popular incorrect responses.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>2</td><td>a</td><td></td><td>Any two from:
Change the glass beaker for a metal container ✓

Move the spirit burner closer to the container / glass beaker / metal container ✓

Use a draught shield ✓

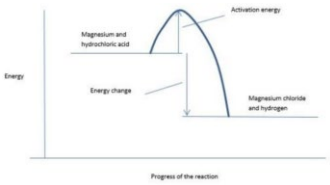
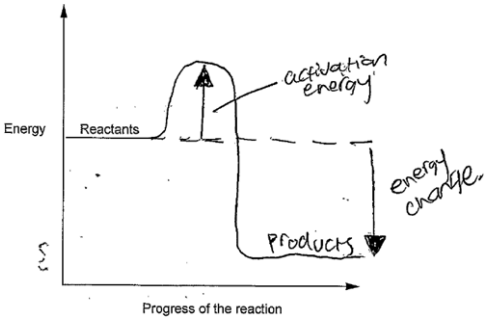
Add a lid (to the beaker) ✓</td><td>2
(AO3.3b ×2)</td><td>IGNORE put all thermometer (bulb) in water</td></tr>
<tr><td></td><td>b</td><td>i</td><td><table><tr><th>Reaction mixture</th><th>Start temperature (°C)</th><th>End temperature (°C)</th><th>Temperature change (°C)</th></tr><tr><td>X</td><td>20.0</td><td>25.5</td><td>(+) 5.5</td></tr><tr><td>Y</td><td>19.0</td><td>8.0</td><td>–11</td></tr><tr><td>Z</td><td>20.0</td><td>20.0</td><td>0</td></tr></table></td><td>1
(AO1.2)</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>Y ✓

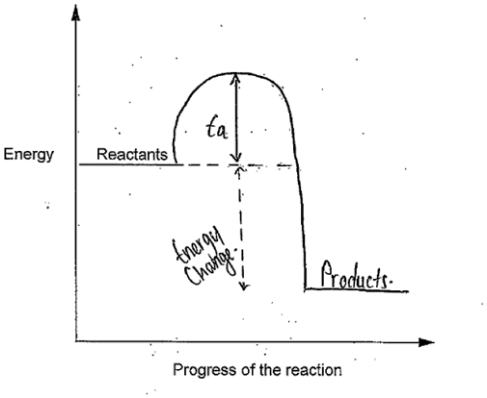
the temperature went down / decreased / energy is taken in ✓</td><td>2
(AO3.2b

1.1)</td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td> 

Activation energy ✓
Energy change ✓
Reactants ✓</td><td>3
(AO1.1)</td><td>ALLOW max 1 mark for correct shape if labels are missing / incorrect</td></tr>
</table>

			Total	**8**	
3	a	i	7.6✓	1 (AO3.2b)	
		ii	error taking the temperature (at start or at end) ✓	1 (AO3.2a)	**ALLOW** used more/less metal / used more/less acid **ALLOW** reaction did not finish **IGNORE** faulty thermometer **Examiner's Comments** Most candidates explained what an anomalous result is rather than explain what might have caused the anomalous result.
		iii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 10.3 (°C) award 2 marks** (10.3 + 10.5 + 10.2) ÷ 3 = 10.3333…. (°C) ✓ = 10.3 (°C) (1 decimal place) ✓	2 (AO2.2)	**Examiner's Comments** Most candidates calculated the mean correctly but some truncated their answer rather than rounding it.
	b	i	**Improvement** **Any one from:** Put a lid on the polystyrene cup / Put insulating material around the polystyrene cup / Use a digital thermometer ✓ Use a data logger ✓ **AND** **Reason** **Any one from:** Stops/reduces heat loss (through evaporation) / Prevents/reduces heat loss (from the polystyrene cup) / (Digital thermometer) is easier to read / (Digital thermometer) gives more accurate/precise readings ✓ (data logger) gives continuous data so can get max T	2 (AO3.3b) (AO2.2)	Reason must be linked to the Improvement to be awarded the second mark **ALLOW** add same amount of metal / acid/measure mass metal / measure volume acid ..... so can compare results **ALLOW** more metal / acid ..... gives larger T change / errors are less significant **Examiner's Comments** Candidates found this very difficult. Repetition was the most common improvement with accuracy for the reason. Some thought glass to be a better insulator than polystyrene. Most able candidates discussed either heat loss or digital devices.
		ii	**Any two from:** Use different types of acids ✓ Use a wider range of metals ✓ Change the mass of metal used ✓ Change the volume of acid used ✓	2 (AO3.3a)	**ALLOW** more reactive/less reactive metals **IGNORE** concentration **Examiner's Comments** Candidates found this difficult with a significant number omitting the question.

					Those that answered the question usually only gave one further test. Using a wider range of metals was the most common response.
	c		 Reactants above and to the left of products and both labelled in words or formulae ✓ Energy change downward arrow and labelled ✓ Activation energy upward arrow and labelled ✓	3 (AO1.2) (AO2.2 ×2)	**ALLOW ECF** if endothermic is given as answer in **(a)(i)** **ALLOW** label as just 'products' **ALLOW** double headed labelled -ΔH **DO NOT ALLOW** activation energy with a double headed arrow **DO NOT ALLOW** activation energy arrow pointing downwards **<u>Examiner's Comments</u>** Candidates found this difficult with a significant number omitting the question. Many candidates placed and labelled the products correctly but few gained any further credit. The labels for energy change and activation energy were frequently written on the curve or in space. The arrows were often in the wrong place on the curve. The lines which were in the correct place were almost always double headed. **Exemplar 6**  The candidate has the product line in the correct place and labelled. Both energies are labelled and correct. Scores all 3 marks.

					Exemplar 7  The candidate has the product line in the correct place and labelled. Both energies are labelled and the arrows are in the correct places but the use of double headed arrows means that they cannot score. This response scores marking point 1 only.
	d	i	Exothermic ✓	1 (AO1.1)	**Examiner's Comments** Exothermic was quite well known. Common incorrect responses included: endothermic, chemical, combustion, melting and redox
		ii	$Mg + \mathbf{2}HCl \rightarrow MgCl_2 + H_2$ Formulae ✓ Balancing ✓	2 (AO2.1) (AO2.2)	**ALLOW** any correct multiple, including fractions **ALLOW** = / ⇌ instead of → **NOT** and / & instead of + balancing mark is dependent on the correct formulae but **ALLOW** 1 mark (M2) for a balanced equation with a minor error in subscripts / formulae eg MG + **2**HCl → $MgCl_2 + H_2$ **Examiner's Comments** Candidates found this very difficult with few gaining marks. Most gave H or 2H as the formula for hydrogen.
		iii	Aluminium chloride ✓	1 (AO2.2)	**ALLOW** correct formula $AlCl_3$ **Examiner's Comments** Candidates found naming the salt difficult and a significant number omitted the question. Common incorrect responses included: aluminium hydroxide, aluminium oxide, aluminium hydrochloride, salt, and magnesium chloride.

<table>
<tr><td></td><td></td><td></td><td>Total</td><td>15</td><td></td></tr>
<tr><td>4</td><td></td><td></td><td>
<table>
<tr><th>Molten electrolyte</th><th>Formula</th><th>Product at negative electrode (cathode)</th><th>Product at positive electrode (anode)</th></tr>
<tr><td>sodium chloride</td><td>NaCl</td><td>sodium (1)</td><td>chlorine</td></tr>
<tr><td>lead bromide</td><td>$PbBr_2$</td><td>lead</td><td>bromine (1)</td></tr>
</table>
</td><td>2</td><td>DO NOT ALLOW bromide</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>5</td><td></td><td></td><td>(1 × 40.1) + [(16.0 + 1.0) × 2]

Correct use of number of atoms (1)
Correct use of A_r (1)</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>6</td><td>a</td><td></td><td>large surface area to volume ratio (2)</td><td>2</td><td>ALLOW large surface area (1)</td></tr>
<tr><td></td><td>b</td><td></td><td>Number of particles = 80.0 mg ÷ (5.0 × 10^{-3} mg) (1)
= 16 000 particles (1)</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
<tr><td>7</td><td></td><td></td><td>B</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
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