



**General Certificate of Education**

**Chemistry (5421)**

**CHM2      Foundation Physical and  
Inorganic Chemistry**

**Mark Scheme**

*2008 examination - January series*

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**Question 1**

- |     |      |   |        |
|-----|------|---|--------|
| (a) | (i)  | Cream/off white ppt<br>$\text{Ag}^+ + \text{Br}^- \rightarrow \text{AgBr}$  | 1<br>1 |
|     | (ii) | Precipitate dissolves/ colourless solution formed   | 1      |
| (b) | (i)  | Yellow/orange/brown solution forms<br>$\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$   | 1<br>1 |
|     | (ii) | $\text{F}^-$ / fluoride ion<br>$\text{Cl}_2$ less reactive than $\text{F}_2$ / $\text{Cl}_2$ weaker oxidising agent than $\text{F}_2$<br>$\text{F}^-$ worse reducing agent than $\text{Cl}^-$ | 1<br>1 |
| (c) |      | $2\text{NaOH} + \text{Br}_2 \rightarrow \underbrace{\text{NaBr} + \text{NaOBr}} + \text{H}_2\text{O}$<br>1 mark<br>1 mark for balanced equation   | 2      |

**Total 9****Question 2**

- |     |   |             |
|-----|---|-------------|
| (a) | Increase<br>Reaction is exothermic<br>System tries to raise temperature of system/ opposes the change | 1<br>1<br>1 |
| (b) | No effect<br>Same no of moles on each side / each side affected equally                               | 1<br>1      |
| (c) | System tries to lower concentration of hydrogen (and moves the right)                                 | 1           |
| (d) | Increases the rate of the forward and backward reactions<br>Equally                                   | 1<br>1      |

**Total 8****Question 3**

- |     |   |             |
|-----|---|-------------|
| (a) | Enthalpy change when 1 mole of compound<br>Is completely burned in oxygen<br>Under standard conditions  | 1<br>1<br>1 |
| (b) | $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$  | 1           |
| (c) | $\Delta H = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants}$ (or correct cycle)<br>$(-393 \times 3) + (-286 \times 4) - (-315)$<br>$- 2011 \text{ kJmol}^{-1}$ | 1<br>1<br>1 |
|     | (+ 2011 $\text{kJmol}^{-1}$ scores 1 mark)  |             |
| (d) | Less negative (QWC)   | 1           |

- |     |   |   |
|-----|---|---|
| (e) | $Q = mc\Delta T$  | 1 |
|     | $250 \times 4.2 \times 16 = 16800 \text{ J}$                                | 1 |
|     | Moles propanol = $0.92/60$ (= 0.0153)                                       | 1 |
|     | $\Delta H_c = 16800/0.0153$   |   |
|     | $- 1096 \text{ kJmol}^{-1}$   | 1 |
|     | (allow answers in range $- 1090$ to $- 1120$ )                              |   |
| (f) | Heat loss occurs in (e)/ no heat loss in (c) / incomplete combustion in (e) | 1 |

**Total 13****Question 4**

- |     |  |   |
|-----|--|---|
| (a) | Curve lower and skewed to right  | 1 |
|     | Starts at origin and does not touch x axis or cross drawn curve on right                                   | 1 |
| (b) | Peak height in same place as drawn curve   | 1 |
|     | Peak height twice as high as drawn curve   | 1 |
| (c) | (i) Particles <b>A</b> and <b>B</b> may not have the activation energy required for a successful collision | 1 |
|     | (ii) Increasing temperature by a small amount increases the number of particles having $E \geq E_a$        | 1 |
|     | Increasing pressure by a small amount increases collisions by a small amount (QWC)                         | 1 |
| (d) | Provides an alternative route of lower activation energy   | 1 |

**Total 9****Question 5**

- |     |   |   |
|-----|---|---|
| (a) | (+) 4   | 1 |
|     | (+) 6   | 1 |
| (b) | (i) $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$  | 1 |
|     | (ii) $\text{H}_2\text{O} + \text{SO}_3^{2-} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + 2\text{e}^-$                 | 1 |
|     | (iii) $\text{Cl}_2 + \text{H}_2\text{O} + \text{SO}_3^{2-} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + 2\text{Cl}^-$ | 1 |
|     | (iv) Reducing agent   | 1 |

**Total 6**

**Question 6**

- (a) Sulphur removed using Mg (or Ca) 1  
 $\text{Mg} + \text{S} \rightarrow \text{MgS}$  1
- C removed by blasting with oxygen 1  
 $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$  1  
 Or  $\text{C} + \frac{1}{2} \text{O}_2 \rightarrow \text{CO}$
- P removed by blowing oxygen into the (molten) iron 1  
 $4\text{P} + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$  1  
CaO added (which combines with the phosphorus oxide) calcium phosphate is made / slag is made 1
- (Or  $6\text{CaO} + \text{P}_4\text{O}_{10} \rightarrow 2\text{Ca}_3(\text{PO}_4)_2$  scores the last 2 marks)
- Otherwise  $\text{SO}_2$  formed (which causes acid rain)/ Fe oxidised in preference to S 1
- (b) C not used to extract Ti since TiC formed 1  
 Makes the Ti brittle 1
- (c) Electricity used for electrolysis is expensive 1
- C not reactive enough/ 1  
 C not used to extract Al since the temperature needed would be too high/  
 $\text{Al}_2\text{O}_3$  very stable
- $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$  1  
 $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$  1

**Total 15**