

General Certificate of Education

Chemistry 5421

CHM2 Foundation Physical and Inorganic Chemistry

Mark Scheme

2006 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

CHM2

- Question 1**
- (a) Enthalpy change when 1 mol of compound (1)
 Is formed from its elements(1)
 All substances in their standard state(1)
- (b) $\Delta H = \sum \Delta H^{\ominus}_c$ (reactants) - $\sum \Delta H^{\ominus}_c$ (products) (1)
 $= (7 \times -394) + (4 \times -286) - (-3909)$ (1)
 $= +7 \text{ kJmol}^{-1}$ (1)
- (c) Heat change = $m c \Delta T$ (1)
 $= 250 \times 4.18 \times 60 = 62700 \text{ J} = 62.7 \text{ kJ}$ (1)
 Moles $\text{C}_7\text{H}_8 = 2.5 / 92 = 0.0272$ (1)
 $\Delta H = 62.7 / 0.0272 = -2307 \text{ kJ mol}^{-1}$ (1)
 (allow -2300 to -2323)
- (d) Mass of water heated = $25 + 50 = 75 \text{ g}$
 Temp rise = $26.5 - 18 = 8.5 \text{ }^{\circ}\text{C}$ both for (1) mark
 Heat change = $75 \times 4.18 \times 8.5 = 2665 \text{ J} = 2.665 \text{ kJ}$ (1)
 Moles $\text{HCl} = \underline{0.05}$ (1)
 $\Delta H = -2.665 / 0.05 = -53.3 \text{ kJmol}^{-1}$ (1)
 (allow -53 to -54)
- (e) Less heat loss (1)

15 marks

- Question 2**
- (a) (i) Z (1)
 (ii) Collisions (1)
 Cause some molecules to slow down or lose energy (1)
- (b) Curve starts at origin and is displaced to the right (1)
 Curve lower and does not touch energy axis (1)
- (c) (i) Only a small percentage/very few collisions have $E > E_a$ (1)
 (ii) Add a catalyst (1)
 Lowers E_a (1)
 More collisions/molecules have energy $> E_a$ (1)

9 marks

- Question 3**
- (a) Rate forward reaction = rate backward reaction (1)
Concentrations of reactants and products are constant (1)
- (b) System opposes change (1)
Moves to the side with fewer moles (1)
In this case NH₃ (2moles) on right side < N₂ + H₂ together (4 moles) on left side of equation (1)
- (c) Too expensive to generate etc (1)
- (d) (i) Yield of ammonia increases (1)
Exothermic reaction favoured (1)
System moves to raise temp / or oppose decrease in temp (1)
- (ii) Faster reaction (1)
- (iii) Balance between rate and yield (1)

11 marks

- Question 4**
- (a) Batch process involves stopping and starting (1)
Energy lost when cools down after stopping or energy needed to heat up each time (1)
- (b) $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$ use of C or CO (1)
balance (1)
or $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
or $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$
- (c) $\text{TiO}_2 + 2\text{C} + 2\text{Cl}_2 \rightarrow \text{TiCl}_4 + 2\text{CO}$ use of C and Cl₂ (1)
balance (1)
or $\text{TiO}_2 + \text{C} + 2\text{Cl}_2 \rightarrow \text{TiCl}_4 + \text{CO}_2$
- $\text{TiCl}_4 + 4\text{Na} \rightarrow \text{Ti} + 4\text{NaCl}$ use of Na or Mg (1)
or $\text{TiCl}_4 + 2\text{Mg} \rightarrow \text{Ti} + 2\text{MgCl}_2$ balance (1)
- (d) Na (or Mg) is expensive or Cl₂ is expensive (1)
- (e) Expensive electricity needed in electrolysis (1)

10 marks

- Question 5** (a) Reduction involves gain of electrons (1)
A reducing agent loses (donates) electrons (1) 2 marks
- (b) (i) Sulphur dioxide (1) oxidation state +4 (1)
Sulphur (1) oxidation state 0 (1)
Hydrogen sulphide (1) oxidation state – 2 (1) 6 marks
- (ii) Sulphur dioxide is a choking gas or has a pungent odour (1)
Sulphur is a yellow solid (1)
Hydrogen sulphide has a smell of bad eggs (1) Any 2 marks
- (iii) $\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$ (1)
 $\text{SO}_4^{2-} + 8\text{H}^+ + 6\text{e}^- \rightarrow \text{S} + 4\text{H}_2\text{O}$ (1)
 $\text{SO}_4^{2-} + 10\text{H}^+ + 8\text{e}^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O}$ (1) Any 2 marks
(Allow equations with H_2SO_4)
 $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{H}^+ + \text{Cl}^- + \text{HOCl}$
- (c) or $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow 2\text{H}^+ + \text{Cl}^- + \text{OCl}^-$
or $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HOCl}$ (1)
Water is not oxidised (1)
The oxidation states of O (-2) and H(+1) remain unchanged (1) 3 marks

Total 15 marks