



General Certificate of Education

Chemistry 5421

**CHM2 Foundation Physical and
Inorganic Chemistry**

Mark Scheme

2007 examination - June series

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CHM2**Question 1**

- (a) (i) Curve starts at the origin and does not touch the x axis on the right hand side. (should be asymptotic) (1)
- Curve is skewed left (1)
- (ii) Minimum energy needed for a reaction to occur (2)
- (iii) Area under candidates curve from E_a to the right of it should be shaded (1)
- (b) (i) None (1)
- (ii) More molecules have energy greater than the activation energy (1)
- Therefore there are more successful collisions (1)
- (c) Increases rate (1)
- Follows an alternative route (1)
- Which has a lower activation energy (1)

Question 2

- (a) (i) Reduction is the gain of electrons (1)
- A reducing agent donates electrons (not pairs of electrons) (1)
- (ii) C or CO (1)
- $$\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO} \quad (1)$$
- Or $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
- Or $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$
- (iii) High temperature needed or in range 700°C to 2000°C (1)
- (b) Blast with oxygen (1)
- so the carbon is oxidised (1)
- (or use equation e.g. $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$)
- (c) (i) $\text{TiO}_2 + 2\text{C} + 2\text{Cl}_2 \rightarrow \text{TiCl}_4 + 2\text{CO}$ (1)
- Or $\text{TiO}_2 + \text{C} + 2\text{Cl}_2 \rightarrow \text{TiCl}_4 + \text{CO}_2$
- $$\text{TiCl}_4 + 4\text{Na} \rightarrow \text{Ti} + 4\text{NaCl} \quad (1)$$
- Or $\text{TiCl}_4 + 2\text{Mg} \rightarrow \text{Ti} + 2\text{MgCl}_2$

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- (ii) Argon (1)
- Prevent Ti reacting with oxygen, nitrogen, air (1)
 Or prevent Na/Mg reacting with oxygen, nitrogen, water, air
 Or prevent TiCl_4 hydrolysing/ reacting with water
- (d) Any two from (2)
- Mg/Na/ Cl_2 have to be made first by electrolysis
 - Batch process
 - Argon atmosphere needed
 - High temperatures needed in both stages

Question 3

- (a) Enthalpy change when one mole of substance (1)
 Is formed from its elements (1)
 All reactants and products in their standard states (1)
- (b) $\frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{N}_2(\text{g}) + \frac{3}{2} \text{O}_2(\text{g}) \rightarrow \text{HNO}_3(\text{l})$ (1) for equation
 (1) for state symbols
- (c) Enthalpy change is independent of the route taken (1)
- (d) (i) It is an element (1)
- (ii) $\Delta H = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants}$ or correct cycle (1)
 $-128 = 2x - (-286 + 2(34))$ (1)
 $-346 + 2x$ (1)
 $x = -173 \text{ kJmol}^{-1}$ (1)

Question 4

- (a) Rate of forward reaction = rate of backward reaction (1)
 Concentration of reactants and products are constant (QoL) (1)
- (b) Increases (1)
 More moles on the left hand side of equation (1)
 Equilibrium moves to reduce pressure/ oppose the change (1)
- (c) Decreases (1)
 Reaction is exothermic (1)
 Equilibrium moves to absorb heat/ lower the temperature/ oppose the change (1)
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- (d) (+) 5 (1)
 (+) 5 (1)

Question 5

- (a) Increase (1)
- (b) $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$ (1)
 $2\text{H}^+ + \text{H}_2\text{SO}_4 + 2\text{e}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$ (1)
 $2\text{H}^+ + \text{H}_2\text{SO}_4 + 2\text{I}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O} + \text{I}_2$ (1)
 (allow alternative correct equations with SO_4^{2-})
 H_2S or S (1)
- (c) Yellowy solution turns to a brown solution/ black ppt (need both colours) (1)
 $\text{Br}_2 + 2\text{KI} \rightarrow \text{I}_2 + 2\text{KBr}$ (1)
 Br_2 is an oxidising agent (1)
- (d) Add silver nitrate solution (1)
 KBr forms creamy ppt (1)
 KI forms yellow ppt (1)
 $\text{AgNO}_3 + \text{KBr} \rightarrow \text{AgBr} + \text{KNO}_3$
 or $\text{AgNO}_3 + \text{KI} \rightarrow \text{AgI} + \text{KNO}_3$ (1)
 or ionic equations
 Then add (dilute or conc) ammonia (1)
 AgBr / cream ppt dissolves in conc NH_3 or slightly dissolves
 in dilute NH_3 (QoL) (1)
 AgI is insoluble in dilute or conc NH_3 (1)

Alternative answers to d

Either add chlorine /Cl₂ (1)

Yellow brown/yellow/ orange brown solution formed with KBr (1)

Brown solution/black ppt formed with KI (1)



or add bromine/Br₂ (1)

no reaction with bromide ions (1)

Brown solution/black ppt formed with KI (1)

*Confirmatory test for either alternative above answers*

Either Add starch (1)

No change with Bromine formed (1)

Goes black with iodine formed (1)

Or add CCl₄/ organic solvent (1)

Bromine goes yellow/orange brown (1)

Iodine goes purple (1)