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ASSESSMENT and QUALIFICATIONS ALLIANCE

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)

$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ (1)
Or $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
Or $2\,Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

(iii) High temperature needed or in range 700^0C to 2000^0C (1)

(b) Blast with oxygen (1)

so the carbon is oxidised (1)
(or use equation e.g. $C + O_2 \rightarrow CO_2$)

(c) (i) $TiO_2 + 2C + 2Cl_2 \rightarrow TiCl_4 + 2CO$ (1)
Or $TiO_2 + C + 2Cl_2 \rightarrow TiCl_4 + CO_2$

$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$ (1)
Or $TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

(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) $\frac{1}{2}H_2(g) + \frac{1}{2}N_2(g) + \frac{3}{2}O_2(g) \rightarrow HNO_3(l)$ (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) $\Delta H = \Sigma \Delta H_f$ products $- \Sigma \Delta H_f$ reactants or correct cycle (1)

$-128 = 2x - (-286 + 2 (34))$ (1)

$-346 + 2x$ (1)

$x = -173$ 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)

(d) (+) 5 (1)

(+) 5 (1)

Question 5

(a) Increase (1)

(b) $2I^- \rightarrow I_2 + 2e^-$ (1)

$2H^+ + H_2SO_4 + 2e^- \rightarrow SO_2 + 2H_2O$ (1)

$2H^+ + H_2SO_4 + 2I^- \rightarrow SO_2 + 2H_2O + I_2$ (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)

$Br_2 + 2KI \rightarrow I_2 + 2\ KBr$ (1)

Br_2 is an oxidising agent (1)

(d) Add silver nitrate solution (1)

KBr forms creamy ppt (1)

KI forms yellow ppt (1)

$AgNO_3 + KBr \rightarrow AgBr + KNO_3$
or $AgNO_3 + KI \rightarrow AgI + KNO_3$ (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 /Cl_2 (1)

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

Brown solution/black ppt formed with KI (1)

Cl_2 +2 KBr → Br_2 + 2 KCl (1)
or Cl_2 +2 KI → I_2 + 2 KCl

or add bromine/Br_2 (1)

no reaction with bromide ions (1)

Brown solution/black ppt formed with KI (1)

Br_2 +2 KI → I_2 + 2 KBr (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 CCl_4/ organic solvent (1)

Bromine goes yellow/orange brown (1)

Iodine goes purple (1)