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ASSESSMENT and QUALIFICATIONS ALLIANCE

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 it's 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 x – 394) + (4 x – 286) – (- 3909) (1)

= + 7 kJmol^{-1} (1)

(c) Heat change = m c ΔT (1)
= 250 x 4.18 x 60 = 62700J = 62.7kJ (1)
Moles C_7H_8 = 2.5 /92 = 0.0272 (1)
ΔH = 62.7 / 0.0272 = - 2307 kJ mol^{-1} (1)
(allow -2300 to -2323)

(d) Mass of water heated = 25 + 50 = 75g
Temp rise = 26.5 – 18 = 8.5 ^{0}C both for (1) mark
Heat change = 75 x 4.18 x 8.5 = 2665 J = 2.665 kJ (1)
Moles HCl = $\underline{0.05}$ (1)
ΔH = - 2.665 / 0.05 = -53.3 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 NH_3 (2moles) on right side < N_2 + H_2 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) $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ use of C or CO (1) balance (1)

or $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

or $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

(c) $Ti O_2 + 2C + 2Cl_2 \rightarrow Ti Cl_4 + 2CO$ use of C and Cl_2 (1) balance (1)

or $Ti O_2 + C + 2Cl_2 \rightarrow Ti Cl_4 + CO_2$

$Ti Cl_4 + 4Na \rightarrow Ti + 4 NaCl$ use of Na or Mg (1)

or $Ti Cl_4 + 2Mg \rightarrow Ti + 2MgCl_2$ balance (1)

(d) Na (or Mg) is expensive or Cl_2 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) $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ (1)

$SO_4^{2-} + 8H^+ + 6e^- \rightarrow S + 4H_2O$ (1)

$SO_4^{2-} + 10H^+ + 8e^- \rightarrow H_2S + 4H_2O$ (1) Any 2 marks

(Allow equations with H_2SO_4)

(c) $Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl$

or $Cl_2 + H_2O \rightarrow 2H^+ + Cl^- + OCl^-$

or $Cl_2 + H_2O \rightarrow HCl + HOCl$ (1)

Water is not oxidised (1)

The oxidation states of O (-2) and H(+1) remain unchanged (1) 3 marks

Total 15 marks