



GCE MARKING SCHEME

**CHEMISTRY
AS/Advanced**

SUMMER 2013

GCE CHEMISTRY – CH5

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- Q.1** (a) Name of any commercially/ industrially important chlorine containing compound e.g. (sodium) chlorate(I) as bleach/ (sodium) chlorate(V) as weedkiller/ aluminium chloride as catalyst in halogenation
- do not accept CFCs [1]
- (b) (i) $K_c = \frac{[HI]^2}{[H_2][I_2]}$ must be square brackets [1]
- (ii) $K_c = \frac{0.11^2}{3.11^2} = 1.25 \times 10^{-3}$ follow through error (ft) [1]
- (iii) K_c has no units ft [1]
- (iv) when temperature increases K_c increases (1)
this means equilibrium has moved to RHS
/ increasing temperature favours endothermic reaction (1)
therefore ΔH for forward reaction is +ve (1)
(mark only awarded if marking point 2 given) [3]
- (c) (i) +2 [1]
- (ii) co-ordinate/ dative (covalent) [1]
- (iii) pink is $[Co(H_2O)_6]^{2+}$ **and** blue is $[CoCl_4]^{2-}$ (1)
(ligand is) Cl^- (1)
(addition of HCl sends) equilibrium to RHS (1) [3]
- (iv) $[Co(H_2O)_6]^{2+}$ shown as octahedral [with attempt at 3D] (1)
 $[CoCl_4]^{2-}$ shown as tetrahedral/ square planar (1) [2]

Total [14]

- Q.2** (a) (i) tangent drawn at $t = 40$ (1)
rate calculated 0.017 to 0.027 (ignore units) (1) [2]
- (ii) as reaction proceeds less collisions (per unit time) occur [1]
- (b) (i) 1st order shown by:
calculation of rates at at least 2 concentrations (1)
statement rate \propto concentration (1)
OR
constant half-life (1)
half-life is 24 minutes (1) [2]
- (ii) rate = $k[\text{N}_2\text{O}_5]$ (1) [1]
- (iii) $k = \text{rate (from (i))} / [\text{N}_2\text{O}_5 \text{ (from graph)}]$ (1)
(mark correct numbers – no need to check evaluation)
units = minutes^{-1} (1) ft from (ii) [2]
- (iv) (student A more likely to be correct) reaction is 1st order and 1 $[\text{N}_2\text{O}_5]$ involved in rate determining step [1]
- (c) correct curve starting at 100 kPa and becoming horizontal (1)
horizontal at 250 kPa (1) [2]
- Total [11]**

- Q.3** (a) an acid is a proton / H^+ donor [1]
- (b) $pH = -\log[H^+]$ / negative log of hydrogen ion concentration [1]
- (c) a low pH corresponds to a high concentration of H^+ (1)
- a strong acid is totally dissociated whilst a weak acid is partially dissociated (1)
- need to consider concentration (of acid solution) as well as strength of the acid (1)
- a concentrated solution of a weak acid could have a lower pH than a dilute solution of a strong acid (1) [4]
- QWC Accuracy of spelling, punctuation and grammar* QWC [1]
- (d) (i) $K_a = \frac{[HCOO^-][H^+]}{[HCOOH]}$ [1]
- (ii) $1.75 \times 10^{-4} = \frac{x^2}{0.1}$ (1)
- $x = 4.183 \times 10^{-3}$ (1)
- $pH = 2.38$ (1) [3]
- (e) (i) buffer [1]
- (ii) $RCOOH \rightleftharpoons RCOO^- + H^+$ and $RCOONa \rightarrow RCOO^- + Na^+$ (1)
- added H^+ removed by salt anion/ $A^- + H^+ \rightarrow HA$ (1)
- added OH^- removed by acid/ $OH^- + HA \rightarrow A^- + H_2O$ (1) [3]
- Total [15]**

Q.4 (a) diagram with labels to show

H_2/H^+ shown in electrode (1)

platinum (in both electrodes) (1)

$\text{Fe}^{2+}(\text{aq})$ and $\text{Fe}^{3+}(\text{aq})$ (1)

high resistance voltmeter (1)

salt bridge (1)

gas at 1 atm pressure, solutions of concentration 1 mol dm^{-3} , temperature 298K (1)

[any 5]

[5]

(b) (i) successive ionisation energies increase gradually/ the energies of the d orbitals are similar **[1]**

(ii) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} / 3d^{10} 4s^2$ **[1]**

(iii) after 4s electrons lost 3d is full/ stable/ d electrons ionisation energy very high **[1]**

(c) (i) violet solution contains V^{2+} (1)

SEP Zn^{2+}/Zn is more negative than $\text{VO}_3^-/\text{VO}^{2+}$ and $\text{VO}^{2+}/\text{V}^{3+}$ and therefore

releases electrons/ $\text{VO}_3^-/\text{VO}^{2+}$ and $\text{VO}^{2+}/\text{V}^{3+}$ are more positive than

Zn^{2+}/Zn and are stronger oxidising agents (1)

V^{2+} cannot be reduced (to V) since SEP is more negative than Zn^{2+}/Zn (1) **[3]**

(ii) 1.1V (ignore sign) **[1]**

(iii) $\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^- / \text{Zn}(\text{s}) \rightleftharpoons \text{Zn}^{2+}(\text{aq}) + 2\text{e}^-$ with some indication of direction **[1]**

(iv) if $\text{Zn}^{2+}(\text{aq})$ concentration increased equilibrium moves to LHS (1)

so electrode potential becomes less negative (1) **[2]**

(d) (i) 2.74×10^{-3} (mol) [1]

(ii) 1.37×10^{-3} (mol) [1]

(iii) $M_r \text{KIO}_3 = 214.1$

moles $\text{KIO}_3 = 0.978 / 214.1 = 4.57 \times 10^{-3}$ in 250 cm^3

4.57×10^{-4} in 25 cm^3 [1]

(iv) $1.37 \times 10^{-3} / 4.57 \times 10^{-4} = 3$ (1)

equation 1 is correct since 3 moles of iodine formed (mark awarded for reason) (1) [2]

Total [20]

- Q.5**
- (a) (i) atomisation of magnesium / vaporisation of magnesium [1]
- (ii) increased ratio positive charge on nucleus: number of electrons [1]
- (iii) is positive because the (negative) electron is repelled by negative species [1]
- (iv) lattice enthalpy is $-3835(\text{kJ mol}^{-1})$ numerical value (1) negative sign (1) [2]
- (b) (i) gases are more random/ have more disorder / move more freely and therefore have a higher entropy [1]
- (ii) $\Delta S = 21.8 (\text{JK}^{-1}\text{mol}^{-1})$ [1]
- (iii) $\Delta G = \Delta H - T\Delta S$ (1) ft from (ii)
- ΔG must be $-ve$ if reaction to be spontaneous/ to calculate T make $\Delta G = 0$ (1)
- $0 = 318000 - T 21.8$ $T = 14587/21.8$ (K) (1) [3]
- (c) use of aqueous sodium hydroxide (1)
- white precipitate for all possible ions (1)
- excess aqueous sodium hydroxide – precipitate dissolves for Pb^{2+} and Al^{3+} (1)
- use of aqueous (potassium) iodide/ hydrochloric acid/ sulfuric acid / soluble chloride/ soluble sulfate (1)
- result – yellow ppt for $\text{Pb}^{2+} + \text{I}^-$ and no ppt for Al^{3+} / white ppt for $\text{Pb}^{2+} + \text{Cl}^-$ or SO_4^{2-}
- and no ppt for Al^{3+} [result for both needed] (1) [5]
- QWC Organisation of information clear and coherent* (1)
- Use of specialist vocabulary* (1) QWC [2]
- (d) (i) diagram to show central Al, 4 Cl^- and 4 shared pairs of electrons, all Cl outer electrons, dative pair identifiable [1]
- (ii) chlorination of benzene (1) produces Cl^+ as electrophile (1)
- OR gives ionic liquids (1) with low vapour pressure/ non-volatile/ do not evaporate in use (1)
- OR catalyst (1) in polymerisation of alkenes (1) [2]
- Total [20]**