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) $K_c = \dfrac{[HI]^2}{[H_2][I_2]}$ must be square brackets **[1]**

(ii) $K_c = \dfrac{0.11^2}{3.11^2} = 1.25 \times 10^{-3}$ 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 α concentration (1)

OR

constant half-life (1)

half-life is 24 minutes (1) **[2]**

(ii) rate = k[N_2O_5] (1) **[1]**

(iii) k = rate (from (i))/ [N_2O_5] (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 [N_2O_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) $K_a = \dfrac{[HCOO^-][H^+]}{[HCOOH]}$ **[1]**

(ii) $1.75 \times 10^{-4} = \dfrac{x^2}{0.1}$ (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)

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

high resistance voltmeter (1)

salt bridge (1)

gas at 1atm 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 VO_3^-/ VO^{2+} and VO^{2+}/ V^{3+} and therefore

releases electrons/ VO_3^-/ VO^{2+} and VO^{2+}/ 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) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e$ / $Zn(s) \rightleftharpoons Zn^{2+}(aq) + 2e$ with some indication of direction **[1]**

(iv) if Zn^{2+}(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) $M_r\, KIO_3 = 214.1$

moles $KIO_3 = 0.978/\ 214.1 = 4.57 \times 10^{-3}$ 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(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) $\Delta S = 21.8$ ($JK^{-1}mol^{-1}$) **[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 = 14587/14600 (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 $Pb^{2+} + I^-$ and no ppt for Al^{3+} / white ppt for $Pb^{2+} + Cl^-$ 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]