WJEC
CBAC

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2011

CHEMISTRY - CH5

Q.1 (a) Reacts with both acids **and** bases / behaves as an acid **and** a base. [1]

(b) Chromium atom, Cr [1]

1s	2s	2p			3s	3p			3d					4s
⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	↾	↾	↾	↾	↾	↾

Chromium(III) ion, Cr^{3+} [1]

1s	2s	2p			3s	3p			3d					4s
⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	⇂↾	↾	↾	↾			

(c) (i) Orange → yellow [1]

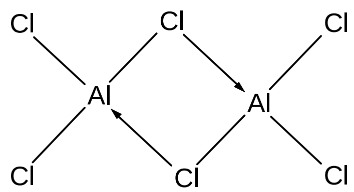
(ii) Cr +6 (1) in both reactant and product - do not accept 6+
no change in oxidation states so not a redox reaction. (1) [2]

(d) Add sodium hydroxide solution dropwise until there is an **excess** / small volume at a time until **excess**. [1]

White precipitate forms with Mg but doesn't dissolve again (therefore not amphoteric). [1]

White precipitate forms with Al then dissolves in excess NaOH (therefore amphoteric). [1]

(e) (i)



[1]

(co-ordinate bonds can be shown as lines but are incorrect if shown as arrows from Al to Cl)

Al is electron deficient - do not accept '$AlCl_3$ is electron deficient' [1]

Cl has lone pairs [1]

(ii) Tetrahedral (1); four electron pairs and no lone pairs/ four bonding pairs (1) [2]

Total [14]

Q.2 (a) (i) $H_2 + ½ O_2 \rightarrow H_2O$ [1]

(ii) Higher efficiency / no carbon dioxide emissions / water only / no greenhouse gases / can use renewable energy resources. [1]
Too vague - do not accept clean / no polluting gases / no global warming.

(iii) A = Salt bridge (1)
B = High resistance voltmeter /potentiometer (1)
C = Platinum electrodes (1) [3]

(b) (i) $\Delta H = 2 \times \Delta H\ (H_2O) + \Delta H\ (CO_2) - \Delta H(CH_3OH)$
= 2 x -286 + (-394) –(-239) (1)
= -727 kJ mol^{-1} (1) [2]

(ii) Entropy of (methanol) gas is higher than liquid (1)
So entropy change will be more negative (1) [2]

(iii) ΔG = -727000 – (298x -81) = -703 kJ mol^{-1} (1) *Allow ECF*
Negative ΔG means reaction is feasible. (1) [2]

Total [11]

Q.3 (a) Any 2 for (1) each from:

- Measure pressure (at constant volume) over time
- Measure volume (at constant pressure) over time
- Colorimetry/ measuring colour over time

1 mark allowed if time not mentioned [2]

(b) (i) When concentration doubles, rate doubles (1)

Therefore first order or rate is proportional to concentration (*must give reason to obtain this mark*) (1) [2]

Credit possible by alternative methods:

Calculate k for each and show that all values are the same;
Calculate k for one concentration and use to calculate other values.

(ii) k = Rate ÷ $[N_2O_5]$ e.g. k = $3.00 \times 10^{-5} \div 4.00 \times 10^{-3}$ (1)
= 7.50×10^{-3} (1) *must be 3 significant figures*
Units = s^{-1} (1) [3]

(iii) Rate determining step must have one N_2O_5 molecule as reactant. (1)
Mechanism A matches this rate equation (1) *need reason to get this mark*
Accept reverse argument. [2]

(c) (i) $K_p = \frac{p_{N_2O_4}}{p_{NO_2}{}^2}$ [1]

(ii) Increasing temp shifts equilibrium to left / favours endothermic reaction (1) so value of K_p is decreased. (1) [2]

(iii) $P_{N2O4} = 9.5 \times 10^3$ Pa (1)
$K_p = 9.5 \times 10^3 \div (2.81 \times 10^5)^2 = 1.20 \times 10^{-7}$ (1) *Allow ECF*
Units = Pa^{-1} (1) Mark consequentially on answer to (c)(i) [3]

Total [15]

Q.4 (a) (i) Transition metals have partially filled *d*-orbitals (in atom or ion) [1]

(ii) Iron and copper have partially filled d-orbitals in their **ions**, zinc does not [1]

(b) *QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate.(1)*
QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter. (1) [2]

- Ligands cause d-orbitals to split
- into 2 higher energy/ 3 lower energy
- Electrons <u>absorb light</u> (frequencies) to move to <u>higher</u> energy level
- Colour seen is colour transmitted/reflected/not absorbed
- Copper(II) complexes absorb red /orange/yellow/all colours except blue.

[MAX 4 marks from points above]

- Different ligands cause different splittings / different ΔE.
- Copper(I) ion has full d-orbitals.
- So electrons cannot move to upper energy levels.

[OVERALL MAX 6]

(c) (i) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [1]

(ii) Fe oxidation state goes from +3 to 0 (1) / so it is reduced (1)
OR C (not CO) oxidation state goes from +2 to +4 (1)/ so it is being oxidised. (1) *Allow ECF* [2]

(iii) Stable oxidation state of (C is +4 whilst) Pb is +2 (1)
Due to inert pair effect becoming more significant down the group. (1) [2]

(d) (i) $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$ [1]

(ii) Moles $Cr_2O_7^{2-}$ = 23.80 x 0.0200 ÷ 1000 = 4.76×10^{-4} moles (1)
Moles Fe^{2+} = 4.76×10^{-4} x 6 = 2.86×10^{-3} moles (1) [2]

(iii) Mass Fe in sample = 2.86×10^{-3} x 10 x 55.8 = 1.59 g (1)
Percentage Iron = 1.59 ÷ 1.870 x 100 = 85.2% (1) [2]

Total [20]

Q.5 (a) Named compound examples, need both name and use for (1)

- Sodium chlorate(I) = bleach
- Sodium chlorate(V) = weedkiller
- PVC = windows frames/guttering/pipes/insulation for electrical wires
- Dichloromethane – solvent / paintstripper
- CFCs = refrigerants / aerosol propellants
- Aldrin / Dieldrin / DDT = Insecticides [1]

(b) (i) $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ [1]

(ii)
- Emf for reaction of bromide with chlorine is +0.27 V / $E^ø$ for chlorine is more positive than for bromine. (1)
- Emf for reaction of bromide with iodine is -0.55 V / $E^ø$ for iodine is less positive than for bromine. (1)
- Reactions are only feasible if Emf is positive / if $E^ø$ for oxidising agent is more positive than for species being oxidised. (1)

[3]

(c) (i) White precipitate with (sodium) chloride, yellow precipitate with (sodium) iodide [1]

(ii) *QWC: legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning. (1)* [1]

- NaCl: Steamy gas / bubbles (1)
- NaI: Steamy gas /smell of rotten eggs / purple vapour or brown solution or black solid / yellow solid (1 mark for 2 observations)
- NaCl: $NaHSO_4$, HCl / NaI: $NaHSO_4$ / HI / I_2 / H_2S / SO_2 / S / H_2O (1 mark for 2 products; 2 marks for 4 products)
- Iodide is easier to oxidise / iodide is a stronger reducing agent than chloride (1)

[5]

(d) (i) (Almost) completely dissociates to release H^+. [1]

(ii) $K_a = \dfrac{[H^+][OCl^-]}{[HOCl]}$ [1]

(iii) $[H^+] = 10^{-pH}$ OR $pH = -\log [H^+]$ (1)
$[H^+] = 5.88 \times 10^{-5}$ mol dm^{-3} (1) [2]

(iv) $K_a = \dfrac{[H^+][OCl^-]}{[HOCl]} = \dfrac{(5.88 \times 10^{-5})^2}{0.100}$ (1)= 3.47×10^{-8} (mol dm^{-3}) (1)
(allow consequential answers) [2]

(v) pH above 7 (up to 10) (1)
OCl^- in equilibrium with HOCl / OCl^- will remove H^+ from solution (1) [2]

Total [20]