



GCE MARKING SCHEME

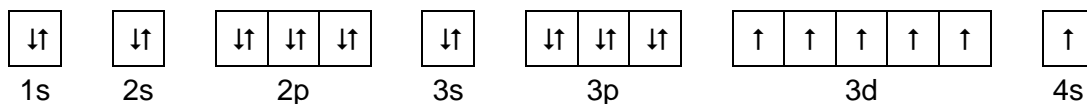
**CHEMISTRY
AS/Advanced**

SUMMER 2011

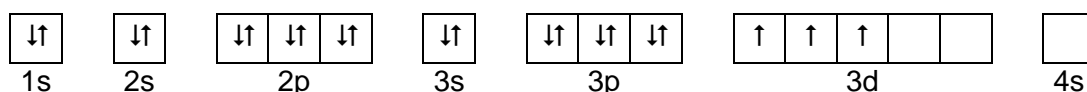
CHEMISTRY - CH5

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

(b) Chromium atom, Cr [1]



Chromium(III) ion, Cr³⁺ [1]



(c) (i) Orange → yellow [1]

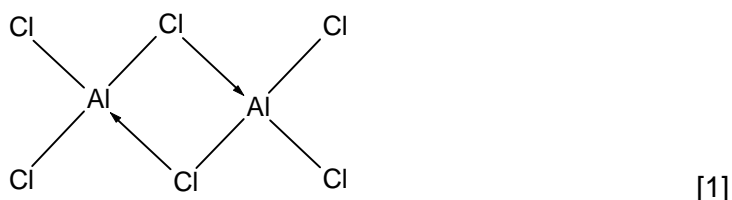
(ii) Cr +6 (1) in both reactant and product - do not accept 6+
no change in oxidation states so not a redox reaction. (1) [2]

(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)



(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 'AlCl₃ 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) $\text{H}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{H}_2\text{O}$ [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) $\Delta H = 2 \times \Delta H (\text{H}_2\text{O}) + \Delta H (\text{CO}_2) - \Delta H(\text{CH}_3\text{OH})$
 $= 2 \times -286 + (-394) - (-239)$ (1)
 $= -727 \text{ kJ mol}^{-1}$ (1) [2]
- (ii) Entropy of (methanol) gas is higher than liquid (1)
So entropy change will be more negative (1) [2]
- (iii) $\Delta G = -727000 - (298 \times -81) = -703 \text{ kJ mol}^{-1}$ (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) $k = \text{Rate} \div [\text{N}_2\text{O}_5]$ e.g. $k = 3.00 \times 10^{-5} \div 4.00 \times 10^{-3}$ (1)
 $= 7.50 \times 10^{-3}$ (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) $K_p = \frac{P_{\text{N}_2\text{O}_4}}{P_{\text{NO}_2}^2}$

[1]

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

[2]

(iii) $P_{\text{N}_2\text{O}_4} = 9.5 \times 10^3 \text{ Pa}$ (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 absorb light (frequencies) to move to higher 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) $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ [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) $6\text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \rightarrow 6\text{Fe}^{3+} + 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$ [1]
- (ii) Moles $\text{Cr}_2\text{O}_7^{2-} = 23.80 \times 0.0200 \div 1000 = 4.76 \times 10^{-4}$ moles (1)
 Moles $\text{Fe}^{2+} = 4.76 \times 10^{-4} \times 6 = 2.86 \times 10^{-3}$ moles (1) [2]
- (iii) Mass Fe in sample = $2.86 \times 10^{-3} \times 10 \times 55.8 = 1.59$ g (1)
 Percentage Iron = $1.59 \div 1.870 \times 100 = 85.2\%$ (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) $\text{Cl}_2 + 2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{Cl}^-$ [1]
- (ii)
 - Emf for reaction of bromide with chlorine is +0.27 V / E^\ominus for chlorine is more positive than for bromine. (1)
 - Emf for reaction of bromide with iodine is -0.55 V / E^\ominus for iodine is less positive than for bromine. (1)
 - Reactions are only feasible if Emf is positive / if E^\ominus for oxidising agent is more positive than for species being oxidised. (1)
- (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)
$$K_a = \frac{[\text{H}^+][\text{OCl}^-]}{[\text{HOCl}]}$$
 [1]
- (iii) $[\text{H}^+] = 10^{-\text{pH}}$ OR $\text{pH} = -\log [\text{H}^+]$ (1)
 $[\text{H}^+] = 5.88 \times 10^{-5} \text{ mol dm}^{-3}$ (1) [2]
- (iv)
$$K_a = \frac{[\text{H}^+][\text{OCl}^-]}{[\text{HOCl}]} = \frac{(5.88 \times 10^{-5})^2}{0.100}$$
 (1) = $3.47 \times 10^{-8} \text{ (mol dm}^{-3})$ (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]