GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2012

CH5

SECTION A

1. (a) 1 dm^3 at 20°C contains 52.9 g and at 0°C it contains 17.5 g (1)
$\therefore$ amount crystallised = 52.9 – 17.5 = 35.4 g (1) [2]

(b) (i) 2 mol of $K_2S_2O_8$ give 1 mol of O_2
2 mol of $K_2S_2O_8$ give 29.0 dm^3 of O_2 (1)
$\therefore$ 0.1 mol of $K_2S_2O_8$ gives 29.0/20 = 1.45 dm^3 of oxygen (1) [2]

(ii) Measure the volume of oxygen produced at specified time intervals /
Measure the pH of the solution at specified time intervals [1]

(c) (i) An (inert) electrode that is used to carry the charge / current / electron flow [1]

(ii) A comment on the relative values (e.g. the persulfate system is the more positive of the two systems) (1)
The more positive 'reagent' / persulfate ions acts as the oxidising agent, accepting electrons via the external circuit (1)
- must have the first mark to get second [2]

(d) (i) The experiments show that both the concentrations of iodide and persulfate have doubled (1) therefore the initial rate should increase four times
$4 \times 8.64 \times 10^{-6} = 3.46 \times 10^{-5}$ (1) [2]

(ii) Rate = $k\,[S_2O_8^{2-}]\,[I^-]$ (1)

$$\therefore k = \frac{8.64 \times 10^{-6}}{0.0400 \times 0.0100}$$

= 0.0216 (1) $dm^3\ mol^{-1}\ s^{-1}$ (1) [3]

(iii) In the rate equation one $S_2O_8^{2-}$ ion reacts with one I^- ion.
The rate-determining step therefore has to have 1 mole of each reacting, as (only) seen in step 1 [1]

Total [14]

2. (a) - 705 (kJ mol^{-1}) (1) for correct sign (1) for correct number [2]

(b) (i) ………………………………. hydration ……………………

…………………….. lattice **breaking** [1]

(ii) e.g. add a small 'amount' of an alkali / sodium hydroxide / NaOH / OH^- ions (1)
this would remove / react with hydrogen ions giving water, shifting the position of equilibrium to the left (removing iodine) (1)
add $P6^{2+}$ / Ag^+ ect. [2]

(c) (i) Any TWO from
white / misty fumes (of HI)
yellow solid / solution (of sulfur)
brown / black solid / purple vapour (of iodine)
bubbles / effervescence / fizzing

One mark for each correct response [2]

(ii) The values show that chlorine is the best oxidising agent, as it has the most positive E^θ value and therefore iodide is the better reducing agent (1) and is 'strong' enough to reduce the sulfuric acid. / OWTTE (1) [2]

(d) (i) $2\ NaOH + Cl_2 \rightarrow NaOCl + NaCl + H_2O$ [1]

(ii) e.g. bleach, kills bacteria [1]

Total [11]

3. (a) (i)

$$\text{Number of moles of EDTA} = \frac{19.20 \times 0.010}{1000} = 1.92 \text{ x } 10^{-4} / 0.000192 \qquad [1]$$

- error carried forward throughout (a)

(ii) $1.92 \times 10^{-4} / 0.000192$ [1]

(iii)

$$\text{Concentration} = \frac{1.92 \times 10^{-4} \times 1000}{50} = 3.84 \times 10^{-3} / 0.00384 \text{ mol dm}^{-3} \quad (1)$$

$$\text{Concentration} = 3.84 \times 10^{-3} \times 63.5 = 0.244 \text{ g dm}^{-3} \quad (1) \qquad [2]$$

(iv)

$$\% \text{ Cu} = \frac{0.244 \times 100}{11.56} = 2.11 \qquad [1]$$

(b) Transition elements have either a partly filled 3d sub-shell or form ions that have a partly filled 3d sub-shell (1)
However copper forms Cu^{2+} ions that are '$3d^9$' / partly filled 3d sub-shell (1)
whereas Zn^{2+} ions are '$3d^{10}$' / full 3d sub-shell (1) - any 2 from 3 [2]

QWC Organisation of information clearly and coherently; use of specialist vocabulary where appropriate. [1]

(c)

Complex ion	Shape	Colour
$[CuCl_4]^{2-}$	tetrahedral	yellow / lime green
$[Cu(NH_3)_4(H_2O)_2]^{2+}$	octahedral	deep blue

Any two correct (1) all correct (2) [2]

(d) The more negative the ΔH_f value the more stable the oxide (1)
PbO is relatively the more stable / CuO is relatively the less stable (1) [2]
- must have the first mark to get second

(e) (i) Any TWO from
variable oxidation states
partially filled 3d energy levels
ability to adsorb 'molecules'
ability to form complexes with reacting molecules / temporary / co-ordinate bonds

One mark for each correct response [2]

(ii) e.g. to allow lower pressures / temperatures
use recyclable catalysts - needs qualifying [1]
longer lasting / less toxic catalysts

Total [15]

SECTION B

4. (a) CO → C +2 CO_2 → +4   (1)

Increase of (positive) oxidation number = oxidation / reducing agents themselves are always oxidised are always oxidised (1)

OR

I_2O_5 → I +5 I_2 → I_2 0   (1)

Oxidation number of iodine reduced, reduction occurring, CO reducing agent (1) [2]

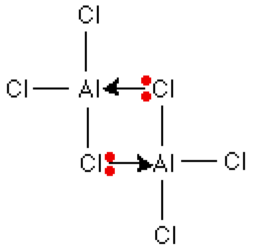
(b) +2 state becomes mores stable down the group and +4 becomes less stable. [1]

(c) (i) Add (a little) sodium hydroxide solution (1) to each solution.
A white precipitate (1) of aluminium / lead(II) hydroxide (1) is seen.
When more sodium hydroxide solution is added these precipitates (dissolve giving a colourless solution). (1) [4]

QWC Legibility of text: accuracy of spelling, punctuation and grammar; clarity of meaning. [1]

(ii) Yellow precipitate (1) $Pb^{2+} + 2\,I^- \rightarrow PbI_2$ [2]

(d) (i) The bonding of **aluminium** in the monomer has not completed the octet / suitable diagram / 6 electrons in its outer shell (1)
When the dimer is formed this octet of bonded electrons is formed (1)



(1) [3]

(ii) (As a catalyst) in the chlorination of benzene / making ionic liquids [1]

(iii) I The number of (gaseous) species is increasing, leading to less order [1]

II For the reaction to be just spontaneous ΔG = 0 (1)

substituting 0 = 60 000 - 88 T

T = 60 000 / 88 = 682 K / 409°C (1) [2]

(e) $$K_c = \frac{[[Al(H_2O)_5(OH)]^{2+}(aq)][[H^+](aq)]\}}{[[Al(H_2O)_6]^{3+}(aq)]}$$

$\therefore \quad 1.26 \times 10^{-5} = [H^+]^2 / 0.10$

$\therefore \quad [H^+]^2 = 1.26 \times 10^{-6}$ [1]

$\therefore \quad [H^+] = \sqrt{}\,1.26 \times 10^{-6} = 1.12 \times 10^{-3}$ / 0.00112 (1)

- error carried forward

$pH = -\log_{10}[H^+] = -\log_{10} 1.12 \times 10^{-3} = 2.95$ (1) [3]

Total [20]

5. (a) (i) $K_p = \dfrac{pSO_3(g) \times pNO(g)}{pSO_2(g) \times pNO_2(g)}$ (1) there are no units (1) [2]

(ii) The line for SO_3 / NO at equilibrium should be above the SO_2 / NO_2 line (1)
as K_p has a value of 2.5, the partial pressures of SO_3 and NO at equilibrium will be greater than the partial pressures of SO_2 and NO_2. (1)
- accept answer in terms of alternative calculated K_p value

The line for equilibrium should start at 9 hours. (1)
as at equilibrium the concentrations is unchanged as time progresses. (1)
[4]

There may be other acceptable forms of explanation to be discussed at the conference

(iii) If the temperature rises then the position of equilibrium will move to the left, (reducing the quantities of SO_3 and NO). (1)
This will make the value of K_p smaller. (1) [2]

(b) (i) Nitric acid is a strong acid and its pH is low / <2 / 1.0 (1)
As aqueous ammonia is added the pH slowly rises (1) until a pH of ~3 is reached, when it rises rapidly (1)
At a pH of 8-9, it tails off slowly as ammonia is a weak base. (1)
Accept any 3 from 4 . [3]

Selection of a form and style of writing which is appropriate to purpose and to complexity of subject matter [1]

(ii) The equivalence point is reached when 20.0 cm^3 of ammonia solution has been added as this is at the mid point of the more vertical section. (1)

Since both reagents have the same concentration and the volumes used are both 20 cm^3 / the same, the number of moles of each are the same (1)

OR the number of moles of both nitric acid and aqueous ammonia are calculated (0.0020) and shown to be the same (1)

∴ Mole ratio must be 1 : 1 (1) [2]

(iii) I Ammonium nitrate is the salt of a strong acid and weak base / there is a buffering effect in operation. [1]
II ~ 5.5 [1]

(iv) Blue, as bromophenol blue is blue at a pH of 4.7 and above [1]

(c) Number of moles of ammonium nitrate $= \dfrac{40}{80} = 0.50$ (1)

- error carried forward

Concentration of ammonium nitrate solution $= \dfrac{0.5 \times 1000}{200} = 2.5 \text{ mol dm}^{-3}$ (1)

∴ Temperature drop $= 2.5 \times 6.2 = 15.5$°C (1) [3]

Total [20]