GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2014

GCE CHEMISTRY – CH5

SUMMER 2014 MARK SCHEME

SECTION A

Q.1 (a) (i) $NH_4^+(aq) + OH^-(aq) \rightleftharpoons NH_3(aq) + H_2O(l)$

Acid 1 Base 2 Base 1 Acid 2 [2]

(1 mark for each pair)

(b) (i)

	$[NH_4^+(aq)]$/mol dm^{-3}	$[NO_2^-(aq)]$/mol dm^{-3}	Initial rate/mol dm^{-3} s^{-1}
1	0.200	0.010	4.00×10^{-7}
2	**0.100**	0.010	2.00×10^{-7}
3	0.200	**0.030**	1.20×10^{-6}
4	0.100	0.020	**4.00×10^{-7}**

(1 mark for each correct answer) [3]

(ii) $k = \dfrac{4.00 \times 10^{-7}}{0.200 \times 0.010} = 2.0 \times 10^{-4}$ (1)

Units = mol^{-1} dm^3 s^{-1} (1) [2]

(iii) No change [1]

(iv) Increases

If temperature is increased rate increases (1)

and since concentrations do not change the rate constant must increase (or similar) (1) [2]

Total [10]

Q.2 (a) $K_w = [H^+][OH^-]$ (1)
Units = $mol^2\ dm^{-6}$ (1) [2]

(b) (i) In pure water $[H^+] = [OH^-]$ or $[H^+] = \sqrt{1.0 \times 10^{-14}}$ (1)
$pH = -\log 10^{-7} = 7$ (1) [2]

(ii) Final volume of solution is 1000 cm^3 so acid has been diluted by a factor of 100 so final concentration of acid is 0.001

or moles acid = $\frac{0.1 \times 10}{1000} = 0.001$ (1)

$pH = -\log 0.001 = 3$ (1) [2]

(c) $1.78 \times 10^{-5} = \frac{[H^+] \times 0.02}{0.01}$ (1)

$[H^+] = 8.90 \times 10^{-6}$ (1)

pH = 5.05 allow 5 or 5.1 (1) [3]

(d) The solution is a buffer (1)

Solution contains a large amount of CH_3COOH and CH_3COO^- ions

(Accept correct equations) (1)

When an acid is added, the CH_3COO^- ions react with the H^+ ions, removing them from solution and keeping the pH constant (1) [3]

Total [12]

Q.3 (a)

$$H : \underset{\cdot\cdot}{\overset{\cdot\cdot}{O}} : \underset{\cdot\cdot}{\overset{\cdot\cdot}{O}} : H$$ [1]

(b) 20 dm^3 oxygen = 0.83 mol (1)

Moles H_2O_2 = 1.67 and $[H_2O_2]$ = 1.67 mol dm^{-3} (1) [2]

(c) (i) Variable oxidation states / partially filled 3d energy levels /ability to adsorb 'molecules' / form complexes (or temporary bonds) with reacting molecules
(Accept any two answers)
Do not accept 'empty / unfilled d-orbitals' [2]

(ii) 3d orbitals split by ligands (1)

Three d-orbitals have lower energy, two have higher energy (1)

Electrons absorb (visible light) energy to jump from lower level to higher level (1)

The colour is that due to the remaining / non-absorbed frequencies (1)
(Appropriate diagrams are acceptable alternatives)
[4]

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

(d) (i) $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ [1]

(ii) $5H_2O_2 + 6H^+ + 2MnO_4^- \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$ [2]

(Mark consequentially from (i) – 1 mark if formulae correct but equation not balanced properly)

(iii) Moles MnO_4^- = $\frac{0.02 \times 14.8}{1000} = 2.96 \times 10^{-4}$ (1)

Moles H_2O_2 = 7.40×10^{-4} (1)

Concentration H_2O_2 = $\frac{7.40 \times 10^{-4}}{0.020}$ = 0.037 mol dm^{-3} (1) [3]

(e) Oxidation state of oxygen starts at –1 (in peroxide) (1)
Oxidation state in water is –2 (reduced)
oxidation state in oxygen is 0 (oxidised) (1) [2]

Total [18]

SECTION B

Q.4 (a) (i) Oxidising agent [1]

(ii) A = lead(II) chloride / $PbCl_2$ (1)
B = chlorine / Cl_2 (1) [2]

(iii) $[Pb(OH)_6]^{4-}$ / $[Pb(OH)_4]^{2-}$ / $Na_4[Pb(OH)_6]$ etc. [1]

(iv) Yellow [1]

(v) $PbO + 2HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$ [1]

(b) (i) Each C atom covalently bonded to three other C atoms forming layers (1)

Layers held together by weak intermolecular forces (1)

BN is isoelectronic with C so it forms similar structures (1)

Graphite conducts electricity since electrons are delocalised but in BN, each N has a full unbonded p-orbital and each B has an empty unbonded p-orbital so it does not conduct electricity (1) [4]

(Accept electrons are not delocalised in BN so it does not conduct electricity)

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(ii) Wear-resistant coatings/catalyst support/for mounting high power electronic components / drills in industry / cutting instruments [1]

(c) (i) $\Delta G = \Delta H - T\,\Delta S$ ($\Delta G = 0$ for reaction to be spontaneous) (1)

$T = \frac{1.92}{0.0067}$ (1)

T = 286.6 K (1) [3]

(ii) Changes in temperature (above or below 286.6 K) caused the tin to change form making it unstable (and causing it to disintegrate) [1]

(d) (i) (At the anode) $H_2 \longrightarrow 2H^+ + 2e^-$ (1)

(At the cathode) $O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$ (1)

(Overall reaction) $2H_2 + O_2 \longrightarrow 2H_2O$ (1)

[3]

(ii) Hydrogen is difficult to store / takes up large volume / too flammable / explosive / produced from fossil fuels which leads to a net energy loss / Pt electrodes very expensive [1]

Total [20]

Q.5 (a) (i) Cold $Cl_2 + 2NaOH \longrightarrow NaCl + NaClO + H_2O$ (1)

Warm $3Cl_2 + 6NaOH \longrightarrow 5NaCl + NaClO_3 + 3H_2O$ (1)

[2]

(ii) Disproportionation [1]

(b) P can (extend the normal octet of electrons) by using 3d orbitals /
P can promote 3s electron to 3d orbital (1)
N cannot do this since it is in the second period / 3d orbitals not available (1)
[2]

(c) The terms involved are: lattice breaking enthalpy which is endothermic (1)

and hydration enthalpy which is exothermic (1)

ΔH solution = ΔH lattice breaking + ΔH hydration (or similar) (1)

If ΔH solution is negative then the ionic solid will be soluble (1)

[4]

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

(d) (i) Iodide (1)
Only one with less positive standard potential than
Fe^{3+}, Fe^{2+} half-cell (1) [2]
(2^{nd} mark can be obtained from calculation value and statement)

(ii) $Pt(s) | Fe^{2+}(aq), Fe^{3+}(aq) || Ce^{4+}(aq), Ce^{3+}(aq) | Pt(s)$ (1)

EMF = 1.45 – 0.77 = 0 .68 V (1) [2]

(e) (i) $K_c = \dfrac{[CH_3COOCH_3][H_2O]}{[CH_3COOH][CH_3OH]}$ (1)

No units (1) [2]

(ii) moles = $\dfrac{1.25 \times 32.0}{1000}$ = 0.04(0) [1]

(iii) $[CH_3COOH]$ = 0.04, therefore 0.06 used in reaction and

$[CH_3COOCH_3]$ = 0.06, $[H_2O]$ = 0.06 and

$[CH_3OH]$ = 0.083 – 0.06 = 0.023 (1)

$K_c = \dfrac{0.06 \times 0.06}{0.04 \times 0.023}$ = 3.91 (1) [2]

(iv) Value of K_c decreases since the equilibrium shifts to the left /
the forward reaction is exothermic [1]

Total [20]