GCE MARKING SCHEME

SUMMER 2016

CHEMISTRY - CH5
1095-01

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INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

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GCE CHEMISTRY - CH5

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SECTION A

1. (a) (i) Calculation of rates, at least two concentrations (1)

As concentration doubles, rate doubles (1)

Accept answers in terms of time instead of rate calculation

e.g. [0.064] 20 s, [0.032] 40 s (1)

As concentration doubles, time halves therefore rate doubles (1)

In both cases, values from graph must be used in order to award first mark

[2]

(ii) I Zero order (1)

First order (1) [2]

II Rate = $k[CH_3COCH_3][H^+]$ [1]

III 7.0×10^{-5} (1)

$dm^3\ mol^{-1}\ s^{-1}$ (1)

Error carried forward (ecf) from parts I and II [2]

(b) (i) The slowest step in the reaction [1]

(ii) First step has 2 molecules of NO_2 as the only reactant (1)
(e.g. $2NO_2 \rightarrow 2NO + O_2$)

Second step has CO as reactant with products from step 1 (1)
(e.g. $2NO + O_2 + 2CO \rightarrow 2NO + 2CO_2$)

Both equations must be balanced

[2]

Total [10]

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2. (a) A weak acid is one that partially dissociates (in aqueous solution) (1)
A dilute acid is one where a small amount of acid has been dissolved in a large volume of water (1) [2]

(b) (i) 0.1 mol dm^{-3} HCl / **W** (1)

Only acid with pH of 1 / curve starts at 1 / strong acid since centre of vertical region is around pH 7 (1) [2]

(ii) 0.1 mol dm^{-3} CH_3COOH / **Y** (1)

Weak acid since vertical region of curve is between 6 and 10 /
centre of vertical region is around pH 8 /
part of curve shows buffering effect (1)

pH is about 3 at start so concentration cannot be 0.001 (1) [3]

(iii) Thymol blue (1)

pH range coincides with pH change during sharp rise in curve **B** (1) [2]

(iv) Volume NaOH at equivalence point = 30.0 cm^3 (1)

Concentration NaOH = 0.083(3) mol dm^{-3} (1)

Ecf from part (i) [2]

(c) Salt hydrolysis occurs $NH_4^+ + H_2O \rightleftharpoons NH_4OH + H^+$
(Accept NH_4^+ partially dissociates to release H^+) [1]

Total [12]

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

(b) pH = 7, therefore $[H^+] = 1.0 \times 10^{-7}$ (1)

$[OH^-] = \dfrac{5.13 \times 10^{-13}}{1.0 \times 10^{-7}} = 5.13 \times 10^{-6}$ (1)

$[OH^-] > [H^+]$ therefore solution is alkaline (1)

Alternative method

$[H^+] = 7.16 \times 10^{-7}$ at 100 °C (1)

pH = 6.15 (1)

pH 7 above neutral so $[OH^-] > [H^+]$ and solution is alkaline (1) [3]

(c) Half-cell where hydrogen at 1 atm (1)
Bubbles over a Pt electrode in contact with 1 mol dm^{-3} H^+(aq) at 298K (1)
[2]

(d) (i) $\Delta H = (–394) + 2(–286) – (–75)$ (1)

$\Delta H = –891$ kJ mol^{-1} (1) [2]

(ii) Heat per unit mass H_2 = $\dfrac{286}{2.02}$ = 141.6 kJ g^{-1} (1)

Heat per unit mass CH_4 = $\dfrac{891}{16.04}$ = 55.5 kJ g^{-1} (1) [2]

(e) The fuel cell uses electrochemical methods to get energy from hydrogen / generates EMF / creates a flow of electricity (1)

Hydrogen is oxidised producing H^+ ions and electrons at anode (1)

(Accept equation)

Oxygen is reduced at the cathode to water (1)

(Accept equation) [3]

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

(f) (i) $K_p = \dfrac{(pNH_3)^2}{(pH_2)^3(pN_2)}$ do not accept [ ] [1]

(ii) pH_2 = 58 atm and pNH_3 = 16 atm (1)

$K_p = 7.3 \times 10^{-5}$ (1)

Units = atm^{-2} (1)

Ecf from part (i) but not from incorrect partial pressures [3]

Total [18]

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SECTION B

4. (a) (i) Good catalysts [1]

(ii) Cu^{+} has full 3d orbitals (1)
(Accept electronic configuration)

Electrons cannot move from lower energy 3d orbitals to higher ones (1)
[2]

(b) Suitable example of ligand substitution (1)
e.g. reaction of <u>excess</u> ammonia solution with $CuSO_4$/$[Cu(H_2O)_6]^{2+}$

Suitable observation (1)
e.g. formation of <u>royal blue</u> solution

Correct formula (1)
e.g. $[Cu(NH_3)_4(H_2O)_2]^{2+}$

Suitable example of precipitation (1)
e.g. reaction between $CuSO_4$ and NaOH

Suitable observation (1)
e.g. pale blue precipitate

Correct formula (1)
e.g. $Cu(OH)_2$ [6]

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

(c) (i) Starch
[1]

(ii) Moles $S_2O_3^{2-} = 4.80 \times 10^{-3}$ (1)

Moles Cu^{2+} in original solution = 1.92×10^{-2} (1)

Mass Cu = 1.22 g (1)

Percentage Cu = 59.5 % (1) [4]

(d) (i) Salt bridge (1)

It completes the circuit by allowing the ions to move (1) [2]

(ii) Cu electrode since electrons flow to it through the external circuit /
Cu has <u>more</u> positive E^{θ} - do not accept 'higher E^{θ}' [1]

(iii) 0.78 V [1]

(iv) No – Fe better reducing agent / has more negative E^{θ} / emf is negative
[1]

Total [20]

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5. (a) (i) Oxidation state II becomes more stable / oxidation state IV becomes more unstable (1)

Inert pair effect / the two outer s electrons become more stable (as group is descended) (1) [2]

(ii) Carbon dioxide is acidic while lead(II) oxide is amphoteric (1)

e.g. $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$ (1)

$Pb^{2+} + 2OH^- \rightarrow Pb(OH)_2$

$Pb(OH)_2 + 2OH^- \rightarrow [Pb(OH)_4]^{2-}$ (1)

or

$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$

$PbO + 2OH^- + H_2O \rightarrow [Pb(OH)_4]^{2-}$ (1)

Carbon monoxide is a reducing agent while lead(IV) is an oxidizing agent (1)

e.g. $CO + CuO \rightarrow CO_2 + Cu$ (1)

$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$ (1) [6]

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

(b) (i) A gas (and a liquid) forms / more moles form in the reaction and the molecules have more freedom [1]

(ii) $\Delta S = 530$ ($J\ K^{-1}\ mol^{-1}$) [1]

(iii) $\Delta G = 135 - 298(0.53)$ (1)

$\Delta G = -22.9$ ($kJ\ mol^{-1}$) (1)

ΔG is negative so the reaction is feasible (1) [3]

(c) $\Delta H_f = \Delta H_{at}Ba + I.E.Ba + \Delta H_{at}Cl_2 + E.A.Cl + \Delta H_{lat}BaCl_2$ (1)

Doubling value for forming 2Cl and $2Cl^-$ (1)
(These marks can be obtained from Born-Haber cycle)

$\Delta H_f\ BaCl_2 = 176 + 1468 + 242 - 728 - 2018$ (1)

$\Delta H_f\ BaCl_2 = -860$ ($kJ\ mol^{-1}$) (1) [4]

(d) NaCl / Cl^- (1)

$NaClO_3$ / ClO_3^- (1) [2]

Total [20]

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