GCE MARKING SCHEME

SUMMER 2016

CHEMISTRY-CH1 (LEGACY)
1091/01

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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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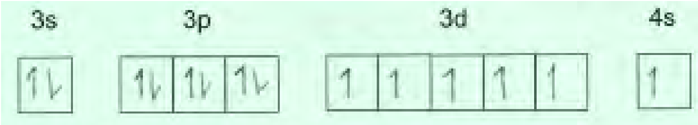
GCE CHEMISTRY-CH1 (LEGACY)

SUMMER 2016 MARK SCHEME

SECTION A

1.



[1]

2. B [1]

3. (a) $_{11}Na$ [1]

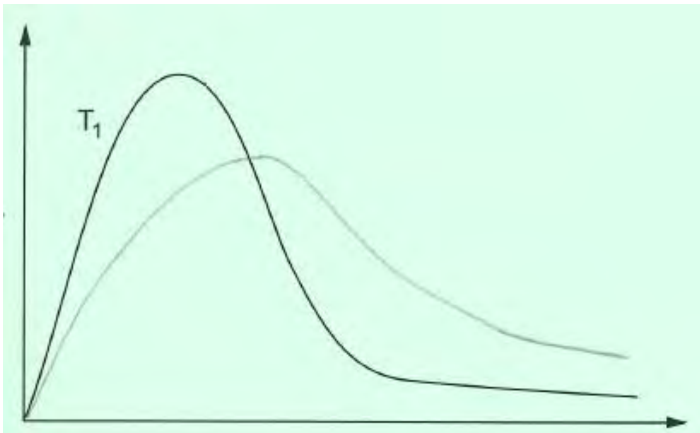
(b) 45 hours is the time of 3 half-lives and therefore 1/8 of the mass of the radioactive isotope mass is left (1)

$\therefore$ original mass = $0.15 \times 8 = 1.2$ (g) (1) [2]

4. The relative isotopic masses of the bromine atoms are
$136 - (3 \times 19) = 79$ and $138 - (3 \times 19) = 81$ (1)

(As they have equal intensities) each is 50% of the bromine atoms present (1) [2]

5. Sketch shows a lower peak to the right of the peak for T_1 and a higher percentage of higher energy molecules.



[1]

6. (a) Temperature 298 K / 25°C

Pressure 101.3 kPa / 1.013×10^5 Pa / 1 atmosphere [1]

(b) 100 (kJ) [1]

Total Section A [10]

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SECTION B

7. (a) $CH_2N_2O_2$ [1]

(b) (i) $\Delta H_1 + \Delta H_d = \Delta H_2$

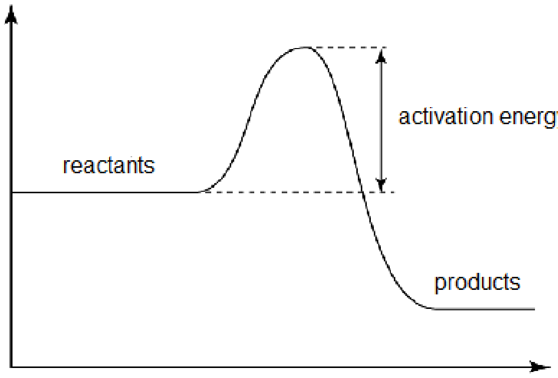
$\therefore \Delta H_d = \Delta H_2 - \Delta H_1$ (1)

$\Delta H_1 = +62$

$\Delta H_2 = (3 \times -111) + (3 \times -242) = -333 + (-726) = -1059$ (1)

$\Delta H_d = -1059 - (+62) = -1121$ (kJ mol^{-1}) (1) [3]

(ii)



reactants / products / activation energy correctly labelled (1)
profile shown as exothermic (1) [2]

(iii) The activation energy is the minimum energy required by molecules for them to react (1)

The lower figure for mercury fulminate suggests that it is less stable than RDX as it is easier for molecules to attain the activation energy and react (1) [2]

(c) (i) Other unwanted products / methanol / water are produced [1]

(ii) Unsafe / toxic solvent propanone / benzene used / non-renewable solvent used [1]

(d) (i) Green has the higher energy as energy is inversely proportional to wavelength / as it has the shorter wavelength [1]

(ii) Electrons are excited and absorb energy as they move to a higher energy level (1)

When they relax / return to a lower level (1)

This energy is given out as energy in the visible part of the (electromagnetic) spectrum (1) [3]

Total [14]

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8. (a) (i) An acceptor of hydrogen ions / $H^+(aq)$ [1]

(ii) He overshot the endpoint / the burette was not rinsed out with the acid solution / some water remained in the burette [1]

(iii) Mean volume of iodic(V) acid = 18.60 (1)

Number of mol of NaOH used $= \dfrac{25.00 \times 0.125}{1000} = 0.003125$ (1)

Mole ratio is 1:1

$\therefore$ 18.60 cm^3 of the iodic(V) acid solution contain 0.003125

$\therefore$ 1.00 dm^3 of the iodic(V) acid solution contains

$$\frac{0.003125 \times 1000}{18.60} = 0.168$$

Concentration of iodic(V) acid = 0.168 (mol dm^{-3}) (1) [3]

(iv) Using only 10.00 cm^3 would lead to a titre of ~7.50 cm^3, this is too small and likely to lead to errors in accuracy [1]

(b) (i) Correct plots and straight line joining them [1]

(ii) Moles of carbon monoxide from the graph $= 1.235 \times 10^{-4}$ (1)

$\therefore$ Volume of carbon monoxide $= 1.235 \times 10^{-4} \times 24000$

$= 2.964 / 2.97$ (1)

% of carbon monoxide in the mixture $= \dfrac{2.964 \times 100}{300} = 0.988$ (1) [3]

Accept a range from the graph of 1.230 to 1.240 × 10^{-4} moles of CO giving a % of CO in the mixture from 0.984 to 0.992

(c) $2NO + 2CO \rightarrow 2CO_2 + N_2$ [1]

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(d) Catalysts increase the rate of the reaction by providing an alternative pathway of lower activation energy (1)

This results in more molecules having enough energy to react / more successful collisions in a given time (1)

Although catalysts reduce the amount of time taken for a reacion to reach the position of equilibrium (1) they do not affect the position of equilibrium (1)

This is because they increase the rate of the forward and reverse reactions equally (1)

Any 4 from 5 points [4]

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

Total [16]

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9. (a) (i) Bonds broken = 1949 Bonds made = 2039 (1)

Enthalpy change = ΔH bonds broken – ΔH bonds made
= 1949 – 2039
= –90 (kJ mol^{-1}) (1) do not accept 90 [2]

(ii) Bond enthalpies are an average value (and the actual value for each bond depends on its environment) / they refer to standard conditions [1]

(iii) In this reaction methanol is produced as a liquid – it is more exothermic because **heat is given out** when a gas becomes a liquid [1]

(iv) I A reaction where the rate of the forward reaction is equal to the rate of the reverse reaction [1]

II High pressure is needed as there are more (gaseous) moles on the left hand side than on the right hand side – using a higher pressure will move the position of equilibrium to the right creating more methanol (1)

The answer to (i) indicates that the reaction is exothermic – if the temperature is increased this will favour the endothermic / reverse reaction therefore a lower temperature will give a higher equilibrium yield of methanol (1)

accept appropriate explanation if *endothermic* given in (i) [2]

(b) (i) Each carbon (or CH_2) being oxidised gives an extra 653 (kJ mol^{-1}) evolved
$\therefore$ a loss of 3 C / CH_2 will reduce the figure by $3 \times 653 = 1959$ (kJ mol^{-1}) (1)

$\therefore$ Answer is ~ –719 (kJ mol^{-1}) (1) [2]

(ii) Heat losses are occurring (1)

Use a lid / conical flask / insulate the beaker / provide shielding around the burner (1) [2]

One mark for mentioning heat loss and the other mark for a method that reduces the loss of heat

(iii) M_r methanol 32.04

680 kJ from 32.04 g methanol (mass of 1 mol) (1)
1 kJ from $\dfrac{32.04}{680}$

$\therefore$ 18.7 kJ from $\dfrac{32.04 \times 18.7}{680}$ = 0.88 (g) (1) [2]

Total [13]

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10. (a) $1_s^2\ 2_s^2\ 2_p^6\ 3_s^2$ (1)

As successive electrons are removed the value of the ionisation energy increases due to electrons being removed from an increasingly positive charged ion / greater effective nuclear charge (1)

The large increase in value between 2 and 3 is due to removal of an electron from the 2p subshell which is closer to the nucleus (1)

There is also a large difference in the figures between electrons 10 and 11 where an electron is being removed from the 1s energy level, which is closest to the nucleus (1)

Credit correct reference to changes in 'shielding' for (1)

Any 4 from 5 points [4]

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

(b) (i) Mole ratio 1 : 1
1 mol H_2 from 1 mol Sr (1)

$\therefore$ 0.0140 mol H_2 from 0.0140 mol Sr

$\therefore A_r$ of strontium $= \dfrac{1.26}{0.0140} = 90.(0)$ (1) [2]

(ii) Mass of water must be 11.95 – 5.47 = 6.48 (1)

Moles of water $= \dfrac{6.48}{18.02} = 0.360$

Moles of $Sr(OH)_2 = \dfrac{5.47}{121.62} = 0.045$ (1)

Ratio 8 : 1

$\therefore x = 8$ (1) [3]

(iii) Titration of a known mass of strontium hydroxide with a standard solution of hydrochloric acid (1) accept 'acid'

Hence finding the M_r of $Sr(OH)_2.\,xH_2O$ (1) and then the value of x by subtraction of the M_r of $Sr(OH)_2$ from the M_r of $Sr(OH)_2.\,xH_2O$ (1)

[3]

(c) Addition of chloride ions from the acid causes the position of equilibrium to move to the left as solid strontium chloride is precipitated from solution (1)

This occurs because of the need to restore the position of equilibrium (according to Le Chatelier’s principle) (1)

[2]

Total [15]

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11. (a) To stop mass loss due to solution / acid spray / to only let carbon dioxide out [1]

(b) (i) 4.4 (minutes) [1]

(ii) Accept values from 0.44 to 0.46 inclusive (1)

$g\ min^{-1}$ (1) [2]

(iii) As the reaction proceeds the concentration of hydrogen ions decreases (1)

As a result the rate of successful collisions between H^+ / $MgCO_3$ becomes less (1)

In addition the surface area of the $MgCO_3$ reduces (as it reacts to become aqueous Mg^{2+} ions) (1)

[3]

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

(iv) New line shows a shallower curve (1)

Finishes with the same loss in mass at time > 16 minutes
or
Loss in mass still rising but less than 3.4 at 20 minutes (1) [2]

(c) pH value increases from ~ 1-2 to 7 (2)

pH value increases (1) [2]

Total [12]

Total Section B [70]

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