Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**CHEMISTRY** **9701/23**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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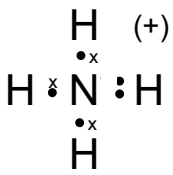
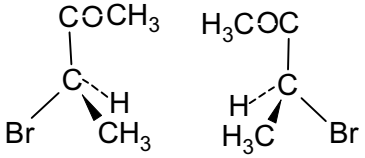
Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| 1 (a) (i) | $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$ | [1] | [1] |
| (ii) | $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$ | [1] | [1] |
| (iii) | $(0.025 \times 32.0/1000=)\ 8 \times 10^{-4}$ | [1] | [1] |
| (iv) | $(8 \times 10^{-4} \times 6 =)\ 4.8 \times 10^{-3}$ | [1] | [1] |
| (v) | $(4.8 \times 10^{-3} \times 250/25.0=)\ 4.8 \times 10^{-2}$ | [1] | [1] |
| (vi) | $(4.8 \times 10^{-2} \times 55.8=)$ 2.68 / 2.678 | [1] | [1] |
| (vii) | (2.68/3.35=) 80% | [1] | [1] |
| (b) (i) | covalent<br>small(er) difference in electronegativity between Fe and C$l$ (than between A$l$ and C$l$) | [1]<br>[1] | [2] |
| (ii) | $FeCl_3 + 6H_2O \rightarrow [Fe(H_2O)_6]^{3+} 3Cl^-$ OR<br>$FeCl_3 + 6H_2O \rightarrow [Fe(H_2O)_6OH]^{2+} + H^+ + 3Cl^-$ | [1] | [1] |
| | | | **[10]** |
| 2 (a) | $NH_3 + HNO_3 \rightarrow NH_4NO_3$ | [1] | [1] |
| (b) (i) | line from origin AND below left-hand end of original with peak to right of and lower than original<br>crosses original once AND above right-hand end of original AND above energy axis | [1]<br>[1] | [2] |
| (ii) | (curves show) more molecules with $E > E_a$ (at higher T)<br>so greater frequency of successful (owtte) collisions / more successful (owtte) collisions per unit time | [1]<br>[1] | [2] |
| (iii) | catalysed $E_a$ shown to left of original on horizontal axis<br>so more molecules with $E > E_a$ (in presence of catalyst) | [1]<br>[1] | [2] |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| **(iv)** | production of ammonia is <u>exothermic</u> / (forward) reaction <u>exothermic</u><br>position of eqm would move to left / reverse / reduce yield (at higher T) | [1]<br>[1] | [2] |
| **(c)** | $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$<br>N changes from –3 to +2 (so oxidation)<br>O changes from 0 to –2 (so reduction) | [1]<br>[1]<br>[1] | [3] |
| **(d) (i)** |  (+) | [1+1] | [2] |
| **(ii)** | shape = tetrahedral<br>angle = 109°–109.5° | [1]<br>[1] | [2] |
| **(e)** | eutrophication / algal bloom / stimulates growth of algae<br>(bacteria) use up oxygen when decomposing the plants / algae<br>block light for plants so less oxygen produced<br>aquatic life / fish die (due to lack of oxygen) | [1]<br>[1]<br>[1]<br>[1] | [max 3] |
| | | | **[19]** |
| **3 (a) (i)** | vaporise / boil / turn to gas | [1] | [1] |
| **(ii)** | increasing molecular size / no of carbon atoms per molecule / length of carbon chain | [1] | [1] |
| **(iii)** | increasing b.pt / decreasing volatility<br>increasing viscosity<br>increasing density<br>increasing depth of colour<br>decreasing flammability / decreasing 'cleanliness' of flame owtte | [1]<br>[1] | [2] |
| **(b) (i)** | $C_{12}H_{26} \rightarrow 2C_2H_4 + C_8H_{18}$ | [1] | [1] |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| (ii) | ethene use = <u>making</u> polythene / plastic / polymers<br>feature of ethene = double bond / unsaturated<br>octane / alkane use = fuel / petrol<br>feature of octane / alkane = flammability / releases energy when burned / combusted | [1]<br>[1]<br>[1]<br>[1] | [4] |
| (c) (i) | (produced by) reaction of (atmospheric) oxygen and nitrogen<br>due to high temperature / engine provides energy / combustion provides energy | [1]<br>[1] | [2] |
| (ii) | $2NO + 2CO \rightarrow N_2 + 2CO_2$ / $NO + CO \rightarrow \frac{1}{2}N_2 + CO_2$ | [1] | [1] |
| (iii) | $NO + \frac{1}{2}O_2 \rightarrow NO_2$<br>$NO_2 + SO_2 \rightarrow SO_3 + NO$<br>$SO_3 + H_2O \rightarrow H_2SO_4$ / $2H^+ + SO_4^{2-}$ / $H^+ + HSO_4^-$ | [1]<br>[1]<br>[1] | [3] |
| (iv) | lowers pH of rivers / lakes / kills fish<br>leaches (toxic) aluminium from soil (into rivers / lakes)<br>leaches away soil nutrients<br>damage to buildings / statues / trees / plants / crops<br>ocean acidification / damage to coral | [1]<br>[1]<br>[1]<br>[1]<br>[1] | [max 2] |
| | | | **[17]** |
| **4** (a) | 3-hydroxybutan(-2-)one | [1] | [1] |
| (b) | $H_2$ / $Cr_2O_7^{2-}$ or names<br><br>heat / reflux / warm | [1]<br><br>[1] | [2] |
| (c) (i) | absorption at 1670–1740 C (=) O<br>absorption at 2850–3000 C (-) H<br>absorption at 3200–3650 O (-) H | [1]<br>[1]<br>[1] | [3] |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| **(ii)** | no absorption at 3200–3650<br>O-H disappears / no O-H bond in diacetyl | [1]<br>[1] | [2] |
| **(d) (i)** | $CH_3COCH(=)CH_2$ | [1] | [1] |
| **(ii)** | one of the double-bonded C atoms / first C has 2H atoms attached **ora**<br>so no cis-trans / *E-Z* / geometric(al) isomerism possible<br>OR<br>no chiral C<br>so mirror images superimposable / molecule not asymmetric | [1]<br><br><br>[1] | [2] |
| **(iii)** | asymmetric / chiral C atom / carbon with four different groups / atoms attached | [1] | [1] |
| **(iv)** |  | [1+1] | [2] |
| | | | **[14]** |