

CAMBRIDGE INTERNATIONAL EXAMINATIONS
GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/22

Paper 2 (AS Structured Questions), maximum raw mark 60

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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- 1 (a) a base is a proton acceptor **or**
a lone pair donor (1)
a weak base is not fully ionised (1)
e.g. $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$ **or**
 $\text{B} + \text{H}^+ \rightleftharpoons \text{BH}^+$ **or** equivalent
 \rightleftharpoons is necessary (1) [3]
- (b) (i) **stated** pressure greater than 1 atm up to 5 atm (1)
stated temperature 400 to 500 °C (1)
named catalyst V_2O_5 /vanadium(V) oxide (1)
- (ii) SO_3 is dissolved in concentrated H_2SO_4
and then diluted with water
not ' SO_3 dissolved in water' as the only statement (1) [4]
- (c) (i) **with concentrated sulfuric acid**
 $\text{ClCH}_2\text{CH}=\text{CHCl}$ (1)
- with ammonia**
 $\text{H}_2\text{NCH}_2\text{CH}(\text{OH})\text{CH}_2\text{NH}_2$ (1)
- (ii) nucleophilic (1)
substitution (1) [4]

[Total: 11]

| Page 3 | Mark Scheme | Syllabus | Paper |
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- 2 (a) (i) $n(\text{H}_2\text{SO}_4) = \frac{25.0 \times 1.00}{1000} = 0.025 \text{ mol}$ (1)
- (ii) $n(\text{NaOH}) = \frac{16.2 \times 2.00}{1000} = 0.0324 \text{ mol}$ (1)
- (iii) $n(\text{H}_2\text{SO}_4) \text{ reacting with NaOH} = \frac{0.0324}{2} = 0.0162 \text{ mol}$ (1)
- (iv) $n(\text{H}_2\text{SO}_4) \text{ reacting with NH}_3 = 0.025 - 0.0162 = 0.0088 \text{ mol}$ (1)
- (v) $n(\text{NH}_3) \text{ reacting with H}_2\text{SO}_4 = 2 \times 0.0088 = 0.0176 \text{ mol}$ (1)
- (vi) $n(\text{NaNO}_3) \text{ reacting} = n(\text{NH}_3) \text{ produced} = 0.0176 \text{ mol}$ (1)
- (vii) mass of NaNO_3 that reacted = $0.0176 \times 85 = 1.496 \text{ g}$ (1)
- (viii) $\% \text{ of NaNO}_3 = \frac{1.496 \times 100}{1.64} = 91.2195122 = 91.2$
- give one mark for the correct expression (1)
- give one mark for answer given as 91.2 – i.e to 3 sig. fig. (1)
- allow ecf where appropriate
- [9]
- (b) NaNO_3 +5 and NH_3 -3 both required (1) [1]

[Total: 10]

| | | | |
|--------|--------------------------------|----------|-------|
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3 (a) penalise (-1) the use of names of elements or formulae of compounds

- (i) Ca (1)
(ii) O or N or C (1)
(iii) C or N or S or F or Cl or Br (1)
(iv) Si or Ge or B (1)
(v) Al or Si or P or S or H (1)
(vi) Al (1) [6]

(b) (i)

| element | Na | Mg | Al | Si | P | S |
|---------|------------------------|-------|--------------------------------|------------------|---|-----------------|
| oxide | Na ₂ O | MgO | Al ₂ O ₃ | SiO ₂ | P ₂ O ₅ /P ₄ O ₁₀ or P ₂ O ₃ /P ₄ O ₆ | SO ₂ |
| flame | yellow or orange | white | white | white | white or yellow | blue |

formula of oxide (1)
colour of flame (1)

(ii)

| | | | | | | |
|----------|------|-------------------|--|-------------------|--|--|
| chloride | NaCl | MgCl ₂ | AlCl ₃ or Al ₂ Cl ₆ | SiCl ₄ | PCl ₃ or PCl ₅ | SCl ₂ or S ₂ Cl ₂ |
| pH | 7 | 6.5 to 6.9 | 1 to 4 | | | |

formula of chloride (1)
pH of solution formed (1) [4]

(c) (i)



(1)

- (ii) intermolecular forces/van der Waals' forces
are stronger or greater in ICl (1)
ICl has most electrons or
has the largest permanent dipole (1)

- (iii) ICl (1)
greatest difference in electronegativity is between I and Cl (1) [5]

[Total: 15]

| | | | |
|--------|--------------------------------|----------|-------|
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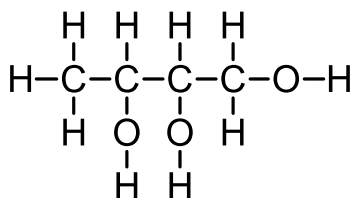
4 (a)

| | | |
|---|--|--|
| A | Br ₂ in an inert organic solvent | CH ₃ CHBrCHBrCH ₂ OH |
| B | PCl ₅ | CH ₃ CH=CHCH ₂ Cl |
| C | H ₂ and Ni catalyst | CH ₃ CH ₂ CH ₂ CH ₂ OH |
| D | NaBH ₄ | NO REACTION |
| E | K ₂ Cr ₂ O ₇ /H ⁺ , heat under reflux | CH ₃ CH=CHCO ₂ H |

give one mark for each correct answer

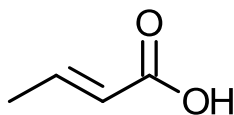
(5 × 1) [5]

(b)



(1) [1]

(c)



correct C₄ with C=C in position 2

accept *cis* form

correctly shown -CO₂H

allow ecf on candidate's answer to E in (a)

(1)

(1)

[2]

| | | | |
|---------------|---------------------------------------|-----------------|--------------|
| Page 6 | Mark Scheme | Syllabus | Paper |
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| (d) (i) reagent | observation | |
|---|---|---------|
| 2,4-dinitrophenylhydrazine Tollens' reagent | red/orange ppt. silver mirror or grey ppt. or black ppt. | |
| Fehling's reagent | brick red ppt. | |
| correct reagent | | (1) |
| observation | | (1) |
| (ii) reduction or nucleophilic addition | | (1) [3] |
| (e) | $\text{C} : \text{H} : \text{O} = \frac{73.7}{12} : \frac{12.3}{1} : \frac{14.0}{16}$ $= 6.14 : 12.3 : 0.875$ $= 7.01 : 14.1 : 1$ | (1) |
| gives C ₇ H ₁₄ O formula must be given | | (1) [2] |

[Total: 13]

| | | | |
|---------------|---------------------------------------|-----------------|--------------|
| Page 7 | Mark Scheme | Syllabus | Paper |
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5 (a) $C_4H_8O_2$ (1) [1]

(b)

| | |
|---------------------------------|--------------------------------|
| $HCO_2CH_2CH_2CH_3$ W | $HCO_2CH(CH_3)_2$ X |
| $CH_3CO_2CH_2CH_3$ Y | $CH_3CH_2CO_2CH_3$ Z |

give one mark for each correct answer (4 × 1) [4]

(c) (i) $-CHO$ or aldehyde absent (1)
(ii) $>CO$ or carbonyl absent (1)
(iii) $-CO_2H$ or carboxylic acid present (1) [3]

(d) (i) CH_3CO_2H or ethanoic acid (1)
(ii) Y above (1) [2]

(e) none – no chiral carbon atoms present (1) [1]

[Total: 11]