



Rewarding Learning

ADVANCED
General Certificate of Education
January 2013

Chemistry

Assessment Unit A2 1

assessing

Periodic Trends and Further Organic,
Physical and Inorganic Chemistry

[AC212]

MONDAY 14 JANUARY, AFTERNOON

**MARK
SCHEME**

Section A

- 1 D
- 2 A
- 3 A
- 4 C
- 5 B
- 6 A
- 7 A
- 8 A
- 9 D
- 10 D

[2] for each correct answer

[20]
Section A

AVAILABLE MARKS	
	20
Section A	20

Section B

- 11 (a) Entropy is the (degree of) disorder (in a system) [1]
- (b) Despite the drop in temperature which means ΔH is positive there is a (great) increase in entropy [1]
because of the carbon dioxide produced
hence ΔG is negative and the reaction is spontaneous [1] [2]
- (c) $\Delta G = \Delta H - T\Delta S$
if ΔS is -ve then $-T\Delta S$ is +ve [1]
(ΔH is +ve i.e. both are +ve)
then ΔG must be +ve and the reaction is not possible/feasible [1] [2]
- (d) (i)
- | | | | | | |
|------------------------|--------------|---|--------------|----------------------|---------|
| | N_2 | + | $3H_2$ | \rightleftharpoons | $2NH_3$ |
| Mol before equilibrium | 1.0 | | 3.0 | | 0 |
| Mol after equilibrium | $1.0 - 0.75$ | | $3.0 - 2.25$ | | 1.5 |
| | 0.25 | | 0.75 | | 1.5 |
- Nitrogen = $0.25/2.5 = 0.1$
Hydrogen = $0.75/2.5 = 0.3$
Ammonia = $1.5/2.5 = 0.6$ [2]
- (ii) Nitrogen = $0.1 \times 3 \times 10^7$ Pa
Hydrogen = $0.3 \times 3 \times 10^7$ Pa
Ammonia = $0.6 \times 3 \times 10^7$ Pa
- Nitrogen = 3×10^6 Pa
Hydrogen = 9×10^6 Pa
Ammonia = 1.8×10^7 Pa units needed [2]
- (iii) $K_p = (1.8 \times 10^7)^2 / 3 \times 10^6 \times (9 \times 10^6)^3 = 1.48 \times 10^{-13} \text{ Pa}^{-2}$ [2]

AVAILABLE
MARKS

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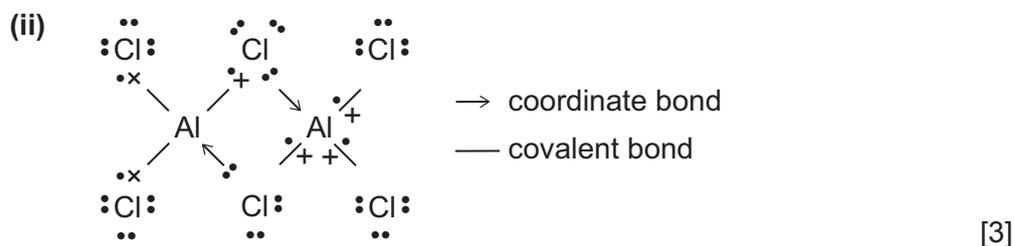
name	formula	approximate pH of solution	bonding in structure of chloride
sodium chloride	$NaCl$	7	ionic
magnesium chloride	$MgCl_2$	6	ionic
aluminium chloride	Al_2Cl_6	1 or 2	covalent/coordinate
phosphorus pentachloride	PCl_5	1 or 2	covalent or covalent + ionic

[5]

(b) sodium +1 magnesium +2 aluminium +3 phosphorus +5 chlorine -1 [2]
error [-1]

(c) $PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$
or
 $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$ [2]

(d) (i) Two molecules joined together [1]



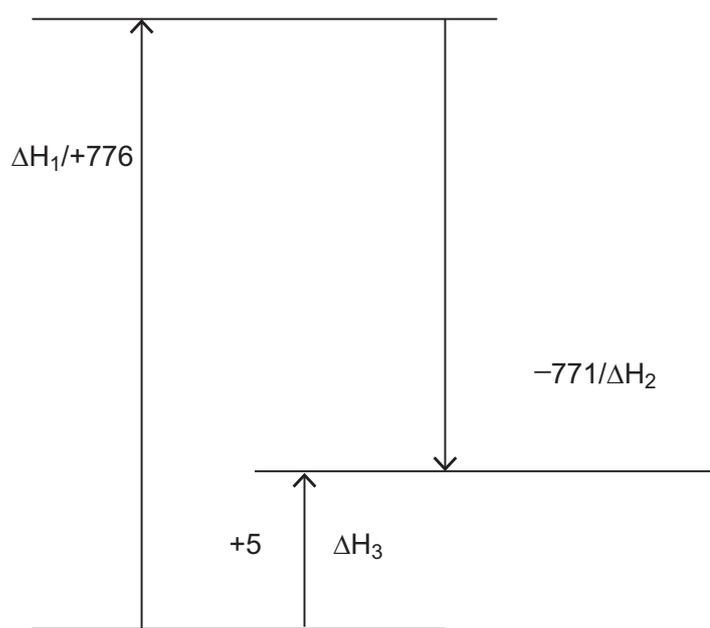
[3]

(e) Magnesium chloride is formed from a weak(er) base and a strong acid [1]
sodium chloride is formed from a strong(er) base and a strong acid [1] [2]
or Mg^{2+} polarises H_2O [2]

(f) (i) Lattice enthalpy/energy [1]

(ii) Hydration enthalpy/energy [1]

(iii) No need to write the symbols on the lines



[3]

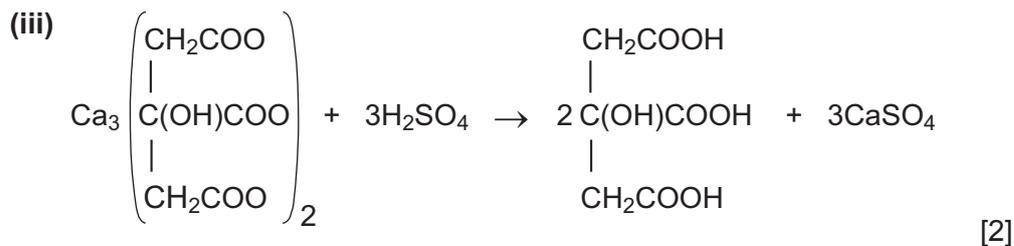
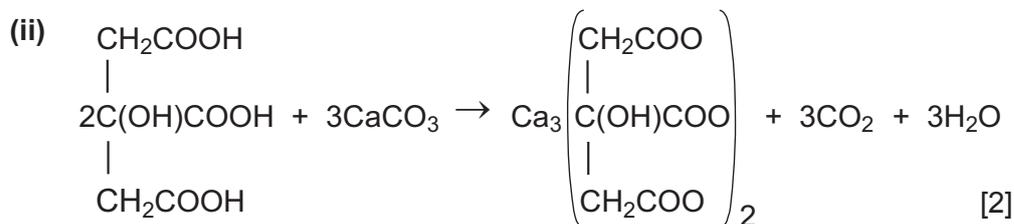
or an equivalent Hess Law diagram.

(iv) $\Delta H_3 = -771 + 776 = +5$ (kJ) [1]

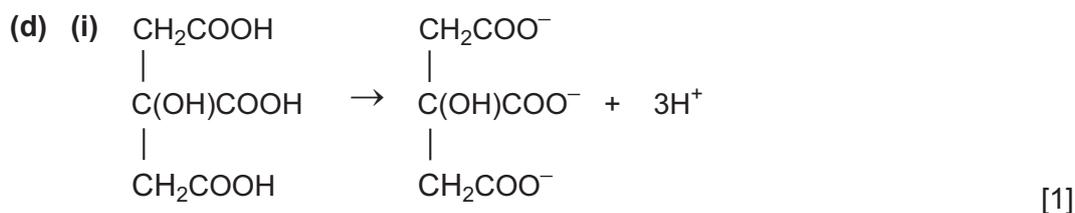
21

13 (a) One molecule of citric acid/contains three $-\text{COOH}$ [1]
or donates three protons [1] per molecule [1] [2]

(b) (i) No effect [1]
e.g. citric acid melts at 153°C [1]



(c) A Hydrogen chloride/phosphorus pentachloride/ SOCl_2 [1]
B (acidified) potassium dichromate etc [1]
C hydrogen cyanide [1]
D named dilute $\text{HCl}/\text{H}_2\text{SO}_4/\text{HNO}_3$ or conc HCl [1]
or NaOH/KOH followed by acid [1]



(ii) Citric acid = $\text{C}_6\text{H}_8\text{O}_7 = 6 \times 12 + 8 \times 1 + 7 \times 16 = 72 + 8 + 112 = 192$

60g of citric acid = $60/192$ mole in 1000cm^3 water = 0.31M

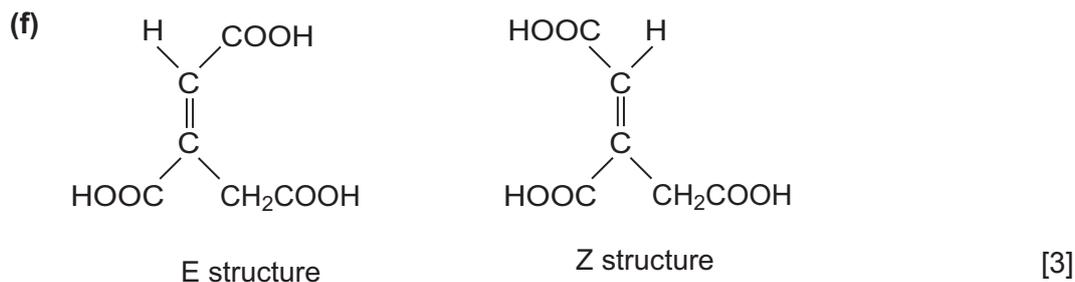
$$8.9 \times 10^{-4} = [\text{H}^+]^2/[\text{HX}]$$

$$[\text{H}^+]^2 = 8.9 \times 10^{-4} \times 0.31 = 2.76 \times 10^{-4}$$

$$[\text{H}^+] = 1.66 \times 10^{-2}$$

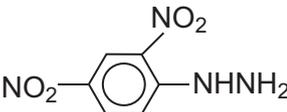
$$\text{pH} = 1.78 \quad [4]$$

(e) Tertiary alcohol group [1]
carbon attached to the oxygen is attached to three carbons [1] [2]



AVAILABLE
MARKS

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- 14 (a) An ion or molecule with a lone pair of electrons that attacks regions of low electron density [2]
- (b) The nucleophile is attracted to the δ^+ on the carbon atom [1]
- (c)
$$\begin{array}{c} \text{H} \\ \diagdown \\ \text{C}=\text{O} \\ \diagup \\ \text{H} \end{array} + \text{CN}^- \rightarrow \begin{array}{c} \text{H} \quad \text{O} \\ \diagdown \quad \diagup \\ \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{CN} \end{array} + \text{H}^+ \rightarrow \begin{array}{c} \text{H} \quad \text{OH} \\ \diagdown \quad \diagup \\ \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{CN} \end{array}$$
 [2]
- (d) (i)
$$\text{CH}_3\text{COCH}_3 + \text{NH}_2\text{NH}_2 \rightarrow \begin{array}{c} \text{CH}_3 \\ \diagdown \\ \text{C}=\text{N.NH}_2 \\ \diagup \\ \text{CH}_3 \end{array} + \text{H}_2\text{O}$$
 [2]
- (ii)
$$\begin{array}{c} \text{CH}_3 \\ \diagdown \\ \text{CO} \\ \diagup \\ \text{CH}_3 \end{array} + \text{NH}_2\text{NH}_2 \rightarrow \begin{array}{c} \text{CH}_3 \quad \text{O}^- \\ \diagdown \quad \diagup \\ \text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{NH}_2^+\text{NH}_2 \end{array}$$
 [1]
- (iii)  [1]
- (iv) 2,4-dinitrophenylhydrazine is large/large mass [1]
it has polar groups [1]
hence van der Waals forces larger in the derivative [1]
polar forces larger [1]
hydrazone is more likely to precipitate from solution/be a solid [1]
more likely to have a high melting point [1]
- To a maximum of [3] [3]
- (e)
$$\text{CH}_3\text{CH}_2\text{CHO} + \text{NH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}=\text{NOH} + \text{H}_2\text{O}$$
 [2]
- (f) (i)

reagent	formula of metal/ion before test	formula of metal/ion after a positive test
Fehling's solution	Cu^{2+}	Cu^+
Tollen's reagent	Ag^+	Ag

 [2]
- (ii) Fehling's and Tollen's [1]
- (g) Infrared spectrum [1]
specific frequencies for specific bonds [1]
mass spectrometry [1]
molecular ion pattern [1]
- To a maximum of [3] [3]

AVAILABLE
MARKS

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- 15 (a) (i) $C_nH_{2n}O_2$ [1]
- (ii) There is an increase in mass [1]
van der Waals forces increase [1] [2]
- (iii) Al block/water/oil bath [1] + melting point tube/sealed capillary tube [1]
heat slowly/e.g. one degree every 10 seconds [1]
note when the solid starts to melt [1]
note when the solid stops melting [1] } m.pt range [1]
- To a maximum of [4] [4]
- Quality of written communication [2]
- (b) (i) $C_8H_{16}O$ [1]
- (ii)
$$\begin{array}{c} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} + \begin{array}{c} C_{15}H_{31}COOH \\ \\ C_{15}H_{31}COOH \\ \\ C_{15}H_{31}COOH \end{array} \rightarrow \begin{array}{c} CH_2OCOC_{15}H_{31} \\ | \\ CHOCOC_{15}H_{31} \\ | \\ CH_2OCOC_{15}H_{31} \end{array} + 3H_2O$$
 [2]
- (iii) Number of milligrams of [1]
potassium hydroxide [1]
required to react with 1 g of fat/oil [1] [3]
- (iv) Moles of palmitin = $1/806 = 0.00124$ mole
moles of KOH required = $3 \times 0.00124 = 0.00372$
mass of KOH required = $56 \times 0.00372 = 0.208$ g
= 208 mg [3]
- (c) (i) Contains no double bonds [1]
of the type $C=C$ [1] [2]
- (ii) No iodine value [1]
no $C=C$ bonds [1] [2]
- (iii) Increased levels of cholesterol [1]
leading to increased level of heart disease [1]
saturated fats are useful for
insulation [1]/energy [1]/protection [1] (max. [2])
all to a maximum of [3] [3]
- (d) Sodium/potassium hydroxide [1]
any hydrochloric/dilute sulfuric acid [1] [2]

AVAILABLE
MARKS

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Section B

100

Total

120