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]	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) $K_p = (1.8 \times 10^7)^2/3 \times 10^6 \times (9 \times 10^6)^3 = 1.48 \times 10^{-13}\ Pa^{-2}$ [2] 11

12 (a)

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*

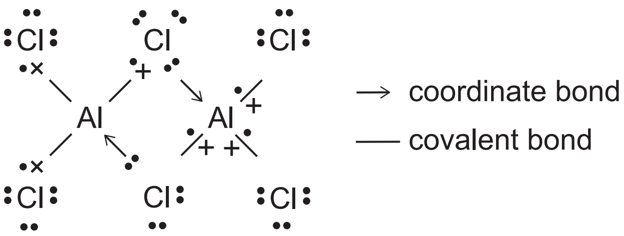
[5]

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

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

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

(ii)



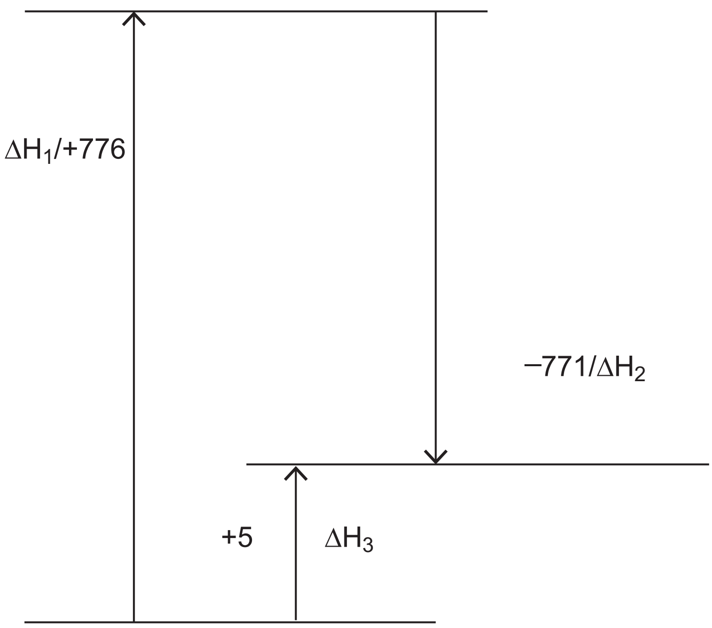
[3]

(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]

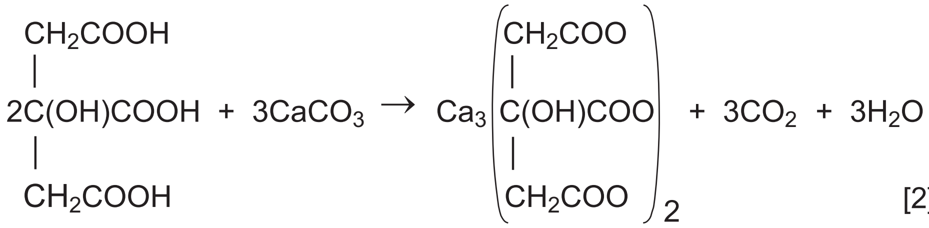
or an equivalent Hess Law diagram.

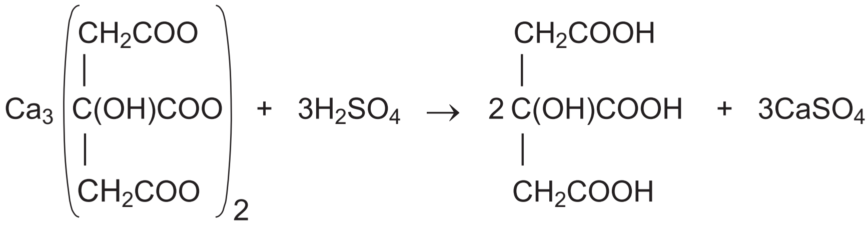
(iv) $\Delta H_3 = -771 + 776 = +5$ (kJ) [1]

21

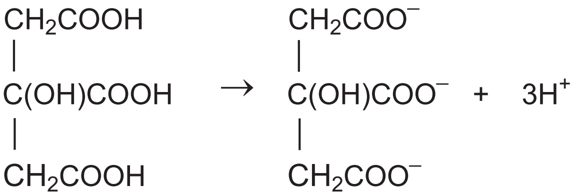
13 **(a)** One molecule of citric acid/contains three –COOH [1]
or donates three protons [1] per molecule [1] [2]

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

(ii)

[2]

(iii)

[2]

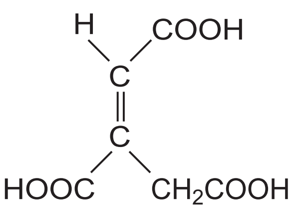
(c) A Hydrogen chloride/phosphorus pentachloride/$SOCl_2$ [1]
B (acidified) potassium dichromate etc [1]
C hydrogen cyanide [1]
D named dilute $HCl/H_2SO_4/HNO_3$ or conc HCl
or NaOH/KOH followed by acid [1]

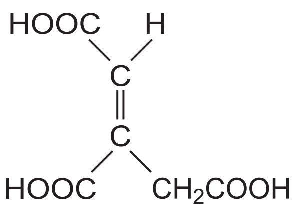
(d) **(i)**

[1]

(ii) Citric acid = $C_6H_8O_7$ = $6 \times 12 + 8 \times 1 + 7 \times 16 = 72 + 8 + 112$
$= 192$

60 g of citric acid = 60/192 mole in 1000 cm^3 water = 0.31 M
$8.9 \times 10^{-4} = [H^+]^2/[HX]$
$[H^+]^2 = 8.9 \times 10^{-4} \times 0.31 = 2.76 \times 10^{-4}$
$[H^+] = 1.66 \times 10^{-2}$
pH = 1.78 [4]

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

(f)

E structure

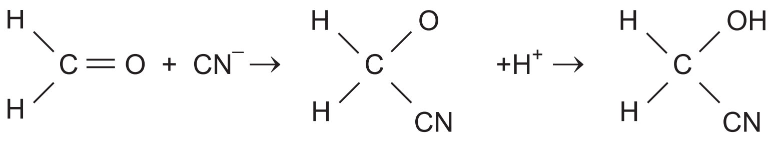

Z structure [3]

21

14 (a) An ion or molecule with a lone pair of electrons that attacks regions of low electron density [2]

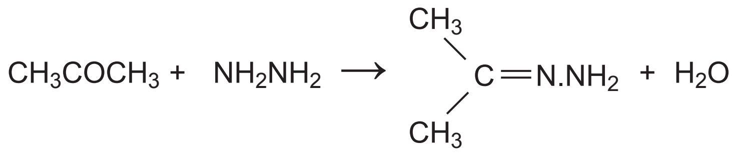
(b) The nucleophile is attracted to the $\delta+$ on the carbon atom [1]

(c)



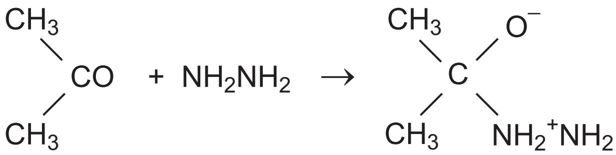
[2]

(d) (i)



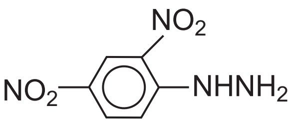
[2]

(ii)



[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) $CH_3CH_2CHO + NH_2OH \longrightarrow CH_3CH_2CH{=}NOH + H_2O$ [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] 20

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] } m.pt range [1]
note when the solid stops melting [1] }

To a maximum of [4] [4]

Quality of written communication [2]

(b) (i) $C_8H_{16}O$ [1]

(ii)

$$\begin{array}{lcccccc} CH_2OH & & C_{15}H_{31}COOH & & CH_2OCOC_{15}H_{31} & & \\ | & & & & | & & \\ CHOH & + & C_{15}H_{31}COOH & \rightarrow & CHOCOC_{15}H_{31} & + & 3H_2O \\ | & & & & | & & \\ CH_2OH & & C_{15}H_{31}COOH & & CH_2OCOC_{15}H_{31} & & \end{array}$$

[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 × 0.00124 = 0.00372
mass of KOH required = 56 × 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] 27

Section B	**100**
Total	**120**