Rewarding Learning

ADVANCED
General Certificate of Education
January 2012

Chemistry

Assessment Unit A2 1

assessing

Periodic Trends and Further Organic, Physical and Inorganic Chemistry

[AC212]

THURSDAY 26 JANUARY, MORNING

MARK SCHEME

Section A

1 B

2 C

3 C

4 B

5 C

6 A

7 A

8 B

9 D

10 B

[2] for each correct answer [20] 20

Section A **20**

Section B

11 (a) (i) $\Delta G = \Delta H - T\Delta S$

$\Delta S = 220 - 214 - 2 \times 192 - 70$
$= 220 - 214 - 384 - 70$
$= 220 - 668$
$= -448$

$-25 = -170 - T\Delta S$
$+145 = -T\Delta S = -T(-0.448)$
$T = \frac{145}{0.448}$
$T = 324$ K **or** 51 °C [3]

(ii) the forward reaction is exothermic [1]
less CO_2 removed [1] [2]

(b) (i) $(NH_4)_2CO_3 + 2CH_3COOH \rightarrow 2CH_3COONH_4 + H_2O + CO_2$ [1]

(ii) $\Delta G \leqslant 0$ [1]

(iii) $T\Delta S$ greater than ΔH [1]

(c) (i) $H^+ + CH_3COO^- \rightarrow CH_3COOH$ [1]

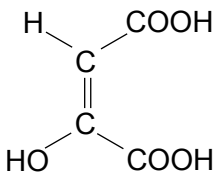
(ii) $CH_3COOH + OH^- \rightarrow CH_3COO^- + H_2O$
or $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ [1]

(d) (i) $CH_3COONH_4(s) \rightleftharpoons CH_3COOH(l) + NH_3(g)$ [2]

(ii) ethanoic acid is present on the RHS [1]
excess ethanoic acid will drive the equilibrium to the LHS [1] [2] 14

12 (a) (i) two [1]

(ii)



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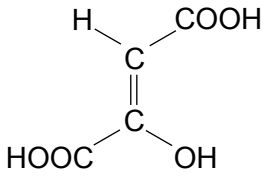


Z

structures [2]
correct labelling [1] [3]

(iii) removal of carbon dioxide/carboxylic acid group [1]

(b) (i) Ag_2O [1]

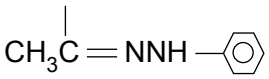
(ii) $CH_3CHOHCOOH + [O] \rightarrow CH_3COCOOH + H_2O$ [1]

(c) sodium/potassium cyanide [1]
hydrochloric acid/sulfuric acid [1]

(d) $CH_3CBr_2COOH \rightarrow CH_3C(OH)_2COOH \rightarrow CH_3COCOOH$ [2]

(e) $SOCl_2$: $CH_3COCOCl$ [1]

$C_6H_5NHNH_2$:



[1]

HCN: $CH_3C(OH)CNCOOH$ [1]

$LiAlH_4$: $CH_3CH(OH)CH_2OH$ [2]

PCl_5: $CH_3COCOCl$ [1] [6]

(f) **(i)** $K = \dfrac{[CH_3COCOO^-]\,[H^+]}{[CH_3COCOOH]}$ [1]

(ii) $K = 0.56 = [H^+]^2/0.25$
$[H^+]^2 = 0.56 \times 0.25 = 0.14$
$[H^+] = 0.37$
pH = 0.43 [3]

(iii) very soluble/soluble in all proportions [1]

(iv) hydrogen bonding [1]
of carboxylic acid group (and carbonyl group) with water [1] [2]

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13 **(a)** **(i)** ΔH_{diss}: heat/enthalpy of dissociation/bond energy of oxygen [1]

(ii) ΔH_{atom}: heat/enthalpy of atomisation [1]

(iii) I_{Mg}: heat/enthalpy of first and second ionisation of magnesium [1]

(b) **(i)** $-602 + U = +148 + 2189 + 249 + 657$
$-602 + U = +3243$
$U = +3845$ [2]

(ii) the value of U is very high [1]
lots of energy needed to separate the ions in MgO [1] [2]

(c) phosphorus(V) oxide is not ionic/is covalent [1]

8

14 **(a)** **(i)** $S + O_2 \rightarrow SO_2$ [1]

(ii) $2S + 3O_2 \rightarrow 2SO_3$ [1]

(b) **(i)** $SO_2 + H_2O \rightarrow H_2SO_3$ [1]

(ii) $SO_3 + H_2O \rightarrow H_2SO_4$ [1]

(c) **(i)** $2NaOH + H_2SO_3 \rightarrow Na_2SO_3 + 2H_2O$ [1]

(ii) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ [1]

(d) sodium hydroxide is a strong base [1]
sulfurous acid is a weak acid [1]
sulfuric acid is a strong acid [1] [3]

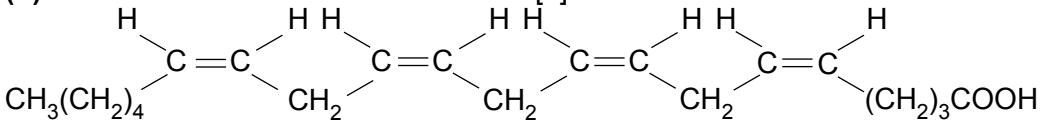
(e) **(i)** pH of dilute solutions is more than concentrated solutions [1]

(ii) range of indicator [1]
matches vertical portion of titration curve [1] [2]

(f) moles of H^+ = 0.2000
moles of OH^- = 0.1998
excess moles of H^+= 0.0002
$[H^+]$ = 0.001
pH = 3.00 [3]

15 **(a)** monounsaturated: one double bond; oleic acid
polyunsaturated: more than one double bond; linoleic, linolenic, arachidonic acids [2]

(b) all the double bonds must be *cis* for [2]



[2]

(c) $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH + I_2 \rightarrow CH_3(CH_2)_7CHICHI(CH_2)_7COOH$ [2]

(d) **(i)** the number of grams of iodine that will react with 100 g of oil/fatty acid [2]

(ii) linolenic acid has the formula $C_{18}H_{30}O_2$ = 216 + 30 + 32 = 278
it has three double bonds hence requires $3I_2 = 6 \times 127$ g = 762 g
278 g of linolenic reacts with 762 g iodine
100 g reacts with 762/278 × 100 = 274.1 g = 274 g of iodine [4]

(iii) arachidonic acid [1]
has four double bonds/the most double bonds [1] [2]

(e) naturally occurring polyunsaturates (mostly cis) lower risk of heart disease [1]
they lower cholesterol/lower LDLs/increase HDLs [1]
many synthetic polyunsaturates/trans fats [1]
increase the risk of heart disease [1]
linolenic acid (Omega-3) and linoleic acid (Omega-6) are essential in the diet (essential fatty acids) [1]
provide energy/insulation/organ protection [1]
synthetic role/cell membranes/hormones/prostaglandins [1]
To a maximum of [4] [4]

Quality of written communication [2]

(f) nickel [1]
finely divided [1]
100–200 °C [1] [3]

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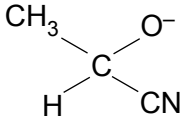
16 **(a)** **(i)**



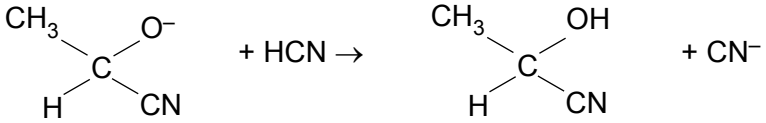
[1]

(ii) the slowest step in the reaction process/mechanism [1]

(iii) rate = k[CH_3CHO][$C\bar{N}$] [1]
rate constant k [1] [2]

(iv) second order [1]

(b) **(i)**



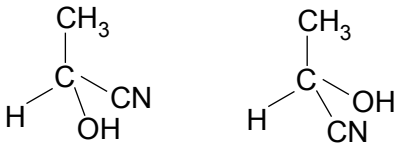
[2]

(ii) fast step [1]
not involved in the rate determining step/ionic reaction [1] [2]

(c) the cyanide ion is regenerated [1]

(d) **(i)** does not rotate the plane [1]
of plane polarised light [1] [2]

(ii)



[2]

(iii) both products equally formed [1]
no overall rotation [1] [2]

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Section B **100**

Total **120**