GCE

Edexcel GCE

Chemistry (8080, 9080)

6246/02

Summer 2005

advancing learning, changing lives

Mark Scheme (Results)

Edexcel GCE
Chemistry (8080, 9080)

IGNORE significant figures throughout

Section A

1. (a) (i) Points plotted correctly **(1)**

Curve drawn **(1)** **(2 marks)**

(ii) Tangent drawn and at correct place **(1)**

Calculation of Δy and Δx **(1)**

$\Delta y \div \Delta x$ to give slope *(ignore sign of slope)* **(1)**

Accuracy of answer: accept anything between 0.01 and 0.02 **(1)**

(4 marks)

(b) (i) Rate = slope (or more accurately rate = - slope)
OR
0.060 ÷ their slope (= 4 approximately) **(1)**

so, when the concentration halves, the rate goes down by a factor of 4, **(1)**

so the reaction is second order (standalone mark) **(1)** **(3 marks)**

(ii) *Any two of*

I Rate = k $[S_2O_8^{2-}]$ $[H_3AsO_3]$
II Rate = k $[S_2O_8^{2-}]^2$
III Rate = k $[H_3AsO_3]^2$ **(2)**

[Only penalise the omission of k or wrong type of [ ] once. Rate equations must be marked consequentially on their order in (i)]

Repeat experiment using double / different initial $[S_2O_8^{2-}]$ / initial $[H_3AsO_3]$, **(1)**
but keeping the [other] unchanged **(1)**

E.g. Any one of the following, as applicable to their two chosen rate equations

If initial rate doubles rate equation **I** is correct
If initial rate quadruples with doubling $[S_2O_8^{2-}]$, rate equation **II** is correct
If initial rate does not alter with doubling/ changing $[S_2O_8^{2-}]$, rate equation **III** is correct.
If initial rate quadruples with doubling $[H_3AsO_3]$, rate equation **III** is correct
If initial rate does not alter with doubling / changing $[H_3AsO_3]$, rate equation **II** is correct. **(1)** **(5 marks)**

Total 14 marks

SECTION B

2. (a) (i) Step 1
hydrogen bromide / HBr / concentrated hydrobromic acid/KBr + concentrated H_2SO_4 **(1)**

Step 2
sodium/potassium hydroxide / NaOH / KOH **(1)**

then any acid *OR* its formula *OR* H^+ **(1)**

Step 3
(potassium) (di)chromate((VI)) and sulphuric acid/acidified *OR* their formulae / Tollens' / Fehling's / Benedict's / acidified (potassium) manganate(VII) **(1)** **(4 marks)**

(ii)

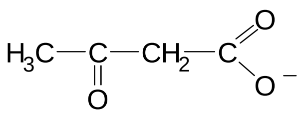
(1)

Not enough energy/heat to break (and cause rotation) the (π / double) **bond** **(1)** **(2 marks)**

(b) (i) $CH_3CH(OH)CH(OH)COO^-$
OR structural formula drawn.
ALLOW acid **(1 mark)**

(ii) $CH_3C(OH)(CN)CH_2COOH$
OR structural formula drawn **(1 mark)**

(c) (i)



(1 mark)

(ii) The acid is **partially** ionised
OR equation $HX\ (+H_2O)$ $H^+\ (H_3O^+) + X^-$ **(1)**

QWC

The salt is **totally** ionised *OR* equation $NaX \rightarrow Na^+ + X^-$ **(1)**

When OH^- ions are added they react with the **large** reservoir of HX molecules **(1)**

$OH^- + HX \rightarrow H_2O + X^-$ (or words), thus removing the added OH^- ions **(1)**

Alternative 3rd and 4th marks:
OH^- reacts with H^+ from ionisation of acid **(1)**
Causing further ionisation of **large** reservoir of HX **(1)** **(4 marks)**

(iii) $K_a = \frac{[H^+] \times [salt]}{[weak\ acid]}$ or $[H^+] = \frac{K_a \times [weak\ acid]}{[salt]}$ or $K_a = \frac{[H^+]\ [X^-]}{[HX]}$ **(1)**

$[H^+] = 10^{-pH} = 10^{-3.80} = 1.58 \times 10^{-4}$ ($mol\ dm^{-3}$) **(1)**

[salt] = K_a x [weak acid] ÷ $[H^+]$ = $2.63 \times 10^{-4} \times 0.500 \div 1.58 \times 10^{-4}$
= 0.832 / 0.830 ($mol\ dm^{-3}$) **(1)**

mass of salt in 1000 cm^3 = 0.832(or 0.830) $mol\ dm^{-3}$ x 124 $g\ mol^{-1}$
= 103 (g) **(1)**

mass of salt needed to be added to 100 cm^3 = 10.3 (g) **(1)**

OR

$pH = pK_a + \log \frac{[salt]}{[weak\ acid]}$ or $pH = pK_a - \log \frac{[weak\ acid]}{[salt]}$ **(1)**

$pK_a = -\log 2.63 \times 10^{-4} = 3.58$ **(1)**

log [salt]/[weak acid] = pH – pK_a = 3.80 – 3.58 = 0.22
[salt]/[weak acid] = $10^{0.22}$ = 1.66
[salt] = 1.66 x 0.500 = 0.830 ($mol\ dm^{-3}$) **(1)**

mass of salt in 1 dm^3 = 0.830mol dm^{-3} x 124 $g\ mol^{-1}$ = 103 (g) **(1)**

mass of salt in 100 cm^3 = 10.3 (g) **(1)** **(5 marks)**

Total 18 marks

3 (a) $K_c = \dfrac{[\text{ester or its formula}] \times [H_2O]^2}{[HOCH_2CH_2OH] \times [CH_3COOH]^2}$ **(1)**

both molar masses **(1)**

$HOCH_2CH_2OH \quad + 2CH_3COOH \quad \rightleftharpoons \text{Ester} \quad + 2H_2O$

Moles at start

24.8/62 = 0.400 66.0/60 = 1.10 **(1)**

Moles at equilibrium

0.400 – 0.320 = 0.080 1.10 – 0.640 = 0.460 0.320 0.640 **(1)**

Concentration at equilibrium **divide above by 0.0900 dm^3** **(1)**

0.080/0.0900 = 0.889 5.11 3.56 7.11

OR explain why volume cancels in this case

$K_c = \dfrac{(3.56) \times (7.11)^2}{(0.889) \times (5.11)^2} = \dfrac{180}{23.2}$

= 7.76 / 7.8 / 7.74 etc. **(1)**

There are no units for *K* **(1)** **(7 marks)**

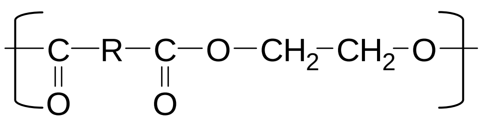
(b) Amount of ethan-1,2-diol = 1054/62 = 17 mol

Amount of ethene = $\dfrac{560}{28}$ = 20 mol or $\dfrac{1054}{1240} \times 100$ **(1)**

Yield = 17 x 100 ÷ 20 = 85% **(1)** **(2 marks)**

(c) (i) Any acid with two COOH groups or its acid dichloride or its dimethyl ester **(1)**

Accept HOOCCOOH



(Where R = the hydrocarbon part of their diacid).

for correct ester linkage drawn out **(1)**

for remainder with continuation **(1)** **(3 marks)**

(ii) No, because the acid would hydrolyse / is a catalyst for the hydrolysis of the ester.

OR

Yes, not hydrolysed at low temperature / only hydrolysed at high temperature **(1 mark)**

(d) The ester cannot form (intermolecular) hydrogen bonds but the acid can **(1)**

Q W C The ester does not have a δ+hydrogen atom
OR
the acid has δ+hydrogen / polar OH / O and H have a large difference in electronegativities **(1)**

thus less energy / heat is required to separate molecules of the ester **(1)**

but as ethanoic acid has **fewer electrons** than propanoic acid, **(1)**

it has **weaker intermolecular** instantaneous induced dipole/ induced dipole forces / van der Waals / dispersion / London forces **(1)**

Allow vdW **(5 marks)**

Total 18 marks

4. (a) (i)

$Ca^{2+}(g)$ + $2OH^-(g)$

$-\Delta H_{lat}$ $\quad$ ΔH hyd $Ca^{2+}(g)$ or –1650 $\quad$ **2** x ΔH hyd OH^- (g) or **2** x (-460)

ΔH soln

$Ca(OH)_2(s)$ $\quad$ $Ca^{2+}(aq)$ + $2OH^-(aq)$

or –16.2 **(1)**

cycle with state symbols or as energy level diagram. **(1)**

labels (*in symbols, words or numbers*) **(1)**

$\Delta H_{soln} = - \Delta H_{lat} + \Delta H_{hyd}\ Ca^{2+} + 2 \times \Delta H_{hyd}\ OH^-$ OR values

(1) **(4 marks)**

$\Delta H_{lat} = -1650 + 2 \times (-460) - (-16.2)$
$= - 2553.8$

(ii) Solubility increases down the group **(1)**
(if this is wrong, no marks available in this part)

Q ΔH_{hyd} of cation decreases / less exothermic **(1)**
W
C but ΔH_{latt} decreases **more** **(1)**

therefore ΔH_{sol} gets **more** exothermic / increases **(1)** **(4 marks)**

(b) (i) Calcium hydroxide will be less soluble at the higher temperature, **(1)**
(if this is wrong, no marks available in this part)

because the reaction is exothermic (left to right) **(1)**

(an increase in temperature will cause a) **decrease in the value of** *K* (and hence drive the equilibrium to the left). **(1)**
(3 marks)

(ii) The solubility will decrease, **(1)**
(if this is wrong, no marks available in this part)

because the addition of OH^- ions will increase **[OH⁻]** / **concentration of OH⁻** **(1)**

driving the equilibrium to the left.

(1) **(3 marks)**

(c) *The three gases are:*

hydrogen bromide $\}$ OR formulae **(1)**
bromine **(1)**
sulphur dioxide **(1)**

The hydrogen chloride / $CaCl_2$ / chloride evolved is not a strong enough reducing agent to reduce / cannot reduce the concentrated sulphuric acid (or sulphuric not a strong enough oxidising agent to ...) **(1)** **(4 marks)**

Total 18 marks
TOTAL FOR PAPER: 50 MARKS