ANDERSON SERANGOON JUNIOR COLLEGE

H2 Chemistry 9729

2019 JC2 Prelim Exam Paper 4 Solutions

1 (a) Results

Chosen time/min	Actual time	t/min	Initial burette reading/cm ³	Final burette reading/cm ³	Volume of FA 4 used/cm ³
4	4 min 6s	4.1	0.00	15.90	15.90
8	8 min 3s	8.1	15.90	30.30	14.40
12	12 min 3s	12.1	0.00	12.90	12.90
16	15 min 56s	15.9	12.90	24.40	11.50
20	19 min 59s	20.0	24.40	34.50	10.10



(ii) Order of reaction is <u>zero</u> with respect to I₂ because it is <u>straight line with constant</u> gradient / <u>rate of reaction is independent of [I₂] / [I₂] decreases linearly with time / [I₂] does not affect rate / [I₂] decreases at a constant rate.</u>

⁽c) (i) Rate = $k [CH_3COCH_3][H^+]$

(ii) Gradient =
$$\frac{y2-y1}{x2-x1} = \frac{9-14.8}{18.75} = -0.309 \text{ cm}^3 \text{ min}^{-1}$$
 (3 s.f with units)
Show coordinates on the graph or in the working
(iii) rate of change = (c)(ii) x 0.01/1000
= -0.309 x 0.01/1000 rate of change is a negative
= -3.09 x 10^{-6} value since [S₂O₃²] decreases
= -3.09 x 10^{-6} over time
(iv) I₂ = 2S₂O₃²⁻
rate of disappearance of I₂ = $\frac{1}{2}$ x |(c)(iii)|
= $\frac{1}{2}$ x 3.09 x 10⁻⁶
= 1.545 x 10⁻⁶ Positive value since the
direction of change,
= 1.55 x 10⁻⁶ mol min⁻¹ (3 s.f.) "disappearance", is specified
(v) rate of change of [I₂] = -(c)(iv) ÷ 10/1000 rate of change is a
= -1.55 x 10⁻⁶ mol min⁻¹ (3 s.f.) "disappearance", is specified
(v) rate of change of [I₂] = -(c)(iv) ÷ 10/1000 rate of change is a
= -1.55 x 10⁻⁴ mol dm⁻³ min⁻¹ (3 s.f with units) decreases over time
(vi) rate = k[CH₃COCH₃][H⁺]
1.545 x 10⁻⁴ = k [CH₃COCH₃][H⁺]
1.545 x 10⁻⁴ = k (1.00 x ½)(1.00 x 2 x ½)
k = 1.24 x 10⁻³ mol⁻¹ dm³ min⁻¹ (3 s.f with units)

- (d) It is added to <u>react with acid catalyst</u> so that the <u>reaction will stop</u> / It is to <u>quench the reaction</u> by <u>reacting with the acid catalyst</u>.
- (e) The low concentration of iodine means that very little propanone and acid are reacted away from the reaction mixture and hence the <u>concentration</u> of propanone and acid remain <u>effectively constant</u>. Hence, the <u>order of reaction with respect to iodine can be determined</u> because any change in the rate is due to the change in concentration of iodine.
- (f) (i) nucleophilic substitution
 - (ii) To prevent reaction of CH₃CH₂CH₂Br with water/hydrolysis (if wet)
 - (iii) Due to the low solubility of NaBr in propanone, <u>NaBr formed gets precipitated out</u>. <u>Position of equilibrium</u> shifts to the <u>right</u>. **or** Since <u>sodium bromide is sparingly soluble in propanone, there will not be sufficient</u> <u>Br ions to attack the electrophilic C attached to I, hence position of equilibrium</u> favors right **or** Since NaI is much more soluble than NaBr, <u>[NaI] is much greater than</u> <u>[NaBr]. Forward rate is much greater than the backward rate</u>. Hence, <u>the reaction</u> <u>favors right.</u>
 - (iv) Since 100% yield of pure 1-iodopropane is obtained and sodium iodide is used in excess,

 $n(CH_3CH_2CH_2Br)$ required = $n(CH_3CH_2CH_2I)$ obtained

mass of CH₃CH₂CH₂Br = 0.05886 x 122.9 = 7.234 g

minimum volume of CH₃CH₂CH₂Br = $7.234 / 1.35 = 5.36 \text{ cm}^{3}$

9729/04/H2

(v) Minimum mass of sodium iodide required = $0.05885 \times 149.9 = 8.82 \text{ g}$

Since sodium iodide is added in excess, mass of sodium iodide to be used > 8.82 g

Preparation of crude 1-iodopropane

- 1. Weigh accurately about <u>10 g</u> of sodium iodide in a <u>50 cm³ round–bottomed flask</u>.
- 2. Using a 10 cm^3 measuring cylinder, transfer 6 cm^3 of 1-bromopropane to the flask.
- 3. Using a 50 cm^3 measuring cylinder, transfer 25 cm^3 of propanone to the flask.
- 4. Swirl the flask to ensure even mixing.
- 5. Add boiling chips (anti-bumping granules) to the mixture.
- 6. Using a <u>water bath / heating mantle</u>, gently <u>heat</u> the flask fitted with a <u>reflux</u> <u>condenser</u> for about 30 minutes.
- 7. <u>Cool</u> down the flask by removing the water bath / heating mantle.
- 8. Remove the flask and fractionally distil the mixture to obtain the pure 1–iodopropane at its boiling point of 102.6 °C.

thermometer fractionating column crude product mixture heating by heating mantle

(Note: solid NaI and NaBr will remain in the flask)

2 (i) Results (a)

mass of empty weighing bottle / g	
mass of weighing bottle + KI / g	
mass of weiging bottle + residual KI / g	
mass of KI used / g	2.018

initial temperature of water / °C	
minimum temperature reached / °C	
$\Delta T_{KI} / °C$	2.0



mass of KI / g

(b)



(c) (i) $m = \frac{\text{mass of FA 6 used}}{2} = \frac{6.020}{2} = 3.010 \text{ g}$ Using the graph in (a)(ii), $\Delta T_{\text{KI}} = 3.0 \text{ °C}$

Or correctly calculates using ΔT per gram of KI by finding gradient Working on the graph, e.g. dotted lines or otherwise, must be shown.

(ii)
$$\Delta T_m - \Delta T_{KI} = \Delta T_{LiCl} = 19.8 + 3.0 = 22.8 \text{ °C} (1 \text{ d.p})$$

(iii)
$$\Delta T \text{ per gram of LiC} = \frac{22.8}{(6.020 \div 2)} = 7.57 \,^{\circ}\text{C g}^{-1} (3 \text{ s.f})$$

- (d) (i) <u>Insoluble barium chromate</u> is formed.
 - (ii) The <u>formation of insoluble barium sulfate</u> will ensure that insoluble barium chromate is not formed during titration.



- (iv) 1. Weigh accurately about <u>3.00 g</u> of BaC*l*₂.xH₂O in a pre–weighed weighing bottle, using a weighing balance (or electronic balance)
 - 2. <u>Dissolve</u> this solid in a beaker with 30 cm³ of *water*.
 - 3. <u>Transfer the solution and washings</u> into a 250 cm³ graduated flask and <u>make up</u> to <u>the mark</u> with deionised water
 - 4. <u>Stopper the graduated flask and shake the solution</u> to obtain a homogeneous solution.
 - 5. <u>Reweigh</u> the emptied weighing bottle.
- (v) First: sulfuric acid Second: potassium chromate(VI) Third: silver nitrate

(a)		test	observations
	1.	Add 1 cm depth of FA 7 to a test-tube. Add aqueous ammonia slowly, with shaking, until no further change is seen. Filter the mixture and add dilute nitric acid drop-wise to the filtrate, until no further change is seen.	Off-white ppt. formed, insoluble in excess NH ₃ (aq). Off-white ppt. rapidly turned brown on contact with air. White ppt, soluble in excess NH ₃ to form a colourless solution. <u>Filtrate</u> is <u>colourless</u> <u>Residue</u> is <u>brown</u> in colour
		(You may continue with test 2, while waiting for the filtration process to complete.)	<u>White ppt</u> refomed, <u>soluble</u> in excess acid
	2.	Add 1 cm depth of FA 7 to a test-tube. Add aqueous barium nitrate to FA 7 ,	White ppt formed
		followed by dilute nitric acid.	White ppt insoluble in acid

FA 7 contains the cations $\underline{Mn^{2+}}$ and $\underline{Zn^{2+}}$.

identity	evidence
FA 7 contains cation: Mn ²⁺	In test 1, when aq NH_3 is added to FA 7 , an off-white ppt of $Mn(OH)_2$ is formed which is insoluble in excess aq. NH_3 . $Mn(OH)_2$ is oxidised by oxygen in air to brown $Mn(OH)_3$.
FA 7 contains cation: Zn ²⁺	In test 1, when aq NH ₃ is added to FA 7 , a white ppt of $Zn(OH)_2$ is formed, which is soluble in excess aq. NH ₃ to form a colourless solution of $[Zn(NH_3)_4]^{2+}$

FA7 contains the anion $\underline{SO_4^{2-}}$.

3

(b) (i)

	test	observations	
1.	Add 1 cm depth of FA 8 to a test–tube.	Yellow solution turns brown/reddish brown/dark orange/violet	
	Add FA 4 slowly, with shaking, until no further change is seen.		
	Leave it to stand.	Yellow solution reforms	
2.	Add 1 cm depth of FA 8 to a test–tube.	Orange/red–brown ppt. <u>Effervescence</u> observed.	
	Add 1 cm depth of FA 5 , with shaking, until no further change is seen.	Colourless CO ₂ <u>gas</u> evolved gives a <u>white ppt with</u> Ca(OH) ₂ / limewater.	
3.	Add 1 cm depth of FA 8 to a test–tube.	Yellow solution turns brown.	
	Add 1 cm depth of aqueous potassium iodide, with shaking, until no further change is seen.		

(ii) Fe³⁺ has a <u>high charge density</u>. Hence, the cation can polarise the water molecules, giving rise to an <u>acidic solution</u>.

 $[Fe(H_2O)_6]^{3+}(aq) + H_2O(I) = [Fe(H_2O)_5(OH)]^{2+}(aq) + H_3O^{+}(aq)$

The acidic solution undergoes <u>acid–base reaction</u> with NaHCO₃ to give CO_2 and a red–brown ppt of Fe(OH)₃.

- (iii) Fe³⁺ is an oxidising agent. Fe³⁺ oxidises I= to brown I₂
 - Reaction between [Fe(H₂O)₆]³⁺(aq) and I⁻:
 E^e_{cell} = +0.77 0.54 = <u>+0.23 V > 0</u> ⇒ reaction is <u>feasible</u>
- (iv) Reaction between $[Fe(CN)_6]^{3-}$ and I^- : E°cell = +0.36 - 0.54 = -0.18 V < 0 thus reaction is not feasible.

[1]: Correct calculation of E^ocell (E^o values quoted)

<u>CN⁻ ligands stabilise Fe³⁺ more than Fe²⁺, thus E^o([Fe(CN)₆]³⁻/[Fe(CN)₆]⁴⁻) is less positive than E^o(Fe³⁺/Fe²⁺). [Fe(CN)₆]³⁻ is less easily reduced / is a weaker oxidising agent than Fe³⁺(aq). **[1**]</u>

(v) • <u>Purple organic</u> layer
• <u>Yellow / Brown aqueous</u> layer

Note: Both layers are immiscible.