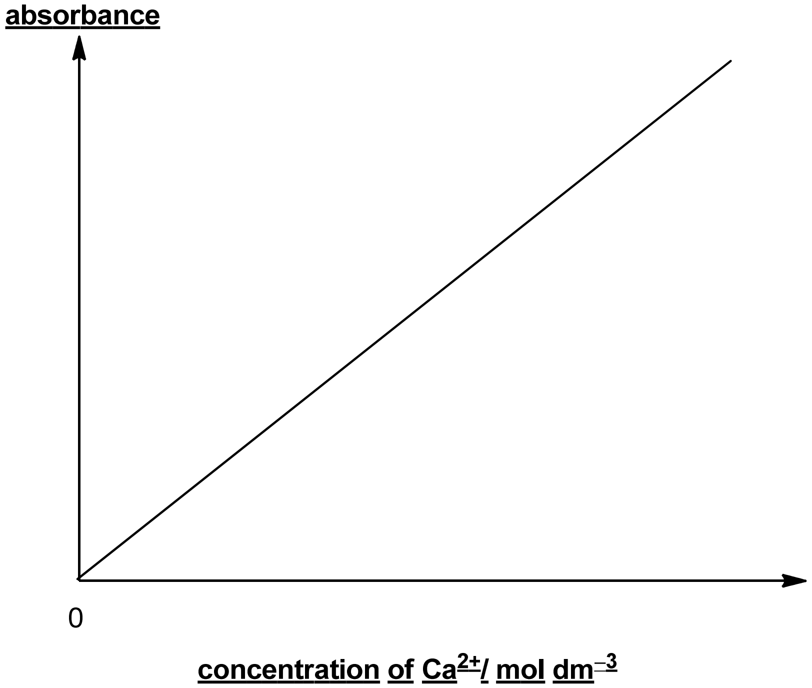
JURONG JUNIOR COLLEGE
2015 JC 2 PRELIMINARY EXAMINATION
Higher 2
Paper 2 (solutions)

1 Preparation of 5 diluted solutions from 0.0500 mol dm^{-3} Ca^{2+} (aq)

Solution	[Ca^{2} (aq)] / mol dm^{-3}	Volume of Ca^{2+} stock solution, V / cm^{3}
1	0.0250	**12.50**
2	0.0200	**10.00**
3	0.0150	**7.50**
4	0.0100	**5.00**
5	0.00500	**2.50**

Dilution and measurement:

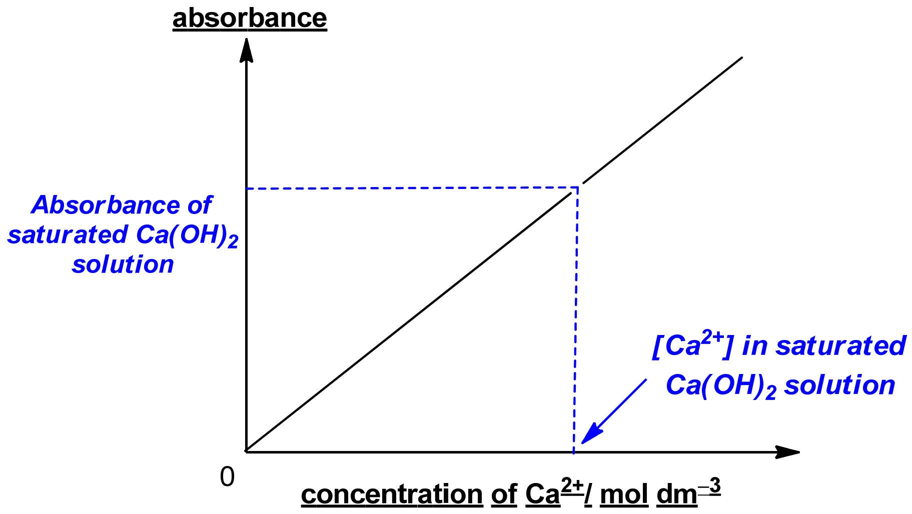
1. Using a burette, run Vcm^{3} of Ca^{2+} stock solution into a 25.0 cm^{3} graduated flask.
2. Make up to the graduated mark with deionised water.
3. Stopper and shake the flask to obtain a homogeneous solution.
4. Repeat steps 1-3 using the volumes specified in the table above in the preparation of solutions 2 to 5.
5. Place each of the prepared solutions into the atomic absorption spectrophotometer and record the absorbance value for each solution.
6. Plot absorbance value for each solution against concentration of Ca^{2+}



1 **Preparation of saturated solution of $Ca(OH)_2(aq)$**

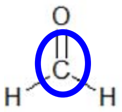
1. Using a measuring cylinder, place 100 cm^3 of deionised water into a 250 cm^3 beaker.
2. Using a spatula, add a few tips of solid $Ca(OH)_2$ into the flask. Stir to dissolve all the solids using a glass rod. Keep adding more solids, with stirring after each addition, until some solids are left undissolved.
3. To ensure that the solution is saturated, stir the solution for a while and leave the conical flask containing the solution to stand in a water bath at 25 ^oC for some time. There must be some solids left undissolved.
4. To remove undissolved solids, filter the saturated solution into a clean, dry conical flask using a dry filter funnel and a piece of dry filter paper.
5. Place the saturated $Ca(OH)_2$ solution into the atomic absorption spectrophotometer and record the absorbance value for the solution.

Using the calibration line, read the corresponding concentration of Ca^{2+}, for the absorbance value for the saturated $Ca(OH)_2$ solution.



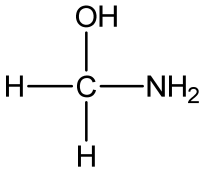
(b) Solubility product of $Ca(OH)_2$ = **$4x^3$ mol^3 dm^{-9}**

2 **(a)**



(b) Nucleophile

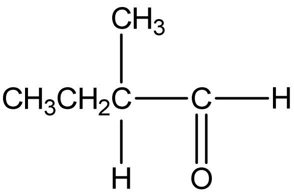
(c)



$$H-\overset{OH}{\underset{H}{C}}-NH_2$$

(d) Nucleophilic addition

(e)



$$CH_3CH_2\overset{CH_3}{\underset{H}{C}}-\underset{\overset{\|}{O}}{C}-H$$

(f) **(i)** Since half life are constant (t½ $\approx$ 76 min), the reaction is first order wrt [HCN].

(ii) When [CH_2=NH] is halved, rate is halved.

The reaction is first order wrt [CH_2=NH].

(iii) Rate = k[HCN][CH_2=NH]

(iv) Rate = k'[HCN] where k'=k[CH_2=NH]

$k' = \ln 2 / t_{1/2} = \ln 2 / 76 = 0.00912\ min^{-1}$

k = 0.00912 / 0.2

= 0.0456 $mol^{-1}\ dm^{3}\ min^{-1}$

Or

Initial rate = gradient = 0.01/ 124 = 0.0000807 mol $dm^{-3}\ min^{-1}$

0.0000807 = k(0.01)(0.2)

k = 0.0403 $mol^{-1}\ dm^{3}\ min^{-1}$

(v) 78 min

3 **(a)** $K_c = \dfrac{[Pb^{2+}][Cr^{2+}]^2}{[Cr^{3+}]^2}$ units: mol dm^{-3}

(b) **(i)** $[Pb^{2+}(aq)] = \frac{1}{2}(2.96 \times 10^{-4}) = 1.48 \times 10^{-4}$ mol dm^{-3}

(ii) $K_c = \dfrac{(1.48 \times 10^{-4})(2.96 \times 10^{-4})^2}{(0.200)^2} = 3.24 \times 10^{-10}$

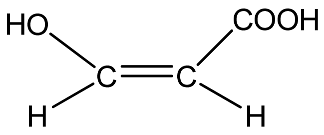
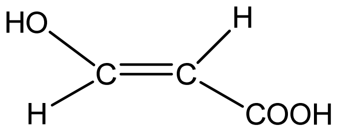
(iii) K_c value is significantly smaller than 1. Equilibrium position lies to the left, reaction hardly proceeds.

(c) **(i)** $PbSO_4$

(ii) $[Pb^{2+}]$ decreases as $PbSO_4$ is precipitated. Equilibrium position will shift right to form more Pb^{2+}.

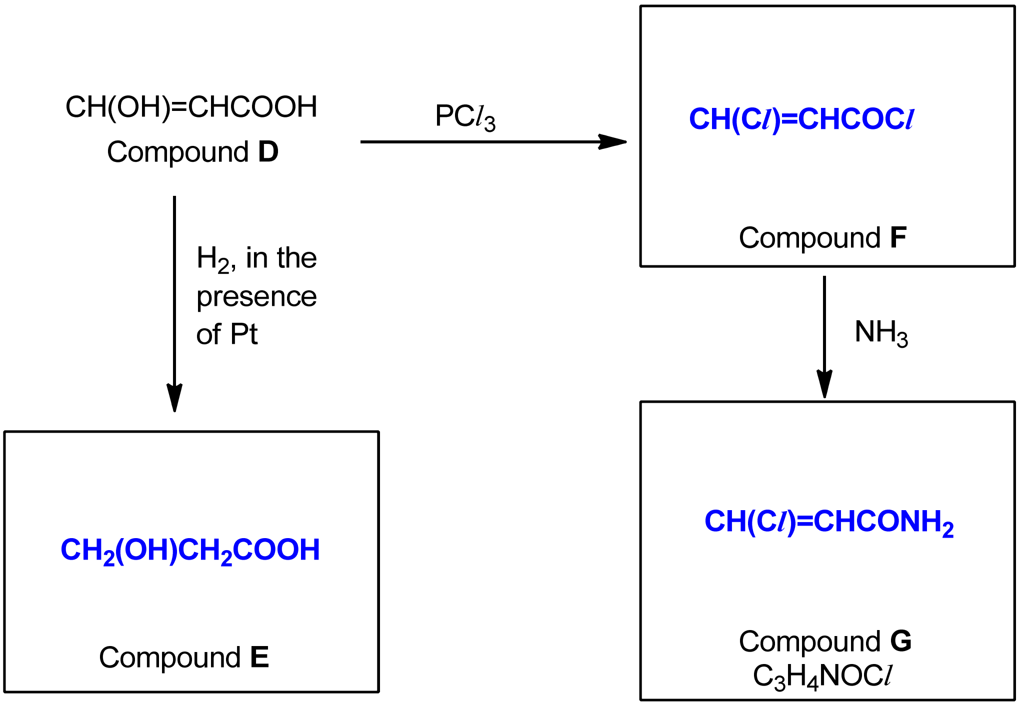
No change in K_c as K_c is only dependent on temperature.

4 **(a)** **(i)**

	Cis isomer	Trans isomer
Structure		

(ii) In the cis isomer, there will be intramolecular molecular hydrogen bonding between the -COOH and –OH as they are close to each other. Hence less energy is required to overcome the less extensive hydrogen bonding between the cis isomer molecules as compared to the trans isomer.

(b)



(c) **(i)** Stage I: $NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$

Stage II: $CH(OH)=CHCOOH + HBr \rightarrow CH_2(OH)CHBrCOOH$

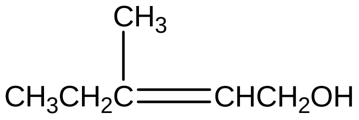
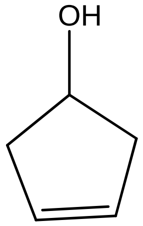
or $CH(OH)=CHCOOH + HBr \rightarrow CHBr(OH)CH_2COOH$

(ii) Inorganic by-product: Br_2

Equation: $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$

5 **(a)** Functional groups present: alkene and alcohol

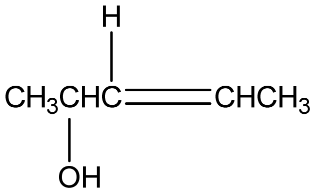
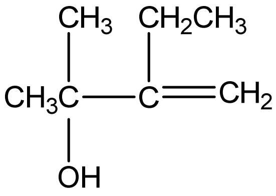
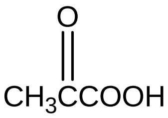
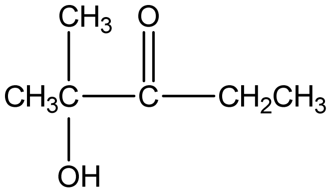
(b)

Compound **P**	Compound **Q**
 $CH_3CH_2C(CH_3){=}CHCH_2OH$ **P** ($C_6H_{12}O$)	 **Q** (C_5H_8O)

(c) **(i)** Functional groups present in **T**: carboxylic acid

Functional groups present in **U**: alcohol

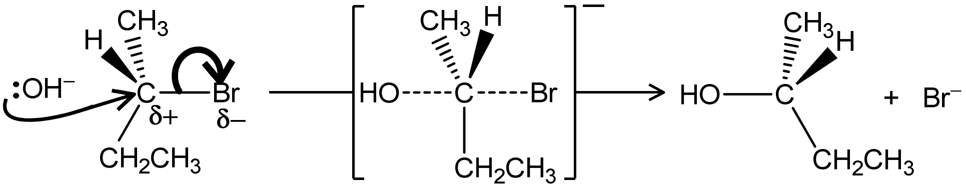
(ii)

Compound **R**	Compound **S**
 $CH_3CH(OH)CH{=}CHCH_3$ **R** ($C_5H_{10}O$)	 $CH_3C(CH_3)(OH){-}C(CH_2CH_3){=}CH_2$ **S** ($C_7H_{14}O$)
Compound T	**Compound U**
 $CH_3C(=O)COOH$ **T** ($C_3H_4O_3$)	 $CH_3C(CH_3)(OH){-}C(=O){-}CH_2CH_3$ **U** ($C_6H_{12}O_2$)

(d) **(i)** Reagents and condition: NaOH(aq), Heat under reflux.

Type of reaction: Nucleophilic Substitution

(ii)



6 **(a)** **(i)** Cu^+ ion: $1s^22s^22p^63s^23p^6\mathbf{3d^{10}}$

Cu^{2+} ion: $1s^22s^22p^63s^23p^6\mathbf{3d^9}$

(ii) $[Cu(H_2O)_6]^{2+}$: pale blue

$[Cu(NH_3)_4(H_2O)_2]^{2+}$: deep blue

(b) **(i)** White precipitate **J**: CuI

Equation: $Cu^{2+}(aq) + 4I^-(aq) \rightarrow CuI(s) + I_2(aq)$

(ii) Formula of **K**: $[Cu(NH_3)_2]^+$

(iii) Cu^+ is oxidised to Cu^{2+} by oxygen in air.

(iv) Solid **L**: Cu

Type of reaction: Disproportionation

(c) **(i)** $Cu(NO_3)_2 \rightarrow CuO + 2NO_2 + \frac{1}{2}O_2$

(ii) Ionic radius of $\mathbf{Cu^{2+}}$ = **0.069**nm

Ionic radius of $\mathbf{Ca^{2+}}$ = **0.099** nm

Since Cu^{2+} has a smaller ionic radius, Cu^{2+} has a larger charge density and is able to polarise the large NO_3^- to a larger extent than Ca^{2+} ion.

Hence, $Cu(NO_3)_2$ is less thermally stable than $Ca(NO_3)_2$.

(iii) Decomposition temperature for $Cu(NO_3)_2$

= **any temp between 330°C and 561°C.**