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2010-2011

Advanced Level
Mock Examination

Chemistry- Paper II

Marking Scheme

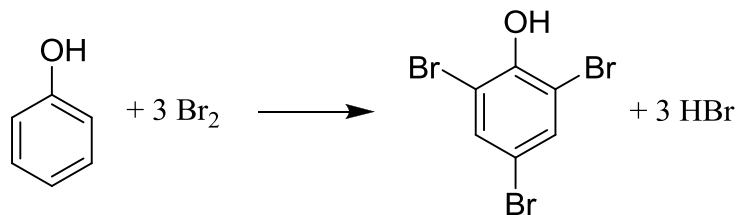
Dr. Kelvin Lau

Marks



1

(ii)



1

(iii) The methyl orange is used as an indicator for the reaction. 0.5

Bromine produced in the reaction reacts with phenol rapidly.

Once all the phenol is used up, the excess bromine produced will bleach the methyl orange immediately. 1

The time for the disappearance of red color indicates the time for the formation of a fixed amount of bromine in the reaction mixture 0.5

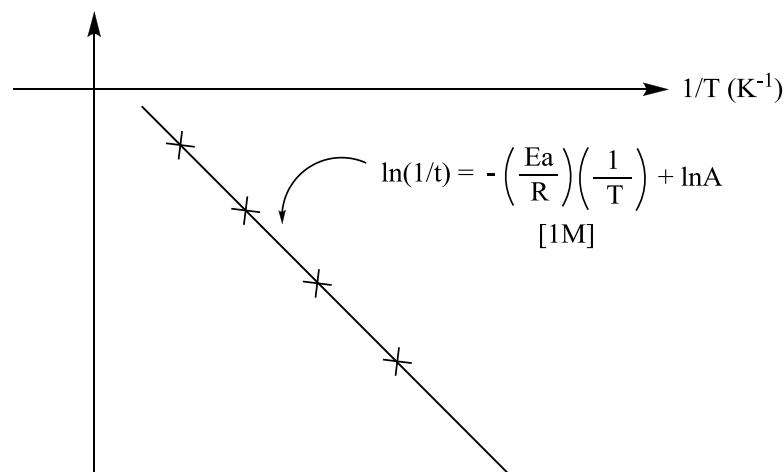
(iv) No.

The bromate (V) ion is an oxidizing agent. It oxidizes the iodide to iodine. 1

(v)

T/ K	304	311	315	320
t/ s	113	70	54	39
(1/T) / K ⁻¹	0.003290	0.003215	0.003175	0.003125
ln(1/t)	-4.727	-4.248	-3.989	-3.665

ln(1/t)



2

[0.5 marks for axis, 0.5 marks for straight line]

$$\text{Slope} = \frac{-4.248 + 4.727}{0.003215 - 0.003289} = -6473 \text{ K}$$

1

$$E_a = -R \times \text{Slope} = -8.314(-6473) = 53.82 \text{ kJmol}^{-1}$$

1

(Accept $\pm 5\%$ error)

	<u>Marks</u>
(vi) Colorimetric measurement/ colorimeter	1
(b) (i) $2 \text{MnO}_4^- (\text{aq}) + \text{MnO}_2 (\text{s}) + 4\text{OH}^- (\text{aq}) \rightarrow 3 \text{MnO}_4^{2-} (\text{aq}) + 2\text{H}_2\text{O}(\text{l})$	1
Beaker A: the color of the solution changes from colorless to green (or MnO_2 dissolves)	0.5
Beaker B: the color of the solution change for purple to greenish purple.	0.5
(ii) Standard electrode potential = $0.56 - 0.59 - 0.03 \text{ V}$	0.5
Number of electron transferred in the stoichiometric equation = 2	0.5
At pH = 14, $[\text{OH}] = 1 \text{ M}$	
Therefore, according to Nernst equation:	
$0.0763 = -0.03 - \frac{0.059}{2} \log \frac{(0.1)^3}{[\text{MnO}_4^-]^2 (1)^4}$	1
	1
$[\text{MnO}_4^{2-}] = 2 \text{ M}$	
(iii) No change. It is because buffer can resist the change in pH upon dilution.	1
[Award 0 mark for wrong explanation]	
(iv) $3 \text{MnO}_4^{2-} + 4 \text{H}^+ \rightarrow 2 \text{MnO}_4^- + \text{MnO}_2 + 2 \text{H}_2\text{O}$	1
(c) (i) $4 \text{FeO}_4^{2-} + \text{C}_2\text{H}_5\text{OH} + 7 \text{H}_2\text{O} \rightarrow 4 \text{Fe}(\text{OH})_3 + 2 \text{CO}_2 + 8 \text{OH}^-$	1
(ii) In alkaline medium, the carbon dioxide formed reacts with the hydroxide ion to form carbonate ion.	1

(iii) Standard enthalpy change of reaction

$$= \frac{8.31 \ln\left(\frac{1}{3}\right)}{\left(\frac{1}{131.3} - \frac{1}{310}\right)}$$

1

$$= -2080 \text{ Jmol}^{-1}$$

1

Since the decomposition is exothermic, NH_4HS is energetically less stable than its decomposition product.

1

(b) (i) No change in the equilibrium position since there are no change in the partial pressure of NH_3 and H_2S .

1

Equilibrium total pressure increases.

0.5

(ii) According LeChatelier's principle, the equilibrium position shift to the left in order to offset the increase in the partial pressure of the gaseous components.

1

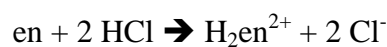
No change in the equilibrium total pressure.

0.5

(c) (i) When a solute is distributed between a pair of immiscible solvents, the solute will distribute itself between a pair of immiscible solvents in such a way that the ratio of its concentration in each layer is constant, at a given temperature.

1

(c) (ii) Reaction between en and HCl(aq)



number of mole of en in 25 cm³ organic layer

$$= \frac{1}{2} (2.6) \left(\frac{100}{1000} \right) = 0.13 \text{ mol}$$

$$[\text{en}] \text{ in organic layer} = \frac{0.13}{0.025} = 5.2 \text{ M} \quad 0.5$$

Since $K_d = 13$

$$13 = \frac{5.2}{\text{free [en] in aqueous layer}}$$

$$\text{Free [en] in aqueous layer} = 0.4 \text{ M} \quad 0.5$$

Number of mole of free en in 25 cm³ aqueous layer

$$= 0.4 \left(\frac{25}{1000} \right) = 0.01 \text{ mol} \quad 0.5$$

Number of mole of en (complex + free) in 25 cm³ layer

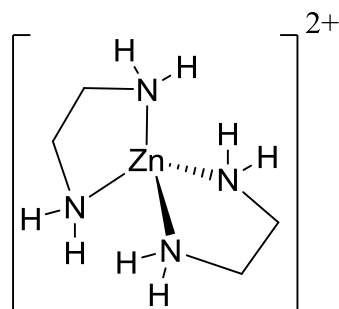
$$= \frac{1}{2} (0.3) \left(\frac{100}{1000} \right) = 0.015 \text{ mol} \quad 0.5$$

$$\text{Number of mole of en (complex)} = 0.015 - 0.01 = 0.005 \text{ mol} \quad 0.5$$

$$\text{Number of mole of Zn(en)}^{2+} = 0.3 \left(\frac{50}{1000} \right) \left(\frac{25}{150} \right) = 0.0025 \text{ mol} \quad 0.5$$

$$\text{Value of } y = \frac{0.005}{0.0025} = 2 \quad 0.5+0.5$$

(iii)



1

(iv) No. Zn(en)^{2+} has no chiral center. It is optically inactive.

1

Marks

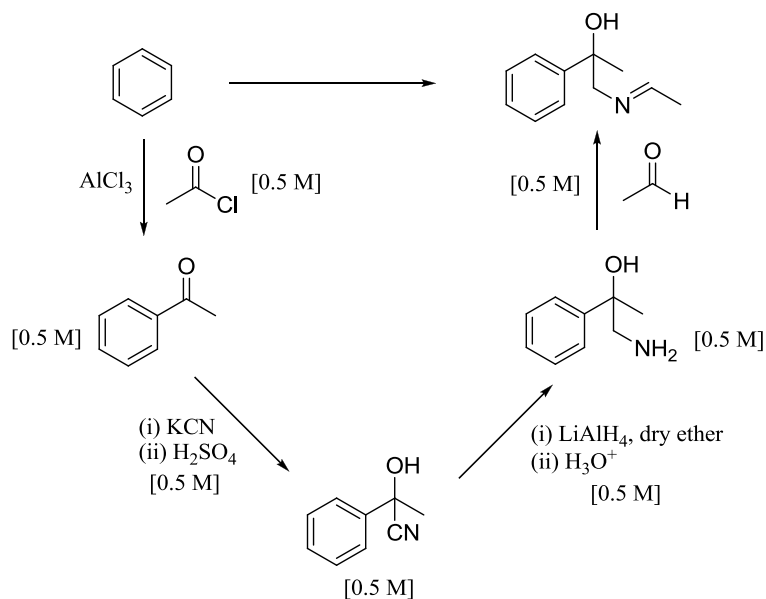
3. (a) (i) Correct. 1
According to Arrhenius equation, if the activation energy is high, the magnitude of the rate constant changes to a greater extent when the temperature changes.
(Also accept explanation using Maxwell-Boltzmann distribution curve)
[Award 0 mark for wrong explanation]
- (ii) Incorrect. 1
The energetic stability of an ionic compound is affected by its standard enthalpy of formation rather than lattice enthalpy. The more negative is the enthalpy change of formation, the more stable is the ionic compound. 1
[Award 0 mark for wrong explanation]
- (iii) Correct. 1
Period (III) elements have larger sizes. They form longer covalent bonds. This leads to the poor side-way overlap of their unhybridized p orbitals. Therefore the π bonds formed are weaker and they prefer forming single bonds. 1
[Award 0 mark for wrong explanation]
- (iv) Correct. 0.5
Group(II) metal cations have higher charge density than group (I) metal cations. Their lattice enthalpies are more negative and this effect always outweighs the changes in the solvation energy. 0.5
Therefore, the standard enthalpy changes of solution of group(II) salts are generally less negative/ or more positive than group(I) salts. 1
[Award 0 mark for wrong explanation]

Marks

3. (b) (i) Number of mole of sodium chloride = $\frac{10.53}{23+35.5}=0.18 \text{ mol}$
- Mass of sulphuric acid = $0.98 \times 1.84 \times 3 = 5.41 \text{ g}$ 0.5
- Number of mole of sulphuric acid = $\frac{5.41}{2(1) + 32.1 + 4(16)}$
- = 0.055 mol 0.5
- Sulphuric acid is the limiting reagent. 0.5
- Chemical equation involved:
- $2 \text{ NaCl(s)} + \text{H}_2\text{SO}_4\text{(l)} \rightarrow \text{Na}_2\text{SO}_4\text{(s)} + 2 \text{ HCl(g)}$ 1
- (0.5 mark for equation, 0.5 mark for physical states)
- (Not accept $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$)
- Number of mole of hydrogen chloride = $2 \times 0.055 = 0.11 \text{ mol}$ 0.5
- Volume of hydrogen chloride = $0.11 \times 24 = 2.64 \text{ dm}^3$ 1
- (ii) Formation of white smoke. 1
- $\text{NH}_3\text{(g)} + \text{HCl(g)} \rightarrow \text{NH}_4\text{Cl(s)}$ 1
- (0.5 mark for equation, 0.5 mark for physical states)

		<u>Marks</u>	
(c)	(i)	Add excess of potassium iodide solution to a <u>known volume of iodate (V) solution.</u>	0.5
		$5 \text{ I}^- + \text{IO}_3^- + 6 \text{ H}^+ \rightarrow 6 \text{ I}_2 + 3 \text{ H}_2\text{O}$	0.5
		Then back titrate the iodine solution by <u>standard thiosulphate solution</u> using <u>starch</u> as the indicator.	0.5
		$\text{I}_2 + 2 \text{ S}_2\text{O}_3^{2-} \rightarrow 2 \text{ I}^- + \text{S}_4\text{O}_6^{2-}$	0.5
		End point: the color the solution changes from deep blue to colorless.	0.5
	(ii)	Since MnO_4^- is <u>purple in color</u> , the concentration of MnO_4^- at different time can be followed by <u>measuring the absorbance of the complementary color of purple</u> in the reaction mixture.	0.5
		Different <u>standard KMnO_4 was prepared</u> and their absorbance are measured.	0.5
		A calibration curve of absorbance verse the concentration of MnO_4^- is plotted.	1
		Mixing $\text{KMnO}_4(\text{aq})$ and ethanol and put the reaction mixture to a colorimeter. The absorbances of the reaction mixture at different time intervals are recorded.	0.5

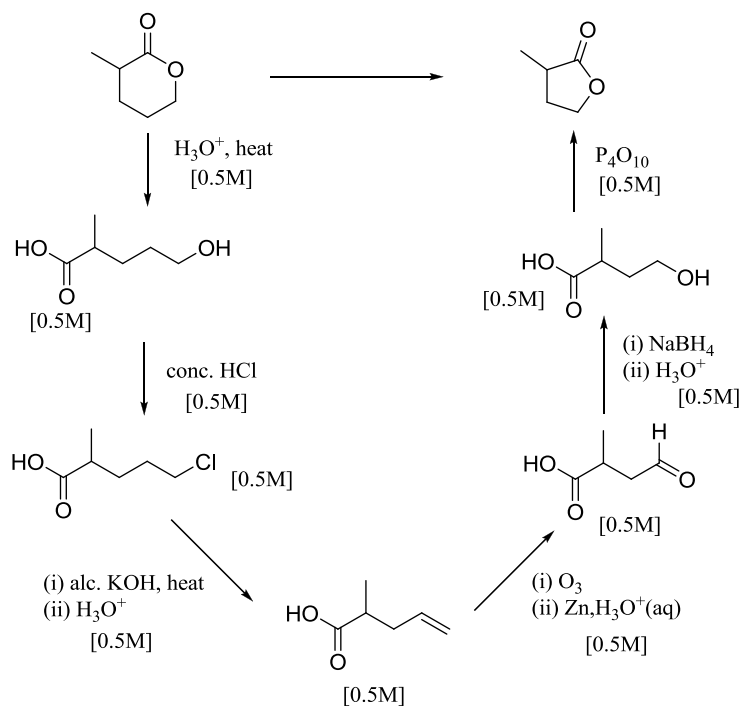
4. (a) (i)



[Award the remaining marks for complete synthesis]

[Also accept other correct synthetic paths]

(ii)

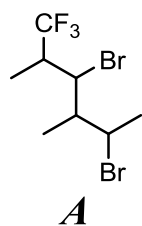


5

[Award the remaining marks for complete synthesis]

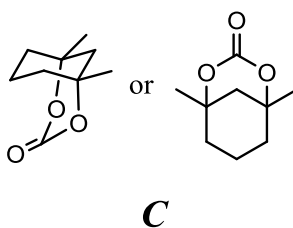
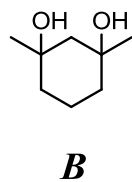
[Also accept other correct synthetic paths]

4. (b) (i)



1

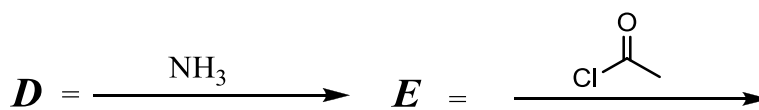
(ii)



1

1

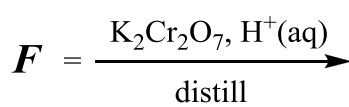
(iii)



1

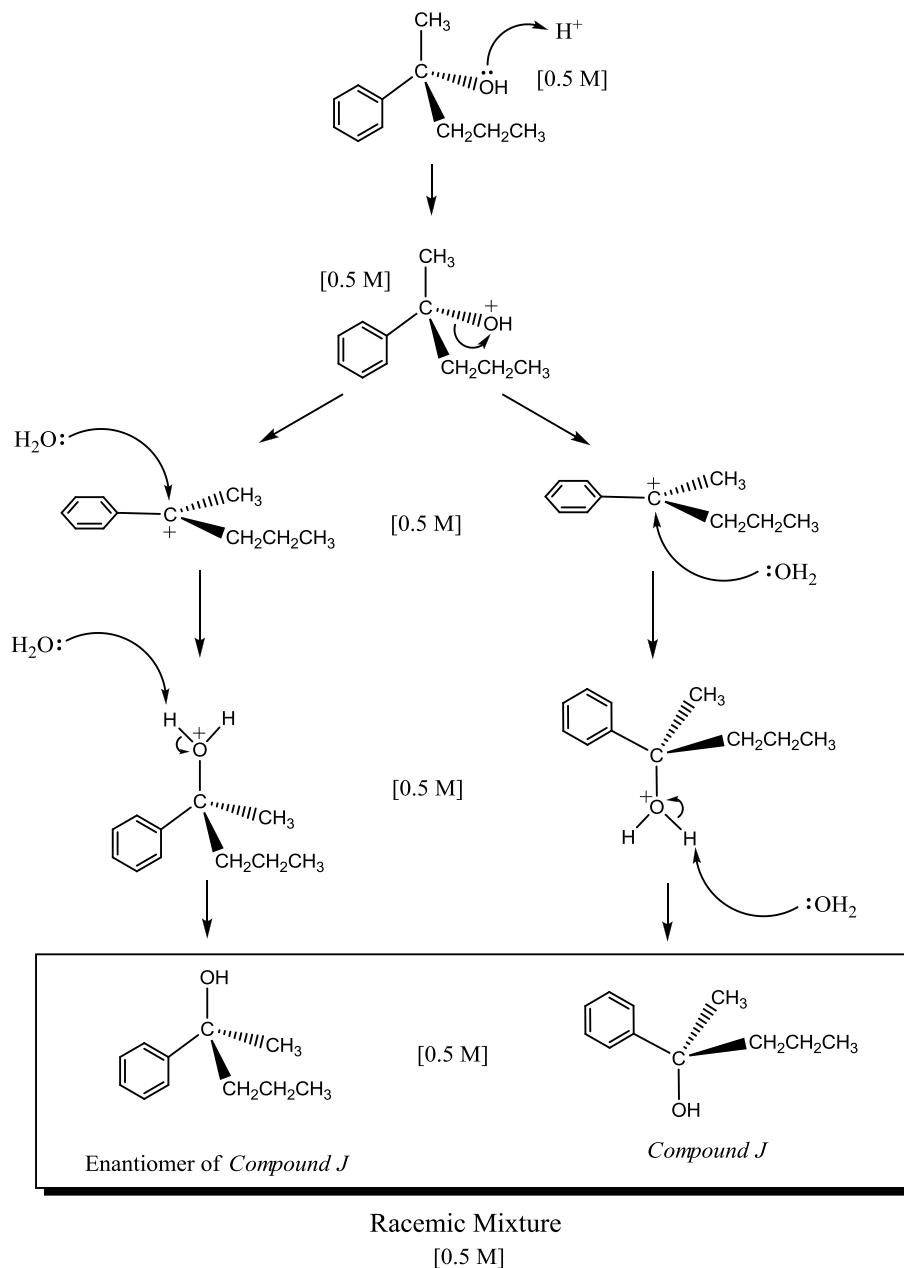
1

(iv)

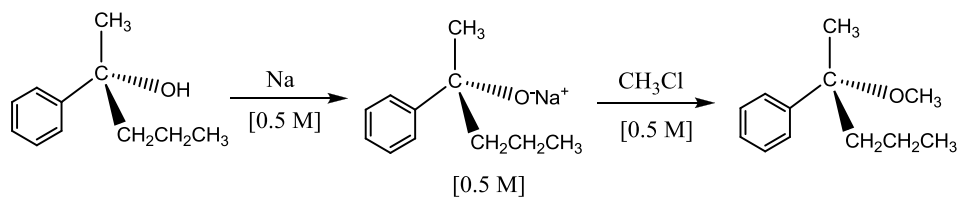


1

(c) (i)



(ii)



[Award the remaining marks for complete synthesis]

5. (a) (i) Number of mole of C: H O = $\frac{66.7}{12} : \frac{8.0}{1} : \frac{25.3}{16}$
 $= 5.56 : 8 : 1.58$
 $\approx 7 : 10 : 2$

0.5

Empirical formula of W = C₇H₁₀O₂

Molar mass of W = $\frac{(3)(8.31)(177+273)}{(445.8)(200 \times 10^{-3})} = 126 \text{ g mol}^{-1}$

0.5

Let the molecular formula of W = [C₇H₁₀O₂]_y where y is an integer

$y[7(12)+10(1)+2(16)] = 126 \rightarrow y = 1$

0.5

Therefore, molecular formula of W = C₇H₁₀O₂

0.5

(ii) Double bond equivalence = $\frac{2(7)+2-10}{2} = 3$

0.5

From IR spectrum,

The peak with the wavenumber 1720 cm⁻¹ and 1610 cm⁻¹ correspond to the C=O stretching and C=C stretching respectively.

1

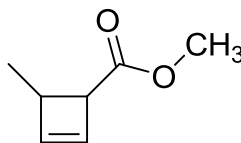
The absence of the peak around 3400 cm⁻¹ indicates that X does not contain hydroxyl (OH) group.

0.5

W can undergo hydrolysis with sulphuric acid to give methanol, it should be a methyl ester

1

Since W has two chiral centers, the structure of W should be:



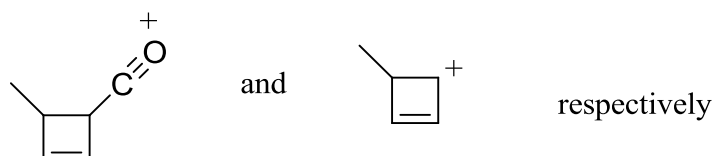
2

Mass spectroscopy:

The peak with the mass to charge ratio 126 correspond to the molecular ion.

1

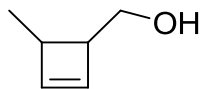
The peak with the mass to charge ratio 95 and 67 correspond to



2

Marks

5. (b) The structure of X is



1

$$\text{Number of mole of } W = \frac{5}{126} = 0.0396 \text{ mol}$$

0.5

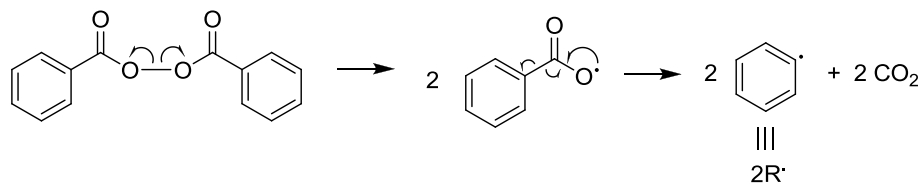
$$\text{Number of mole of } X = \frac{1.8}{6(12) + 10(1) + 16} = 0.0184 \text{ mol}$$

0.5

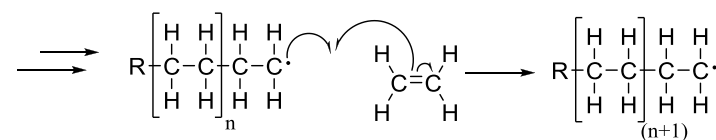
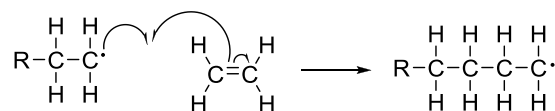
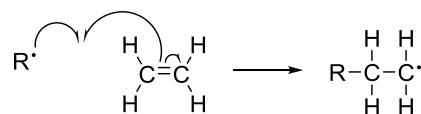
$$\% \text{ yield} = \frac{0.0184}{0.0396} \times 100\% = 46.4\%$$

1

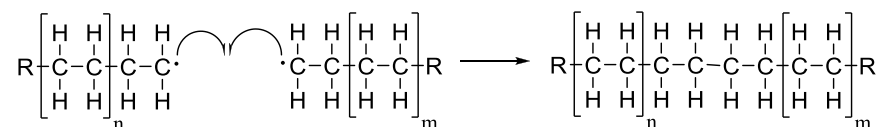
5. (c) (i) **Chain initiation**



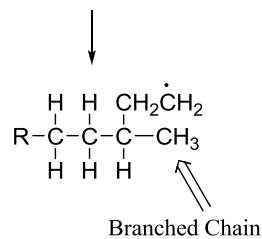
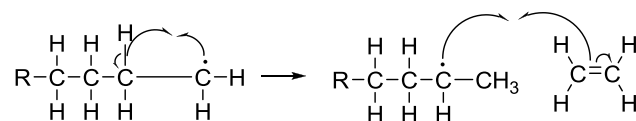
Chain Propagation



Chain Termination



(ii) The formation of branched chain is due to the hydrogen atom transfer reaction in the polymerization.



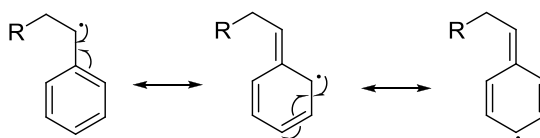
Marks

5. (c) (iii) The presence of branched chains reduces the packing efficiency of the polymer chains, which lowers the melting point of the polymer.

1

(iv) The free radical polymerization of styrene involves the formation of benzyl radical, which can be stabilized by the resonance.

0.5



1

Therefore, there is no hydrogen atom transfer reaction in polymerization.

0.5