

## Paper-2

### JEE Advanced, 2015

### PART II: CHEMISTRY

**Note:** Answers have been highlighted in "Yellow" color and Explanations to answers are given at the end

#### **READ THE INSTRUCTIONS CAREFULLY:**

##### **GENERAL:**

1. This sealed booklet is your Question Paper. Do not break the seal till you are told to do so.
2. The question paper CODE is printed on the left hand top corner of this sheet and the right hand top corner of the back cover of this booklet.
3. Use the Optical Response Sheet (ORS) provided separately for answering the questions.
4. The ORS CODE is printed on its left part as well as the right part. Ensure that both these codes are identical and same as that on the question paper booklet. If not, contact the invigilator.
5. Blank spaces are provided within this booklet for rough work.
6. Write your name and roll number in the space provided on the back cover of this booklet.
7. After breaking the seal of the booklet, verify that the booklet contains **32** pages and that all the **60** questions along with the options are legible.

#### **QUESTIONS PAPER FORMAT AND MARKING SCHEME:**

8. The question paper has three parts: Physics, Chemistry and Mathematics, Each part has three sections.
9. Carefully read the instructions given at the beginning of each section.
10. Section 1 contains 8 questions. The answer to each question is a single digit integer ranging from 0 to 9 (both inclusive).

Marking scheme: +4 for correct answer and 0 in all other cases.

11. Section 2 contains 8 multiple choice questions with one or more than one correct option.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

12. Section 3 contains 2 “paragraph” type questions. Each paragraph describes an experiment, a situation or a problem. Two multiple choice questions will be asked based on this paragraph. One of or more than one option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

**OPTICAL RESPONSE SHEET:**

13. The ORS consists of an original (top sheet) and its carbon- less copy (bottom sheet.)

14. Darken the appropriate bubbles on the original by applying sufficient pressure. This will leave an impression at the corresponding place on the carbon – less copy.

15. The original is machine – gradable and will be collected by the invigilator at the end of the examination.

16. You will be allowed to take away the carbon – less copy at the end of the examination,

17. Do not tamper with or mutilate the ORS.

18. Write your name, roll number and the name of the examination center and sign with pen in the space provided for this purpose on the original. **Do not write any of these details anywhere else.** Darken the appropriate bubble under each digit of your roll number.

**Note:** Answers have been highlighted in “Yellow” color and Explanations to answers are given at the end

SECTION 1 (Maximum Marks: 32)

- This section contains **EIGHT** questions
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive
- For each question, darken the bubble corresponding to the correct integer in the ORS
- Marking scheme:

+4 If the bubble corresponding to the answer is darkened

**Q.21** In the complex acetyl bromidodicarbonylbis (triethylphosphine)iron(II), the number of Fe-C bond(s) is

**Ans.21** (3)

**Q.22** Among the complex ions,  $[\text{Co}(\text{NH}_2\text{-CH}_2\text{-CH}_2\text{-NH}_2)_2\text{Cl}_2]^+$ ,  $[\text{CrCl}_2(\text{C}_2\text{O}_4)_2]^{3-}$ ,  $[\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2]^+$ ,  $[\text{Fe}(\text{NH}_3)_2(\text{CN})_4]$ ,  $[\text{Co}(\text{NH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-NH}_2)_2(\text{NH}_3)\text{Cl}]^{2+}$  and  $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{OCl})]^{2+}$ , the number of complex ion(s) that show(s) cis-trans isomerism is

Ans.22 (6)

Q.23 Three moles of  $B_2H_6$  are completely reacted with methanol. The number of moles of boron containing product formed is

Ans.23 (6)

Q.24 The molar conductivity of a solution of a weak acid HX (0.001 M) is 10 times smaller than the molar conductivity of a solution of a weak acid HY (0.10 M). If  $\lambda_x^0 \approx \lambda_y^0$ , the difference is their  $pK_a$  values,  $pK_a(HX) - pK_a(HY)$ , is (consider degree of ionization of both acids be  $\ll 1$ )

Ans.24 (3)

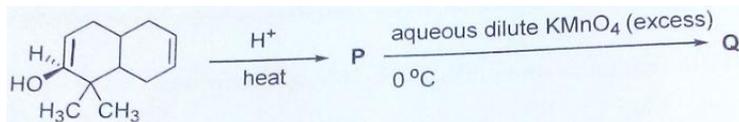
Q.25 A closed vessel with rigid walls contains 1 mol of  ${}^{238}_{92}\text{U}$  and 1 mol of air at 298 K. Considering complete decay of  ${}^{238}_{92}\text{U}$  to  ${}^{206}_{82}\text{Pb}$ , the ratio of the final pressure to the initial pressure of the system at 298 K is

Ans.25 (9)

Q.26 In dilute aqueous  $H_2SO_4$ , the complex diaquodioxalatoferate(II) is oxidized by  $MnO_4^-$ . For this reaction, the ratio of the rate of change of  $[H^+]$  to the rate of change of  $[MnO_4^-]$  is

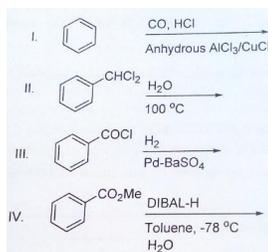
Ans.26 (8)

Q.27 The number of hydroxyl group(s) in Q is



Ans.27 (4)

Q.28 Among the following, the number of reaction(s) that produce (s) benzaldehyde is



Ans.28 (4)

SECTION 2 (Maximum Marks: 32)

- This section contains **EIGHT** questions
- Each question has **FOUR** option (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option (s) is (are) correct
- For each questions, darken the bubble (s) corresponding to all the correct option (s) in the ORS
- Marking scheme:

+4 If only the bubble (s) corresponding to all the correct option (s) is (are) darkened

0 If none of the bubbles is darkened

-2 In all other case

**Q.29** When  $O_2$  is adsorbed on a metallic surface, electron transfer occurs from the metal to  $O_2$ . The TRUE statement(s) regarding this adsorption is(are)

- (A)  $O_2$  is physisorbed (B) heat is released  
(C) occupancy of  $\pi_{2p}^*$  of  $O_2$  is increased (D) bond length of  $O_2$  is increased

**Ans.29** (B,C,D)

**Q.30** Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are

- (A)  $CH_3SiCl_3$  and  $Si(CH_3)_4$  (B)  $(CH_3)_2SiCl_2$  and  $(CH_3)_3SiCl$   
(C)  $(CH_3)_2SiCl_2$  and  $CH_3SiCl_3$  (D)  $SiCl_4$  and  $(CH_3)_3SiCl$

**Ans.30** (B)

**Q.31** The pair(s) of ions where BOTH the ions are precipitated upon passing  $H_2S$  gas in presence of dilute HCl, is(are)

- (A)  $Ba^{2+}$ ,  $Zn^{2+}$  (B)  $Bi^{3+}$ ,  $Fe^{3+}$   
(C)  $Cu^{2+}$ ,  $Pb^{2+}$  (D)  $Hg^{2+}$ ,  $Bi^{3+}$

**Ans.31** (C,D)

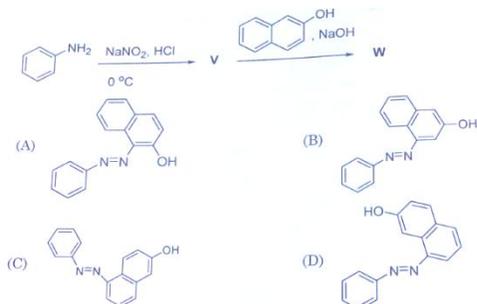
**Q.32** The correct statement(s) regarding, (i)  $HClO$ , (ii)  $HClO_2$ , (iii)  $HClO_3$  and (iv)  $HClO_4$ , is (are)

- (A) The number of  $Cl = O$  bonds in (ii) and (iii) together is two

- (B) The number of lone pairs of electrons on Cl in (ii) and (iii) together is three  
(C) The hybridization of Cl in (iv) is  $sp^3$   
(D) Amongst (i) to (iv), the strongest acid is (i)

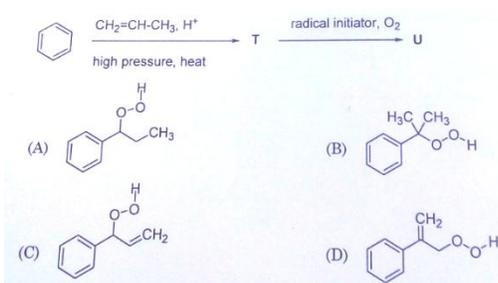
Ans.32 (B,C)

Q.33 In the following reactions, the major product W is



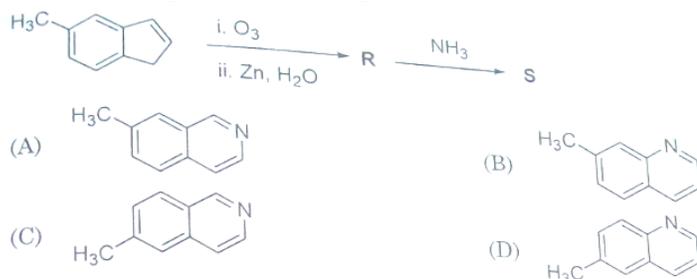
Ans.33 (A)

Q.34 The major product U in the following reactions is



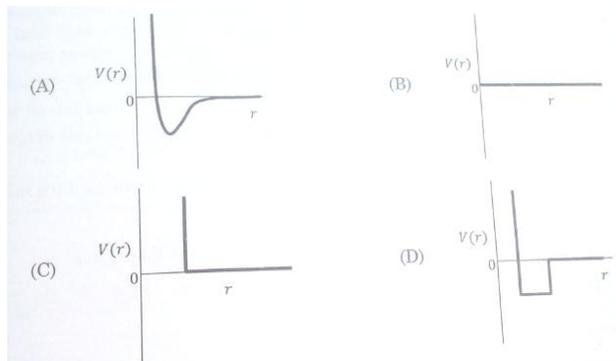
Ans.34 (B)

Q.35 In the following reactions, the product S is



Ans.35 (A)

**Q.36** One mole of a monatomic real gas satisfies the equation  $p(V - b) = RT$  where  $b$  is a constant. The relationship of interatomic potential  $V(r)$  and interatomic distance  $r$  for the gas is given by



**Ans.36** (C)

### SECTION 3 (Maximum Marks: 16)

- This section contains **TWO** paragraphs
- Based on each paragraph, there will be **TWO** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- Marking scheme:
  - +4 If only the bubble(s) corresponding to all the correct option(s) is(are) darkened
  - 0 If none of the bubbles is darkened
  - 2 In all other cases

### PARAGRAPH 1

When 100 mL of 1.0 M HCl was mixed with 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increase of 5.7 °C was measured for the beaker and its contents (Expt. 1). Because the enthalpy of neutralization of a strong acid with a strong base is a constant (-57.0 kJ mol<sup>-1</sup>), this experiment could be used to measure the calorimeter constant

In a second experiment (Expt. 2), 100 mL of 2.0 M acetic acid ( $K_a = 2.0 \times 10^{-5}$ ) was mixed with 100 mL of 1.0 M NaOH (under identical conditions to Expt.1) where a temperature rise of 5.6° was measured.

(Consider heat capacity of all solutions as 4.2 J g<sup>-1</sup> k<sup>-1</sup> and density of all solutions as 1.0 g mL

**Q.37** Enthalpy of dissociation (in  $\text{kJ mol}^{-1}$ ) of acetic obtained from the Expt.2 is

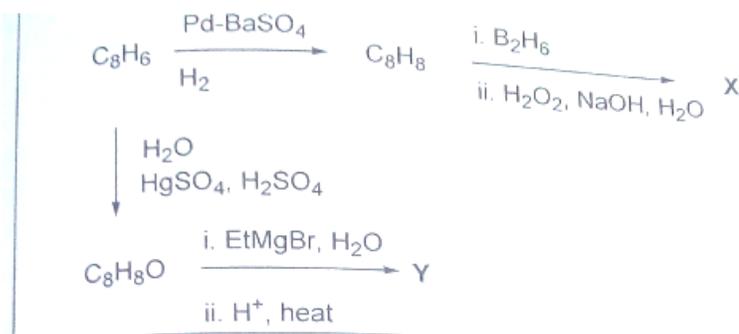
- (A) 1.0 (B) 10.0  
 (C) 24.5 (D) 51.4

**Ans.37** (A)

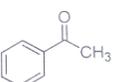
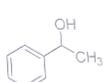
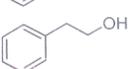
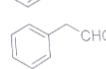
**Q.38** The pH of the solution after Expt. 2 is

- (A) 2.8 (B) 4.7  
 (C) 5.0 (D) 7.0

**Ans.38** (B)

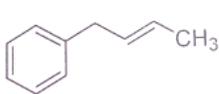
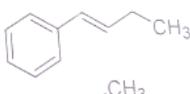
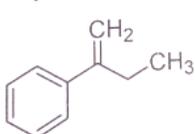
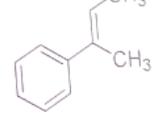


**Q.39** Compound X is

- (A)  (B)   
 (C)  (D) 

**Ans.39** (C)

**Q.40** The major compound Y is

- (A)  (B)   
 (C)  (D) 

**Ans.40** (D)

## Answer Keys and Explanations

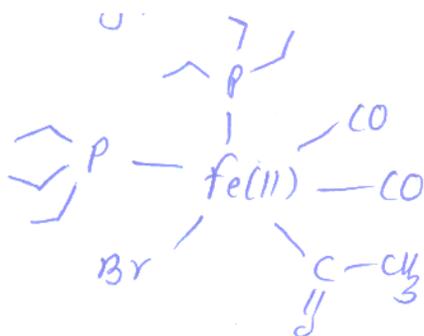
Sol.21 (3)

acetyl  $\text{CH}_3\text{CO} \rightarrow$  mono coordination

Bromido  $\text{Br}^- \rightarrow$  mono coordination

dicarbonyl  $\text{CO} \ \& \ \text{CO} \rightarrow$  di coordination

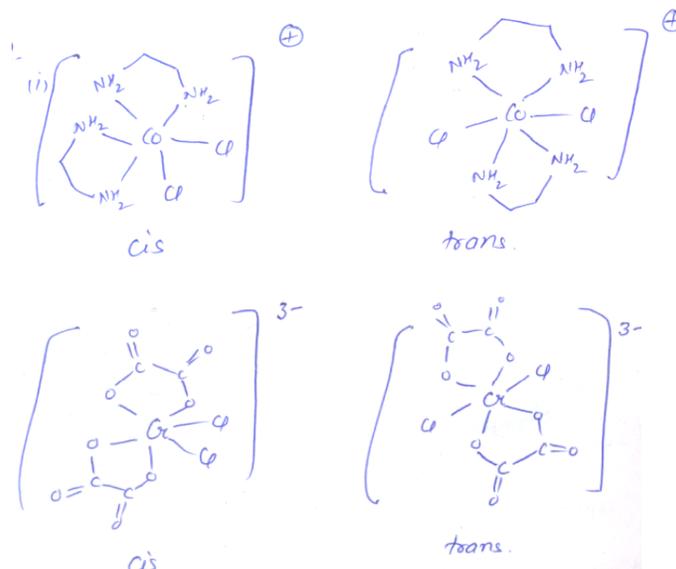
bis (triethylphosphene)  $\rightarrow$  di coordination

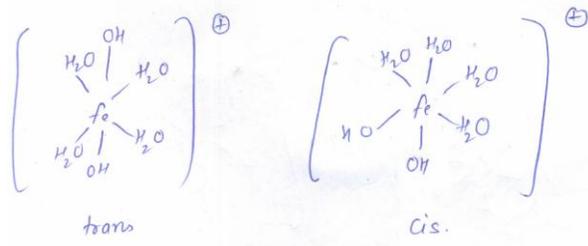
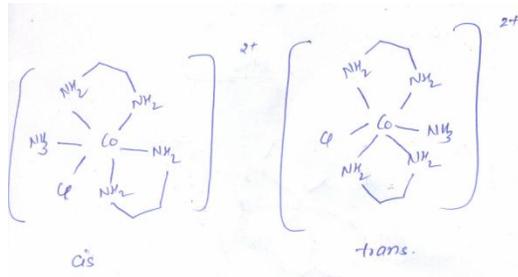
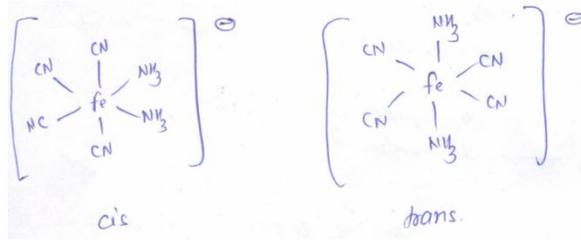


no. of Fe - C (bonds) is 3.

Ans = 3

Sol.22 (6)





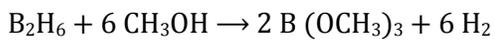
Similar to the above structures,  $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})(\text{Cl})]^{2+}$

Also exists in cis & trans forms

Ans - 6.

**Sol.23** (6)

The rxn is



Ans  $\rightarrow$  6.

**Sol.24** (3)

$$\Lambda_{\text{mHX}} = 10 \lambda_{\text{mHY}}$$

$$M_{\text{HX}} = 0.01 \text{ M}$$

$$M_{\text{HY}} = 0.10 \text{ M}$$

given that  $\lambda_{x-}^{\infty} = \lambda_{y-}^{\infty}$

$$\left(\frac{1000 \times k_{HX}}{M_{HX}}\right) = \left(\frac{1000 \times k_{HY}}{M_{HY}}\right) \quad (10)$$

Solving this, we get

$$\left(\frac{k_a^{HY}}{k_a^{HX}}\right) = 1000$$

$$\Rightarrow \log \frac{k_a^{(HY)}}{k_a^{(HX)}} = 3$$

$$\Rightarrow \log K_a(HY) - \log K_a(HX) = 3$$

$$- \text{p}K_a(HY) + \text{p}K_a(HX) = 3$$

$\Rightarrow$  Ans 3.

**Sol.25** (9)

We have to apply equation of state

$$PV = n R T$$

According to this, the pressure of mixture in the container is directly proportional to the no. of particles in the container.

${}_{92}^{238}U$  undergoes  $\alpha$  (alpha) dissociation.

Till it reaches  ${}_{82}^{206}Pb$

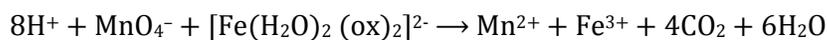
Finally, in the container,

$$\frac{\text{no. of particles after decay}}{\text{no. of particles before decay}} = \frac{9}{1}$$

$$\therefore \frac{P_f}{P_i} = \frac{9}{1}$$

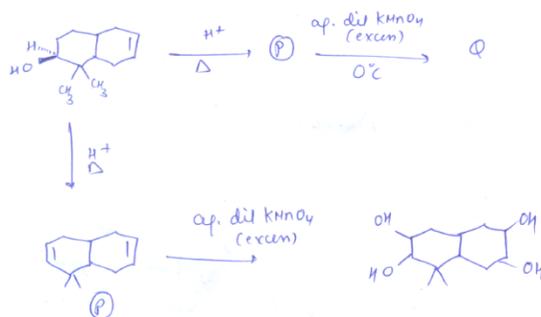
Ans 9.

**Sol.26** (8)



$$\frac{\text{rate of change of } [H^+]}{\text{rate of change of } [MnO_4^-]} = 8 \qquad \frac{[H^+]}{[MnO_4^-]} = 8$$

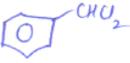
Sol.27 (4)



Ans. (4).

Sol.28 (4)

(i) Rxn is Gattermann Koch Rxn & gives benzaldehyde.

(ii) Treatment of  with water at high temp also yields benzaldehyde.

Also, on reduction of benzoylchloride

With  $H_2$  yields benzaldehyde.

Reduction of (iv) also yields the product

$\therefore$  Ans (4)

Sol.29 (B,C,D)

Surface +  $O_2 \rightarrow e^-$  transfer taken place.

$O_2 + e^- \rightarrow O_2^-$  (bond length of  $O_2^- > O_2$ )

heat is released during the rxn.

& on acceptance of  $e^-$  by  $O_2$ , the occupancy of  $\pi_{2p}^*$  of  $O_2$  increases

Ans: (B) (C) (D)

Sol.30 (B)

$(CH_3)_3SiCl$  is used for chain termination rxn.

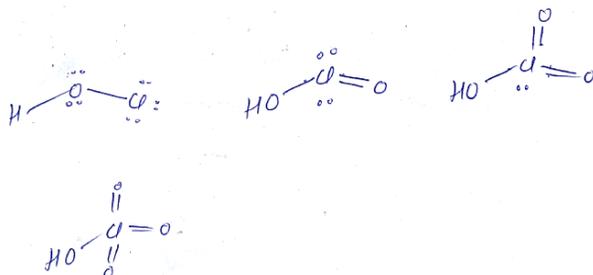
for chain propagation, we use  $(CH_3)_2SiCl_2$   $\therefore$  Ans. (B)

Sol.31 (C,D)

By looking at the concept of Qualitative analysis, we can say that  $\text{Cu}^{2+}$ ,  $\text{Pb}^{2+}$  and  $\text{Hg}^{2+}$  can be precipitated upon passing  $\text{H}_2\text{S}$  in dil aq. sol of salts.

Ans: (c) (d)

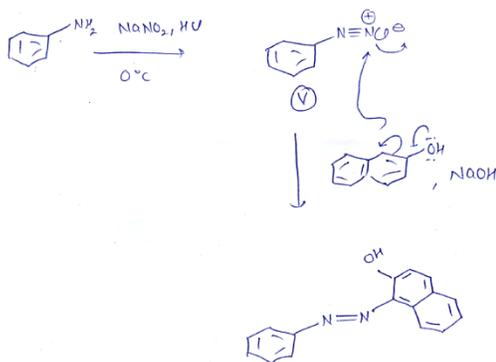
Sol.32. (B,C)



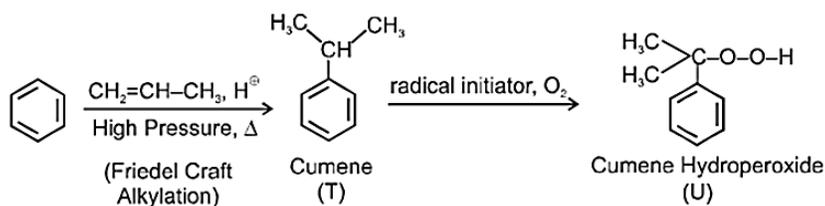
Acc. to the above structures,

the correct statements are (C) (B)

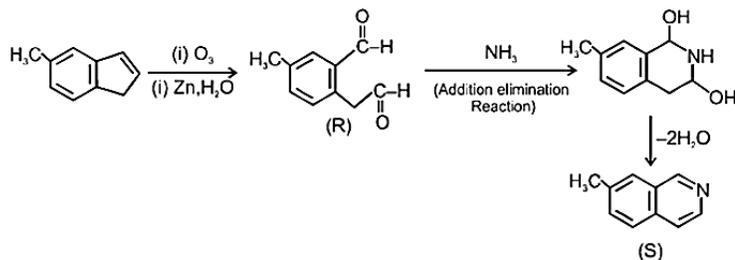
Sol.33 (A)



Sol.34 (B)



Sol.35 (A)



Sol.36 (C)

$$P(V-b) = RT$$

$$\Rightarrow PV - Pb = RT \quad \Rightarrow \frac{PV}{RT} = \frac{Pb}{RT} + 1$$

$$\Rightarrow Z = 1 + \frac{Pb}{RT}$$

Hence  $Z > 1$  at all pressures.

This means, repulsive tendencies will be dominant when interatomic distance are small.

This means, interatomic potential is never negative but becomes positive at small interatomic distances.

Hence answer is (C)

Sol.37 (A)

Let the heat capacity of insulated beaker be  $C$ .

$$\begin{aligned} \text{Mass of aqueous content in expt. 1} &= (100 + 100) \times 1 \\ &= 200 \text{ g} \end{aligned}$$

$$\Rightarrow \text{Total heat capacity} = (C + 200 \times 4.2) \text{ J/K}$$

$$\text{Moles of acid, base neutralised in expt. 1} = 0.1 \times 1 = 0.1$$

$$\Rightarrow \text{Heat released in expt 1} = 0.1 \times 57 = 5.7 \text{ KJ}$$

$$\Rightarrow 5.7 \times 1000 = (C + 200 \times 4.2) \times \Delta T.$$

$$5.7 \times 1000 = (C + 200 \times 4.2) \times 5.7$$

$$\Rightarrow (C + 200 \times 4.2) = 1000$$

In second experiment,

$$n_{\text{CH}_3\text{COOH}} = 0.2, n_{\text{NaOH}} = 0.1$$

Total mass of aqueous content = 200 g

$$\Rightarrow \text{Total heat capacity} = (C + 200 \times 4.2) = 1000$$

$$\Rightarrow \text{Heat released} = 1000 \times 5.6 = 5600 \text{ J.}$$

Overall, only 0.1 mol of  $\text{CH}_3\text{COOH}$  undergo neutralization.

$$\Rightarrow \Delta H_{\text{neutralization}} \text{ of } \text{CH}_3\text{COOH} = -\frac{5600}{0.1} = -56000 \text{ J/mol.}$$

$$\Rightarrow \Delta H_{\text{ionization}} \text{ of } \text{CH}_3\text{COOH} = 57 - 56 = 1 \text{ KJ/mol.} \quad = -56 \text{ KJ/mol.}$$

$$\Rightarrow \Delta H_{\text{ionization}} \text{ of } \text{CH}_3\text{COOH} = 57 - 56 = 1 \text{ KJ/mol}$$

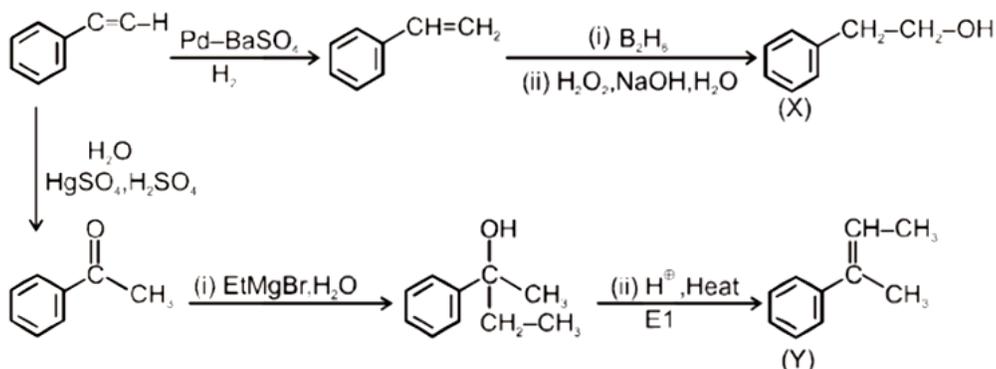
**Sol.38** (B)

Final solution contains 0.1 mole of  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$  each.

Hence it is a buffer solution

$$p_H = pK_a + \log \frac{[H_3COO^-]}{[CH_3COOH]}$$

**Sol.39** (C)



Sol.40 (D)

