

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Scheme for Valuation/Answer Key

Scheme of evaluation (marks in brackets) and answers of problems/key

FIRST SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Name: ENGINEERING CHEMISTRY

PART A

Answer all questions, each carries 2 marks.

Marks

- 1 CHCl₃ protons show a shift in frequency of 728 Hz from TMS signal in a 100MHz NMR instrument, How much would be the shift in frequency for the same proton from TMS in a 300 MHz NMR instrument? (2)

$$\text{Chemical shift } \delta = \frac{\Delta\nu \text{ in Hz}}{\nu \text{ in MHz}} ;$$

since chemical shift (δ) is a constant $\Delta\nu \propto \nu$ or

$$\frac{\Delta\nu_1}{\Delta\nu_2} = \frac{\nu_1}{\nu_2}$$

$$\frac{728}{\Delta\nu_2} = \frac{100}{300}$$

$$\Delta\nu_2 = \frac{300}{100} \times 728 = 2184 \text{ Hz}$$

Attempt 1 mark

- 2 If you take a mixture of ZnSO₄ and CuSO₄ solutions in a beaker and a Zinc rod and a Copper rod are inserted in it will you get electricity? Give the reason. (2)

Ans: Cu²⁺ from solution directly deposited as Cu metal on Zn rod (Metal displacement reaction). Only heat is produced and no electricity

2 marks can be given for the answer displacement reaction

- 3 Explain partition chromatography (2)
- Stationary phase as liquid held on a solid support Partition means ratio of solubility of the component in stationary phase to mobile phase (2)

Marks may be given to principle of chromatography or types of chromatography

- 4 What are Carbon nanotubes? (2)

Ans: Def(2)

- 5 Arrange n-heptane, isooctane, benzene, branched alkanes in increasing order (2)

of knocking tendency in petrol engine.

Benzene < isooctane < branched alkanes < n-heptane (2)

Slight order change can also give full marks

6 Oils having high viscosity need not be having high viscosity index. Comment. (2)

Significance of VI (1) Reason (1)

7 A water sample contains 204 mg of CaSO_4 per litre. Calculate its hardness in terms of CaCO_3 equivalents. (2)

Hardness = $204 \times 100 / 136 = 150$ mg/L or ppm

8 Define reverse osmosis. 8. Reverse osmosis def or Schematic diagram 2 marks. (2)

PART B

Answer all questions, each carries 3 marks.

9 What interpretations are obtained from the chemical shifts in a molecule? (3)

1) number of signals - how many different kinds of protons

2) position of signals – electronegative atom or deshielding

3) Relative peak area – relative proton ratio

(Any two points 3marks)

10 A Zn rod is dipped in 0.4 M CuSO_4 solution, displacement reaction takes place and allowed to attain equilibrium. Calculate the equilibrium constant and $[\text{Cu}^{2+}]$ at equilibrium. . Given that $E^0_{\text{Cu}^{2+}/\text{Cu}} = +0.34\text{V}$ and $E^0_{\text{Zn}^{2+}/\text{Zn}} = -0.76\text{V}$ (3)

Ans: Equilibrium constant $K = 1.67 \times 10^{37}$ (3 marks)

$K = \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$ let 'x' be the con Cu^{2+} at equilibrium

$1.67 \times 10^{37} = (0.4 - x) / x$ since x is very small at equilibrium x in the numerator can be neglected

$1.67 \times 10^{37} = (0.4) / x$

$x = 0.2395 \times 10^{-37} \text{ M}$

Full marks may be given for those answers up to equilibrium constant

11 Write the major applications of DTA. (3)

Ans: 3 applications of DTA

12 What are co-polymers? (1) Illustrate with an example of addition co-polymer. (1) or Give an example for condensation co-polymer. (1) (3)

13 Describe with the significance: i) cloud and pour points (1.5marks) (3)
ii) Flash and fire points. (1.5marks)

- 14 What is meant by aniline point?(1) How is it determined? (2) (3)
- 15 How is the exhausted resin regenerated from an ion-exchange process? (3)
Regeneration cation(1.5marks) anion (1.5 marks)
- 16 What is disinfection?(1) How is it carried out using (a) UV light (1)and (b) (3)
Chlorination?(1)

PART C

Answer all questions, each carries 10 marks.

- 17 a) Discuss the factors affecting chemical shift. (5)
Ans; Any 4 factors 5 marks
- b) Draw the instrumentation of UV-visible spectrometer, explain the various parts (5)
Instrumentation 3 marks+ parts 2 marks.

OR

- 18 a) How will you distinguish the isomers of C₄H₁₀ using NMR spectroscopy? (5)
Two isomers
1)CH₃-CH₂-CH₂-CH₃ (two chemical shifts) CH₃ close to TMS (1:2:1 signal)
CH₂ (1:3:3:1 signal)
- 2) CH₃-CH(CH₃)- CH₃ (two chemical shifts) CH₃ close to TMS (1:1 doublet)
CH (9+1=10 multiplet)
- b) Calculate the force constant of HF molecule, if it shows IR absorption at 4138 cm⁻¹. Given that atomic masses of hydrogen and fluorine are 1u and 19u respectively. What would be the wavenumber if hydrogen atoms are replaced by deuterium atoms? (5)

$$\gamma b \quad \nu = \frac{1}{2\pi} \sqrt{\frac{k}{\mu}}$$

$$\bar{\nu} = \frac{1}{2\pi c} \sqrt{\frac{k}{\mu}}$$

$$\text{Symg} \quad \bar{\nu}^2 = \frac{1}{4\pi^2 c^2} \frac{k}{\mu}$$

$$k = 4\pi^2 c^2 \bar{\nu}^2 \mu$$

$$= 4 \times 314^2 \times (3 \times 10^8)^2 \times (4138 \times 10^2)^2 \times \frac{19 \times 1.66 \times 10^{-27}}{20}$$

$$= 958 \text{ Nm}^{-1}$$

$$\mu = \frac{1 \times 19 \times 1.66 \times 10^{-27}}{1+19} \text{ kg}$$

$$\frac{v_1}{v_2} = \frac{\sqrt{\mu_2}}{\sqrt{\mu_1}} ; \mu_1 = \frac{1 \times 19}{1 + 19}$$

$$\mu_2 = \frac{2 \times 19}{2 + 19}$$

$$\frac{4138}{v_2} = \frac{\sqrt{38/21}}{\sqrt{19/20}}$$

$$v_2 = 2998 \text{ cm}^{-1}$$

3 marks + 2 marks

- 19 a) What are the various types of electrodes? (5)

Ans: Any 4 types 5 (marks)

- b) Calculate the single electrode potentials of H₂ electrode at 25 °C and 1 atm pressure when the solution has pH=0 and pH =14. Based on this which metal (Al or Fe) can liberate H₂ only from acids? Which metal can liberate H₂ from both acid and alkali? Given that E⁰ Fe²⁺/Fe = - 0.44 V and E⁰ Al³⁺/Al = - 1.66 V. (5)

Ans: H₂ electrode potential E = 0 - 0.0591 x pH when pH = 0 (1 M acid) E = 0

When pH = 14 E = -0.0591 x 14 = -0.829 V

Both Fe and Al can liberate H₂ from acid since their reduction potential is lower than 0

Fe cannot liberate H₂ from alkali since H₂ electrode potential -0.829 V is lower than E⁰ Fe²⁺/Fe = - 0.44 V

Al can liberate H₂ from alkali and acid . Since H₂ electrode potential in alkaline medium -0.829 V and acid medium 0V, is higher than E⁰ Al³⁺/Al = - 1.66 V.

Calculation (3) explanation (2)

OR

- 20 a) Discuss the variation in emf of a Daniel cell with respect to temperature at different concentration ratios of Zn²⁺ and Cu²⁺ (5)

Ans: Nernst's equation 2 Three cases - log term zero, -ve and +ve . 3 marks

- b) Calculate the E⁰ cell and concentration ratio of Zn²⁺ and Cu²⁺ in Daniel cell, if (5)

it shows an emf of 1.0969 V at 30 °C and 1.0948 V at 40 °C.

Ans

at 30°C = 303K

$$1.13006 = E_{cell}^{\circ} - \frac{2.303 \times R \times 303 \log 0.1}{n \times 96500}$$

$$1.13006 = E_{cell}^{\circ} + \frac{0.06012}{n} \quad \text{--- (1)}$$

at 40°C = 313K

$$1.13105 = E_{cell}^{\circ} + \frac{0.06210}{n} \quad \text{--- (2)}$$

$$\text{(2) - (1)} \quad 0.00099 = \frac{0.00198}{n}$$

$$n = 2$$

Sub in (1) $E_{cell}^{\circ} = 1.13006 - \frac{0.06012}{2}$

$$= \underline{\underline{1.1V}}$$

There is error in question paper 1.13105V is written as 1.1.3105V

Full marks can be given for writing two equations

- 21 a) Make a comparison between GSC and GLC.(4 points) (5)
- b) Discuss the terms i) Carrier gas(1) ii) column(1)s iii) stationary phase(2) iv) detectors(2) (5)

OR

- 22 a) Write down the experimental procedures for the measurement of conductivity. (4)

Ans:

Conductivity cell (2) schematic diagram of experimental set up or procedure (2)

- b) Describe the terms i) cell constant(2) ii) specific conductance (2) iii) conductivity cell(2) (6)
- 23 a) What is poly pyrrole ?What is poly pyrrole (2), structure (2), synthesis (2) (6)
- b) Which kind of doping is possible (p or n) in poly pyrrole why? –only p-doping is possible in poly pyrrolewith acids as pyrrole is base (1) (4)
- Give two properties and applications (3)



OR

- 24 a) What is ABS ? (2)What are its impotent properties and applications (4) (6)
b) What is Buna-S .(3) Mention the Historical importance?(1)- It is the (4)
synthetic rubber made during World war II by Germany.

Full marks can be given to answers without Historical importance

- 25 a) A sample of coal contains 60% C, 33% O, 6% H, 0.5% S, 0.2% N, and 0.3% (4)
Ash. Calculate the GCV and NCV of coal.
 $GCV = (8080 \times 60 + 34500(6-33/8) + 2240 \times 0.5)/100 = 5506 \text{ kcal/kg}$
 $NCV = 5506 - 0.09 \times 6 \times 587 = 5189 \text{ kcal/kg}$
b) Define grease(1). Under what conditions they are used as lubricant.-thy are (6)
used when it is difficult to maintain liquid lubricant between contacts surfaces
due to low viscosity liquid lubricant may flow out. Eg Ball Barings (2) How a
viscous lubricant are converts into grease?(2)

OR

- 26 a) What is Natural gas? (2)Distinguish between LNG and CNG. (2) Can you use (5)
LNG as fuel in a car?- No since the critical temperature is -82°C only CNG
can be used (1)
b) Calculate the HCV and LCV of ethanol using Dulong's formula. (5)
Calculate the HCV and LCV of ethanol using Dulong's formula
 $\%C = 24 \times 100 / 46 = 52.17$
 $\%H = 13.04$
 $\%O = 34.79$
 $HCV = (8080 \times 52.17 + 34500(13.04 - 34.79/8))/100 = 7213.8 \text{ Kcal/Kg}$
 $LCV = 7213.8 - .09 \times 13.04 \times 587 = 6524.9 \text{ Kcal/kg}$

- 27 a) 100 mL sewage water is diluted to 1000mL with dilution water; the initial (5)
dissolved oxygen was 7.6 ppm, dissolved oxygen level after five days of
incubation was 3.2 ppm. Find the BOD of the sewage water.
Difference in DO = $7.6 - 3.2 = 4.4 \text{ ppm}$
DO used up by 100 mL sewage = $4.4 \times 1 \text{ L} = 4.4 \text{ mg}$
BOD = $4.4 \times 10 = 44 \text{ mg/L}$ or ppm
or BOD = Difference in DO x dilution factor = $4.4 \times 10 = 44 \text{ ppm}$
b) Compare aerobic and anaerobic oxidation of sewage water. (4 points) (5)



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5 marks

Pages:7

OR

- 28 a) Discuss the steps involved in sewage water treatment. (5)
- (a) Three steps (3 marks) Primary/Physical, Secondary/biological and tertiary/chemical methods. diagram (2 marks).
- b) Explain the working of trickling filter process(3) with a neat labelled sketch(2). (5)

