

Code : 100103/100203

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B.Tech 2nd Semester Special Exam., 2020

( New Course )

## CHEMISTRY

Time : 3 hours

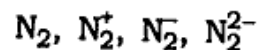
Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.  
 (ii) There are **NINE** questions in this paper.  
 (iii) Attempt **FIVE** questions in all.  
 (iv) Question No. 1 is compulsory.

1. Answer any seven questions in brief :  $2 \times 7 = 14$ 

- (a) Arrange the following in increasing order of stability :



- (b) Transition metal ions like  $Cu^+$  and  $Ag^+$  are colourless. Why?  
 (c) Which of  $Cr^+$  or  $Cu^+$  is expected to be coloured?

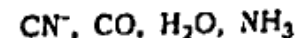
- (d)  $^{13}C$  is NMR active, but  $^{12}C$  is not. Why?  
 (e) What is the direction of a reaction when  $\Delta G = 0$ ?

(f) Why is work not a state function?

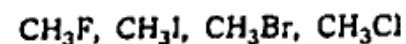
(g) Write the relationship between parts per million (ppm) and Clarke's degree ( $^{\circ}Cl$ ).

(h) What is critical temperature of a gas?

(i) Arrange the following ligands in order of increasing field strength :



(j) Arrange the following in order of their increasing reactivity in nucleophilic substitution reaction :



2. (a) At what temperature will water boil when the applied pressure is 528 mm of Hg? (Latent heat of vaporisation of water = 545.5 cal/g) 4

(b) At NTP, 2.8 L of  $O_2$  were mixed with 19.6 L of  $H_2$ . Calculate the increase in entropy (assume ideal gas behaviour). 4

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- (c) The equilibrium constants for the reaction  $\text{H}_2(\text{g}) + \text{S}(\text{s}) \rightleftharpoons \text{H}_2\text{S}(\text{g})$  are 18.5 at 925 K and 9.25 at 1000 K. Calculate standard enthalpy of the reaction. Also calculate  $\Delta G^\circ$  and  $\Delta S^\circ$  at 925 K. 6
3. (a) The uncertainties in the position and velocity of a particle are  $9.5 \times 10^{-10}$  m and  $5.5 \times 10^{-20} \text{ ms}^{-1}$ , respectively. Calculate the mass of the particle. ( $h = 6.626 \times 10^{-34} \text{ J-s}$ ) 4
- (b) Calculate the kinetic energy of a moving electron which has a wavelength of 4.8 pm. (Mass of electron =  $9.11 \times 10^{-31}$  kg) 5
- (c) Discuss the failures of classical mechanics to explain properties of particles at atomic and sub-atomic levels. 5
4. (a) Draw the MO energy-level diagram for  $\text{O}_2$  and based on the diagram, and explain the magnetic property observed in  $\text{O}_2$ ,  $\text{O}_2^+$  and  $\text{O}_2^-$ . 8

- (b) Explain geometrical isomerism and optical isomerism for transition metal complex with an example for each. 6
5. (a) The internuclear distance of NaCl is  $2.36 \times 10^{-10}$  m. Calculate the reduced mass and moment of inertia of NaCl. (Atomic mass of Cl =  $35 \times 10^{-3} \text{ kg mol}^{-1}$  and Na =  $23 \times 10^{-3} \text{ kg mol}^{-1}$ ) 4
- (b) Calculate the force constant for CO, if it absorbs at  $2.143 \times 10^5 \text{ m}^{-1}$ . (Atomic mass of C =  $12 \times 10^{-3} \text{ kg mol}^{-1}$  and O =  $16 \times 10^{-3} \text{ kg mol}^{-1}$ ) 4
- (c) How many  $^1\text{H}$  NMR signals are there in—
- (i)  $\text{CH}_3\text{---CH}_3$ ;
- (ii)  $\text{CH}_3\text{---CH}_2\text{---CH}_3$ ;
- (iii)  $\text{CH}_3\text{---CH}_2\text{---Cl}$ ;
- (iv)  $\text{CH}_3\text{---CHCl---CH}_3$ ;
- (v)  $\text{C}_6\text{H}_5\text{CH}_3$ ;
- (vi)  $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3$ ? 6

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6. (a) 2 mole of  $\text{NH}_3$  at 300 K occupy a volume of  $5 \times 10^{-3} \text{ m}^3$ . Calculate the pressure using van der Waals equation ( $a = 0.417 \text{ N m}^4 \text{ mol}^{-2}$  and  $b = 0.037 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1}$ ). Compare the above result with the pressure calculated using ideal gas equation. 5

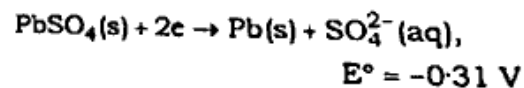
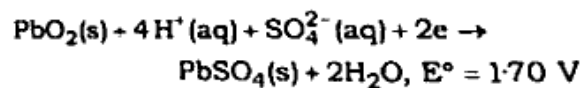
(b) Write short notes on the following : 9

(i) Magnetic resonance imaging

(ii) Fingerprint region in infrared spectroscopy

(iii) Different types of electronic excitations

7. (a) Consider the following half-cell reactions :



Write the cell (in proper cell notation) and the cell reaction. Calculate the value of  $E^\circ$  for the cell and the EMF generated if  $[\text{H}^+] = 0.1 \text{ M}$  and  $[\text{SO}_4^{2-}] = 2 \text{ M}$ . 7

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(b) A water sample had the following constituents per litre :

$\text{CaCO}_3 = 81 \text{ mg}$ ,  $\text{MgHCO}_3 = 75 \text{ mg}$ ,

$\text{CaSO}_4 = 136 \text{ mg}$ ,  $\text{MgSO}_4 = 120 \text{ mg}$ ,

$\text{NaCl} = 4.7 \text{ mg}$

Calculate the quantity of temporary and permanent hardness in the water sample. Calculate the quantity of lime (78% purity) and soda (92% purity) required for softening of 1.5 million litres of the above water sample. 7

8. (a) Describe two methods used for resolving racemic mixtures into optically active compounds. 4

(b) Write the possible optical isomers of tartaric acid and indicate the point of symmetry or plane of symmetry (if any) in the isomers. 5

(c) Differentiate between (i) enantiomers and diastereomers and (ii) racemic mixture and meso compounds. 5

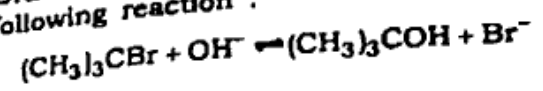
9. (a) How do you decide whether the reaction  $\text{CH}_3\text{Br} + \text{OH}^- \rightleftharpoons \text{CH}_3\text{OH} + \text{Br}^-$  proceeds by  $\text{S}_{\text{N}}1$  or  $\text{S}_{\text{N}}2$  reaction? Give justification in favour of your answer. 4

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(b) Draw the energy profile diagram for the following reaction : 4



(c) Write short notes on the following : 6

(i) Steric effects

(ii) Diels-Alder reaction

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