

**B.Tech 1st Semester Exam., 2019
(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 (answer in brief) : 2×7=14

- (a) What is the designation of the orbital having $n = 4$ and $l = 3$?
- (b) Which quantum number specifies the shape of an orbital?
- (c) What are the shapes of NF_3 and ClF_3 molecules?
- (d) Arrange O_2 , O_2^- , O_2^{2-} and O_2^+ in order of increasing bond length.

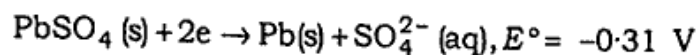
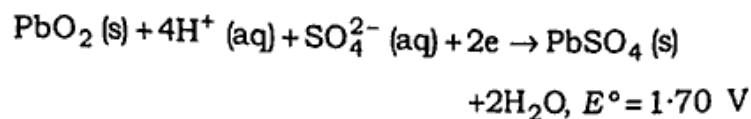
- (e) Out of Cr^{2+} and Cr^{3+} , which one is stable in aqueous solution?
- (f) Write the electronic configuration of Zn^{2+} and comment on its magnetic behaviour.
- (g) What is selection rule?
- (h) A reaction has $\Delta H < 0$ and $\Delta S < 0$. At what temperature the forward reaction proceed?
- (i) What is the condition for a reaction to be in equilibrium?
- (j) How are exhausted ion-exchange resins regenerated? <http://www.akubihar.com>

2. (a) Discuss Heisenberg's uncertainty principle and deduce a mathematical expression involving position and velocity uncertainty of an electron. 5
- (b) Explain dual nature of light and give one example (property/experiment) in favour of its particle nature and wave nature. 4

- (c) Electromagnetic radiation of wavelength 242 nm is just sufficient to ionize sodium ion. Calculate the ionization energy of sodium atom in kJ/mol
 (c = 10^8 m s⁻¹, $h = 6.626 \times 10^{-34}$ Js). 5
3. (a) Draw the MO energy-level diagram for O₂ and based on the diagram, explain the paramagnetic property observed in O₂. 8
- (b) Explain ionization isomerism and linkage isomerism for transition metal complex with an example for each. 6
4. (a) ¹H³⁵Cl has a force constant (*k*) value of 480 Nm⁻¹. Calculate the fundamental frequency and its wave number. 4
- (b) The spacing between lines in rotational spectra of HBr is 16.94 cm⁻¹. Calculate the bond length of the molecule (H = 1, Br = 80). 4
- (c) What is an absorption spectrum? Discuss about $\pi-\pi^*$ and $n-\pi^*$ transitions giving examples. 6

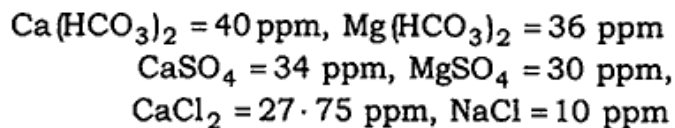
5. (a) With reference to NMR spectroscopy, discuss chemical shift, shielding and deshielding of protons and spin-spin interaction. 6
- (b) A what frequency shift from TMS, would a group of nuclei with $\delta = 1.00$ resonate in an NMR spectrometer operating at 500 MHz? 4
- (c) Use the equation of state of van der Waals to calculate the pressure of 8 g of gaseous CO₂ occupying a volume of 8 L at 27 °C. (Given, $a = 3.6$ L² atm mol⁻², $b = 0.043$ L mol⁻¹, $R = 0.082$ L atm K⁻¹ mol⁻¹). Compare the above result with the pressure calculated using ideal gas equation. 4
6. (a) The boiling point of water is 373 K at 1 atm. Calculate w , q , ΔU , ΔH , ΔG , ΔA and ΔS when 1 mole of steam is compressed isothermally and reversibly. Given, latent heat of vaporization of water is 40.67 kJ mol⁻¹. 7

(b) Consider the following half-cell reactions :



Write the cell in proper cell notation and also write the cell reaction. Calculate the value of E° for the cell and the EMF generated if $[\text{H}^+] = 0.1 \text{ M}$ and $[\text{SO}_4^{2-}] = 2 \text{ M}$. <http://www.akubihar.com> 7

7. (a) Calculate the amount of lime (94% purity) and soda (82% purity) required for the treatment of a million litres of water per day for a week having following constituents : 5



(b) 0.5 g of CaCO_3 was dissolved in HCl and the solution made up to 500 mL with distilled water. 50 mL of this solution required 48 mL of EDTA solution for titration. 50 mL of hard water sample required 15 mL of EDTA

and same volume of hard water sample, after boiling and filtering, required 10 mL of EDTA solution. Calculate total hardness and carbonate hardness for the hard water sample. 3

(c) Give the theory of zeolite method, its limitations and advantages. 6

8. (a) Write notes on the following : 3×4=12

- (i) Geometrical isomerism
- (ii) Optical isomerism
- (iii) Enantiomers
- (iv) meso-compounds

(b) Which among the following molecules shows geometrical isomerism? 2

- (i) 2-butene
- (ii) 2-methyl-2-butene
- (iii) 2-pentene
- (iv) 1, 2-dichloropropane

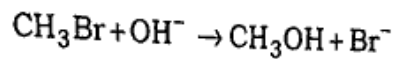
9. (a) Explain the following : 9

- (i) Haloalkanes on reaction with KCN give cyanides and with AgCN give isocyanides.

(ii) Addition of HBr to alkene does not follow Markownikoff's rule in presence of peroxide.

(iii) S_N1 leads to racemic mixture, whereas S_N2 gives rise to inverted products.

(b) How do you decide whether the reaction



proceeds by S_N1 or S_N2 mechanism?

Give proper explanation.

3

(c) Comment on the stability of carbocations.

2

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