

Total number of printed pages-7

3 (Sem-1/CBCS) CHE HC 2

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE-HC-1026

(Physical Chemistry-I)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following as directed : $1 \times 7 = 7$

- (a) The compressibility factor for hydrogen and helium gases is less than one at all pressures. (State True **or** False)

Contd.

(b) A real gas obeying the van der Waals' equation will closely resemble an ideal gas, if

(i) the parameters a and b are small

(ii) a is large but b is small

(iii) a is small but b is large

(iv) both a and b are large

(Choose the correct option)

(c) A free falling liquid drop is spherical. Explain why.

(d) Define the term 'plane of symmetry' in crystal system.

(e) State the law of constancy of interfacial angles.

(f) Explain why an aqueous solution of Na_2CO_3 is alkaline.

(g) pH of $1.0 \times 10^{-8} \text{M HCl}$ solution is not 8. Explain.

2. Answer the following questions : $2 \times 4 = 8$

(a) Explain why real gases deviate from ideal behaviour.

(b) Viscosity of liquids generally decreases while that of gases increases with increase in temperature. Give reasons.

(c) A crystal plane has intercepts on the three axes of crystal in the ratio $\frac{1}{2} : \frac{2}{3} : \infty$. What are Miller indices of the plane?

(d) Calculate pH of a $1.0 \times 10^{-5} \text{M NaOH}$ solution at 298K.

3. Answer **any three** of the following questions : $5 \times 3 = 15$

(a) (i) Derive van der Waals' equation for n moles of a gas. 4

(ii) Under what conditions a van der Waals' gas behaves ideally? 1

(b) Define critical constants of a gas. Derive the relations expressing the critical constants of a gas in terms of van der Waals' constants. 5

(c) (i) Define surface tension of a liquid. Give the SI unit of surface tension. How does surface tension of a liquid vary with temperature? 3

(ii) At 293K, $1.0 \times 10^{-5} m^3$ of water gave 29 drops and same volume of diethyl ether gave 86 drops from the same stalagmometer. At the same temperature density of water is $1.0 \times 10^3 kg m^{-3}$ and that for diethyl ether is $7.0 \times 10^2 kg m^{-3}$. Also at 293K surface tension for water is 72 dyne cm^{-1} . Calculate the surface tension of diethyl ether at 293K. 2

(d) Explain the symmetry elements of crystal belonging to simple cubic system. 5

(e) Write the dissociation equilibria for a dibasic acid H_2A in aqueous solution. Establish a relation for the dissociation equilibria constant. 5

4. Answer **any three** of the following questions: $10 \times 3 = 30$

(a) (i) Enumerate the assumptions of kinetic theory of gases. 3

(ii) Derive the fundamental kinetic gas equation. 4

(iii) Calculate the temperature at which root mean square velocity of N_2 molecules will be $1000 ms^{-1}$. 3

(b) (i) Derive the reduced equation of state from van der Waals' equation. What is the law of corresponding states? $4+2=6$

(ii) The reduced volume and reduced temperature of a gas are 10.2 and 0.7 respectively. If the critical pressure of the gas is 42.56 bar, calculate its pressure. 4

(c) (i) Explain the theory of experimental determination of surface tension of a liquid by drop number method. 4

(ii) Explain the effect of addition of various types of solutes on the surface tension of a liquid. 4

(iii) Explain why at the boiling point of a liquid temperature does not rise although this is being heated. 2

(d) (i) Derive Bragg's equation. 4

(ii) X-rays of wavelength 0.15nm are used in an X-ray diffraction experiment. First order diffraction is observed when the angle of incidence is 10.02° . Calculate the interplanar distance in the crystal used. 3

(iii) What are liquid crystals? Mention one use of liquid crystal. 3

(e) (i) What is point defect in a crystal? Explain Schottky and Frenkel defects. Give examples.

$$2+(2+2)+1=7$$

(ii) Sketch 100 planes of a cubic lattice. 2

(iii) Explain why Schottky defects decrease the density of crystals. 1

(f) (i) Show the variation of pH with volume of base added during titration of strong acid with strong base and titration of weak acid with strong base. 4

(ii) What are acid-base indicators? Explain a theory to explain the behaviour of indicator in acid-base titration. 2+4=6

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3 (Sem-1/CBCS) CHE HC 1

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE-HC-1016

(Inorganic Chemistry-I)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : $1 \times 7 = 7$

(a) What is eigenvalue ?

(b) What is normalisation constant ?

(c) How many unpaired electrons are there in the element present in fourth period and sixth group of the periodic table ?

Contd.

- (d) What is the IUPAC name of the element having atomic no. 114 ?
- (e) How many unpaired electrons are there in O_2^- ion ?
- (f) What type of hybridisation does the central atom of BeH_2 molecule undergo ?
- (g) What is the covalency of chlorine in Cl_2O_7 molecule ?

2. Answer the following questions : $2 \times 4 = 8$

- (a) Find the expression of Bohr's radius for the electron of hydrogen atom.
- (b) Calculate the effective nuclear charge experienced by the 4s electron of copper atom.

(c) Calculate the limiting radius ratio, r_+/r_- for Ax_3 type ionic crystal.

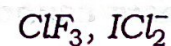
(d) Draw the Lewis electron dot structure of the following :



3. Answer **any three** questions from the following : $5 \times 3 = 15$

(a) Write a note on Bent's rule.

(b) Using VSEPR theory explain the shapes of the following molecules : $2\frac{1}{2} + 2\frac{1}{2} = 5$



(c) Give the basic outlines of molecular orbital theory of covalent bonding. 5

(d) Taking the example of lithium explain the band theory of metallic bonding.

5

(e) Write a note on semiconductors. 5

4. Answer the following questions : $10 \times 3 = 30$

(a) Answer **either** (i) and (ii) **or** (iii) and (iv)

(i) What are spherical harmonics ?

Find the expression for normalised angular wave function of p_z orbital.

$1+5=6$

(ii) State Pauli's antisymmetry principle. Prove that two electrons with same set of four quantum numbers cannot stay together.

$1+3=4$

Or

(iii) Write a note on radial probability distribution function. 6

(iv) Explain aufbau principle. 4

(b) Answer **either** (i) and (ii) **or** (iii) and (iv)

(i) Discuss the variation in ionisation energies of the elements present in second period of the periodic table. 5

(ii) Discuss Mulliken's scale of electronegativity. 5

Or

(iii) What is electron gain enthalpy ? What are the factors on which it depends ? Discuss its variation in a group and along a period.

$1+2+3=6$

(iv) Electronegativity values of H, F and Cl are 2.1, 4.0 and 3.5 respectively. Calculate percent ionic character in HCl and HF bond. $2+2=4$

(c) Answer **either** (i) and (ii) **or** (iii) and (iv)

(i) How can you determine lattice energy of NaCl using Born-Haber cycle. Explain. 6

(ii) What is standard electrode potential? How can it be applied to predict the feasibility of a reaction? 1+3=4

Or

(iii) Draw the molecular orbital energy level diagram of CO molecule. Write its electronic configuration. Find its bond order and give its magnetic behaviour. 3+1+(1+1)=6

(iv) What is redox reaction? Write the reactions involved in the estimation of Fe^{2+} ion using standardized KMnO_4 solution.

1+3=4

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3 (Sem-1/CBCS) CHE HG/RC

2021

(Held in 2022)

CHEMISTRY

(Honours Generic/Regular)

Paper : CHE-HG/RC-1016

**(Atomic Structure Bonding, General,
Organic Chemistry and Aliphatic
Hydrocarbons)**

Full Marks : 60

Time : Three hours

**The figures in the margin indicate
full marks for the questions.**

Answer either in English or in Assamese

1. Answer the following questions : $1 \times 7 = 7$

তলৰ প্ৰশ্নকেইটাৰ উত্তৰ দিয়া :

(a) What is a meso compound ?

মেছ' যৌগ বুলিলে কি বুজা ?

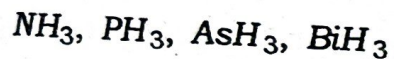
Contd.

(b) What is meant by a normalized wave function ?

অনুলম্বীয় তৰংগ কাৰ্য্য বুলিলে কি বুজা ?

(c) Arrange the following compounds in increasing order of bond angle :

তলত দিয়া যৌগসমূহ বাহুৰ কোণৰ বৰ্দ্ধিত ক্ৰমত অনুযায়ী সজোৱা :

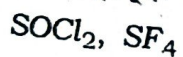


(d) Draw the structure of the most stable conformer of cyclohexane.

চাইক্ল'হেক্সেনৰ আটাইতকৈ স্থিৰ কনফৰ্মাৰটো অংকন কৰা।

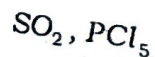
(e) Predict the shape of the following molecule :

তলত দিয়া অণুসমূহৰ আকৃতি নিৰ্ণয় কৰা :



(f) Which of the following molecules is nonpolar ?

তলত দিয়াসমূহৰ কোনটো অণু অপ্ৰ-বৰীয় ?



(g) Why is phenol a stronger acid than aliphatic alcohol ?

এলিফেটিক এলকহলৰ তুলনাত ফিনল কিয় বেছি আম্লিক ?

2. Answer the following questions : $2 \times 4 = 8$

তলৰ প্ৰশ্নবোৰৰ উত্তৰ লিখা :

(a) Explain the physical significance of ψ and ψ^2 .

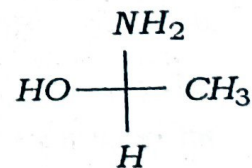
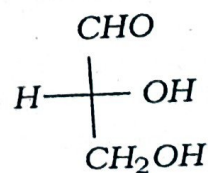
ψ আৰু ψ^2 -ৰ ভৌতিক বিশেষত্ব ব্যাখ্যা কৰা।

(b) Explain why racemic mixtures are optically inactive ?

বেছিমীয় মিশ্ৰণবোৰ কিয় আলোক অসক্রিয়, ব্যাখ্যা কৰা।

(c) Assign R/S configuration of the following compounds :

তলত দিয়া যৌগসমূহৰ R/S দিক্‌বিন্যাস নিৰ্ণয় কৰা :



(d) What is Baeyer's test ? Give the reaction.

বেয়াৰ'ৰ পৰীক্ষা বুলিলে কি বুজা ? বিক্ৰিয়াটো লিখা।

3. Answer **any three** of the following questions : 5×3=15

তলৰ যিকোনো তিনিটাৰ উত্তৰ লিখা :

(a) (i) State Saytzeff's rule and explain with suitable example. 2

উপযুক্ত উদাহৰণসহ ছেইট্‌জেফ'ৰ বিধি ব্যাখ্যা কৰা।

(ii) Describe the mechanism of dehydrohalogenation of alkyl halides. 3

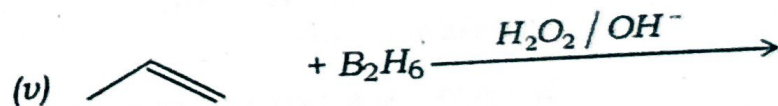
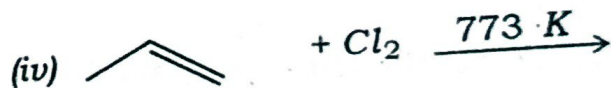
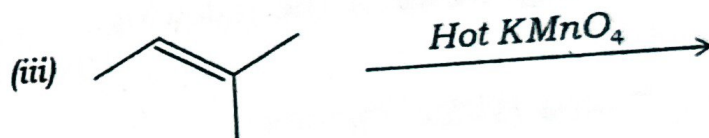
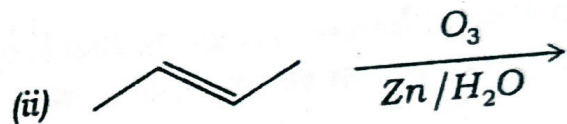
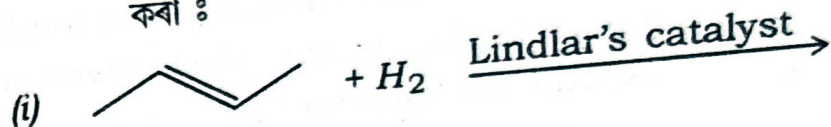
এলকাইল হেলাইডৰ ডিহাইড্ৰ'হেল'জিনেচনত জৰিত বিক্ৰিয়াবিধি বৰ্ণনা কৰা।

(b) Describe the utility of Born-Haber cycle for calculating the lattice energy of sodium chloride. 5

ছ'ডিয়াম ক্ল'ৰাইডৰ লেটিছৰ শক্তি গণনা কৰিবলৈ ব'ৰ্ন-হেৰাৰ চক্ৰৰ ব্যৱহাৰ বৰ্ণনা কৰা।

(c) Identify the products of the following reactions : 1×5=5

তলত দিয়া বিক্ৰিয়াসমূহৰ বিক্ৰিয়াজাত পদাৰ্থবোৰ নিৰ্ণয় কৰা :



(d) How are alkanes prepared by the following ? 2½ + 2½ = 5

তলত দিয়াসমূহৰ দ্বাৰা কেনেদৰে এলকেন প্ৰস্তুত কৰা হয় ?

(i) Corey-House reaction

ক'ৰে-হাউছ বিক্ৰিয়া

(ii) Wurtz reaction

উর্টজ বিক্রিয়া

(e) Draw the radial probability distribution curves for 1s, 2p and 3d-electrons and explain the difference. 5

1s, 2p আৰু 3d ইলেক্ট্ৰনৰ ৰেডিয়াল সম্ভাৱিতা বিতৰণ বক্ৰৰেখা অংকন কৰি সিহঁতৰ পাৰ্থক্য ব্যাখ্যা কৰা।

4. Answer **any three** of the following questions : 10×3=30

তলৰ যিকোনো তিনিটাৰ উত্তৰ লিখা :

(a) (i) Write *two* differences between electromeric effect and resonance effect. 2

ইলেক্ট্ৰমৰিক আৰু সংস্পন্দন প্ৰভাৱৰ মাজত দুটা পাৰ্থক্য লিখা।

(ii) Write down the mechanism of oxymercuration-demercuration of reaction of propane. 3

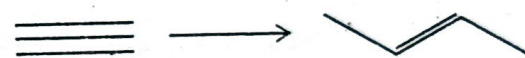
প্ৰপেনৰ অক্সিমাৰকিউৰেচন-ডিমাৰকিউৰেচন বিক্রিয়াৰ বিক্রিয়াবিধিটো লিখা।

(iii) State and explain Hofmann's rule with an example. 3

উদাহৰণসহ হফমেনৰ বিধি লিখি ব্যাখ্যা কৰা।

(iv) Carry out the following conversion : 2

তলত দিয়াটো পৰিৱৰ্ত্তন কৰা :



Ethyne

but-2-ene

(b) (i) Discuss the bonding in NO molecule with the help of molecular orbital theory and from its molecular orbital energy level diagram explain why bond energy of NO⁺ is larger than that of NO. 5

আণৱিক অৱবিটেল তত্ত্বৰ সহায়ত NO অণুৰ গঠন বৰ্ণনা কৰা আৰু ইয়াৰ আণৱিক অৱবিটেল শক্তিস্তৰ চিত্ৰৰ সহায়ত ব্যাখ্যা কৰা যে NO⁺-ৰ বান্ধনি শক্তি তকৈ NO বেছি।

- (ii) What is radius ratio rule ? How can it help to predict the structure of an ionic crystal ? What is its limitation ? 5

ব্যাসার্ধ অনুপাত বিধি বুলিলে কি বুজা ? আয়নীয় স্ফটিক এটাৰ গঠন নিৰ্ণয় কৰাত ই কেনেদৰে সহায় কৰে ? ইয়াৰ সীমাবদ্ধতাবোৰ লিখা।

- (c) (i) What is lattice energy ? How does the solubility of an ionic solid depend upon its lattice energy ? Mention the factors on which lattice energy of an ionic solid depends. 5

লেটিচ শক্তি বুলিলে কি বুজা ? আয়নীয় কঠিন পদাৰ্থ এটাৰ দ্রৱণীয়তা ইয়াৰ লেটিছ শক্তিৰ ওপৰত কেনেদৰে নিৰ্ভৰ কৰে ? কঠিন পদাৰ্থ এটাৰ লেটিচ শক্তি নিৰ্ভৰ কৰা কাৰকসমূহ লিখা।

- (ii) Calculate the % ionic character in HCl molecule. Given the bond distance in this molecule is 1.275 \AA and observed dipole moment value is $1.03 D$. 3

HCl অণুৰ % আয়নীয় ধৰ্ম নিৰ্ণয় কৰা। দিয়া আছে যে HCl অণুৰ বান্ধনি দূৰত্ব 1.275 \AA আৰু পর্যবেক্ষিত দ্বিমৰু ভ্রামক $1.03 D$.

- (iii) The dipole moment of NH_3 is larger than that of NF_3 . Justify the statement. 2

NF_3 তকৈ NH_3 -ৰ দ্বিমৰু ভ্রামক বেছি। ব্যাখ্যা কৰা।

- (d) (i) What are quantum numbers ? How do they arise in the wave mechanical model of an atom ? Discuss the physical significance of different quantum numbers. 1+2+4=7

কোৱান্টাম সংখ্যা কি কি ? এটা অণুৰ তৰংগীয় যান্ত্ৰিক আৰ্হিৰ পৰা কেনেদৰে উৎপত্তি হয় ? বিভিন্ন কোৱান্টাম সংখ্যাৰ ভৌতিক বিশেষত্ব বৰ্ণনা কৰা।

- (ii) Write Schrödinger wave equation for hydrogen atom. What are various parameters used in the equation ? 3

হাইড্রোজেন পৰমাণুৰ বাবে শ্ৰডিঞ্জাৰৰ তৰংগ সমীকৰণটো লিখা। সমীকৰণটোত ব্যৱহাৰ হোৱা বিভিন্ন পেৰামিটাৰবোৰ লিখা।

- (e) (i) Compare and contrast about the structure and stability of carbocation and carbanion. 5

কাৰ্বকেটায়ন আৰু কাৰ্বএনায়নৰ গঠন আৰু স্থিৰতাৰ তুলনা আৰু পাৰ্থক্য লিখা।

- (ii) How is benzene converted to acetophenone ? Name the reaction and discuss the mechanism explaining each step. 5

বেনজিনক কেনেদৰে এচিটফিননলৈ পৰিৱৰ্তন কৰা হয়। বিক্ৰিয়াটোৰ নাম লিখা আৰু প্ৰতিটো খাপ ব্যাখ্যা কৰাকৈ বিক্ৰিয়া বিধিটো বৰ্ণনা কৰা।

- (f) (i) State and explain Huckel's rule of aromaticity with suitable examples. 3

উপযুক্ত উদাহৰণসহ হাকল'ৰ এৰ'মেটিক বিধি লিখি ব্যাখ্যা কৰা।

- (ii) What are anti-aromatic compounds ? Give examples. 2

এন্টি-এৰ'মেটিক যৌগ বুলিলে কি বুজা ? উদাহৰণ দিয়া।

- (iii) Compare the relative stability of benzene, toluene and nitrobenzene towards electrophilic substitution. 3

ইলেক্ট্ৰফিলীয় প্ৰতিষ্ঠাপন বিক্ৰিয়াৰ প্ৰতি বেনজিন, টলুইন আৰু নাইট্ৰ'বেনজিনৰ স্থিৰতা তুলনা কৰা।

- (iv) Explain the difference between the terms conformation and configuration by taking suitable examples. 2

উপযুক্ত উদাহৰণসহ গঠন আৰু দিকবিন্যাসৰ মাজৰ পাৰ্থক্য ব্যাখ্যা কৰা।