

3 (Sem-1/CBCS) CHE HC 1

2019

CHEMISTRY

(Honours)

Paper : CHE-HC-1016

(Inorganic Chemistry—I)

Full Marks : 60

Time : 3 hours

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

1. Choose the correct answer from the following : 1×7=7

(a) Maximum number of electron possible in N shell of an atom of an element is

(i) 18

(ii) 8

(iii) 28

(iv) 32

(b) Physically meaningful quantity is given by

(i) only ψ

(ii) only ψ^2

(iii) both ψ and ψ^2

(iv) none of ψ and ψ^2

(2)

(c) In the long form of modern periodic table, element 49 has the position at

- (i) group 12 of 4th period
- (ii) group 13 of 5th period
- (iii) group 13 of 4th period
- (iv) group 15 of 4th period

(d) The radii of Mg^{2+} and O^{2-} ions are 0.66 Å and 1.40 Å, and that of B^{3+} and O^{2-} ions are 0.23 Å and 1.40 Å respectively. The crystals formed by MgO and B_2O_3 have shapes respectively

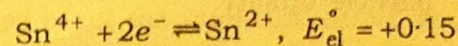
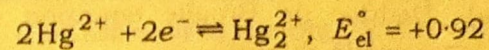
- (i) octahedral and trigonal planar
- (ii) tetrahedral and octahedral
- (iii) octahedral and cubic
- (iv) trigonal planar and octahedral

(e) The van der Waals' forces active in solid I_2 are

- (i) ion-dipole forces
- (ii) dipole-dipole interactions
- (iii) induced dipole interactions
- (iv) zero

(3)

(f) The half-cell reaction of two redox systems are as follows :



If the two half cells are linked to give a cell, then

- (i) Hg_2^{2+} will be oxidized and Sn^{4+} will be reduced
- (ii) Hg^{2+} will be reduced and Sn^{2+} will be oxidized
- (iii) both Hg^{2+} and Sn^{2+} will be oxidized
- (iv) both Hg^{2+} and Sn^{2+} will be reduced

(g) When you prepare KMnO_4 and $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution by transferring a measured amount of these from chemical balance, then it is necessary to standardize

- (i) both KMnO_4 and $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution
- (ii) only $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution, but not KMnO_4
- (iii) only KMnO_4 , but not $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution
- (iv) none of KMnO_4 and $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ solution

(4)

2. Answer the following questions :

2×4=8

(a) Deduce de Broglie equation of wave-particle duality.

(b) Write Born-Landé equation with meaning of all the terms involved. From this equation, predict which of CaO and $\text{Al}_2(\text{SO}_4)_3$ has higher lattice energy.

(c) Define the terms 'bond moment' and 'dipole moment'. Taking an example, explain that bond moment in a molecule does not lead to a non-zero dipole moment in the molecule.

(d) Isolate the equation in acidic medium $\text{MnO}_4^- + \text{I}^- \rightarrow \text{I}_2 + \text{Mn}^{2+}$ into oxidized half reaction and reduced half reaction and balance the two parts separately and write down the overall balanced reaction.

3. Answer the following questions :

5×3=15

(a) Find an expression for energy of hydrogen atom. Write the Schrödinger's wave equation for the electron in hydrogen atom.

4+1=5

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(Continued)

(5)

Or

Draw the proper diagram of *p*-orbitals and *d*-orbitals of an atom. Write the values of all the quantum numbers for an atom when $n=3$.

3+2=5

(b) Define electronegativity and deduce the expression for Pauling electronegativity scale. Calculate the electronegativity of carbon atom following Allred-Rochow's approach. (Covalent radius of carbon atom is 0.77 Å)

1+2+2=5

(c) Discuss Heitler-London approach of valence bond theory.

5

Or

(i) What is solvation energy? Discuss the mechanism of dissolution of an ionic solute in a polar solvent.

3

(ii) Calculate the formal charge of P and H in PH_3 .

2

4. Answer the following questions (any three) :

10×3=30

(a) (i) What are the factors that affect ionization energy? Discuss its periodic trend. Why does successive ionization enthalpy of atom of an element increase immensely? 1+2+2=5

20A/595

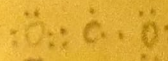
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(6)

- (ii) State Slater's rule. Calculate the effective nuclear charge at the periphery of chromium atom. $3+2=5$
- (b) (i) Draw Lewis dot picture for NO and CO_3^{2-} . 2
- (ii) Give a neat molecular orbital diagram of N_2 . Identify HOMO and LUMO in this diagram. Is it possible to obtain an N_2^+ molecular ion? Justify it. $3+1+1=5$
- (iii) What is non-bonding molecular orbital? Explain it with appropriate example. $1+2=3$
- (c) (i) Explain the terms 'radial' and 'angular' wave functions for hydrogen atom. Draw radial probability distribution curve for hydrogen atom when $n=2$. $3+2=5$
- (ii) What are the two basic postulates of VSEPR theory? Is it possible to give suitable explanation for the shape of PCl_3F_2 molecule by VSEPR theory? Elaborate your answer. $2+3=5$
- (d) (i) State and explain Hund's rule of maximum multiplicity. 2

(7)

- (ii) How does electronegativity change in sp , sp^2 and sp^3 hybridization? 2
- (iii) Apply molecular orbital theory to CO molecule. 3
- (iv) Describe the theory involved in estimation of Fe^{2+} ion in a given solution of unknown strength. 3



3 (Sem-1/CBCS) ENG-AE

2 0 1 9

ENGLISH COMMUNICATION

Paper : ENG-AE-1014

(English Language Proficiency)

Full Marks : 80

Time : 3 hours

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

- 1.** Match the following meanings to the terms given within the box. Please note that there is one extra term within the box which does not match with any of the meanings :

1×10=10

- (a) to find or meet by chance
- (b) a situation in which everyone has an equal chance of winning
- (c) a time in which some decisive change takes place

(2)

- (d) lacking in quantity or quality
- (e) obstacle
- (f) move from one region to another
- (g) see an event happen
- (h) something that is hip or popular at a given point of time
- (i) the basic physical and organisational structure and facilities
- (j) a list drawn from a longer list of people found to be most suitable for some job

hurdle, meagre, stumbled upon, internship, shortlisted, a level playing field, turning point, infrastructure, migrate, witness, trend

2. Write the contracted forms of the expressions in bold in the following sentences : 2+2=4

- (a) She **should not** have gone there knowing that **she would** be ridiculed by her teammates.

(3)

- (b) Ravi **is not** the type of guy who can be bullied into doing something he **does not** believe in.

3. Write the definition of any *three* of the following items along with illustrations :

2×3=6

- (a) Virtual
- (b) Catalyst
- (c) Internship
- (d) Portal
- (e) Tier 2 and tier 3 cities

4. Read the instructions carefully and do as directed : 5×4=20

- (a) Punctuate the following sentences : 5

- (i) A friend recommended that I upload these clips on YouTube, Meera says.

(ii) Meera, who won the Asia Award for most popular Indian channel in Seoul South Korea in 2016, has collaborated with many Bollywood stars.

(iii) These include Shah Rukh Khan, Priyanka Chopra and Varun Dhawan from the Hindi film industry.

(iv) According to advertisement revenue analysis, a top Indian YouTuber earns up to rupees one crore a month on an average of two video uploads.

(v) After my first video on Facebook friends suggested I better not waste the content on my timeline alone Meera says

(b) Complete the paragraph by using the appropriate linking expressions from the box :

5

meanwhile, later, since, by now, since

since ~~meanwhile~~ there wasn't any movement in Husing and Turbung valley the previous day, we decided to trek to

(Continued)

Rumbak. We reached the tri junction and our spotters started climbing the ridges to scan for snow leopards.

by now, we were all busy photographing vultures and eagles near the area till Dorjee and his team brought us a sumptuous lunch. ~~since~~ ^{later}, some of the people who wanted to speak to their families trekked up to the village.

since this was the second day and no sighting of a snow leopard had taken place, we trekked back to the base camp. ~~later~~ ^{now} a general dip in enthusiasm seemed to be setting since there were only two days left to sight the snow leopard.

(c) Find the words in the box that collocate with the ones on the list and write them down together :

5

fast, quick, share, give, do

(i) shower *quick*

(ii) advice *give*

(iii) food *fast*

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(Turn Over)

(iv) a secret *share*

(v) the dishes *do*

(d) Fill in the blanks with the comparative and superlative form of the adjectives given in the brackets :

5

(i) Venus shines _____ among the stars in the night sky. (bright, brighter, the brightest)

(ii) Rose is considered as _____ of all flowers. (beautiful, more beautiful, the most beautiful)

(iii) December is supposed to be _____ month. (cold, colder, the coldest)

(iv) Rahul is _____ but mona is _____. (intelligent, more intelligent, the most intelligent)

5. Do as directed :

4+6=10

(a) Read the text given in the annexure carefully and answer the following questions :

2+2=4

(i) What is the 'silent internship revolution in India' that the author is talking about?

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(Continued)

(ii) What is the prediction made by Sarvesh Agarwal about the virtual internship in the days to come?

(b) Fill in the blanks in the following sentences by using information from the text in the annexure (any three) :

2×3=6

(i) Zainul faced problems in getting _____ mainly because he was from _____.

(ii) _____ has made it possible for students from small towns and cities to compete with the ones from bigger cities for the _____.

(iii) There is a *new* demand for virtual internships especially in the _____.

(iv) Portals like _____ connects aspiring interns to _____.

6. Write the summary of the text given in the annexure.

10

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(Turn Over)

7. Write a listing paragraph about the reasons for visiting social networking sites like Facebook, Instagram, etc. 10

Or

Write a paragraph describing an area of difference between living in a big city and living in a smaller town.

8. Do as directed : 4+6=10

- (a) Frame sentences by using any two of the expressions given below. Your sentences for each expression should bring out its meaning. For this purpose, you might need to write more than one sentence for each expression : 2×2=4

- (i) Kick the bucket
- (ii) Blow his trumpet
- (iii) Bite my tongue
- (iv) Go an extra mile

- (b) Change the following sentences into indirect speech : 6

- (i) Bhatia said, "What are we doing here, wasting our lives?"

- (ii) "By the time Microsoft figured it out," Bhatia told a reporter, "we had six million users."

- (iii) She said, "He is a big time pop music fan !"

- (iv) Meena said, "I am a homemaker."

- (v) "What are you doing in Kolkata?" Bijoy asked me.

- (vi) Harpreet said, "Only a few of my friends understand me."

Annexure

Zainul Abedin from Ganderbal, Kashmir, had a bachelor's degree in computer application from the Government Degree College in his town, but no job offers. The hurdle was not his education but his location. "I lived in a place where chances of getting a job were meagre, let alone an internship. So I began searching for virtual internships. I stumbled upon one that proved to be a turning point. I was soon

shortlisted for a Web development internship," says Zainul, who currently teaches students of the organization he interned into code in HTML, CSS, Angular JS, Bootstrap and so on.

There has been a silent internship revolution in India over the last few years. Technology has created a level playing field and removed geographical barriers for students from Tier 2 and 3 cities. Internships are picking up fast amongst these students, the biggest catalyst being virtual internships.

"In recent times, we have noticed a growing demand for virtual or work-from-home internships," says Sarvesh Agarwal, founder and CEO of internshala, a portal that links aspiring interns to possible employers. According to the latest internshala internship trends report for 2019, virtual internships receive three times as many applications as in-office ones and the interest in them is higher in Tier 2 and 3 cities.

According to Agarwal, "virtual internships will redefine work culture in days to come. With proper infrastructure, knowledge will be free-flowing and jobs will migrate to talent. We are about to witness a trend where 'jobs will reach out to talent' and not the other way round."

Total No. of printed pages = 23

3 (Sem-1) MAT-HG/RC-1

2019

MATHEMATICS

(Honours Generic/Regular)

Paper : MAT-HG-1016/MAT-RC-1016

Full Marks – 80

Time – Three hours

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

Answer either in English or in Assamese.

ইংৰাজী অথবা অসমীয়াত উত্তৰ কৰিবা।

1. Answer the following questions : $1 \times 10 = 10$

তলৰ প্ৰশ্নবোৰৰ উত্তৰ দিয়াঁ :

(a) Find the value of $\cos 1740^\circ$.

$\cos 1740^\circ$ ৰ মান উলিওৱা।

(b) Write the equation which shifted the graph
of the equation $x^2 + y^2 = 25$ into 3 units up
and 4 units left.

$x^2 + y^2 = 25$ সমীকৰণৰ লেখটোক 3 একক ওপৰলৈ
আৰু 4 একক বাওঁফালে স্থানান্তৰ কৰা সমীকৰণটো
উলিওৱা।

[Turn over

- (c) State whether the following statement is true or false :

“The domain of the function

$$f(x) = x^{\frac{1}{3}} \text{ is } (-\infty, \infty)”$$

তলৰ উক্তিটো সচাঁ নে মিছা লিখা :

$$“f(x) = x^{\frac{1}{3}} \text{ ফলনটোৰ আদিক্ষেত্র } (-\infty, \infty)”$$

- (d) If $\lim_{x \rightarrow a} f(x) = 2$, then find the value of

$$\lim_{x \rightarrow a} \sqrt[3]{6 + f(x)}.$$

$$\lim_{x \rightarrow a} f(x) = 2 \text{ হলে } \lim_{x \rightarrow a} \sqrt[3]{6 + f(x)} \text{ -ৰ মান নিৰ্ণয় কৰা।}$$

- (e) If the function $f(x) = \begin{cases} 7x - 2, & x \leq 1 \\ kx^2, & x > 1 \end{cases}$

is continuous everywhere then find the value of k.

$$f(x) = \begin{cases} 7x - 2, & x \leq 1 \\ kx^2, & x > 1 \end{cases} \text{ ফলনটো সদায়েই অবিচ্ছিন্ন}$$

হ'লে k ৰ মান নিৰ্ণয় কৰা।

- (f) What is the nth derivative of x^{n-1} ?

x^{n-1} ৰ nতম অবকলজটো কি ?

- (g) Write the range of $\arctan x$.

$\arctan x$ ৰ পৰিসৰ লিখা।

- (h) State Euler's theorem on homogeneous function.

সুষম ফলনৰ ইউলাৰৰ উপপাদ্যটোৰ উক্তি লিখা।

- (i) Write the Maclaurin series for e^x .

e^x ৰ মেক্লৰিন শ্ৰেণীটো লিখা।

- (j) State whether the following statement is true or false :

“If $f'(x) = g'(x)$, $\forall x \in (a, b)$ then $f - g$ is a constant function”.

তলৰ উক্তিটো সচাঁ নে মিছা লিখা :

“ $f'(x) = g'(x)$, $\forall x \in (a, b)$ হ'লে $f - g$ এটা ধ্ৰুবক ৰাশি।”

2. Answer the following questions : $2 \times 5 = 10$

তলৰ প্ৰশ্নবোৰৰ উত্তৰ দিয়া :

(a) Draw the graph of $f(x) = \begin{cases} x, & 0 \leq x \leq 1 \\ 2-x, & 1 < x \leq 2 \end{cases}$

$f(x) = \begin{cases} x, & 0 \leq x \leq 1 \\ 2-x, & 1 < x \leq 2 \end{cases}$ ফলনটোৰ লেখ আঁকা।

(b) Find the n th derivative of e^{ax} .

e^{ax} ৰ n তম অবকলজটো উলিওৱা।

(c) If $f'(x) = x(x-1)$, then on what interval the function f is decreasing?

যদি $f'(x) = x(x-1)$ হয় তেন্তে কি অন্তৰালত f ফলনটো হ্ৰাসমান হব?

(d) Prove that $\arcsin x + \arccos x = \frac{\pi}{2}$.

প্ৰমাণ কৰা যে $\arcsin x + \arccos x = \frac{\pi}{2}$.

(e) If $v = x^2 + y^2 + z^2$, then prove that

$$x \frac{\partial v}{\partial x} + y \frac{\partial v}{\partial y} + z \frac{\partial v}{\partial z} = 2v.$$

যদি $v = x^2 + y^2 + z^2$ হয় তেন্তে প্ৰমাণ কৰা যে

$$x \frac{\partial v}{\partial x} + y \frac{\partial v}{\partial y} + z \frac{\partial v}{\partial z} = 2v.$$

3. Answer any four questions : $5 \times 4 = 20$

যিকোনো চাৰিটা প্ৰশ্নৰ উত্তৰ দিয়া :

(a) For any angle θ , measured in radians, prove that

$$-|\theta| \leq \sin \theta \leq |\theta| \text{ and } -|\theta| \leq 1 - \cos \theta \leq |\theta|$$

θ ৰেডিয়ান জোখৰ যিকোনো কোণৰ বাবে প্ৰমাণ কৰা যে :

$$-|\theta| \leq \sin \theta \leq |\theta| \text{ আৰু } -|\theta| \leq 1 - \cos \theta \leq |\theta|$$

(b) Prove by analytical method $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$.

বিশ্লেষণাত্মক পদ্ধতিৰে প্ৰমাণ কৰা যে $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$.

(c) State and prove Rolle's theorem.

বলৰ উপপাদ্যটোৰ উক্তি লিখি প্ৰমাণ কৰা।

(d) If $y = e^{a \sin^{-1} x}$ then show that

$$(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2+a^2)y_n = 0.$$

$y = e^{a \sin^{-1} x}$ হ'লে দেখুওৱা যে

$$(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2+a^2)y_n = 0.$$

(e) If three resistors R_1 , R_2 and R_3 are connected in parallel, the total resistance R is determined by the equation :

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

(i) What is $\frac{\partial R}{\partial R_1}$?

(ii) Suppose that R_1 , R_2 and R_3 are variable resistors. How fast is R changing with respect to R_1 when $R_1=100$ ohms, $R_2=200$ ohms and $R_3=300$ ohms ?

সমান্তৰালভাৱে সংযোজিত তিনিটা ৰোধ R_1 , R_2 আৰু R_3 ৰ লব্ধ বল R এ তলৰ সমীকৰণটো সিদ্ধ কৰে :

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

(i) $\frac{\partial R}{\partial R_1}$ য়ে কি অৰ্থ প্ৰকাশ কৰে ?

(ii) যদি R_1 , R_2 আৰু R_3 তিনিটা চলমান ৰোধ হয়, তেন্তে R_1 সাপেক্ষে R ৰ পৰিৱৰ্তনৰ হাৰ নিৰ্ণয় কৰা যেতিয়া $R_1=100$ ohms, $R_2=200$ ohms আৰু $R_3=300$ ohms.

(f) If $f(x,y) = \sqrt{y+1} + \log(x^2 - y)$ find $f(e, 0)$ and sketch the domain of f .

যদি $f(x,y) = \sqrt{y+1} + \log(x^2 - y)$ তেন্তে $f(e, 0)$ ৰ মান উলিওৱা। লগতে f ৰ আদিক্ষেত্ৰৰ নক্সা তৈয়াৰ কৰা।

4. Answer either (a) and (b) or (c) and (d) :

(a) আৰু (b) বা (c) আৰু (d) অংশৰ উত্তৰ কৰা :

(a) Prove that

$$\cos(A - B) = \cos A \cdot \cos B - \sin A \cdot \sin B$$

$$\text{Hence deduce that } \sin^2 A + \cos^2 A = 1$$

$$5+1=6$$

প্রমাণ কৰা যে,

$$\cos(A - B) = \cos A \cdot \cos B - \sin A \cdot \sin B. \text{ ইয়াৰ}$$

পৰা দেখুওৱা যে $\sin^2 A + \cos^2 A = 1$.

- (b) In the triangle ABC, $a = 2$ units, $b = 3$ units and $\angle C = 60^\circ$. Find the value of $\sin B$. 4

ABC ত্ৰিভুজত $a = 2$ একক, $b = 3$ একক আৰু $\angle C = 60^\circ$. $\sin B$ ৰ মান উলিওৱা।

(c) Prove that $\int \frac{du}{a^2 + u^2} = \frac{1}{a} \tan^{-1} \left(\frac{u}{a} \right) + c$.

Hence find the value of $\int \frac{dx}{4x^2 + 4x + 2}$
4+2=6

প্রমাণ কৰা যে $\int \frac{du}{a^2 + u^2} = \frac{1}{a} \tan^{-1} \left(\frac{u}{a} \right) + c$.

ইয়াৰ পৰা $\int \frac{dx}{4x^2 + 4x + 2}$ ৰ মান নিৰ্ণয় কৰা।

- (d) Consider the function $f(x) = 2x^2 + 3x + 4$. Find the function which : 4

(i) shifts the graph of f three units up.

(ii) shifts the graph of f one unit to the left.

(iii) stretches the graph of f vertically by a factor 2.

(iv) compresses the graph of f horizontally by a factor 3.

$f(x) = 2x^2 + 3x + 4$ হ'লে, তলৰ ফলন কেইটা নিৰ্ণয় কৰা :

(i) f ফলনটোৰ লেখটোক তিনি একক ওপৰলৈ স্থানান্তৰ কৰা।

(ii) f ফলনটোৰ লেখটোক এক একক বাওঁফালে স্থানান্তৰ কৰা।

(iii) f ফলনটোৰ লেখটোক দুই গুণ উলম্ব ভাবে প্রসাৰিত কৰা।

(iv) f ফলনটোৰ লেখটোক তিনি গুণ আনুভূমিক ভাবে সংকুচিত কৰা।

5. Answer any two of the following : $5 \times 2 = 10$
যিকোনো দুটা অংশৰ উত্তৰ কৰা :

(a) Evaluate any two : $2\frac{1}{2} + 2\frac{1}{2} = 5$

যিকোনো দুটাৰ মান নিৰ্ণয় কৰা :

(i) $\lim_{x \rightarrow \infty} (\sqrt{x^6 + 5} - x^3)$

(ii) $\lim_{x \rightarrow \frac{\pi}{4}} (1 - \tan x) \sec 2x$

$$(iii) \lim_{x \rightarrow -\infty} \frac{\sqrt{x^2 + 2}}{3x - 6}$$

$$(iv) \lim_{x \rightarrow 0^+} \frac{\log x}{\cos e cx}$$

- (b) If the function f is continuous everywhere, then find the values of the constants k and m . 5

$$f(x) = \begin{cases} x^2 + 5 & , x > 2 \\ m(x+1) + k & , -1 < x \leq 2 \\ 2x^3 + x + 7 & , x \leq -1 \end{cases}$$

f ফলনটো সদায়েই অবিচ্ছিন্ন হ'লে k আৰু m ৰ মান নিৰ্ণয় কৰা :

$$f(x) = \begin{cases} x^2 + 5 & , x > 2 \\ m(x+1) + k & , -1 < x \leq 2 \\ 2x^3 + x + 7 & , x \leq -1 \end{cases}$$

$$(c) \text{ Prove that } \lim_{x \rightarrow 0} (1 + \sin x)^{\frac{1}{x}} = e.$$

প্রমাণ কৰা যে $\lim_{x \rightarrow 0} (1 + \sin x)^{\frac{1}{x}} = e.$

6. Sketch the level surfaces of 5+5=10

তলৰ ফলন কেইটাৰ পৃষ্ঠতলৰ অংকন কৰা :

(i) $f(x, y) = x^2 - y^2$

(ii) $f(x, y) = xy.$

$\frac{1}{x} - y$ curve

Or/অথবা

- (a) State and prove Leibnitz theorem. 5

লীবনিটজৰ উপপাদ্যটোৰ উক্তি লিখি প্রমাণ কৰা।

- (b) If $y = \tan^{-1} x$, then find y_n . 5

$y = \tan^{-1} x$ হ'লে y_n ৰ মান নিৰ্ণয় কৰা।

7. If $u = \operatorname{cosec}^{-1} \sqrt{\frac{x^{\frac{1}{2}} + y^{\frac{1}{2}}}{x^{\frac{1}{3}} + y^{\frac{1}{3}}}}$, then prove that

$$x^2 \frac{\partial^2 u}{\partial x^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} + y^2 \frac{\partial^2 u}{\partial y^2} = \frac{\tan u}{12} \left(\frac{\tan^2 u + 13}{12} \right)$$

যদি $u = \operatorname{cosec}^{-1} \sqrt{\frac{\frac{1}{x^2} + \frac{1}{y^2}}{\frac{1}{x^3} + \frac{1}{y^3}}}$ চা তেন্তে প্রমাণ করা যে

$$x^2 \frac{\partial^2 u}{\partial x^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} + y^2 \frac{\partial^2 u}{\partial y^2} = \frac{\tan u}{12} \left(\frac{\tan^2 u + 13}{12} \right)$$

Or/অথবা

State and prove the Mean value theorem. What is its physical interpretation? Verify Mean Value theorem for the function $f(x) = x^2 + 2x - 1$ in the interval $[0, 1]$. 1+4+2+3=10

মধ্যমান উপপাদ্যটোৰ উক্তি লিখি প্রমাণ করা। ইয়াৰ ভৌতিক অর্থ কি? $f(x) = x^2 + 2x - 1$ ফলনটোৰ $[0, 1]$ অন্তৰালত উপপাদ্যটোৰ সত্যতা পরীক্ষা করা।

$$\begin{aligned} 2c+2 &= 3 \\ 2c &= 1 \\ c &= 1/2 \end{aligned}$$

3 (Sem-1/CBCS) CHE HC 2

2019

CHEMISTRY

(Honours)

Paper : CHE-HC-1026

(Physical Chemistry—I)

Full Marks : 60

Time : 3 hours

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

1. Answer the following as directed : 1×7=7

(a) From kinetic gas equation, show that $PV = \text{constant}$ for an ideal gas at constant temperature.

(b) A gas can be liquefied, when

(i) $T > T_c; P = P_c$

(ii) $T < T_c; P < P_c$

(iii) $T < T_c; P > P_c$

(iv) $T = T_c; P < P_c$

(Choose the correct option)

(2)

- (c) Define vapour pressure of a liquid.
- (d) In a cubic crystal, there are 2 C_4 axes of symmetry, 4 C_3 axes of symmetry and six C_2 axes of symmetry.

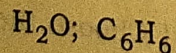
(Fill in the blanks)

- (e) Explain why non-stoichiometric form of NaCl is yellow in colour.
- (f) Explain why pH of 1×10^{-8} mol dm $^{-3}$ hydrochloric acid solution is not 8.
- (g) An aqueous solution of Na_2CO_3 is basic. Explain.



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

- (a) Define mean free path of a gas. How does mean free path of a gas vary with temperature and pressure?
- (b) Give a qualitative idea about the structure of water.
- (c) State the symmetry elements present in the following molecules :



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(Continued)

(3)

- (d) The pH value of a solution containing equimolar concentrations of a weak acid and its salt is 5.0. Calculate the K_a value of the weak acid.
3. Answer any *three* of the following questions : $5 \times 3 = 15$
- (a) Derive the van der Waals' equation for a gas. Explain why van der Waals' equation cannot be considered as a generalized equation of state for real gases.
- (b) What is critical state of a gas? Derive the expressions for critical constants in terms of the van der Waals' constants.
- (c) Derive the Bragg's equation. In an experiment on a crystal using X-rays of wavelength 10^{-10} m, the value of angle of incidence for the first-order reflection was found to be 30° . Calculate the interplanar distance of the crystal.
- (d) For a weak monobasic acid, show that the degree of ionization at a given temperature is inversely proportional to the square root of the initial concentration of the acid. Give the expressions for dissociation constants of carbonic acid.

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(Turn Over)

(4)

- (e) Define solubility product of a sparingly soluble salt solution. Give the conditions for precipitation in terms of solubility product. 50 mL of $0.01 \text{ mol dm}^{-3} \text{ AgNO}_3$ solution is mixed with 50 mL of $0.001 \text{ mol dm}^{-3}$ aqueous NaCl solution. Predict whether AgCl will be precipitated or not. Given $K_{\text{sp}}(\text{AgCl}) = 1.7 \times 10^{-10}$.

4. (a) Answer either [(i) and (ii)] or [(iii), (iv) and (v)] :

(i) Give the postulates of kinetic molecular model of a gas. On the basis of these postulates, derive the kinetic gas equation. 3+4=7

(ii) Two flasks A and B have equal volumes. Flask A contain H_2 gas at 300 K, while flask B contains equal mass of C_2H_6 gas at 900 K. If both the gases behave ideally, answer the following :

In which flask the molecules will have higher average speed and how many times than the average speed of the other?

(5)

(iii) Derive an expression for root-mean-square speed of gas molecules from the expression for Maxwell distribution of molecular speeds of the gas. 3

(iv) Show that root-mean-square speed of hydrogen gas is four times that of oxygen gas at the same temperature. 3

(v) Derive an expression for reduced equation of state for any substance. State the law of corresponding states. 3+1=4

- (b) Answer either [(i), (ii) and (iii)] or [(iv), (v) and (vi)] :

(i) How does viscosity of gas differ from that of liquid? 2

(ii) Describe a method with theory commonly used for the measurement of viscosity of a liquid. 4

(iii) What are liquid crystals? Give the structural difference between smectic and nematic liquid crystals. Give two applications of liquid crystals. 1+2+1=4

(iv) Define the terms—symmetry element, plane of symmetry and centre of symmetry. 3

(6)

- (v) What are Bravais lattices? How can the following crystal systems be characterized?

Cubic; orthorhombic

Give one example each of these two crystal systems.

- (vi) What are Schottky and Frenkel defects? Give example of each of these two defects.

- (c) Answer either [(i), (ii) and (iii)] or [(iv), (v) and (vi)] :

- (i) Define pH of a solution. Give the limitations of pH scale. Calculate pH of a solution obtained by mixing 50 mL 0.1 mol dm^{-3} HCl solution with 50 mL 0.2 mol dm^{-3} NaOH solution at 298 K.

1+1+3=5

- (ii) Discuss briefly about the following : Applications of buffers in qualitative analysis of salt sample.

- (iii) Obtain an expression for hydrolysis constant for the hydrolysis of $\text{CH}_3\text{COONH}_4$ salt.

- (iv) What are acid-base indicators? Give examples. Discuss briefly the Ostwald's theory of acid-base indicators.

1+1+3=5

(7)

- (v) State with reasons, what indicators you would choose for the following titrations :

NaOH vs. CH_3COOH ;

Na_2CO_3 vs. HCl

- (vi) Calculate the solubility of $\text{Mg}(\text{OH})_2$ in pure water at 298 K. Given K_{sp} for $\text{Mg}(\text{OH})_2$ at 298 K is 1.20×10^{-11} .

★ ★ ★