(M)

STUDENT ID

No. of pages - 24

MID-TERM EXAMINATION (2024-25)
CLASS : XI
SUBJECT: CHEMISTRY (043)

Maximum Marks : 70
अधिकतम अंक – 70

Time Allowed : 3 hours
समय : 3 घंटे

सामान्य निर्देश:

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका सख्ती से पालन कीजिए।

(i) इस प्रश्न पत्र में 33 प्रश्न हैं। सभी प्रश्न अनिवार्य है।

(ii) यह प्रश्न पत्र पाँच खंडो में विभाजित है- क, ख, ग, घ एवं ङ।

(iii) खण्ड-क में प्रश्न संख्या 1 से 16 तक बहुविकल्पीय प्रकार के एक-एक अंक के प्रश्न हैं।

(iv) खण्ड-ख में प्रश्न संख्या 17 से 21 तक अति लघु उत्तरीय प्रकार के दो-दो अंकों के प्रश्न हैं।

(v) खण्ड-ग में प्रश्न संख्या 22 से 28 तक लघु उत्तरीय प्रश्न है। प्रकार के तीन-तीन अंकों के प्रश्न हैं।

(vi) खण्ड-घ में प्रश्न संख्या 29 तथा 30 केस आधारित चार-चार अंकों के प्रश्न हैं।

(vii) खण्ड-ङ. में प्रश्न संख्या 31 से 33 दीर्घ उत्तरीय प्रश्न प्रकार के पाँच-पाँच अंकों के प्रश्न हैं।

(viii) प्रश्न पत्र में समग्र विकल्प नहीं दिया समग्र गया है। यद्यपि, खण्ड-क के अतिरिक्त अन्य खण्डों के कुछ प्रश्नों आंतरिक विकल्प का चयन दिया गया है।

(ix) कैलकुलेटरों और लॉग टेबलों का उपयोग वर्जित है।

GENERAL INSTRUCTIONS:

Read the following instructions carefully, and strictly follow them :

(i) This question paper contains 33 questions. All questions are compulsory.

(ii) This question paper is divided into five sections – A, B, C, D and E.

(iii) In Section-A – Question No.1 to 16 are Multiple Choice (MCQ) type questions, carrying 1 mark each.

(iv) In Section-B – Question No.17 to 21 are Very Short Answer (VSA) type questions, carrying 2 marks each.

(v) In Section-C – Question No.22 to 28 are Short Answer (SA) type questions, carrying 3 marks each.

(vi) In Section-D – Question No.29 to 30 are Case study based questions, carrying 4 marks each.

(vii) In Section-E – Question No.31 to 33 are Long Answer (LA) type questions, carrying 5 marks each.

(viii) There is no overall choice given in question paper. However, an internal choice has been provided in few questions in all the sections except Section-A.

(ix) Use of Calculators and log tables are not allowed.

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SECTION-A

This section consist of 16 multiple choice questions. Choose the most appropriate option for each question.

1. Radius of the first Bohr's orbit of Hydrogen atom is (a_o = 52.9 pm) :   1

   (a)   26.3 pm

   (b)   13.15 pm

   (c)   52.9 pm

   (d)   105.8 pm

2. Splitting of spectral lines in an electric field is called :   1

   (a)   Zeeman effect

   (b)   Shielding effect

   (c)   Photoelectric effect

   (d)   Stark effect

3. The number of water molecules in a drop of water weighing 0.018 g is :   1

   (a) 6.022×10^{26}

   (b) 6.022×10^{20}

   (c) 6.022×10^{23}

   (d) 18.066×10^{23}

4. When 22.4 L of $H_{2(g)}$ is mixed with 11.2 L of $Cl_{2(g)}$ each at 273 K at 1 atm, the moles of $HCl_{(g)}$ formed is equal to :   1

   (a)   2 moles of $HCl_{(g)}$

   (b)   1.5 moles of $HCl_{(g)}$

   (c)   0.5 moles of $HCl_{(g)}$

   (d)   1 moles of $HCl_{(g)}$

5. If 42g of sodium bicarbonate ($NaHCO_3$) is dissolved in 72g of water then what will be the mole fraction of sodium bicarbonate in this solution? (Atomic mass : Na=23u, H=1u, 0=16u)   1

   (a)   0.11

   (b)   0.22

   (c)   0.33

   (d)   0.44

6. The electronic configuration of elements A and B are $1s^2\ 2s^2\ 2p^6\ 3s^2$ and $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ respectively. The formula of the ionic compound that can be formed between these elements is ;   1

   (a)   AB

   (b) AB_2

   (c) A_2B

   (d) A_2B_3

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7. The IUPAC symbol for the element with atomic number 119 would be :

    (a)   Une   (b)   Uun

    (c)   Uuh   (d)   Uue

8. Which of the following has no unit?

    (a)   Electronegativity   (b)   Electron gain enthalpy
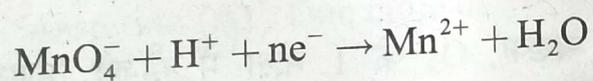
    (c)   Ionization enthalpy   (d)   Atomic radius

9. The smallest bond angle is found in :

    (a) BeF_2 (b) BF_3

    (c) SF_6 (d) CH_4

10. Which of the following molecule has distorted tetrahedral geometry?

    (a) CO_2 (b) NH_3

    (c) BF_3 (d) SF_4

11. The value of 'n' in the following reaction is :

$$MnO_4^- + H^+ + ne^- \rightarrow Mn^{2+} + H_2O$$

    (a)   2   (b)   3

    (c)   4   (d)   5

12. Oxygen has oxidation state of +2 in _____.

    (a) H_2O_2 (b) H_2O

    (c) OF_2 (d) CO_2

For question number 13 to 16, two statements are given - one labelled as Assertion (A) and other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

(a) Both Assertion (A) and Reason are correct and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are correct and Reason (R) is not the correct explanation of the Assertion (A).

(c) Assertion (A) is correct but Reason (R) is incorrect.

(d) Assertion (A) is incorrect but Reason (R) is correct.

13. Assertion (A) : All isotopes of a given element show the same type of chemical properties.

Reason (R) : The chemical properties of an atom are controlled by the number of valence electrons in the atom.   1

14. Assertion (A) : One mole of SO_2 contains double the number of molecules present in one mole of O_2.

Reason (R) : Molecular mass of SO_2 is double to that of O_2.   1

(Atomic mass : O = 16u, S = 32u)

15. Assertion (A) : The atomic radii of Magnesium is smaller than sodium.

Reason (R) : Magnesium has a lower nuclear charge than sodium.   1

16. Assertion (A) : A resonance hybrid is always more stable than any of its canonical structures.

Reason (R) : This stability is due to delocalization of electrons.   1

SECTION-B

This section consist of 5 short answer type questions. Each question carries 2 marks. There is internal choice in one question.

17. (a) Write the electronic configuration of Cu^{2+} (z = 29).

    (b) Find the number of radial nodes for 3d orbital.   2

18. (a) Draw the shape of that d-orbital which does not have four lobes?

    or

    (b) Write relationship between energy and wavelength of photon.   2

19. (a) Write one ion which is isoelectronic with Mg^{2+} ion?

    (b) Mention one similarity in the behaviour of Be and Al to show that they show diagonal relationship.   2

20. In Daniell cell widely used to generate electricity, the following reaction take place:

    $$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$$
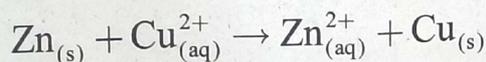
    Further,

    (a) Which of the electrode is negatively charged?

    (b) Show individual reaction at each electrode.   2

    OR

    Given the standard electrode potentials,

    $$K^+/K = -2.\overset{1}{93} \text{ V} \quad , \quad Mg^{2+}/Mg = -2.\overset{2}{37} \text{ V}$$

    $$Ag^+/Ag = 0.\overset{3}{80} \text{ V}, \quad Cr^{3+}/Cr = -0.\overset{5}{74} \text{ V}$$

    $$Hg^{2+}/Hg = 0.\overset{4}{79} \text{ V}$$

    Arrange these metals as follows:

    (a) increasing order of reducing power

    (b) decreasing order of reactivity

21. Arrange the following :

(a) $\overset{3}{N-H}, \overset{1}{F-H}, \overset{4}{C-H}, \overset{0}{O-H}$ (increasing order of ionic character

(b) O_2, N_2^+, F_2 (increasing order of bond length) 2

$O-O \quad N-N \quad F-F$

SECTION-C

This section consists of 7 Short Answer questions. Each question carries 3 marks. There is internal choice in one question.

22. Threshold frequency, ν_0 is the minimum frequency which a photon must possess to eject an electron from a metal. It is different for different metals. When a photon of frequency 1.0×10^{15} s^{-1} was allowed to hit a metal surface, an electron having 1.988×10^{-19} J of kinetic energy was emitted. Calculate the threshold frequency of this metal. (h = 6.626×10^{-34} Js) 3

$h\checkmark$
$\nu\checkmark$ ν_0
$KE\checkmark$ $h(\nu-\nu_0) = KE$

23. (a) Which of the following has maximum number of significant figures?

(i) 0.00453 (ii) 4.8046 $\checkmark$ (iii) 5.643

(b) How much copper can be obtained from 100 g of copper sulphate? (Atomic mass : Cu = 63.5u, O = 16u, S = 32u) 0.627

(c) Calculate number of moles of hydrogen atoms in 3 moles of ethane (C_2H_6). 3

OR

If the density of methanol (CH_3OH) is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution.

(Atomic mass : C = 12u, H = 1u, O = 16u)

24. A compound contains 52.17%, carbon, 13.04% hydrogen and 34.78% oxygen. Its molar mass is 46 g mol^{-1}. What are its empirical and molecular formulas?

(Atomic mass : C = 12u, H = 1u, O = 16u)

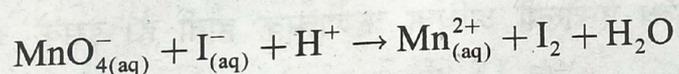25. Account for the following :

   (a) Cations are smaller in radii than their parent atoms.

   (b) First ionization enthalpy of nitrogen is more than that of oxygen.

   (c) The increasing order of reactivity among group 17 elements is I < Br < Cl < F. 3

26. (a) What is the oxidation number of Cr in CrO$_5$?

   (b) Balance the following redox reaction :

   3

   $$MnO_{4(aq)}^- + I_{(aq)}^- + H^+ \rightarrow Mn_{(aq)}^{2+} + I_2 + H_2O$$

27. Describe the hybridization in PCℓ_5. Why are the axial bonds longer as compared to

   3

   equitorial bonds?

28. Use molecular orbital theory to explain magnetic behaviour and bond order of O$_2^-$ and

   3

   O$_2^+$ molecules.

The following questions are case study based questions. Read the case carefully and answer the questions that follow:

29.
Electron Gain Enthalpy

When an electron is added to a neutral gaseous atom (X) to convert it into a negative ion, the enthalpy change accompanying the process is defined as the electron gain enthalpy ($\Delta_{eg}H$). Electron gain enthalpy provides a measure of the ease with which an atom adds an electron to form anion as represented by equation given below :

$$X_{(g)} + e^- \rightarrow X_{(g)}^-$$
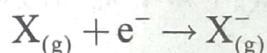
The variation in electron gain enthalpies of elements is less systematic than for ionization enthalpies. As a general rule, electron gain enthalpy becomes more negative with increase in the atomic number across a period. Also, electron gain enthalpy becomes less negative as we go down a group.

First electron gain enthalpies (in kJ mol^{-1}) of some main group elements are given below:

Group 1	$\Delta_{eg}H$	Group 16	$\Delta_{eg}H$	Group 17	$\Delta_{eg}H$	Group 0	$\Delta_{eg}H$
						He	+49
H	−73			F	−328	Ne	+116
Li	−60	O	−141				
Na	−53	S	−200	Cl	−349	Ar	+96
K	−48	Se	−195	Br	−325	Kr	+96
Rb	−47	Te	−190	I	−295	Xe	+77
Cs	−46	Po	−174	At	−270	Rn	+68

Answer the following questions :

(a)   Would you expect the second electron gain enthalpy of O as positive, more negative or less negative than the first?

(b)   What is the basic difference between the terms electron gain enthalpy and electronegativity?

(c)   Give reason :

   (i)   Halogens have highly negative electron gain enthalpies.

   (ii)   'F' has less negative electron gain enthalpy than that of 'Cl.'   1+1+2

<div align="center">OR</div>

   Arrange the following :

   (i) $I_{(g)}, Na_{(g)}, Br_{(g)}, Cl_{(g)}$ (Increasing tendency to gain electron)

   (ii)   Mg, P, S, Cl (least negative to most negative electron gain enthalpy)

<div align="center">**Quantum Numbers**</div>

30.

Erwin Schrödinger, in 1926, proposed an equation called Schrödinger equation to describe the electron distributions in space and the allowed energy levels in atoms. This equation incorporates de-Broglie's concept of wave-particle duality and is consistent with Heisenberg Uncertainty Principle. When Schrödinger equation is solved for the electron in a hydrogen atom, the solution gives the possible energy states the electron can occupy. These quantized energy states and corresponding wave functions which are characterized by a set of three quantum numbers – principle quantum number (n), azimuthal quantum number (ℓ) and magnetic quantum number (m_ℓ) arise as a natural consequence in the solution of the Schrödinger equation.

George Unlenbeck and Samuel Goudsmit proposed the presence of the fourth quantum number known as the electron spin quantum number (m_s).

The quantum numbers of four electrons are given below:

1. $n = 2$, $\ell = 0$, $m_\ell = 0$, $m_s = +\frac{1}{2}$

2. $n = 3$, $\ell = 2$, $m_\ell = 0$, $m_s = +\frac{1}{2}$

3. $n = 3$, $\ell = 3$, $m_\ell = 0$, $m_s = +\frac{1}{2}$

4. $n = 4$, $\ell = 0$, $m_\ell = 0$, $m_s = +\frac{1}{2}$

Answer the following questions :

(a)   Which of the above set of quantum numbers is not possible? Why?

(b)   How many electrons will be present in the subshell having quantum numbers set 1?

(c)   (i)   Draw the shape of orbital having quantum numbers set 1.

    (ii) Which one of the orbital has higher energy : Set 2 or Set 4? Why?   1+1+2

OR

(i)   Which one of the above set of quantum numbers is for a orbital belonging to 3d subshell?

(ii) What is the atomic number of element whose outermost electrons is represented by quantum number set 4?

SECTION-E

This section consists of 3 long answer type questions. Each question carries 5 marks. All questions have internal choice.

31. (a) State Heisenberg Uncertainty Principle.

    (b) A microscope using a suitable photons is employed to locate an electron in an atom within a distance of 0.1 A°. What is the uncertainty involved in the measurement of its velocity? ($m_e = 9.1 \times 10^{-31}$ kg, $h = 6.626 \times 10^{-34}$ Js)

    (c) What is the lowest value of n that allows 'h' orbitals to exist?   5

OR

(a) Calculate the total number of electrons present in one mole of methane.

(b) Show that the circumference of the Bohr's orbit for the hydrogen atom is an integral multiple of the de Broglie wavelength associated with the electron revolving around the orbit.

(c) Calculate the wave number for the longest wavelength transition of Balmer series. ($R_H = 1.097 \times 10^7$ m^{-1})

32. (a) State Avogadro's law.

    (b) Calculate the mass percent of oxygen present in Ethanol (C_2H_5OH)

       (Atomic mass of C = 12u, H = 1u, O = 16u)

    (c) Calculate the mass of sodium acetate (CH_3COONa) required to make 500 mL of 0.375 molar aqueous solution.

       (Atomic mass of C = 12u, H = 1u, Na = 23u, O = 16u)   5

OR

(a) Define molarity and molality. Which of them changes with temperature and why?

(b) Calcium carbonate reacts with aq. HCl to give $CaCl_2$ and CO_2 as per following reaction :

$$2CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow 2CaCl_{2(aq)} + 2CO_{2(g)} + 2H_2O_{(\ell)}$$
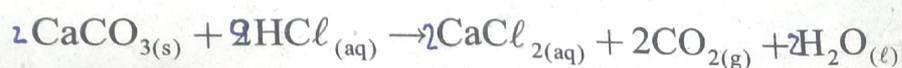
What mass of $CaCl_2$ will be formed when 250 mL of 0.1 M HCl reacts with 1000 g of $CaCO_3$? Name the limiting reagent also.

(Molar masses : $CaCO_3 = 100g\ mol^{-1}$, $CaCl_2 = 111g\ mol^{-1}$)

33. Attempt any five of the following :

(a) Why PCl_5 is trigonal bipyramidal whereas IF_5 is square pyramidal?

(b) All the C–O bonds in CO_3^{2-} (carbonate ion) are equal in length. Why?

(c) NH_3 molecule has more dipole moment than NF_3, although N–F bond is mor polar than N–H bond. Give reason.

(d) Use molecular orbital theory to explain why Be_2 molecule does not exist?

(e) O–nitrophenol is steam volatile while p–nitrophenol is not. Why?

(f) Predict the hybridization of Al in $AlCl_4^-$.

(g) Draw the shape of ClF_3 molecule on the basis of VSEPR theory.