

**AGA KHAN UNIVERSITY EXAMINATION BOARD
HIGHER SECONDARY SCHOOL CERTIFICATE**

CLASS XI

ANNUAL EXAMINATIONS 2022

Chemistry

Total Time: 2 hours 10 minutes

Total Marks: 65 (50-Theory & 15-Alternate to Practical)

INSTRUCTIONS

1. Read each question carefully.
2. Answer the questions on the separate answer sheet provided. DO NOT write your answers on the question paper.
3. There are 100 answer numbers on the answer sheet. Use answer numbers 1 to 65 only.
4. Question Distribution:

Theory	Alternate to Practical (ATP)
50 MCQs	15 MCQs

5. In each question, there are four choices A, B, C, D. Choose ONE. On the answer grid, black out the circle for your choice with a pencil as shown below.

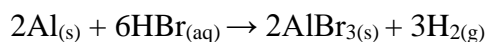
Correct Way	Incorrect Ways
1 (A) (B) (C) (D)	1 (A) (B) (C) (D)
	2 (A) (B) (C) (D)
	3 (A) (B) (C) (D)
	4 (A) (B) (C) (D)

Candidate's Signature

6. If you want to change your answer, ERASE the first answer completely with a rubber, before blacking out a new circle.
7. DO NOT write anything in the answer grid. The computer only records what is in the circles.
8. The marks obtained on the 50 MCQs will be equated to the total marks of 85 for the theory examination results.
9. You may use a scientific calculator if you wish.

THEORY (Questions 1-50)

1. Consider the following reaction.



How many moles of H_2 are produced when 1.61 moles of Al react with 2.48 moles of HBr?

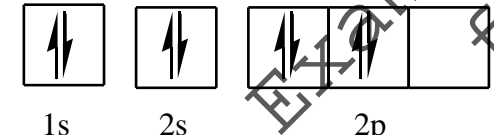
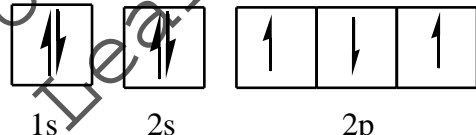
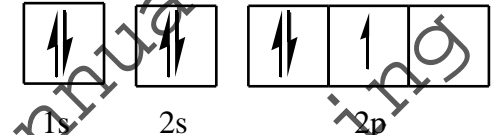
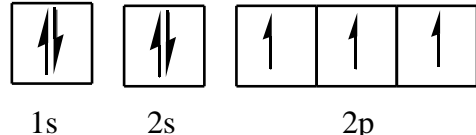
- A. 1.24 moles
B. 2.41 moles
C. 3.00 moles
D. 3.22 moles
2. The type of stoichiometric calculations that does NOT require the use of molar mass is
- A. mole-mole stoichiometric problem.
B. mass-mole stoichiometric problem.
C. mass-volume stoichiometric problem.
D. volume-volume stoichiometric problem.
3. The set of quantities conserved in every chemical reaction are
- A. mass and atoms.
B. moles and volume.
C. mass and molecules.
D. moles and molecules.
4. The FIRST step to calculate the empirical formula of a new compound is to determine the
- A. molar mass.
B. percentage composition.
C. number of particles per mole.
D. volume at standard temperature and pressure.
5. In a laboratory, Zafar synthesised a 13.2 g sample of $\text{C}_9\text{H}_8\text{O}_4$ (aspirin) by using 11.9 g of $\text{C}_7\text{H}_6\text{O}_3$.
- If the expected yield of aspirin is 15.52 g, then the % yield that he will obtain is
- A. 90.1%.
B. 85.0%.
C. 76.6%.
D. 61.8%.
6. All of the following observations exemplifies the use of quantitative science EXCEPT a/ an
- A. preparation of highly concentrated aqueous solution of HCl.
B. chemical reaction which produces 3.22 moles of oxygen.
C. glucose sample which turns brown in the air.
D. ore of silver having 52.38% silver by mass.

7. The electronic configuration of calcium ion in CaCl_2 is
- $1s^2 2s^2 2p^6 3s^2$
 - $1s^2 2s^2 2p^6 3s^2 3p^6$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
8. The spectral lines of **X** series are produced in **Y** region when an electron jumps from $n = 5$ to $n = 3$ energy level.

Based on the given information, the **X** series and **Y** region are represented as

	X	Y
A	Balmer series	visible region
B	Pfund series	infrared region
C	Lyman series	ultraviolet visible region
D	Paschen series	infrared region

9. According to Hund's rules, the CORRECT way of arranging the electrons in 'p' orbitals is

 <p>1s 2s 2p</p>	 <p>1s 2s 2p</p>
A	B
 <p>1s 2s 2p</p>	 <p>1s 2s 2p</p>
C	D

10. Consider the following values of quantum numbers.

- Principal quantum number (n) = 2
- Azimuthal quantum number (l) = $n-1$
- Magnetic quantum number (m) = $-1, 0, +1$

Based on the given information, the designated position of an electron is

- 2s.
- 2p.
- 3s.
- 3d.

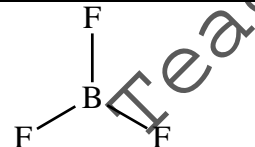
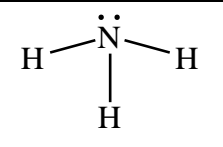
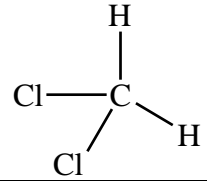
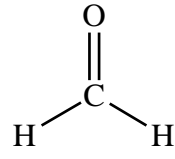
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11. In a discharge tube, a gas can conduct electricity at **X** pressure and **Y** voltage.

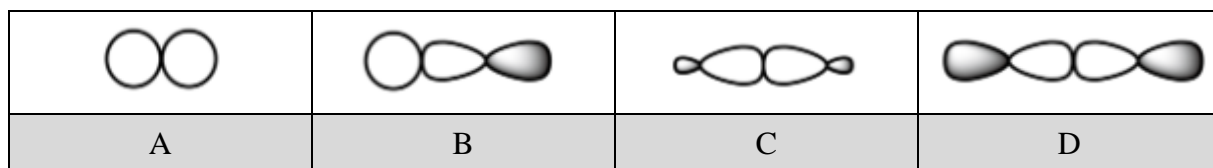
The conditions **X** and **Y** are identified as

	X	Y
A	low	high
B	high	low
C	low	low
D	high	high

12. The INCORRECT description about cathode rays is that they
- move in a straight line and can penetrate through thin metal sheets.
 - are independent of the nature of gas used in a discharge tube.
 - are attracted towards positive terminal in an electric field.
 - remain unaffected in an applied magnetic field.
13. The average enthalpy required to break different bonds of same type within a molecule in a sequential manner is known as
- bond order.
 - bond length.
 - bond energy.
 - bond strength.
14. The ionic character in a covalent molecule is due to its
- polarity.
 - density.
 - odour.
 - state.
15. Which of the following molecules has a net dipole moment of zero?

	
A	B
	
C	D

16. The shape that shows the head-on overlapping between hybrid orbitals is



17. Valence bond theory explains the

- size of a molecule.
- geometry of a molecule.
- repulsion between electron pairs.
- orbitals of atoms involved in a molecule.

18. Glucose is readily soluble in water because it

- splits into charges when dissolved in aqueous medium.
- forms hydrogen bonds with water molecules.
- is a non-polar covalent compound.
- conducts electricity.

19. When heat is provided to the liquid during a phase change, molecules tend to move from their positions.

In the given situation, the impact of heat on the intermolecular forces and energy of the molecules that are close together will be

	Intermolecular Force	Energy
A	strong	low
B	strong	high
C	weak	low
D	weak	high

20. At 4°C, water has a tendency to exhibit maximum

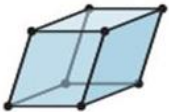
- weight.
- density.
- volume.
- pressure.

21. Ammonia dissolves in water due to the formation of

- ionic bonding.
- ion-dipole forces.
- hydrogen bonding.
- London dispersion forces.

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22. Which of these molecules can form a strong hydrogen bond with itself?
- CH₄
 - H₂S
 - HCOOH
 - CH₃OCH₃
23. NaCl does NOT conduct electricity in solid state because the
- forces between the ions are non-directional.
 - radius ratio of cations and anions is the same.
 - cations and anions are present in parallel layers.
 - electrostatic forces hold the ions in a fixed position.
24. Diamond and silicon carbide are insoluble in all solvents because of their
- large size.
 - low volatility.
 - high melting points.
 - slow rate of reaction.
25. Consider the given table.

Crystal Lattice	Length of Axes	Angle between Axes
	$a = b = c$	$\alpha = \beta = \gamma \neq 90^\circ$

The given unit cell is identified as

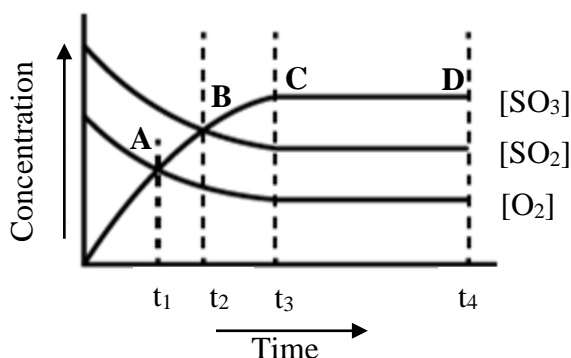
- cubic.
 - trigonal.
 - hexagonal.
 - orthorhombic.
26. The substances that are isomorphs of each other are
- KNO₃ and K₂SO₄
 - K₂SO₄ and NaNO₃
 - K₂SO₄ and K₂CrO₄
 - K₂CrO₄ and NaNO₃
27. The solubility of barium sulphate (BaSO₄) at 298 K is $1.05 \times 10^{-5} \text{ mol dm}^{-3}$.

Based on the given information, the solubility product of BaSO₄ will be

- $1.10 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$
- $1.10 \times 10^{-10} \text{ mol dm}^{-3}$
- $2.10 \times 10^{-5} \text{ mol}^2 \text{ dm}^{-6}$
- $2.10 \times 10^{-5} \text{ mol dm}^{-3}$

28. The given graph shows the change in the concentrations of reactants and products as the reaction $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ approaches equilibrium.

In this graph, equilibrium is reached at point



29. Consider the following endothermic reaction at equilibrium.



What will be the effect when the given stresses are applied on the given reaction?

	Decrease the Container's Volume	Remove CaCO_3
A	More CaCO_3 will be formed	Position of equilibrium will not change
B	More CaO will be formed	Position of equilibrium will shift to the right
C	More CaCO_3 will be formed	Position of equilibrium will shift to the left
D	More CaO will be formed	Position of equilibrium will not change

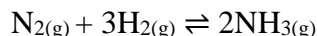
30. Consider the given ions.

- I. NH_4^+ ions
- II. Cl^- ions
- III. OH^- ions

The addition of NH_4Cl in an aqueous solution of NH_4OH will suppress the concentration of

- A. I only.
- B. I and II.
- C. III only.
- D. II and III.

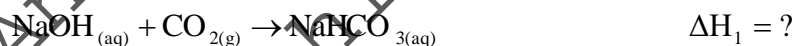
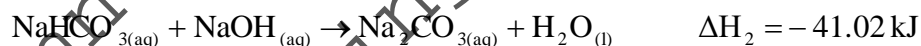
31. The given equation represents the synthesis of ammonia gas.



If the value of equilibrium constant (K_c) at 500°C is 6.0×10^{-2} , and the general gas constant (R) is $0.0821 \text{ dm}^3 \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$, then the value of K_p for this reaction will be

- A. 241.6
B. 2.463
C. 3.5×10^{-5}
D. 1.49×10^{-5}
32. Consider the given reaction that occurs at $400\text{-}450^\circ\text{C}$.
- $$2\text{SO}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightleftharpoons 2\text{SO}_{3(\text{g})} \quad \Delta H = -196 \text{ kJ mol}^{-1}$$
- If the temperature of the given reaction is increased, then the amount of $\text{SO}_{3(\text{g})}$ will
- A. decrease.
B. be tripled.
C. be doubled.
D. remain the same.
33. A solution is prepared for acid base titration by dissolving 10 g of NaOH in 100 g of water. The molality of this solution would be
- (Note: Atomic mass of Na = 23 amu, O = 16 amu, H = 1 amu)
- A. 0.1 mol kg^{-1}
B. 100 mol kg^{-1}
C. 2.5 mol kg^{-1}
D. $2.5 \times 10^{-13} \text{ mol kg}^{-1}$
34. A basic buffer is prepared by mixing a weak base and a salt of
- A. weak acid with a strong acid.
B. weak base with a strong acid.
C. weak acid with a strong base.
D. weak base with a strong base.
35. In the given reaction, the reactant zinc ion can be classified as a/ an
- $$\text{Zn}_{(\text{aq})}^{2+} + 4\text{NH}_{3(\text{aq})} \rightleftharpoons [\text{Zn}(\text{NH}_3)_4]_{(\text{aq})}^{2+}$$
- A. Lewis acid.
B. Lewis base.
C. neutral species.
D. amphoteric species.

36. If the pH of a solution is 10, then the hydroxide ion concentration in the solution will be
- 10^{10}
 - 10^4
 - 10^{-4}
 - 10^{-10}
37. A solution shows a reading of 7.21 on a pH meter. This indicates that the solution is a
- strong base.
 - strong acid.
 - weak base.
 - weak acid.
38. The relationship between the acid dissociation constant (K_a) and the base dissociation constant (K_b) is represented as
- $K_w = K_a + K_b$
 - $pK_w = pK_a \times pK_b$
 - $K_w = K_a \times K_b$
 - $pK_w = pK_a - pK_b$
39. In a bomb calorimeter, the enthalpy of combustion of a compound is measured at a constant
- pressure of 1 atm.
 - pressure of 20 atm.
 - temperature of 10 K.
 - temperature of 298 K.
40. Consider the given data.



Based on the given data, the enthalpy change for the formation of $\text{NaHCO}_{3(aq)}$ is

- 130.08 kJ.
- 48.06 kJ.
- +48.06 kJ.
- +130.08 kJ.

41. Consider the following steps of a Born-Haber's cycle.

- I. Formation of crystal lattice from sodium and chloride ion.
- II. Formation of a chloride ion from a gaseous chlorine atom.
- III. Formation of gaseous sodium metal from solid sodium metal.
- IV. Formation of a chlorine atom from a diatomic chlorine molecule.

The endothermic steps involved in the Born-Haber's cycle of sodium chloride are

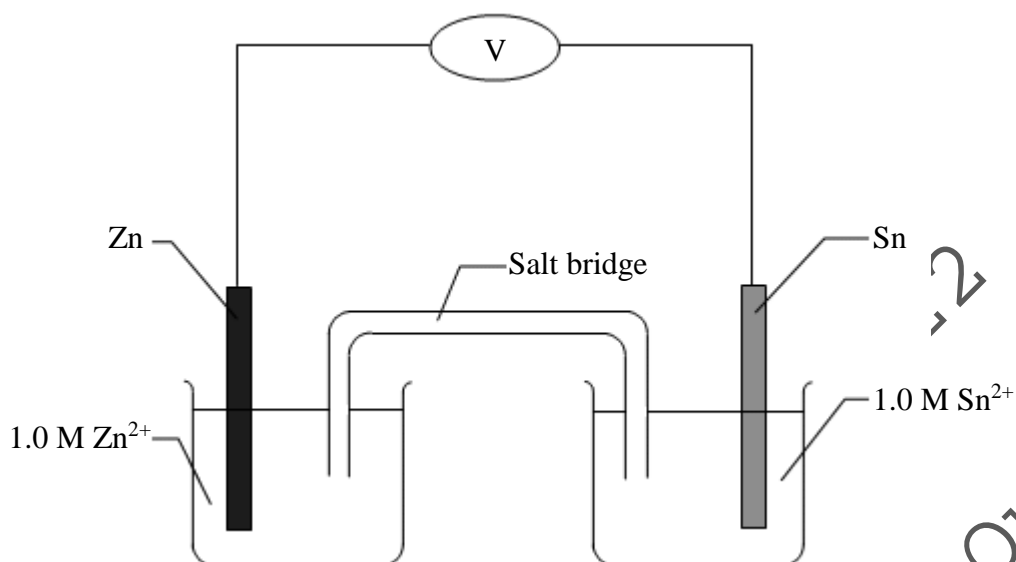
- A. I and II.
 - B. I and IV.
 - C. II and III.
 - D. III and IV.
42. The lattice energy of ionic compounds decreases with the increase in size of cations or anions. This happens because when the size of either ion increases, the
- A. crystal becomes anisotropic.
 - B. habit of the crystal changes.
 - C. repulsion between oppositely charged ions increases.
 - D. packing of the oppositely charged ions becomes less tight.
43. Which of the following statements is TRUE for the given reaction?
- $$2\text{Fe}_{(s)} + 3\text{Cl}_{2(g)} \rightarrow 2\text{FeCl}_{3(s)}$$
- A. Fe is oxidised.
 - B. Cl_2 is oxidised.
 - C. Fe is reduced, but Cl_2 shows no change.
 - D. Cl_2 is reduced, but Fe shows no change.
44. A cell reaction will be spontaneous when
- A. $E^\circ_{\text{cell}} = E^\circ_{\text{anode}}$
 - B. $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}}$
 - C. $E^\circ_{\text{anode}} > E^\circ_{\text{cathode}}$
 - D. $E^\circ_{\text{cathode}} > E^\circ_{\text{anode}}$
45. Which of the following statements is TRUE about the potential of an electrochemical cell?
- A. A reaction is not spontaneous under standard conditions if E°_{cell} is positive.
 - B. A reaction will occur spontaneously under standard conditions if E°_{cell} is negative.
 - C. The standard cell potential is the sum of the reduction potentials of the two half-reactions.
 - D. The measured cell potential depends strongly upon the concentration of the reacting substances.

46. During the electrolysis of molten sodium chloride, a charge of 9650 C is passed through the electrolytic cell. This indicates that the amount of chlorine gas (Cl_2) liberated at the anode will be

(Note: $^{35.5}_{17}\text{Cl}$)

- A. 0.1 g.
B. 0.05 g.
C. 0.85 g.
D. 1.78 g.
47. The oxidation number of oxygen in Cs_2O is
- (Note: $^{133}_{55}\text{Cs}$ and $^{16}_8\text{O}$)
- A. -2
B. -1
C. -1/2
D. 0
48. In which of the following oxidation states does a manganese (Mn) containing compound acts as an oxidising agent only?
- A. +2
B. +4
C. +6
D. +7
49. All of the given biological processes are examples of redox reaction EXCEPT
- A. digestion.
B. respiration.
C. circulation.
D. photosynthesis.

50. The given figure shows a $\text{Zn}^{2+}|\text{Zn}$ ($E^\circ = -0.76 \text{ V}$) and $\text{Sn}^{2+}|\text{Sn}$ ($E^\circ = -0.14 \text{ V}$) voltaic cell.

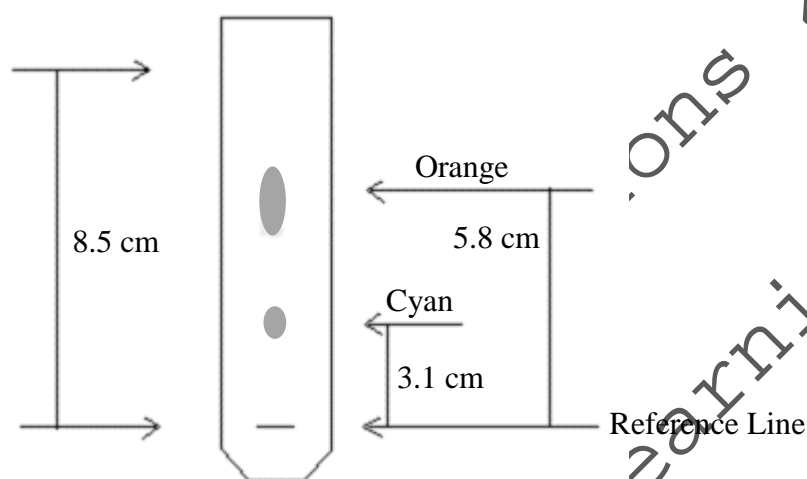


Which of the following options is CORRECT about the reaction at the anode and the flow of electrons in the given electrochemical cell?

	Reaction at Anode	Flow of Electrons
A	Zn^{2+} is reduced	Right to left
B	Zn is oxidised	Left to right
C	Sn^{2+} is reduced	Left to right
D	Sn is oxidised	Right to left

ALTERNATE TO PRACTICAL (ATP: Questions 51-65)

51. In order to calculate the mass of ion through gravimetric analysis, the ion should have all of the following features EXCEPT that
- the precipitated compound must be pure.
 - the precipitates can be filtered easily.
 - it should be completely precipitated.
 - it must form a soluble compound.
52. Consider the given illustration for the separation of an ink spot into its two different colour components: orange and cyan.



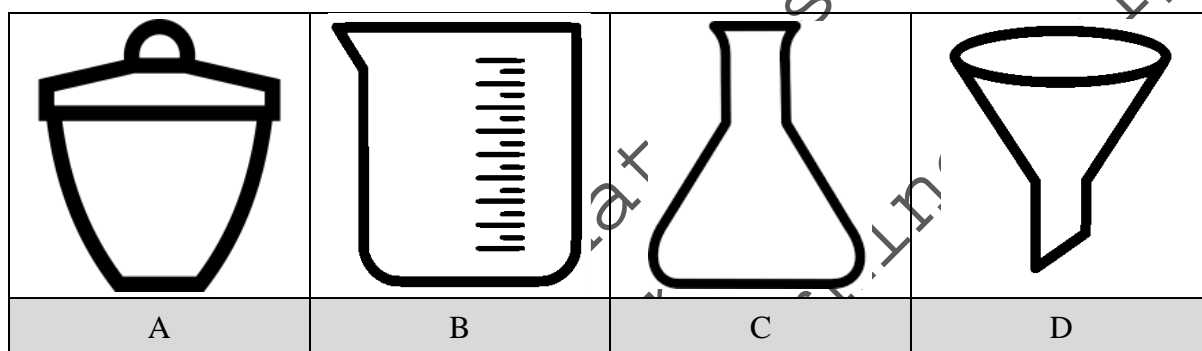
The R_f values for the orange and cyan colours in the given experiment are

	Orange	Cyan
A	0.68	0.36
B	0.32	0.36
C	1.04	0.93
D	0.87	1.04

53. When hydrogen chloride gas is passed through a saturated mixture of the given salts, the salt(s) that will precipitate out from this mixture will be
- sodium chloride
 - sodium sulphate
 - magnesium sulphate
- I only.
 - I and II.
 - III only.
 - II and III.

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54. Applications of common ion effect includes all of the following benefits EXCEPT that it
- determines the amount of a substance through gravimetric analysis.
 - precipitates out a salt of low solubility product from a solution.
 - purifies a salt from other ionic impurities in a solution.
 - maintains the equilibrium of the salt solution.
55. A 500 cm³ solution of H₂SO₄ contains 0.02 moles. The molarity of this solution will be
- 0.01 M.
 - 0.04 M.
 - 10 M.
 - 25 M.
56. The equipment that is NOT associated with volumetric analysis is



57. An aqueous solution of commercial laundry soap is prepared in 250 cm³ of water. 10 cm³ of this solution is titrated against a standard HCl solution of 0.1 M. The concentration of free NaOH calculated in soap solution is 0.03 M.

If 6 g of the commercial laundry soap is taken to prepare the solution, then the percentage of free NaOH present in the overall soap sample is

(Note: Molar mass of NaOH = 40 g/mol)

- 0.3%.
 - 1.2%.
 - 5.0%.
 - 20.0%.
58. A solution is prepared by dissolving 5.5 g impure sample of Na₂CO₃ in 1 dm³ of water. 10 cm³ of this solution is titrated against standard solution of 0.1 M HCl. The result concludes that the concentration of Na₂CO₃ solution is 0.05 M.

Based on the given details, the percent purity of Na₂CO₃ sample is

(Note: Molar mass of Na₂CO₃ = 106 g/mol)

- 0.9%.
- 5.1%.
- 50.0%.
- 96.3%.

59. Consider the given information about an unknown compound.

Molecular mass of compound in its anhydrous form	90 a.m.u
Number of water of crystallisation in its hydrous form	2
Volume of solution	1000 cm ³

If the concentration of solution is 0.05 M, then the amount of hydrated compound used in the solution would be

- A. 126 g.
B. 36 g.
C. 18 g.
D. 6.3 g.
60. If a concentrated sulphuric acid solution is spilled on a person's skin, then the immediate strategy that can be used to neutralise this acid is to
- A. apply sodium hydroxide solution.
B. apply cold cream on the affected part of skin.
C. wash the affected area with water and apply toothpaste.
D. wash the affected area with water and apply baking soda solution.
61. Which of the following statements is INCORRECT about a neutralisation reaction between a strong acid and a strong base?
- A. Neutralisation is an exothermic reaction.
B. 13.7 Kcal heat is used for bond breaking.
C. Both the solutions are completely miscible.
D. Strong acids and bases are completely ionised.
62. In a titration, all of the following measuring equipment are used to measure liquids with precision and accuracy EXCEPT
- A. pipette.
B. burette.
C. conical flask.
D. volumetric flask.
63. Anzish has been given a sample of an iron ore to determine the amount of iron in it. She needs to weigh the iron ore immediately for this purpose because an iron ore
- A. is heavy in weight.
B. is hygroscopic in nature.
C. contains other metals in it.
D. contains organic impurities in it.

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64. Abdullah has prepared a solution of KMnO_4 in a large quantity to perform different titrations over a period of one month.

Before each titration, he standardises this solution with standard oxalic acid solution because KMnO_4 is a/ an

- A. oxidising agent.
 - B. coloured solution.
 - C. primary standard solution.
 - D. secondary standard solution.
65. In redox titrations of KMnO_4 , sulphuric acid is used
- A. as a reducing agent.
 - B. to prevent hydrolysis.
 - C. as a dehydrating agent.
 - D. to maintain the pH of solution.

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