NIOS Class 12 Chemistry Sample Paper-8

Duration: 180 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **43** Questions. The paper is divided into two sections: **Section A – 40** marks, **Section B – 40** marks.
- **Section A** consists of
  - **Q.No. 1 to 16** – Multiple Choice type questions (MCQs) carrying 1 mark each. Select and write the most appropriate option out of the four options given in each of these questions. An internal choice has been provided in some of these questions. You have to attempt only one of the given choices in such questions.
  - **Q. No. 17 to 28** – Objective type questions. Q. No. 17 to 28 carry 02 marks each (with 2 sub- parts of 1 mark each). Attempt these questions as per the instructions given for each of the questions 17 –28.
- **Section B** consists of
  - **Q.No. 29 to 37** – Very Short questions carrying 02 marks each to be answered in the range of 30 to 50 words.
  - **Q.No. 38 to 41** – Short Answer type questions carrying 03 marks each to be answered in the range of 50 to 80 words.
  - **Q.No. 42 and 43** – Long Answer type questions carrying 05 marks each to be answered in the range of 80 to 120 words.
- There is **No Negative marking**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Section: A

Q1. At STP, the volume occupied by 0.50 mol of oxygen gas is: **(1)**

(A) 11.2 L

(B) 22.4 L

(C) 5.6 L

(D) 44.8 L

Q2. The number of neutrons present in $^{35}_{17}Cl$ is: **(1)**

(A) 16

(B) 18

(C) 17

(D) 20

Q3. The number of subshells present in the shell for which $n = 3$ is: **(1)**

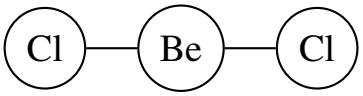
(A) 1

(B) 2

(C) 3

(D) 4

Q4. The molecular shape of $BeCl_2$ in the gaseous state is: **(1)**



(A) Bent

(B) Trigonal planar

(C) Tetrahedral

(D) Linear

Q5. The hybridisation of each carbon atom in ethene, $CH_2{=}CH_2$, is: **(1)**

$$H_2C{=}\ CH_2$$

(A) sp^2

(B) sp

(C) sp^3

(D) dsp^2

Q6. The pH of a 10^{-3} M sodium hydroxide solution at 25°C is: **(1)**

(A) 3

(B) 11

(C) 7

(D) 14

Q7. The sign of entropy change for melting of ice is: **(1)**

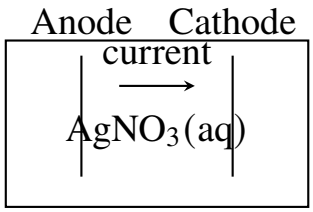
(A) Negative

(B) Zero

(C) Positive

(D) Infinite

Q8. According to Faraday's first law of electrolysis, the mass of a substance deposited at an electrode is: **(1)**



(A) Inversely proportional to the current passed

(B) Independent of the quantity of electricity passed

(C) Proportional only to the concentration of electrolyte

(D) Directly proportional to the quantity of electricity passed

Q9. The unit of the rate constant for a zero-order reaction is: **(1)**

(A) mol L^{-1} s^{-1}

(B) s^{-1}

(C) L mol^{-1} s^{-1}

(D) $L^2\ mol^{-2}\ s^{-1}$

Q10. Among the following, the strongest oxidising agent is: **(1)**

(A) Na_2SO_4

(B) $K_2Cr_2O_7$

(C) KCl

(D) NaCl

Q11. Which of the following oxides is amphoteric? **(1)**

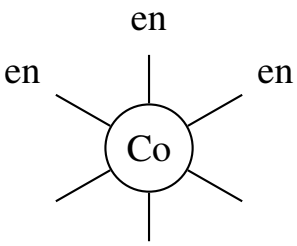
(A) SO_3

(B) Na_2O

(C) Al_2O_3

(D) CO_2

Q12. The coordination number of cobalt in $[Co(en)_3]^{3+}$ is: **(1)**



(A) 2

(B) 3

(C) 4

(D) 6

Q13. Which class of alcohol reacts fastest with Lucas reagent at room temperature? **(1)**

(A) Tertiary alcohol

(B) Secondary alcohol

(C) Primary alcohol

(D) Glycol

Q14. On nitration of toluene, the major products are: **(1)**

(A) Nitrobenzene only

(B) Ortho- and para-nitrotoluene

(C) Meta-nitrotoluene only

(D) Benzoic acid and nitrobenzene

Q15. Which of the following sugars is non-reducing? **(1)**

(A) Glucose

(B) Maltose

(C) Sucrose

(D) Fructose

Q16. The vitamin responsible for normal blood clotting is: **(1)**

(A) Vitamin A

(B) Vitamin C

(C) Vitamin D

(D) Vitamin K

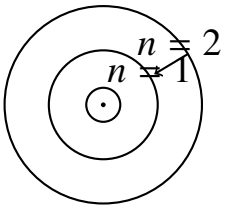
Note: Q. No. 17 to 28 are the objective type questions of 2 marks each.

Q17. Complete the following by using the options given below:
(empirical formula, Avogadro constant, molar mass, stoichiometric coefficient)
(2)

1. The simplest whole-number ratio of the atoms in a compound is called its
2. The mass in grams of one mole of a substance is called its .....

Q18. Read the passage given below and answer the following questions:
According to Bohr's model, electrons move around the nucleus only in certain allowed circular orbits. Each orbit has a definite energy. If an electron jumps

from a higher orbit to a lower orbit, radiation is emitted. If it jumps from a lower orbit to a higher orbit, radiation must be absorbed. **(2)**



1. What is the principal quantum number of the K-shell?
2. Is radiation emitted or absorbed when an electron falls from a higher orbit to a lower orbit?

Q19. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. Molality is independent of temperature.
2. Molarity remains unchanged when temperature changes.

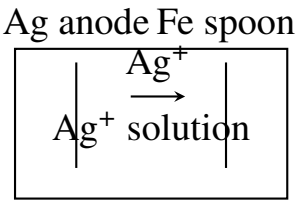
Q20. Complete the following by using the options given below:
(group, period, valence electrons, isotones) **(2)**

1. The vertical columns of the periodic table are called .....
2. Elements belonging to the same group generally have the same number of

Q21. Complete the following by using the options given below:
(absence of *d*-orbitals, acidic, amphoteric, basic) **(2)**

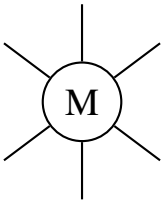
1. Nitrogen does not form pentahalides because of the ...in its valence shell.
2. Al_2O_3 is an example of an ..... oxide.

Q22. Read the passage given below and answer the following questions:
During electroplating of an iron spoon with silver, the spoon is made the cathode and a silver plate is used as the anode. The electrolyte contains a silver salt solution. On passing electric current, silver ions move towards the spoon and get deposited on it. **(2)**



1. What happens at the cathode during electroplating?
2. Why is the object to be plated made the cathode?

Q23. Read the passage given below and answer the following questions:
Coordination compounds contain a central metal atom or ion surrounded by ligands. The number of donor atoms attached directly to the central metal atom is called the coordination number. Complexes containing multidentate ligands are often more stable because the ligand binds through more than one donor atom. **(2)**



octahedral coordination

1. What is the coordination number of cobalt in $[Co(NH_3)_6]Cl_3$?
2. What type of ligand is ethylenediamine, monodentate or bidentate?

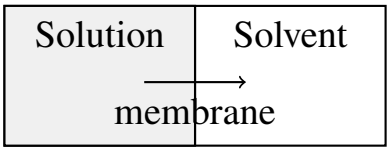
Q24. Match the items given in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Mole fraction	(i) $0.693/k$ for first-order reaction
(b) pH	(ii) Ratio of moles of one component to total moles
(c) Half-life of first-order reaction	(iii) Measure of acidity or alkalinity
(d) k for zero-order reaction	(iv) mol L^{-1} s^{-1}

Q25. Complete the following reaction equations: **(2)**

1. $C_6H_5N_2^+Cl^- \xrightarrow{H_3PO_2} +N_2$
2. $CH_3CH{=}CH_2 + Br_2 \rightarrow$

Q26. Read the passage given below and answer the following questions:
In ordinary osmosis, solvent molecules pass through a semipermeable membrane from the side of lower solute concentration to the side of higher solute concentration. In reverse osmosis, pressure greater than osmotic pressure is applied to force the solvent in the reverse direction. **(2)**



1. In ordinary osmosis, solvent moves from which side to which side?
2. State one practical use of reverse osmosis.

Q27. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. Proteins are polymers of α-amino acids.
2. Sucrose is a reducing sugar.

Q28. Read the passage given below and answer the following questions:
Vitamins are required in very small quantities for healthy growth and metabolism. Vitamin C and members of vitamin B complex are water-soluble. Vitamins A, D, E and K are fat-soluble. Deficiency of vitamin A leads to poor vision in dim light. **(2)**

1. Name one water-soluble vitamin.
2. Which deficiency disease is caused by lack of vitamin A?

Section: B

Q29. (i) Explain the terms: (a) Raoult's law, (b) ideal solution.

OR

(ii) Define osmosis and osmotic pressure. **(2)**

Q30. Explain how an increase in entropy can make some endothermic processes spontaneous. **(2)**

Q31. (i) A gas is compressed against a constant external pressure of 3 atm from 8 L to 5 L. Calculate the work done.

OR

(ii) State the sign of q and w when (a) heat is released by the system, (b) work is done on the system. **(2)**

Q32. (i) State Hess's law of constant heat summation and mention one use of it.

OR

(ii) Why are bond enthalpies usually expressed as average values? **(2)**

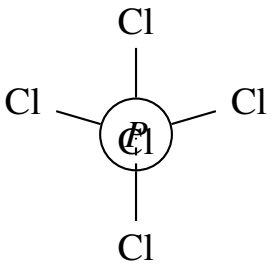
Q33. Explain the Lewis concept of acids and bases with one suitable example. **(2)**

Q34. What is the effect of (a) increase in concentration of reactants, and (b) addition of a catalyst on the rate of a chemical reaction? **(2)**

Q35. (i) Why does PCl_5 exist whereas NCl_5 does not?

OR

(ii) Draw the structure of PCl_5 molecule. **(2)**



Q36. How would you convert ethene into ethanol and then into ethanal? **(2)**

Q37. Complete the following reaction equations: **(2)**

(a) $CH_3CHO + H_2 \xrightarrow{Ni}$

(b) $CH_3COOH + SOCl_2 \rightarrow +SO_2 + HCl$

Q38. Define the following terms:

A. Molality

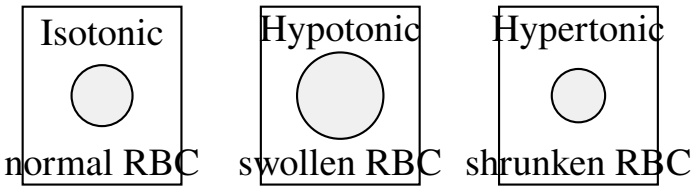
B. Henry's law

C. Isotonic solutions **(3)**

Q39. (i) Explain isotonic, hypertonic and hypotonic solutions with reference to red blood cells.

OR

(ii) Calculate the mole fraction of urea and water in a solution containing 6 g urea dissolved in 90 g water. **(3)**



Q40. Explain the common ion effect with one suitable example and one practical application. **(3)**

Q41. (i) Why does nitrogen exist as a diatomic molecule whereas phosphorus exists as P_4?

OR

(ii) Compare the acidic strengths of the oxoacids $HClO$, $HClO_2$, $HClO_3$ and $HClO_4$. **(3)**

Q42. (i) Answer the following:

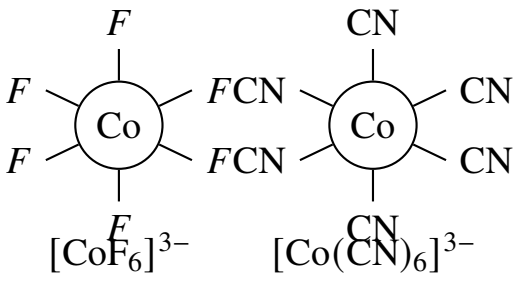
A. Write the IUPAC name of the complex $[Cu(NH_3)_4]SO_4$.

B. What is the denticity of EDTA?

C. Explain why $[CoF_6]^{3-}$ is paramagnetic but $[Co(CN)_6]^{3-}$ is diamagnetic.

OR

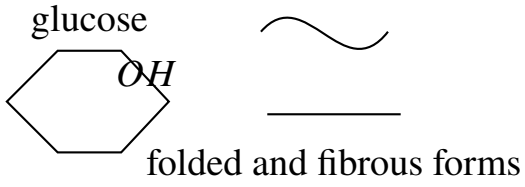
(ii) Explain the hybridisation, shape and magnetic behaviour of $[Ni(CO)_4]$ and $[Fe(CN)_6]^{4-}$ on the basis of valence bond theory. **(5)**



Q43. (i) What is mutarotation? Why is glucose called a reducing sugar? Differentiate between starch and cellulose.

OR

(ii) Differentiate between water-soluble and fat-soluble vitamins. Also explain denaturation of proteins with one suitable example. **(5)**



Detailed Solutions

Q1.

Solution

Concept: At STP, one mole of an ideal gas occupies 22.4 L.

Step 1 — Volume occupied by 1 mol gas at STP is:

$$22.4 \text{ L}$$

Step 2 — Therefore volume occupied by 0.50 mol gas is:

$$0.50 \times 22.4 = 11.2 \text{ L}$$

Step 3 — Hence the correct volume is 11.2 L.

Why other options are wrong:

- **Option B:** This is the volume for one mole.
- **Option C:** This is half of the required value.
- **Option D:** This is double the molar volume.

Final Answer: $\boxed{11.2 \text{ L}}$ (Option A)

Answer: (A) Go Back to Question 1

Q2.

Solution

Concept: Number of neutrons is obtained by subtracting atomic number from mass number.

Step 1 — For $^{35}_{17}\text{Cl}$,

$$\text{mass number} = 35, \qquad \text{atomic number} = 17$$

Step 2 — Therefore number of neutrons is:

$$35 - 17 = 18$$

Step 3 — Hence chlorine-35 contains 18 neutrons.

Why other options are wrong:

- **Option A:** This is not the difference between mass number and atomic number.
- **Option C:** This is the atomic number itself.
- **Option D:** This value is too large for the given nuclide.

Final Answer: $\boxed{18}$ (Option B)

Answer: (B) Go Back to Question 2

Q3.

Solution

Concept: The number of subshells in a shell is equal to the value of the principal quantum number n.

Step 1 — If $n = 3$, then the possible values of l are 0, 1, and 2.

Step 2 — These correspond to the subshells $3s$, $3p$, and $3d$.

Step 3 — Therefore the total number of subshells is 3.

Why other options are wrong:

- **Option A:** Too few.
- **Option B:** Omits one allowed subshell.
- **Option D:** Too many for $n = 3$.

Final Answer: $\boxed{3}$ (Option C)

Answer: (C) Go Back to Question 3

Q4.

Solution

Concept: In $BeCl_2$, the central atom beryllium has two regions of electron density and no lone pair in the gaseous state. According to VSEPR theory, such an arrangement is linear.

Step 1 — Beryllium forms two sigma bonds with two chlorine atoms.

Step 2 — With only two bond pairs and no lone pair, repulsion is minimised when the bond angle becomes 180°.

Step 3 — Therefore the molecular shape is linear.

Why other options are wrong:

- **Option A:** Bent geometry requires lone-pair distortion.
- **Option B:** Trigonal planar needs three electron domains.
- **Option C:** Tetrahedral needs four electron domains.

Final Answer: Linear (Option D)

Answer: (D) Go Back to Question 4

Q5.

Solution

Concept: Carbon atoms involved in a double bond generally use sp^2 hybridisation.

Step 1 — In ethene, each carbon forms three sigma bonds: two with hydrogen atoms and one with the other carbon atom.

Step 2 — One unhybridised p orbital remains on each carbon and these overlap sideways to form the pi bond of the double bond.

Step 3 — Hence each carbon atom in ethene is sp^2 hybridised.

Why other options are wrong:

- **Option B:** sp hybridisation is found in triple-bonded or linear systems.
- **Option C:** sp^3 hybridisation is found in tetrahedral single-bonded systems.
- **Option D:** dsp^2 does not apply here.

Final Answer: sp^2 (Option A)

Answer: (A) Go Back to Question 5

Q6.

Solution

Concept: For a strong base like sodium hydroxide, hydroxide ion concentration equals the base concentration. Then pOH is found first and pH is calculated using pH + pOH = 14.

Step 1 — Since NaOH is a strong base,

$$[OH^-] = 10^{-3}\ M$$

Step 2 — Therefore,

$$pOH = -\log(10^{-3}) = 3$$

Step 3 — Hence,

$$pH = 14 - 3 = 11$$

Why other options are wrong:

- **Option A:** This is pOH, not pH.
- **Option C:** This would indicate neutrality.
- **Option D:** This would correspond to a much stronger hydroxide concentration.

Final Answer: 11 (Option B)

Answer: (B) Go Back to Question 6

Q7.

Solution

Concept: Melting converts an ordered solid into a less ordered liquid, so disorder increases.

Step 1 — Ice has a well-organised crystalline arrangement of water molecules.

Step 2 — On melting, this ordered arrangement breaks down and the molecules move more freely in the liquid state.

Step 3 — Therefore entropy increases and the entropy change is positive.

Why other options are wrong:

- **Option A:** Entropy does not decrease on melting.
- **Option B:** The process definitely changes disorder.
- **Option D:** Entropy change is finite.

Final Answer: Positive (Option C)

Answer: (C) Go Back to Question 7

Q8.

Solution

Concept: Faraday's first law of electrolysis states that the mass of substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed through the electrolyte.

Step 1 — Quantity of electricity is measured as charge, usually in coulomb.

Step 2 — If more charge passes, more ions are discharged at the electrode.

Step 3 — Hence the deposited mass increases directly with the quantity of electricity passed.

Why other options are wrong:

- **Option A:** The relation is direct, not inverse.
- **Option B:** The quantity of electricity is central to the law.
- **Option C:** Concentration alone does not state the law.

Final Answer: Directly proportional to the quantity of electricity passed (Option D)

Answer: (D) Go Back to Question 8

Q9.

Solution

Concept: For a zero-order reaction, rate is independent of concentration and the rate equation is:

$$\text{Rate} = k$$

Therefore unit of k must be the same as the unit of rate.

Step 1 — The unit of rate is concentration per unit time.

Step 2 — Concentration is usually expressed as $\text{mol}\,\text{L}^{-1}$ and time as second.

Step 3 — Therefore unit of k for a zero-order reaction is:

$$\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$$

Why other options are wrong:

- **Option B:** This is for first-order rate constant.
- **Option C:** This is for second-order rate constant.
- **Option D:** This is for third-order rate constant.

Final Answer: $\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$ (Option A)

Answer: (A) Go Back to Question 9

Q10.

Solution

Concept: Potassium dichromate is a well-known strong oxidising agent, especially in acidic medium.

Step 1 — The dichromate ion can be reduced from chromium in the +6 oxidation state to chromium in the +3 state.

Step 2 — This reduction corresponds to oxidising action on other substances.

Step 3 — Therefore $K_2Cr_2O_7$ is the strongest oxidising agent among the given options.

Why other options are wrong:

- **Option A:** Sodium sulphate is not a strong oxidising agent.
- **Option C:** Potassium chloride is not an oxidising agent under normal conditions.
- **Option D:** Sodium chloride is also not a strong oxidising agent.

Final Answer: $\boxed{K_2Cr_2O_7}$ (Option B)

Answer: (B) Go Back to Question 10

Q11.

Solution

Concept: Amphoteric oxides react with both acids and bases.

Step 1 — Aluminium oxide reacts with acids to form salts and water.

Step 2 — It also reacts with strong bases to form aluminates.

Step 3 — Therefore Al_2O_3 is amphoteric.

Why other options are wrong:

- **Option A:** SO_3 is acidic.
- **Option B:** Na_2O is basic.
- **Option D:** CO_2 is acidic.

Final Answer: $\boxed{Al_2O_3}$ (Option C)

Answer: (C) Go Back to Question 11

Q12.

Solution

Concept: Ethylenediamine, abbreviated as en, is a bidentate ligand, so each en ligand contributes two donor atoms to the central metal.

Step 1 — In $[Co(en)_3]^{3+}$, there are three en ligands.

Step 2 — Since each en ligand donates two lone pairs through two nitrogen atoms, the total number of donor atoms attached to cobalt is:

$$3 \times 2 = 6$$

Step 3 — Therefore the coordination number is 6.

Why other options are wrong:

- **Option A:** Counts only one donor pair overall, which is incorrect.
- **Option B:** Counts the number of ligands, not donor atoms.
- **Option C:** Underestimates the total donor atoms.

Final Answer: $\boxed{6}$ (Option D)

Answer: (D) Go Back to Question 12

Q13.

Solution

Concept: Lucas reagent distinguishes alcohols based on the ease of carbocation formation. Tertiary alcohols form carbocations most easily and therefore react fastest.

Step 1 — Tertiary alcohols form the most stable carbocations.

Step 2 — Therefore substitution by chloride ion occurs most rapidly for tertiary alcohols.

Step 3 — Hence tertiary alcohols react fastest with Lucas reagent.

Why other options are wrong:

- **Option B:** Secondary alcohols react more slowly than tertiary alcohols.
- **Option C:** Primary alcohols react very slowly at room temperature.
- **Option D:** Glycol is not the class identified by the classic rapid Lucas test behaviour.

Final Answer: $\boxed{\text{Tertiary alcohol}}$ (Option A)

Answer: (A) Go Back to Question 13

Q14.

Solution

Concept: The methyl group of toluene is electron-releasing and activates the ring, directing incoming electrophiles mainly to the ortho and para positions.

Step 1 — Nitration is an electrophilic substitution reaction.

Step 2 — The methyl group donates electron density by hyperconjugation and inductive effect, making ortho and para positions more reactive.

Step 3 — Therefore the major products are ortho- and para-nitrotoluene.

Why other options are wrong:

- **Option A:** Nitration of toluene does not mainly remove the methyl effect to form nitrobenzene.
- **Option C:** Meta product is not the major one.
- **Option D:** Benzoic acid is not the nitration product.

Final Answer: Ortho- and para-nitrotoluene (Option B)

Answer: (B) Go Back to Question 14

Q15.

Solution

Concept: A non-reducing sugar does not reduce Fehling's solution or Tollens' reagent because no free aldehydic or free hemiacetal group is available in the effective open form.

Step 1 — Glucose, fructose and maltose are reducing sugars under usual test conditions.

Step 2 — In sucrose, the glycosidic bond involves both anomeric carbons, so free reducing character is absent.

Step 3 — Therefore sucrose is non-reducing.

Why other options are wrong:

- **Option A:** Glucose is reducing.
- **Option B:** Maltose is reducing.
- **Option D:** Fructose behaves as a reducing sugar in alkaline medium.

Final Answer: Sucrose (Option C)

Answer: (C) Go Back to Question 15

Q16.

Solution

Concept: Vitamin K is essential for synthesis of clotting factors and normal blood coagulation.

Step 1 — Vitamins A, C and D are associated mainly with vision, connective tissue and immunity, and bone health respectively.

Step 2 — Vitamin K has a central role in blood clotting.

Step 3 — Therefore the correct choice is vitamin K.

Why other options are wrong:

- **Option A:** Vitamin A is linked mainly with vision.
- **Option B:** Vitamin C is associated with scurvy prevention.
- **Option C:** Vitamin D is associated with calcium metabolism and bone health.

Final Answer: Vitamin K (Option D)

Answer: (D) Go Back to Question 16

Q17.

Solution

Concept: Empirical formula and molar mass are basic descriptive quantities in chemical arithmetic.

Step 1 — The simplest whole-number ratio of atoms in a compound is known as its empirical formula.

Step 2 — The mass in grams of one mole of a substance is called its molar mass.

Step 3 — Therefore the required completions are empirical formula and molar mass.

Final Answer: empirical formula; molar mass

Answer: (See above) Go Back to Question 17

Q18.

Solution

Concept: In Bohr's model, the K-shell is the first orbit and downward transitions release energy as radiation.

Step 1 — The K-shell corresponds to the first orbit, so its principal quantum number is 1.

Step 2 — When an electron falls from a higher orbit to a lower orbit, the energy difference is released.

Step 3 — Therefore radiation is emitted.

Final Answer: 1; emitted

Answer: (See above) Go Back to Question 18

Q19.

Solution

Concept: Molality depends on mass of solvent and is independent of temperature, whereas molarity depends on solution volume and can change with temperature.

Step 1 — Statement 1 is true because mass does not change with temperature in ordinary concentration discussion.

Step 2 — Statement 2 is false because volume changes with temperature, so molarity may change.

Step 3 — Hence the correct answers are True and False.

Final Answer: T; F

Answer: (See above) Go Back to Question 19

Q20.

Solution

Concept: The periodic table is organised into groups and periods; elements in the same group have similar valence-shell electronic arrangements.

Step 1 — Vertical columns are called groups.

Step 2 — Members of the same group usually possess the same number of valence electrons.

Step 3 — Therefore the correct completions are group and valence electrons.

Final Answer: group; valence electrons

Answer: (See above) Go Back to Question 20

Q21.

Solution

Concept: Nitrogen lacks valence-shell d-orbitals and aluminium oxide is amphoteric.

Step 1 — Nitrogen belongs to period 2 and does not have vacant d-orbitals available for expanding its octet.

Step 2 — Al_2O_3 reacts with both acids and bases, so it is amphoteric.

Step 3 — Hence the answers are absence of d-orbitals and amphoteric.

Final Answer: absence of d-orbitals; amphoteric

Answer: (See above) Go Back to Question 21

Q22.

Solution

Concept: In electroplating, the metal cations are reduced at the cathode and form a metallic coating.

Step 1 — At the cathode, silver ions gain electrons:

$$Ag^+ + e^- \rightarrow Ag$$

So silver gets deposited on the object.

Step 2 — The object to be plated is made the cathode because reduction and deposition of metal occur there.

Step 3 — Therefore electroplating coats the cathode object with the desired metal.

Final Answer: Silver is deposited at the cathode; the object is made cathode so metal ions are reduced onto it

Answer: (See above) Go Back to Question 22

Q23.

Solution

Concept: Coordination number counts donor atoms, and ethylenediamine is a bidentate ligand because it donates through two nitrogen atoms.

Step 1 — In $[Co(NH_3)_6]Cl_3$, six ammonia ligands are directly attached to cobalt, so the coordination number is 6.

Step 2 — Ethylenediamine has two donor nitrogen atoms and is therefore a bidentate ligand.

Step 3 — Hence the required answers are 6 and bidentate.

Final Answer: 6; bidentate

Answer: (See above) Go Back to Question 23

Q24.

Solution

Concept: Definitions and standard formulae determine the matching.

Step 1 — Mole fraction matches the ratio of moles of one component to total moles, so (a) matches (ii).

Step 2 — pH is the measure of acidity or alkalinity, so (b) matches (iii). Half-life of first-order reaction equals $0.693/k$, so (c) matches (i).

Step 3 — Unit of zero-order rate constant is $\text{mol}\,\text{L}^{-1}\,\text{s}^{-1}$, so (d) matches (iv).

Final Answer: $\boxed{a\text{-}ii,\ b\text{-}iii,\ c\text{-}i,\ d\text{-}iv}$

Answer: (See above) Go Back to Question 24

Q25.

Solution

Concept: Hypophosphorous acid reduces diazonium salts to hydrocarbons, and bromine adds across a carbon–carbon double bond.

Step 1 — Reduction of benzene diazonium chloride gives benzene:

$$C_6H_5N_2^+Cl^- \xrightarrow{H_3PO_2} C_6H_6 + N_2$$

Step 2 — Bromine adds across propene to form 1, 2-dibromopropane:

$$CH_3CH{=}CH_2 + Br_2 \rightarrow CH_3CHBrCH_2Br$$

Step 3 — Thus the two products are benzene and 1, 2-dibromopropane.

Final Answer: $\boxed{C_6H_6;\ CH_3CHBrCH_2Br}$

Answer: (See above) Go Back to Question 25

Q26.

Solution

Concept: Ordinary osmosis moves solvent from lower solute concentration to higher solute concentration. Reverse osmosis is used in water purification.

Step 1 — In ordinary osmosis, solvent moves from the dilute side or pure solvent side to the concentrated solution side through the semipermeable membrane.

Step 2 — In reverse osmosis, pressure larger than osmotic pressure is applied to reverse this flow.

Step 3 — One important use of reverse osmosis is desalination of seawater or purification of drinking water.

Final Answer: From dilute/pure solvent side to concentrated solution side; used in desalination or water purification

Answer: (See above) Go Back to Question 26

Q27.

Solution

Concept: Proteins are made of amino acids, while sucrose is non-reducing.

Step 1 — Statement 1 is true because proteins are polypeptides of α-amino acids.

Step 2 — Statement 2 is false because sucrose is non-reducing, not reducing.

Step 3 — Hence the correct result is True and False.

Final Answer: T; F

Answer: (See above) Go Back to Question 27

Q28.

Solution

Concept: Vitamin C is water-soluble, and vitamin A deficiency causes night blindness.

Step 1 — One water-soluble vitamin is vitamin C. Any vitamin of the B-complex would also be acceptable.

Step 2 — Deficiency of vitamin A leads to night blindness.

Step 3 — Therefore the answers are vitamin C and night blindness.

Final Answer: Vitamin C; night blindness

Answer: (See above) Go Back to Question 28

Q29.

Solution

Concept: Raoult's law applies to ideal solutions, while osmosis and osmotic pressure describe solvent movement through a semipermeable membrane.

Step 1 — Alternative (i): Raoult's law states that the partial vapour pressure of a volatile component in a solution is equal to the product of its mole fraction and vapour pressure in the pure state. An ideal solution is one that obeys Raoult's law over the entire range of composition.

Step 2 — Ideal solutions also show no heat change and no volume change on mixing in the simplest treatment.

Step 3 — Alternative (ii): Osmosis is the spontaneous flow of solvent through a semipermeable membrane from a region of lower solute concentration to a region of higher solute concentration. Osmotic pressure is the minimum pressure that must be applied to stop this flow.

Final Answer: Raoult's law and ideal solution, or osmosis and osmotic pressure, as defined above

Answer: (See above) Go Back to Question 29

Q30.

Solution

Concept: A process may be endothermic and yet spontaneous if the entropy increase is sufficiently large so that the Gibbs free energy becomes negative.

Step 1 — Spontaneity at constant temperature and pressure is governed by:

$$\Delta G = \Delta H - T\Delta S$$

Step 2 — For an endothermic process, ΔH is positive. However, if ΔS is also positive and large, the term $T\Delta S$ may exceed ΔH.

Step 3 — In that case,

$$\Delta G < 0$$

and the process becomes spontaneous. Dissolution of some salts and melting above melting point are typical examples.

Final Answer: Large positive entropy can outweigh positive enthalpy and make $\Delta G < 0$

Answer: (See above) Go Back to Question 30

Q31.

Solution

Concept: Work at constant external pressure is given by $w = -P_{ext}\Delta V$. Sign convention depends on whether energy leaves or enters the system.

Step 1 — Alternative (i): Volume change is:

$$\Delta V = 5 - 8 = -3 \text{ L}$$

So,

$$w = -P_{ext}\Delta V = -3 \times (-3) = +9 \text{ L atm}$$

Thus work is done on the system.

Step 2 — If converted to joule,

$$9 \text{ L atm} \approx 9 \times 101.3 = 911.7 \text{ J}$$

Step 3 — Alternative (ii): If heat is released by the system, q is negative. If work is done on the system, w is positive.

Final Answer: $w = +9$ L atm $\approx +912$ J; $q < 0$ for heat released and $w > 0$ for work done on the system

Answer: (See above) Go Back to Question 31

Q32.

Solution

Concept: Hess's law states that the total enthalpy change of a reaction depends only on initial and final states, not on the path taken. Average bond enthalpies are used because exact bond strengths vary from molecule to molecule.

Step 1 — Alternative (i): Hess's law says that if a reaction occurs in several steps, the total enthalpy change equals the algebraic sum of enthalpy changes of all individual steps.

Step 2 — This law is used to calculate enthalpy changes for reactions that are difficult to measure directly, for example enthalpy of formation or lattice-related quantities via cycles.

Step 3 — Alternative (ii): Bond enthalpies are average values because the same type of bond can have slightly different strengths in different molecules and different chemical environments.

Final Answer: Hess's law allows enthalpy addition across steps; bond enthalpies are averaged because exact bond strengths vary with molecular environment

Answer: (See above) Go Back to Question 32

Q33.

Solution

Concept: A Lewis acid accepts an electron pair and a Lewis base donates an electron pair.

Step 1 — Consider the reaction:

$$BF_3 + NH_3 \rightarrow F_3B \leftarrow NH_3$$

Step 2 — In this reaction, ammonia has a lone pair on nitrogen and donates that electron pair. Therefore NH_3 is the Lewis base.

Step 3 — Boron trifluoride is electron deficient and accepts the electron pair, so BF_3 is the Lewis acid.

Final Answer: Lewis acid accepts an electron pair, Lewis base donates one; e.g. $BF_3 + NH_3$

Answer: (See above) Go Back to Question 33

Q34.

Solution

Concept: Reaction rate increases when effective collisions become more frequent or when activation energy is reduced.

Step 1 — Increasing the concentration of reactants generally increases the number of reactant particles per unit volume, so effective collisions occur more frequently and the rate increases.

Step 2 — Addition of a catalyst provides an alternative pathway with lower activation energy.

Step 3 — Because more molecules can then react successfully, the reaction rate increases.

Final Answer: Higher concentration increases collision frequency; catalyst lowers activation energy and increases rate

Answer: (See above) Go Back to Question 34

Q35.

Solution

Concept: Phosphorus can expand its octet using vacant *d*-orbitals in the classical explanation for hypervalent compounds, whereas nitrogen in the second period cannot. The geometry of PCl_5 is trigonal bipyramidal.

Step 1 — Alternative (i): Nitrogen belongs to the second period and has no vacant *d*-orbitals in its valence shell. Therefore it cannot accommodate five chlorine atoms around it in the usual octet treatment. Phosphorus, on the other hand, belongs to the third period and can form PCl_5.

Step 2 — Alternative (ii): In PCl_5, five bond pairs are arranged around the phosphorus atom. According to VSEPR theory, three positions are equatorial and two are axial.

Step 3 — Hence the structure is trigonal bipyramidal.

Final Answer: NCl_5 does not exist because nitrogen cannot expand its octet; PCl_5 is trigonal bipyramidal

Answer: (See above) Go Back to Question 35

Q36.

Solution

Concept: Ethene can be hydrated to ethanol, and ethanol can be oxidised to ethanal under controlled oxidation conditions.

Step 1 — Hydration of ethene gives ethanol:

$$CH_2{=}CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH$$

Step 2 — Controlled oxidation of ethanol gives ethanal:

$$CH_3CH_2OH \xrightarrow{[O]} CH_3CHO$$

Step 3 — Therefore the overall conversion is ethene to ethanol and then to ethanal.

Final Answer: $CH_2{=}CH_2 \rightarrow CH_3CH_2OH \rightarrow CH_3CHO$

Answer: (See above) Go Back to Question 36

Q37.

Solution

Concept: Hydrogenation of an aldehyde gives an alcohol, and thionyl chloride converts a carboxylic acid into the corresponding acid chloride.

Step 1 — Reduction of ethanal:

$$CH_3CHO + H_2 \xrightarrow{Ni} CH_3CH_2OH$$

Step 2 — Conversion of acetic acid to acetyl chloride:

$$CH_3COOH + SOCl_2 \rightarrow CH_3COCl + SO_2 + HCl$$

Step 3 — Hence the products are ethanol and acetyl chloride.

Final Answer: $\boxed{CH_3CH_2OH;\ CH_3COCl}$

Answer: (See above) Go Back to Question 37

Q38.

Solution

Concept: Molality is a mass-based concentration scale, Henry's law relates gas pressure to solubility, and isotonic solutions have equal osmotic pressure.

Step 1 — Molality: Number of moles of solute dissolved in one kilogram of solvent.

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

Step 2 — Henry's law: At a constant temperature, the amount of gas dissolved in a liquid is proportional to the partial pressure of the gas above the liquid. It is often written as $p = K_H x$.

Step 3 — Isotonic solutions: Two solutions having the same osmotic pressure at a given temperature are called isotonic solutions.

Final Answer: Definitions of molality, Henry's law and isotonic solutions as stated above

Answer: (See above) Go Back to Question 38

Q39.

Solution

Concept: Hypotonic, isotonic and hypertonic media affect red blood cells differently because water moves by osmosis. Mole fraction is calculated from moles of each component divided by total moles.

Step 1 — Alternative (i): In an isotonic solution, osmotic pressure inside and outside the red blood cell is the same, so the cell remains normal. In a hypotonic solution, water enters the cell, causing swelling and possibly bursting. In a hypertonic solution, water leaves the cell, causing shrinking.

Step 2 — Alternative (ii): Moles of urea:

$$\frac{6}{60} = 0.10 \text{ mol}$$

Moles of water:

$$\frac{90}{18} = 5.0 \text{ mol}$$

Total moles:

$$5.0 + 0.10 = 5.10 \text{ mol}$$

Step 3 — Therefore,

$$X_{\text{urea}} = \frac{0.10}{5.10} \approx 0.0196$$

$$X_{\text{water}} = \frac{5.0}{5.10} \approx 0.9804$$

Final Answer: Isotonic keeps RBC normal, hypotonic swells, hypertonic shrinks; $X_{\text{urea}} \approx 0.0196$, $X_{\text{water}} \approx 0.9804$

Answer: (See above)

Go Back to Question 39

Q40.

Solution

Concept: Addition of an electrolyte containing a common ion suppresses the ionisation of a weak electrolyte. This is called the common ion effect.

Step 1 — Consider acetic acid:

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

If sodium acetate is added, the concentration of CH_3COO^- increases.

Step 2 — According to Le Chatelier's principle, the equilibrium shifts to the left and ionisation of acetic acid decreases.

Step 3 — A practical application is preparation of buffer solutions, or suppression of ionisation during qualitative analysis and precipitation control.

Final Answer: Common ion suppresses weak electrolyte ionisation; e.g. sodium acetate with acetic acid, used in buffers

Answer: (See above) Go Back to Question 40

Q41.

Solution

Concept: Nitrogen forms a very strong multiple bond and exists as N_2, whereas phosphorus forms weaker multiple bonds and therefore prefers single-bonded tetra-atomic structures. In oxoacids of the same halogen, acidity increases with oxidation state.

Step 1 — Alternative (i): Nitrogen atoms are small and can form a strong N ≡ N triple bond. This makes diatomic nitrogen highly stable. Phosphorus atoms are larger and do not form equally strong multiple bonds, so phosphorus prefers the tetrahedral P_4 structure with single bonds.

Step 2 — Alternative (ii): For chlorine oxoacids, acidity increases as the number of oxygen atoms increases because the electron-withdrawing effect of oxygen stabilises the conjugate base more strongly.

Step 3 — Therefore the order of acidic strength is:

$$HClO < HClO_2 < HClO_3 < HClO_4$$

Final Answer: N_2 is stable because of strong triple bond while phosphorus prefers P_4; $HClO < HClO_2 < HClO_3 < HClO_4$

Answer: (See above) Go Back to Question 41

Q42.

Solution

Concept: IUPAC naming uses ligand names and oxidation states. Denticity describes the number of donor atoms of a ligand. Magnetic behaviour depends on strong-field and weak-field ligands and on electron pairing.

Step 1 — Alternative (iA): In $[Cu(NH_3)_4]SO_4$, sulphate is the counter ion. The complex cation is $[Cu(NH_3)_4]^{2+}$. The IUPAC name is tetraamminecopper(II) sulphate.

Step 2 — Alternative (iB): EDTA can bind through six donor atoms and is therefore a hexadentate ligand.

Step 3 — Alternative (iC): In $[CoF_6]^{3-}$, fluoride is a weak-field ligand. Cobalt(III) is $3d^6$, and weak-field ligands do not force pairing strongly, so unpaired electrons remain and the complex is paramagnetic. In $[Co(CN)_6]^{3-}$, cyanide is a strong-field ligand, causes pairing of electrons, and gives a diamagnetic inner-orbital complex.

Step 4 — Alternative (ii): In $[Ni(CO)_4]$, nickel is in oxidation state 0 with electronic configuration effectively leading to sp^3 hybridisation, tetrahedral shape and diamagnetic nature because all electrons are paired. In $[Fe(CN)_6]^{4-}$, iron is Fe^{2+} with $3d^6$ configuration. Cyanide causes pairing and the complex becomes an inner-orbital d^2sp^3 octahedral diamagnetic complex.

Final Answer: tetraamminecopper(II) sulphate; EDTA is hexadentate; weak-field and strong-field ligands explain magnetic behaviour

Answer: (See above)

Go Back to Question 42

Q43.

Solution

Concept: Mutarotation is the change in optical rotation due to interconversion of alpha and beta anomers in solution. Reducing behaviour of glucose comes from its open-chain aldehydic form. Vitamins are classified by solubility, and denaturation destroys native protein structure.

Step 1 — Alternative (i): Mutarotation is the gradual change in the specific optical rotation of a freshly prepared solution of glucose until an equilibrium value is reached. This happens because α- and β-glucose interconvert through the open-chain form.

Step 2 — Glucose is called a reducing sugar because in solution it can open to form an aldehydic structure, which reduces mild oxidising agents such as Tollens' reagent and Fehling's solution.

Step 3 — Starch and cellulose are both polysaccharides of glucose, but starch contains mainly α-glycosidic linkages and serves as a storage material, whereas cellulose contains β-glycosidic linkages and serves as a structural material in plant cell walls. Humans digest starch easily but do not digest cellulose efficiently.

Step 4 — Alternative (ii): Water-soluble vitamins include vitamin C and B-complex vitamins; they are not stored extensively and are excreted more readily. Fat-soluble vitamins include A, D, E and K; they can be stored in the body. Denaturation of proteins is the loss of their native folded structure due to heat, pH change or chemicals. For example, egg white coagulates on heating because its proteins become denatured.

Final Answer: Mutarotation arises from interconversion of glucose anomers; glucose is reducing because it forms an open-chain aldehydic form; starch and cellulose differ in linkage and function; vitamins differ by solubility; denaturation destroys native protein structure

Answer: (See above) Go Back to Question 43

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	C	4	D	5	A
6	B	7	C	8	D	9	A	10	B
11	C	12	D	13	A	14	B	15	C
16	D								