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SCO INTERNATIONAL CHEMISTRY OLYMPIAD

CLASS 11 | SAMPLE PAPER

Model Paper | Answer Key & Explanations

Practice-ready sample paper for viewing, download, and student revision

Designed from Class 11 Chemistry syllabus pathways and aligned with SCO's preparation, practice and reporting flow, for confident Olympiad readiness and academic growth.

- practice-ready model paper for schools, teachers, parents and website visitors
- conceptual, numerical and application-based Chemistry questions at Grade 11 Olympiad level
- includes clean answer key and learning-focused explanations for revision

Mole Concept	Atomic Structure	Periodic Trends	Chemical Bonding	Thermodynamics
Equilibrium	Redox	s-Block	p-Block	Organic Chemistry

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Guidelines for the Candidate

Total Questions	Time	Question Type	Marking
50	60 minutes	MCQ	Q1-40: 1 mark | Q41-50: 2 marks

1. Before the exam begins, candidates may use the allotted pre-exam time to complete personal details on the OMR sheet or online profile.
2. Write name, registration ID, school code/class and contact details clearly wherever required.
3. The paper has four parts: General Chemistry, Case Study/Application, Reason-Assertion, and Achievers Section.
4. Each question has one correct answer. Choose only one option for each question.
5. Calculators are not permitted unless specifically allowed by the invigilator or online exam instructions.
6. Use only the permitted writing instrument for OMR marking. For online exams, submit only after reviewing all responses.
7. At the end of the exam, submit the OMR sheet/booklet as instructed by the invigilator.

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General Chemistry Questions (Q1-Q20)

Class 11 foundational concepts, conceptual application and problem solving.

Q.1 A 5.60 g sample of N2 reacts completely with excess H2 to form NH3. What mass of NH3 is produced? Use N2 + 3H2 -> 2NH3.

A. 3.4 g
B. 6.8 g
C. 10.2 g
D. 17.0 g

Q.2 Which set of quantum numbers is impossible for an electron in an atom?

A. n=3, l=2, m=0
B. n=2, l=2, m=0
C. n=4, l=0, m=0
D. n=3, l=1, m=-1

Q.3 Which property generally decreases down Group 17 from F to I?

A. Atomic radius
B. Metallic character
C. Electronegativity
D. Number of occupied shells

Q.4 Which molecule has a linear shape?

A. CO2
B. NH3
C. H2O
D. CH4

Q.5 A gas occupies 5.0 L at 1.0 atm. At constant temperature, what volume will it occupy at 2.0 atm?

A. 2.5 L
B. 5.0 L
C. 10.0 L
D. 20.0 L

Q.6 Which sign combination always makes a reaction spontaneous at all temperatures?

A. Delta H > 0, Delta S < 0
B. Delta H < 0, Delta S > 0
C. Delta H > 0, Delta S > 0
D. Delta H < 0, Delta S < 0

Q.7 For HA(aq) <=> H+(aq) + A-(aq), increasing dilution usually increases ionization of a weak acid. Which principle supports this?

A. Le Chatelier's principle
B. Hund's rule
C. Pauli exclusion principle
D. Aufbau principle

Q.8 Which process is oxidation?

A. Cl2 gaining electrons to form Cl-
B. Na losing an electron to form Na+
C. Cu2+ gaining electrons to form Cu
D. H+ gaining an electron to form H

Q.9 Which statement about Group 1 metals is correct?

A. They are generally poor reducing agents.
B. They have ns1 valence configuration.
C. They have very high ionization energies.
D. They never react with water.

Q.10 Why is BeCl2 largely covalent compared with MgCl2?

A. Be2+ is small and highly polarizing.
B. Beryllium is a noble gas.
C. Mg2+ has a smaller size than Be2+.
D. Chloride cannot form ionic bonds.

Q.11 Which hydride is electron deficient?

A. CH4
B. NH3
C. B2H6
D. H2O

Q.12 Which reagent can distinguish unsaturation in an alkene from an alkane by decolourization?

A. Bromine water
B. Sodium chloride solution
C. Lime water
D. Distilled water

Q.13 Which reaction is most typical of benzene?

A. Electrophilic substitution
B. Nucleophilic addition
C. Ionic precipitation only
D. Hydration in cold water

Q.14 Which greenhouse gas is produced directly by complete combustion of hydrocarbons?

A. CO2
B. O3 only
C. SO2 only
D. NO only

Q.15 What is the molarity of a solution containing 2.0 mol solute in 500 mL solution?

A. 0.25 M
B. 1.0 M
C. 2.0 M
D. 4.0 M

Q.16 Which line spectrum series of hydrogen lies in the visible region?

A. Lyman
B. Balmer
C. Paschen
D. Brackett

Q.17 Which oxide is amphoteric?

A. Na2O
B. MgO
C. Al2O3
D. SO3

Q.18 Which pair has coordinate bonding in its formation?

A. NH3 + H+ -> NH4+
B. Na + Cl -> NaCl
C. H + H -> H2
D. O + O -> O2

Q.19 Which is the conjugate base of H2CO3?

A. CO3 2-
B. HCO3-
C. H3O+
D. H2O

Q.20 Which step is used in qualitative organic analysis to detect nitrogen?

A. Lassaigne's test
B. Tollen's test only
C. Flame test for sodium
D. Lime-water test only

Case Study and Application Questions (Q21-Q30)

Q.21 **Case/Passage:** A sample of limestone is tested in the school laboratory.

A student heats calcium carbonate strongly. Which gas is evolved and how can it be confirmed?

A. H_2; pop sound
B. CO_2; turns lime water milky
C. O_2; relights splint
D. NH_3; turns red litmus blue

Q.22 **Case/Passage:** A buffer used in a biochemical experiment resists pH change.

Which pH change is expected when a small amount of NaOH is added to an acidic buffer?

A. Very large decrease
B. Very large increase
C. Small increase only
D. No chemical response possible

Q.23 **Case/Passage:** Students compare galvanic and electrolytic cells.

In an electrolytic cell, which electrode is connected to the positive terminal of the battery?

A. Cathode
B. Anode
C. Salt bridge
D. Both electrodes are negative

Q.24 **Case/Passage:** An industrial chemist selects reactions with favourable equilibrium yield.

If Kc for a reaction is very large, what does it indicate at equilibrium?

A. Reactants are favoured strongly.
B. Products are favoured strongly.
C. Reaction has stopped before equilibrium.
D. Temperature has no influence.

Q.25 **Case/Passage:** A teacher asks students to classify reactions using oxidation numbers.

Which observation best indicates a redox reaction?

A. Only a colour change with no electron transfer possible
B. Change in oxidation states of elements
C. Dissolving sugar in water
D. Evaporation of ethanol

Q.26 Case/Passage: A plant engineer must balance yield and rate in ammonia production.

Which condition favours maximum ammonia yield in the Haber process?

High pressure favours fewer gas moles

$$N_2(g) + 3H_2(g) \longleftrightarrow 2NH_3(g)$$

4 mol gas 2 mol gas

A. Low pressure and very high temperature
B. High pressure and moderately low temperature with catalyst
C. No catalyst and low pressure
D. Removing nitrogen gas continuously

Q.27 Case/Passage: An organic unknown is tested for unsaturation.

An alkene decolourizes bromine water. What does this prove?

A. Presence of a carbon-carbon multiple bond
B. Presence of only sigma bonds
C. Absence of carbon
D. Formation of an ionic salt only

Q.28 Case/Passage: Air-quality data near an industrial area show elevated acidic deposition.

Which pollutant is mainly responsible for acid rain along with NOx?

A. SO_2
B. O_2
C. N_2
D. Ar

Q.29 Case/Passage: A research team compares real and ideal gas behaviour.

A gas has compressibility factor $Z < 1$ at moderate pressure. What is the dominant real-gas effect?

A. Repulsive molecular volume
B. Attractive intermolecular forces
C. Complete ionization
D. Nuclear decay

Q.30 Case/Passage: A laboratory needs to separate a mixture of ethanol and propanol.

Which is the most suitable method to separate two miscible liquids with close boiling points?

A. Simple filtration
B. Fractional distillation
C. Crystallization only
D. Magnetic separation

Reason and Assertion (Q31-Q40)

Choose the option that best describes the relationship between Assertion and Reason.

Q.31 Assertion (A): The empirical formula gives the simplest whole-number ratio of atoms. Reason (R): It may be different from the molecular formula.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.32 Assertion (A): The 2p subshell can hold a maximum of six electrons. Reason (R): It contains three orbitals, each able to hold two electrons with opposite spins.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.33 Assertion (A): Fluorine has high electronegativity. Reason (R): It has small atomic size and high effective nuclear charge.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.34 Assertion (A): BF_3 is trigonal planar. Reason (R): Boron in BF_3 is sp^3 hybridized.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.35 Assertion (A): Entropy usually increases when a liquid vaporizes. Reason (R): Gas molecules have more accessible microstates than liquid molecules.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.36 Assertion (A): A catalyst changes the equilibrium constant of a reaction. Reason (R): A catalyst lowers activation energy for both forward and reverse reactions.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.37 Assertion (A): In acidic medium, MnO_4^- is reduced to Mn^{2+}. Reason (R): Manganese changes oxidation state from +7 to +2.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.38 Assertion (A): Sodium reacts vigorously with water. Reason (R): Alkali metals have one valence electron and low ionization enthalpy.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.39 Assertion (A): Alkenes are unsaturated hydrocarbons. Reason (R): They contain at least one carbon-carbon double bond.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

Q.40 Assertion (A): Ozone in the stratosphere is useful. Reason (R): It absorbs much of the Sun’s harmful ultraviolet radiation.

A. Both A and R are true, and R correctly explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, R is false.
D. A is false, R is true.

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Achievers Section (Q41-Q50)

Q.41 A compound contains 40.0% C, 6.7% H and 53.3% O by mass. What is its empirical formula?

A. CH2O
B. C2H6O
C. C3H8O
D. CH4O

Q.42 Which species has the largest radius?

A. Na+
B. Mg2+
C. F-
D. O2-

Q.43 Which molecule has the highest bond order?

A. O2
B. N2
C. F2
D. H2

Q.44 At 300 K, Kp = 0.040 for a reaction with Delta n = 1. If R = 0.0821 L atm mol-1 K-1, what is Kc?

A. 0.0016
B. 0.040
C. 0.98
D. 1.64

Q.45 For a weak acid HA with Ka = 1.0 x 10^-5 and concentration 0.10 M, approximate [H+] is:

A. 1.0 x 10^-1 M
B. 1.0 x 10^-3 M
C. 1.0 x 10^-5 M
D. 1.0 x 10^-7 M

Q.46 The standard reduction potentials are Ag+/Ag = +0.80 V and Cu2+/Cu = +0.34 V. What is E0cell when copper reduces silver ions?

A. +0.46 V
B. -0.46 V
C. +1.14 V
D. -1.14 V

Q.47 Which reagent converts an alkene to a vicinal diol under mild conditions?

A. Cold dilute alkaline KMnO4
B. Concentrated H2SO4 only
C. NaCl solution
D. Dry HCl gas

Q.48 Which statement about aromaticity is correct?

A. Benzene is aromatic because it has 6 pi electrons in a planar cyclic conjugated system.
B. Any cyclic compound is aromatic.
C. Aromatic compounds must contain only single bonds.
D. Aromaticity destroys stability.

Q.49 A water sample has high nitrate concentration. Which environmental concern is most direct?

A. Eutrophication of water bodies
B. Immediate removal of all algae
C. Increased dissolved oxygen always
D. No effect on aquatic life

Q.50 Which is the correct IUPAC name of CH3-CH(CH3)-CH2-CH3?

A. pentane
B. 2-methylbutane
C. 3-methylbutane
D. 2-ethylpropane

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Answer Key and Explanations

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1. B	2. B	3. C	4. A	5. A	6. B	7. A	8. B	9. B	10. A
11. C	12. A	13. A	14. A	15. D	16. B	17. C	18. A	19. B	20. A
21. B	22. C	23. B	24. B	25. B	26. B	27. A	28. A	29. B	30. B
31. B	32. A	33. A	34. C	35. A	36. D	37. A	38. A	39. A	40. A
41. A	42. D	43. B	44. A	45. B	46. A	47. A	48. A	49. A	50. B

Detailed Explanations

Q.1 Answer: B - Moles N_2 = 5.60/28 = 0.20 mol. It forms 0.40 mol NH_3. Mass NH_3 = 0.40 x 17 = 6.8 g.

Q.2 Answer: B - For n=2, l can be only 0 or 1. l=2 is not allowed.

Q.3 Answer: C - Down a group, atomic size increases and attraction for shared electrons decreases, so electronegativity decreases.

Q.4 Answer: A - CO_2 has two electron domains around carbon and no lone pair on the central atom, giving a linear shape.

Q.5 Answer: A - Boyle's law gives $P_1V_1=P_2V_2$. V_2 = (1.0 x 5.0)/2.0 = 2.5 L.

Q.6 Answer: B - Delta G = Delta H - T Delta S. If Delta H is negative and Delta S is positive, Delta G is negative at all temperatures.

Q.7 Answer: A - Dilution lowers ion concentrations; the equilibrium shifts toward more ions to oppose the change.

Q.8 Answer: B - Oxidation is loss of electrons. Sodium loses one electron to become Na^+.

Q.9 Answer: B - Alkali metals have general outer electronic configuration ns1.

Q.10 Answer: A - The small Be^{2+} ion has high polarizing power, giving $BeCl_2$ significant covalent character.

Q.11 Answer: C - Diborane has multi-centre bonding and is electron deficient relative to ordinary two-centre covalent bonding.

Q.12 Answer: A - Alkenes add bromine across the double bond and decolourize bromine water; alkanes do not under normal conditions.

Q.13 Answer: A - Benzene preserves aromaticity by substitution rather than addition.

Q.14 Answer: A - Complete combustion converts carbon in hydrocarbons to CO_2 and hydrogen to water.

Q.15 Answer: D - Volume = 0.500 L. Molarity = 2.0/0.500 = 4.0 M.

Q.16 Answer: B - The Balmer series involves transitions ending at n=2 and lies mostly in the visible region.

Q.17 Answer: C - Aluminium oxide reacts with both acids and bases, so it is amphoteric.

Q.18 Answer: A - Nitrogen donates a lone pair to H^+ to form a coordinate covalent bond in ammonium ion.

Q.19 Answer: B - Loss of one proton from carbonic acid gives bicarbonate, HCO_3^-.

Q.20 Answer: A - Lassaigne's sodium fusion converts covalent nitrogen into ionic cyanide, which can be detected.

Q.21 Answer: B - $CaCO_3$ decomposes into CaO and CO_2. Carbon dioxide turns lime water milky due to $CaCO_3$ formation.

Q.22 Answer: C - The weak acid component neutralizes added OH^-, so the pH increases only slightly.

Q.23 Answer: B - In electrolysis, the anode is connected to the positive terminal and oxidation occurs there.

Q.24 Answer: B - A large equilibrium constant means product concentrations dominate at equilibrium.

Q.25 Answer: B - Redox reactions involve oxidation and reduction, identified by changes in oxidation state.

Q.26 Answer: B - High pressure favours fewer gas moles and lower temperature favours the exothermic product; catalyst improves rate.

Q.27 Answer: A - Bromine addition across a C=C bond removes the brown colour, indicating unsaturation.

Q.28 Answer: A - Sulfur dioxide oxidizes and hydrates in the atmosphere to produce sulfuric acid, a major component of acid rain.

Q.29 Answer: B - $Z < 1$ means the real gas occupies less volume or exerts less pressure than ideal prediction, typically due to attractions.

Q.30 Answer: B - Fractional distillation uses repeated vapour-liquid equilibration and is best for miscible liquids with close boiling points.

Q.31 Answer: B - Both statements are true, but the fact that the empirical formula may differ from the molecular formula does not directly explain the definition.

Q.32 Answer: A - A p subshell has three p orbitals, and each orbital can hold two electrons, so capacity is six.

Q.33 Answer: A - Fluorine strongly attracts bonding electrons because its valence shell is close to the nucleus and effective nuclear charge is high.

Q.34 Answer: C - BF_3 is trigonal planar, but boron is sp^2 hybridized, not sp^3.

Q.35 Answer: A - Vaporization increases freedom of motion and accessible microstates, so entropy increases.
Q.36 Answer: D - Catalysts do not change K; they only help reach equilibrium faster by lowering activation energy for both directions.
Q.37 Answer: A - A decrease from +7 to +2 is reduction, so the reason correctly explains the assertion.
Q.38 Answer: A - Sodium readily loses its valence electron, making reaction with water vigorous.
Q.39 Answer: A - A C=C double bond means fewer hydrogens than the corresponding alkane and allows addition reactions.
Q.40 Answer: A - Stratospheric ozone protects living organisms by absorbing high-energy UV radiation.
Q.41 Answer: A - For 100 g: C=40/12=3.33, H=6.7/1=6.7, O=53.3/16=3.33. Divide by 3.33 to get C:H:O = 1:2:1.
Q.42 Answer: D - These are isoelectronic with 10 electrons. The species with the lowest nuclear charge has the largest radius; O2- has 8 protons.
Q.43 Answer: B - N2 has a triple bond with bond order 3, greater than O2 (2), H2 (1) and F2 (1).
Q.44 Answer: A - Kp = Kc(RT)^Delta n. Kc = Kp/(RT) = 0.040/(0.0821 x 300) = 0.00162.
Q.45 Answer: B - For a weak acid, [H+] approx sqrt(Ka C) = sqrt(1.0 x 10^-5 x 0.10) = sqrt(1.0 x 10^-6) = 1.0 x 10^-3 M.
Q.46 Answer: A - Ag+ is reduced at the cathode and Cu is oxidized at the anode. E0cell = 0.80 - 0.34 = +0.46 V.
Q.47 Answer: A - Cold dilute alkaline potassium permanganate adds two -OH groups across the double bond to form a vicinal diol.
Q.48 Answer: A - Benzene follows Huckel's 4n+2 rule with n=1 and has a planar cyclic conjugated pi system.
Q.49 Answer: A - Excess nitrates act as nutrients and can trigger algal blooms, causing eutrophication and oxygen depletion.
Q.50 Answer: B - The longest chain has four carbons, and the methyl substituent gets the lowest locant, giving 2-methylbutane.