School Connect Online

SCO INTERNATIONAL CHEMISTRY OLYMPIAD

CLASS 11 | IChO

Official Question Paper | Set H

Professional question paper for schools, students, and online/PDF publication

Designed for Class 11 Chemistry learning pathways and aligned with SCO's platform flow for guided preparation, assessment, reporting, and future-ready academic growth.

- curriculum-focused coverage of mole concept, atomic structure, bonding, thermodynamics, equilibrium, redox and organic chemistry
- balanced section pattern across General Chemistry, Case Study, Reason-Assertion and Achievers questions
- PDF-ready Word master with compact question blocks, answer key and explanation-ready academic layout

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 compound X reacts with oxygen according to X + 2O2 -> XO4. If 10.0 g of X forms 31.33 g of XO4, what is the molar mass of X?

A. 15 g/mol
B. 30 g/mol
C. 42 g/mol
D. 64 g/mol

Q.2 For an electron present in a 3p orbital, what is the value of the azimuthal quantum number l?

A. 0
B. 1
C. 2
D. 3

Q.3 Across Period 3 from Na to Ar, which general trend is observed?

A. Atomic radius increases and ionization energy decreases.
B. Atomic radius decreases and ionization energy increases.
C. Both atomic radius and ionization energy increase.
D. Both atomic radius and ionization energy decrease.

Q.4 A molecule has four sigma bonds around the central atom and no lone pair. What geometry and hybridization are most likely?

A. Linear, sp
B. Trigonal planar, sp2
C. Tetrahedral, sp3
D. Square planar, dsp2

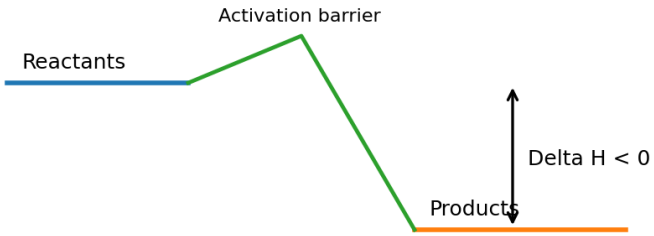
Q.5 Which statement best describes a supercritical fluid such as supercritical CO2?

A. It has zero viscosity and no density.
B. It has liquid-like density and gas-like diffusivity.
C. It cannot dissolve any organic substances.
D. It has a fixed shape and volume like a solid.

Q.6 At constant temperature and pressure, which condition indicates that a chemical reaction is spontaneous?

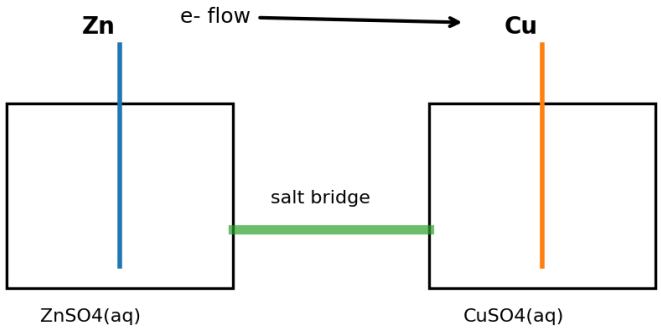
A. Delta G > 0
B. Delta G = 0
C. Delta G < 0
D. Delta H > 0 always

Q.7 For the exothermic equilibrium A + B <=> C + heat, what happens to the concentration of C when temperature is increased?



A. It increases.
B. It decreases.
C. It remains unchanged.
D. It becomes zero instantly.

Q.8 In the reaction Zn(s) + Cu2+(aq) -> Zn2+(aq) + Cu(s), which statement is correct?



A. Zn is reduced and Cu2+ is oxidized.
B. Zn is oxidized and Cu2+ is reduced.
C. Both Zn and Cu2+ are oxidized.
D. Both Zn and Cu2+ are reduced.

Q.9 Why is hydrogen useful in metal hydride storage materials?

A. It has a high atomic mass.
B. It is always chemically inert.
C. Its small size allows diffusion into metal lattices.
D. It cannot form compounds with metals.

Q.10 Which property makes lithium highly valuable in high-energy-density batteries?

A. Large atomic mass and low electrochemical potential
B. Small atomic size and high electrochemical potential
C. Complete chemical inertness
D. Very low tendency to lose electrons

Q.11 Boron trihalides such as BF3 are electron-deficient compounds. Which feature explains this behavior?

A. Boron has an empty p orbital after forming three bonds.
B. Boron has a complete octet in BF3.
C. Fluorine donates all its electrons to boron.
D. BF3 is an ionic compound with no covalent bonds.

Q.12 In organic chemistry, what does the -I effect of a substituent represent?

A. Donation of electrons by resonance only
B. Withdrawal of electron density through sigma bonds
C. Formation of radicals by heat
D. Breaking of pi bonds by light

Q.13 When HBr adds to propene under normal ionic conditions, the major product is:

CH3-CH=CH2 + HBr ⟶ CH3-CHBr-CH3

Markovnikov addition: stable carbocation pathway

A. 1-bromopropane
B. 2-bromopropane
C. propan-1-ol
D. cyclopropane

Q.14 Which pollutant pair is strongly associated with photochemical smog?

A. Nitrogen oxides and unburnt hydrocarbons
B. Sodium chloride and oxygen
C. Helium and argon
D. Calcium carbonate and water vapour

Q.15 If 4.0 mol H2 reacts with 1.0 mol O2 according to 2H2 + O2 -> 2H2O, which reactant is limiting?

A. H2
B. O2
C. Both are exactly limiting
D. Neither reacts

Q.16 In the Bohr model of hydrogen, which transition emits light of highest energy?

A. n=2 to n=1
B. n=3 to n=2
C. n=4 to n=3
D. n=5 to n=4

Q.17 Which element has the highest electronegativity among Li, C, N, O and F?

A. Li
B. C
C. O
D. F

Q.18 Ammonia has three bond pairs and one lone pair around nitrogen. Its molecular shape is:

A. Linear
B. Trigonal planar
C. Trigonal pyramidal
D. Tetrahedral molecule with no lone pair

Q.19 At high pressure and low temperature, real gases commonly deviate from ideal behavior mainly because:

A. Molecular volume and intermolecular forces become significant.
B. Gas molecules stop moving completely.
C. All gases become plasma.
D. The gas constant R changes.

Q.20 Which process is associated with the greatest increase in entropy?

A. Water freezing at 0 deg C
B. Gas expanding freely into a vacuum
C. Steam condensing to liquid
D. Ions forming an ordered crystal lattice

Case Study and Application Questions (Q21-Q30)

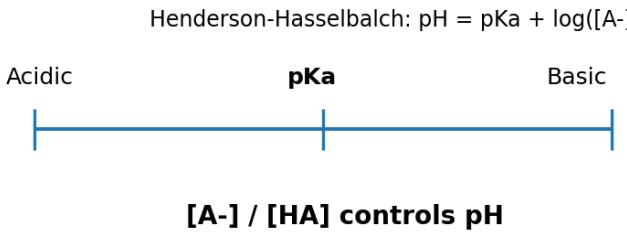
Each passage is placed inside the question block for clean PDF conversion.

Q.21 **Case/Passage:** A laboratory checks the carbon dioxide yield from complete combustion of an alkene fuel sample. Which mass of CO2 is produced when 10.0 g of ethylene is completely combusted? Use C2H4 + 3O2 -> 2CO2 + 2H2O; molar masses: C2H4 = 28.05 g/mol, CO2 = 44.01 g/mol.

A. 15.7 g
B. 22.2 g
C. 31.4 g
D. 44.0 g

Q.22 Case/Passage: A chemistry club prepares an acetate buffer for enzyme-activity testing.

A buffer contains 0.10 M acetic acid and 0.20 M sodium acetate. If pKa = 4.76, what is the pH?



A. 4.46
B. 4.76
C. 5.06
D. 5.36

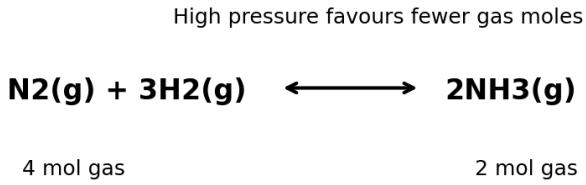
Q.23 Case/Passage: Students build a galvanic cell using zinc and copper half-cells.

For a Zn/Cu cell, E0(Cu2+/Cu)=+0.34 V and E0(Zn2+/Zn)=-0.76 V. What is E0cell and which electrode is the anode?

A. +1.10 V; zinc anode
B. +1.10 V; copper anode
C. -1.10 V; zinc anode
D. -0.42 V; copper anode

Q.24 Case/Passage: An industrial team compares the thermodynamic feasibility of ammonia synthesis at different temperatures.

For NH3 formation, Delta H = -92.4 kJ/mol and Delta S = -198 J/(mol K). At what temperature is Delta G = 0?



A. 234 K
B. 467 K
C. 932 K
D. 1460 K

Q.25 Case/Passage: A sealed tube containing NO2/N2O4 changes colour intensity when cooled.

The equilibrium 2NO2(g) <=> N2O4(g) is exothermic in the forward direction. What happens when temperature is decreased?

A. Equilibrium shifts right toward N2O4.
B. Equilibrium shifts left toward NO2.
C. No shift occurs.
D. Both gases disappear.

Q.26 Case/Passage: A redox titration is performed using acidified potassium permanganate.

In acidic medium, permanganate oxidizes Fe2+ to Fe3+. How many Fe2+ ions are oxidized by one MnO4- ion?

A. 1
B. 2
C. 5
D. 10

Q.27 Case/Passage: A student compares the major and minor products of addition reactions of unsymmetrical alkenes.

During electrophilic addition of HBr to propene, why is 2-bromopropane the major product?

A. Primary carbocation is more stable.
B. Secondary carbocation intermediate is more stable.
C. Bromine attacks the terminal carbon first as a radical only.
D. All carbocations have equal stability.

Q.28 Case/Passage: A research assignment compares bonding polarity across Period 2.

Among Li, Be, B, C, N, O and F, which has the highest electronegativity and why?

A. Li, because it has the fewest electrons.
B. F, because of high effective nuclear charge and small size.
C. B, because it is electron-deficient.
D. C, because it forms many covalent bonds.

Q.29 Case/Passage: A fuel-analysis team compares two gaseous hydrocarbons for domestic energy use.

Why does methane generally release more energy per gram than butane?

A. Methane has a higher hydrogen-to-carbon ratio.
B. Butane contains double bonds.
C. Methane has a higher molar mass.
D. Butane cannot burn completely.

Q.30 Case/Passage: An environmental laboratory studies toxic emissions from the burning of chlorinated plastics.

Which condition most strongly contributes to dioxin formation during incomplete combustion of PVC?

A. Excess oxygen and complete oxidation
B. Oxygen-limited combustion and radical formation
C. Absence of chlorine in the polymer
D. Very low temperature with no decomposition

Reason and Assertion (Q31-Q40)

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

Q.31 Assertion (A): A pure crystalline substance usually has a sharp melting point. Reason (R): Impurities disturb the regular crystal lattice and broaden the melting range.

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): An atom with configuration [Ne]3s2 3p3 has three unpaired electrons. Reason (R): Hund's rule states that degenerate p orbitals are singly occupied before pairing.

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): Ionization energy generally increases across a period. Reason (R): Effective nuclear charge increases across a period and pulls electrons closer.

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): Real gases behave most ideally at high pressure and low temperature. Reason (R): At high pressure, molecular volume and attractions become negligible.

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): For an exothermic reaction, increasing temperature can reduce product yield at equilibrium. Reason (R): Adding heat favours the endothermic direction.

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): Benzene is less reactive toward addition than isolated alkenes. Reason (R): Addition would destroy aromatic stabilization.

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 a galvanic cell, the anode is the electrode where oxidation occurs. Reason (R): Oxidation means gain of electrons.

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): Water has a higher boiling point than H2S. Reason (R): Water molecules form extensive hydrogen bonding.

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): Oxidation numbers are formal bookkeeping tools. Reason (R): They always equal the real charge on every atom in a covalent molecule.

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): Alkanes are less reactive than alkenes toward electrophilic addition. Reason (R): Alkenes contain electron-rich pi bonds that can attack electrophiles.

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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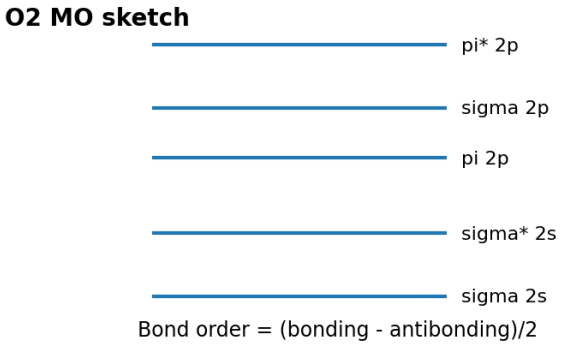
Achievers Section (Q41-Q50)

Higher-order reasoning and multi-step questions. Each question carries 2 marks.

Q.41 The MO description of O2 gives 8 bonding electrons and 4 antibonding electrons. What is the bond order, and why is O2 paramagnetic?



A. Bond order 1; all electrons paired
B. Bond order 2; unpaired electrons remain in pi* orbitals
C. Bond order 3; no antibonding electrons
D. Bond order 0; molecule is unstable

Q.42 Why is the first ionization energy of chlorine higher than that of magnesium in Period 3?

A. Chlorine has fewer protons.
B. Chlorine has higher effective nuclear charge.
C. Magnesium has no valence electrons.
D. Chlorine has more shells than magnesium.

Q.43 A molecule has trigonal planar shape with bond angles close to 120 degrees. Which hybridization is most likely?

A. sp
B. sp2
C. sp3
D. dsp3

Q.44 A gas at high pressure and low temperature shows a measured pressure lower than ideal-gas prediction. Which real-gas effect is mainly responsible?

A. Strong intermolecular attractions
B. Absence of molecular motion
C. Increase in gas constant
D. Complete ionization of the gas

Q.45 For a reaction with Delta H = +40 kJ/mol and Delta S = +120 J/(mol K), above what temperature does it become spontaneous?

A. Below 100 K
B. Above 333 K
C. Exactly 40 K
D. It is never spontaneous

Q.46 For the exothermic reaction CO(g) + H2O(g) <=> CO2(g) + H2(g), what is the effect of increasing temperature?

A. Shift right and increase products
B. Shift left and decrease products
C. No shift
D. K always increases for exothermic reactions

Q.47 For Fe3+ + e- -> Fe2+, E0 = +0.77 V. If [Fe3+] = 0.010 M and [Fe2+] = 0.10 M at 298 K, what is E? Use E = E0 - 0.0591 log([Fe2+]/[Fe3+]).

A. 0.83 V
B. 0.77 V
C. 0.71 V
D. 0.65 V

Q.48 A hydrocarbon contains 85.7% carbon and 14.3% hydrogen by mass. What is its empirical formula?

A. CH
B. CH2
C. C2H3
D. C3H8

Q.49 In benzene nitration, which species acts as the electrophile?

A. NO2+
B. NH4+
C. OH-
D. H-

Q.50 For N2(g) + 3H2(g) <=> 2NH3(g), what is the relation between Kp and Kc?

A. Kp = Kc(RT)2
B. Kp = Kc(RT)-2
C. Kp = Kc(RT)0
D. Kp = Kc/RT only if pressure is 1 atm

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Answer Key and Explanations

For academic review, teacher use, and website publication.

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

Detailed Explanations

Q.1 Answer: B - Oxygen added = 31.33 - 10.00 = 21.33 g. Moles of O2 = 21.33/32 = 0.6666 mol. Since 2 mol O2 react with 1 mol X, moles of X = 0.3333 mol. Molar mass = 10.0/0.3333 = 30 g/mol.

Q.2 Answer: B - s, p, d and f orbitals correspond to l = 0, 1, 2 and 3 respectively. A 3p electron has n = 3 and l = 1.

Q.3 Answer: B - Across a period, nuclear charge increases while shielding changes little. Valence electrons are pulled closer, so atomic radius decreases and ionization energy generally increases.

Q.4 Answer: C - Four electron domains with no lone pair form a tetrahedral arrangement. The corresponding hybridization is sp3.

Q.5 Answer: B - Above critical temperature and pressure, a supercritical fluid combines liquid-like density with gas-like diffusion, making it useful as a solvent.

Q.6 Answer: C - The Gibbs free energy criterion for spontaneity at constant T and P is Delta G < 0.

Q.7 Answer: B - Heat behaves like a product. Increasing temperature shifts equilibrium toward the reactant side to absorb heat, decreasing C.

Q.8 Answer: B - Zinc loses electrons to form Zn2+; therefore it is oxidized. Cu2+ gains electrons to form copper metal; therefore it is reduced.

Q.9 Answer: C - Hydrogen atoms are very small and can enter interstitial sites in many metal lattices, enabling reversible storage as metal hydrides.

Q.10 Answer: B - Lithium has low atomic mass, small ionic size and very high electrochemical potential, giving lithium batteries high specific energy.

Q.11 Answer: A - Boron has only six electrons around it in BF3 and retains an empty p orbital, making the molecule electron deficient.

Q.12 Answer: B - The negative inductive effect (-I) is electron withdrawal through sigma bonds due to electronegativity differences.

Q.13 Answer: B - Markovnikov addition proceeds through the more stable secondary carbocation, leading mainly to 2-bromopropane.

Q.14 Answer: A - Photochemical smog forms when NOx and hydrocarbons react in sunlight, producing ozone, PAN and irritating oxidants.

Q.15 Answer: B - 1.0 mol O2 requires 2.0 mol H2. Since 4.0 mol H2 is available, oxygen is consumed first and is the limiting reagent.

Q.16 Answer: A - The energy gap is greatest for the transition ending at n=1 among the options; therefore n=2 to n=1 emits the highest energy photon.

Q.17 Answer: D - Electronegativity increases across Period 2 and fluorine is the most electronegative element.

Q.18 Answer: C - The electron-pair geometry is tetrahedral, but one position is occupied by a lone pair, so the molecular shape is trigonal pyramidal.

Q.19 Answer: A - Ideal gas assumptions fail when molecules are close together and attractive forces or finite molecular volume become important.

Q.20 Answer: B - Free expansion increases accessible volume and number of microstates, causing a significant entropy increase.

Q.21 Answer: C - Moles of C2H4 = 10.0/28.05 = 0.3565 mol. Moles CO2 = 2 x 0.3565 = 0.713 mol. Mass CO2 = 0.713 x 44.01 = 31.4 g.

Q.22 Answer: C - pH = pKa + log([A-]/[HA]) = 4.76 + log(0.20/0.10) = 4.76 + 0.30 = 5.06.

Q.23 Answer: A - E0cell = E0cathode - E0anode = 0.34 - (-0.76) = +1.10 V. Zinc is oxidized at the anode.

Q.24 Answer: B - At Delta G = 0, T = Delta H/Delta S = (-92400 J/mol)/(-198 J/mol K) = 467 K approximately.

Q.25 Answer: A - Lower temperature favours the exothermic direction, so the equilibrium shifts toward N2O4.

Q.26 Answer: C - The half-reaction MnO4- + 8H+ + 5e- -> Mn2+ + 4H2O consumes 5 electrons. Each Fe2+ supplies one electron, so five Fe2+ ions are required.

Q.27 Answer: B - The path forming a secondary carbocation is favoured; bromide then attacks to give 2-bromopropane.

Q.28 Answer: B - Fluorine has the strongest tendency to attract shared electrons because it is small and has high effective nuclear charge.

Q.29 Answer: A - Methane has a higher proportion of hydrogen and lower molar mass, giving high energy per unit mass and cleaner combustion.

Q.30 Answer: B - Dioxins can form from chlorinated organic materials under oxygen-deficient, incomplete combustion conditions through radical pathways.

Q.31 Answer: A - A pure crystal has a regular lattice and melts sharply; impurities disrupt the lattice and cause melting point depression and broadening.

Q.32 Answer: A - The 3p3 arrangement places one electron in each p orbital before any pairing, giving three unpaired electrons.

Q.33 Answer: A - Greater effective nuclear charge makes electron removal more difficult, so ionization energy tends to rise.

Q.34 Answer: D - Real gases behave most ideally at low pressure and high temperature. The reason is also false because high pressure makes molecular volume and attractions significant.

Q.35 Answer: A - For an exothermic forward reaction, heating shifts equilibrium backward, lowering product yield.

Q.36 Answer: A - Benzene tends to undergo substitution rather than addition because addition disrupts aromatic delocalization.

Q.37 Answer: C - The anode is the site of oxidation, but oxidation is loss of electrons, not gain.

Q.38 Answer: A - Hydrogen bonding between water molecules requires more energy to overcome, raising boiling point.

Q.39 Answer: C - Oxidation numbers are useful formal values, but in covalent molecules they do not necessarily equal actual atomic charges.

Q.40 Answer: A - The pi bond in alkenes is more exposed and electron-rich than sigma bonds in alkanes, enabling electrophilic addition.

Q.41 Answer: B - Bond order = (8 - 4)/2 = 2. O2 is paramagnetic because its antibonding pi* orbitals contain unpaired electrons.

Q.42 Answer: B - Across Period 3, shielding changes little while nuclear charge increases, so chlorine holds valence electrons more strongly.

Q.43 Answer: B - Three electron domains arranged in a plane at 120 degrees indicate sp2 hybridization.

Q.44 Answer: A - Attractive forces pull molecules inward and reduce the force of collisions with container walls, lowering measured pressure.

Q.45 Answer: B - Set Delta G = Delta H - T Delta S < 0. T > Delta H/Delta S = 40000/120 = 333 K.

Q.46 Answer: B - Raising temperature favours the endothermic reverse direction, shifting equilibrium left.

Q.47 Answer: C - The ratio [Fe2+]/[Fe3+] = 10. E = 0.77 - 0.0591 log10 = 0.77 - 0.0591 = 0.71 V.

Q.48 Answer: B - For 100 g: C moles = 85.7/12 = 7.14; H moles = 14.3/1 = 14.3. Ratio is 1:2, so empirical formula is CH2.

Q.49 Answer: A - The nitronium ion NO2+ is generated in the acid mixture and attacks the aromatic ring in electrophilic substitution.

Q.50 Answer: B - Delta n = gaseous product moles - reactant moles = 2 - 4 = -2. Hence Kp = Kc(RT)^Delta n = Kc(RT)^-2.