WEIRD CHEMIST

Group 18 Elements — The Noble Gases

Chapter: p-Block Elements

DPP-11

TOPIC 1 Introduction

(a)–(c) Elements, Nature & Occurrence

SKILL: Analytical Ability

Q1. Radon is the only Group 18 element not found in the atmosphere. It is instead obtained as a decay product of $^{226}_{88}$Ra via the nuclear equation: $^{226}_{88}\text{Ra} \rightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He}$. What type of nuclear decay is this, and how do the mass and atomic numbers on each side confirm it? [JEE]

(1) Beta decay — because the product Rn has a lower atomic number than the reactant Ra, which always indicates beta emission

(2) Gamma decay — because the He nucleus carries away excess energy from the radium atom in the form of electromagnetic radiation

(3) Alpha decay — the emitted $^{4}_{2}$He is an alpha particle; mass numbers balance ($226 = 222 + 4$) and atomic numbers balance ($88 = 86 + 2$) perfectly on both sides, confirming that exactly one alpha particle is released per decay event

(4) Neutron emission — because the helium-4 nucleus has the same mass as two neutrons and can be considered a neutral particle

SKILL: Conceptual Clarity

Q2. Group 18 elements are collectively known as "noble gases." Which of the following correctly connects this name to their chemistry? [NEET]

(1) They are called "noble" because they are found in noble minerals such as gold ore and platinum ore

(2) They are called "noble" because all six are liquids at room temperature, like liquid metal

(3) They are called "noble" because they form many stable compounds with noble metals

(4) They are called "noble" — analogous to noble metals that resist chemical attack — because they are chemically unreactive and form very few compounds

SKILL: Application Skills

Q3. Helium is found in minerals of radioactive origin such as pitchblende, monazite and cleveite, even though it is a gas. Which of the following best explains how helium accumulates inside these solid minerals? [NEET]

(1) Helium is injected into radioactive minerals by volcanic activity and remains trapped within the crystal lattice

(2) Alpha decay of radioactive elements within these minerals produces $^{4}_{2}\text{He}$ (alpha particles) which, after gaining electrons, become helium atoms that remain trapped in the mineral — this is the same type of decay seen in $^{226}_{88}\text{Ra}$ producing radon

(3) Helium is formed from hydrogen present in the deposits through nuclear fusion deep inside the earth's crust

(4) Helium dissolved in ground water is deposited into the mineral lattice as the water evaporates over geological time

SKILL: Diagram-Based Visual Literacy

Q4. The table below summarises key occurrence facts for Group 18 elements. Based on this data, which statement is correctly supported? [JEE]

Element	Primary source	Status
He	Natural gas; radioactive minerals (pitchblende, monazite)	Rare in atmosphere
Ne	Atmosphere (dry air)	Minor component
Ar	Atmosphere (dry air, $\sim$1% vol.)	**Major constituent**
Kr	Atmosphere	Very rare
Xe	Atmosphere	Rarest (with Rn)
Rn	Decay of $^{226}_{88}\text{Ra}$	No atmospheric source

(1) Argon is the most abundant noble gas in dry air and is the dominant constituent of the $\sim$1% noble gas fraction; the main commercial source of helium is natural gas, not the atmosphere

(2) Helium is the most abundant noble gas in dry air since it is the lightest element in the group

(3) Radon is found in large quantities in natural gas deposits alongside helium

(4) All six noble gases occur in the atmosphere in roughly equal proportions of about 0.17% each

SKILL: Time Management and Strategic Thinking

Q5. Consider the following statements and select the option with the correct combination of true statements: [JEE]

I. All noble gases occur in the atmosphere except radon.
II. Argon is a *minor* constituent of the noble gas fraction in dry air.
III. The main commercial source of helium is natural gas.
IV. Xenon and radon are the rarest elements of Group 18.

(1) I, II, III and IV (2) I, II and IV only (3) I, III and IV only (4) II, III and IV only

TOPIC 2 Atomic Properties

(a)–(e) Electronic Configuration, Atomic Radii, Ionisation Enthalpy, Electron Gain Enthalpy & Electronegativity

SKILL: Analytical Ability

Q6. Helium has the highest first ionisation enthalpy (2372 kJ mol^{-1}) of any known element. Which of the following best explains why helium's ionisation enthalpy is so exceptionally high, even compared to the other noble gases? [JEE]

(1) Helium has the highest atomic mass per electron among all elements, making it inherently difficult to remove an electron

(2) Helium has the most protons overall in Group 18, giving it the strongest raw nuclear charge in the group

(3) All monatomic gases have the highest ionisation enthalpies in their periods since their electrons are not shared with neighbouring atoms as in molecules

(4) Helium's two electrons occupy the 1s orbital with zero inter-shell shielding; the effective nuclear charge experienced by each electron is therefore very high, and the completely filled $1s^2$ shell is exceptionally stable — removing either electron requires overcoming this very strong nuclear pull

SKILL: Conceptual Clarity

Q7. The general electronic configuration of noble gases is ns^2np^6, but helium is an exception with $1s^2$. Which of the following correctly explains why helium is an exception, and why both configurations are considered stable? [NEET]

(1) Helium has only one proton, so it can only hold one electron in the 1s orbital and cannot have an np^6 configuration

(2) The $n = 1$ shell has no p subshell, so helium's valence shell is completely filled as $1s^2$ — the same principle of a filled outer shell applies to both $1s^2$ (He) and ns^2np^6 (other noble gases), making both equally stable

(3) Helium should be written as $1s^2 2s^0$ to follow the general noble gas pattern; $1s^2$ is just a simplified notation

(4) Helium's $1s^2$ is not truly stable; it only appears stable because scientists have never attempted vigorous enough conditions to make helium form compounds

SKILL: Application Skills

Q8. The atomic radii of noble gases from Table 7.12 are: He = 120, Ne = 160, Ar = 190, Kr = 200 and Xe = 220 pm. Between which consecutive pair is the *smallest* increase in atomic radius observed? [NEET]

(1) Ar to Kr (increase = 10 pm)
(2) He to Ne (increase = 40 pm)
(3) Ne to Ar (increase = 30 pm)
(4) Kr to Xe (increase = 20 pm)

SKILL: Diagram-Based Visual Literacy

Q9. The table below gives first ionisation enthalpy and electron gain enthalpy for four noble gases. Based on this data, which statement is correctly supported? [JEE]

Element	IE / kJ mol^{-1}	EGE / kJ mol^{-1}
He	2372	+48
Ne	2080	+116
Ar	1520	+96
Kr	1351	+96

(1) Both ionisation enthalpy and electron gain enthalpy decrease steadily from He to Kr without any exception

(2) Noble gases have large negative electron gain enthalpies, showing that they readily accept an extra electron to complete what appears to be an unfilled shell

(3) Ionisation enthalpy decreases steadily from He to Kr (consistent with increasing atomic size), all electron gain enthalpies are *positive* (noble gases resist gaining electrons), and Ne shows the highest positive EGE at 116 kJ mol^{-1} — even higher than He

(4) Ionisation enthalpy increases from He to Kr because a larger atom holds its outer electrons more tightly

SKILL: Time Management and Strategic Thinking

Q10. Consider the following statements and select the option with the correct combination of true statements: [JEE]

I. All noble gases except helium have the general electronic configuration ns^2np^6.
II. Ionisation enthalpy of noble gases decreases down the group due to increasing atomic size.
III. Noble gases have large *negative* electron gain enthalpies since they would gain an electron to complete their already stable shells.
IV. Atomic radii of noble gases increase down the group with increasing atomic number.

(1) I, II, III and IV
(2) I, II and IV only
(3) II, III and IV only
(4) I and III only

TOPIC 3 Physical Properties

(a)–(d) Physical State, Boiling Point, Melting Point & Density

SKILL: Analytical Ability

Q11. Noble gases have very low melting and boiling points compared to most other substances of similar atomic mass. Which of the following best explains why? [JEE]

(1) Noble gases are all diatomic molecules, and diatomic molecules always have lower boiling points than larger polyatomic molecules

(2) Noble gases have very high ionisation enthalpies, and elements with high ionisation enthalpy always have correspondingly low boiling points

(3) Noble gases are colourless and odourless, and colourless substances always have the lowest boiling points in any period

(4) Noble gases are monoatomic and the only interatomic interaction present is weak dispersion (London) forces; since there are no permanent dipoles, no hydrogen bonds, and no ionic or covalent network bonding, very little energy is needed to separate atoms — hence the exceptionally low melting and boiling points

SKILL: Conceptual Clarity

Q12. Helium has the unusual property of diffusing through commonly used laboratory materials such as rubber, glass and plastics. Which of the following best connects this property to helium's structure? [NEET]

(1) Helium is the most reactive noble gas and chemically reacts with materials like rubber, allowing it to pass through

(2) Helium has the smallest atomic size among all noble gases (atomic radius = 120 pm); its exceptionally tiny atoms can pass through the microscopic pores and structural gaps in materials considered gas-tight for larger molecules, making it prone to leaking from ordinary containers

(3) Helium is a liquid at room temperature, and liquids always permeate through porous materials more easily than gases

(4) Helium has a large positive electron gain enthalpy, and this causes it to bond temporarily with material surfaces and "tunnel" through them

SKILL: Application Skills

Q13. From the boiling point data (He = 4.2, Ne = 27.1, Ar = 87.2, Kr = 119.7, Xe = 165.0, Rn = 211 K), which noble gas shows the *largest* increase in boiling point compared to the preceding element in the group? [NEET]

(1) Argon — the step from Ne (27.1 K) to Ar (87.2 K) is 60.1 K, the largest single increase

(2) Neon — the step from He (4.2 K) to Ne (27.1 K) is the largest absolute increase

(3) Krypton — the step from Ar (87.2 K) to Kr (119.7 K) is the largest increase

(4) Radon — having the highest boiling point (211 K) must mean it shows the largest individual increase

SKILL: Diagram-Based Visual Literacy

Q14. The table below lists melting point, boiling point and density at STP for four noble gases. Based on this data, which statement is correctly supported? [JEE]

Property	He	Ne	Ar	Kr
Melting point / K	–	24.6	83.8	115.9
Boiling point / K	4.2	27.1	87.2	119.7
Density / g cm^{-3} (STP)	1.8×10^{-4}	9.0×10^{-4}	1.8×10^{-3}	3.7×10^{-3}

(1) Melting point, boiling point and density all decrease from He to Kr, consistent with decreasing atomic mass down the group

(2) Helium's boiling point and melting point are both 4.2 K, meaning it has essentially no liquid range

(3) Melting point, boiling point and density all increase from Ne to Kr, consistent with increasing atomic mass and progressively stronger dispersion forces; helium has no melting point listed because it does not solidify at standard atmospheric pressure

(4) Density decreases from He to Kr because heavier atoms always occupy more volume and are therefore less dense

SKILL: Time Management and Strategic Thinking

Q15. Consider the following statements about the physical properties of noble gases and select the option with the correct combination of true statements: [JEE]

I. Noble gases are monoatomic, colourless, odourless and tasteless.
II. Noble gases have very low melting and boiling points because the only interatomic interaction present is weak dispersion forces.
III. Helium has the lowest boiling point (4.2 K) of any known substance.
IV. Helium is denser than neon and therefore diffuses more slowly through laboratory materials such as rubber and glass.

(1) I, II, III and IV (2) I, II and IV only (3) II, III and IV only (4) I, II and III only

TOPIC 4 Chemical Properties

(a) General — Inertness, Bartlett's Discovery & Compound Status

SKILL: Analytical Ability

Q16. In 1962, Neil Bartlett had already prepared the red compound $O_2{\equiv}PtF_6^-$ using PtF_6. He then noticed that the first ionisation enthalpy of molecular oxygen (1175 kJ mol^{-1}) was almost identical to that of xenon (1170 kJ mol^{-1}). Which of the following best describes the logical step that led him from $O_2{\equiv}PtF_6^-$ to $Xe{\equiv}PtF_6^-$? [JEE]

(1) Bartlett randomly tried xenon with PtF_6 after failing with other noble gases; the nearly identical ionisation enthalpy values were a coincidence discovered after the experiment

(2) Since PtF_6 had already oxidised O_2 to O_2^+ (removing one electron), and xenon's first ionisation enthalpy (1170 kJ mol^{-1}) was almost the same as that of O_2 (1175 kJ mol^{-1}), Bartlett correctly reasoned that PtF_6 should be equally capable of removing one electron from xenon, forming $Xe{\equiv}PtF_6^-$

(3) Bartlett chose xenon because it is the second heaviest stable noble gas, and heavier noble gases are always more reactive

(4) PtF_6 is a universal oxidising agent that can react with any element regardless of ionisation enthalpy; xenon was simply the most convenient noble gas available in his laboratory

SKILL: Conceptual Clarity

Q17. Which of the following correctly identifies all the reasons cited in the NCERT passage for the chemical inertness of noble gases? [NEET]

(1) Noble gases (except He) have completely filled ns^2np^6 valence configuration, very high ionisation enthalpy, and large *positive* electron gain enthalpy — all three factors together prevent them from forming chemical bonds under ordinary conditions

(2) Noble gases are inert only because they are all gaseous at room temperature; gaseous elements are always less reactive than solid or liquid elements

(3) Noble gases are inert because they are colourless and tasteless; colourless substances are always chemically inactive

(4) Noble gases are inert only because of their high ionisation enthalpy; electron gain enthalpy and electronic configuration play no role in their inertness

SKILL: Application Skills

Q18. A chemist wishes to study the chemistry of three different noble gases: one where only the difluoride has been studied in detail, one where compounds have only been identified by radiotracer technique (not isolated), and one where no true compounds are known. Based on the NCERT passage, which option correctly matches each description to krypton, radon and helium respectively? [NEET]

(1) Krypton: only identified by radiotracer; Radon: only difluoride studied in detail; Helium: no true compounds known

(2) Krypton: only KrF_2 studied in detail; Radon: compounds such as RnF_2 only identified by radiotracer, not isolated in the laboratory; Helium: no true compounds yet known

(3) Krypton: no true compounds known; Radon: only difluoride studied in detail; Helium: only identified by radiotracer

(4) All three have the same status — only the difluoride has been studied for each

SKILL: Diagram-Based Visual Literacy

Q19. The table below summarises the known chemistry of Group 18 elements. Based on this, which statement is correctly supported? [JEE]

Element(s)	Known compound status
He, Ne, Ar	No true compounds known
Kr	Only KrF_2 has been studied in detail
Xe	Many compounds with F and O synthesised after Bartlett's 1962 discovery
Rn	Compounds (e.g. RnF_2) only identified by radiotracer technique; not isolated

(1) Xenon has the richest chemistry among noble gases; its first ionisation enthalpy was close to that of O_2, allowing PtF_6 to oxidise it. Helium, neon and argon have no true compounds known; krypton and radon have very limited or unconfirmed chemistry

(2) Krypton has the richest chemistry among noble gases since it sits in the middle of Group 18

(3) Radon is the easiest noble gas to study chemically since it has the largest atomic size and therefore highest reactivity

(4) Argon has several known compounds, making it the second most reactive noble gas after xenon

SKILL: Time Management and Strategic Thinking

Q20. Consider the following statements and select the option with the correct combination of true statements: [JEE]

I. The first noble gas compound, $Xe{\equiv}PtF_6^-$, was prepared by Neil Bartlett in March 1962 by mixing PtF_6 and xenon.
II. Bartlett's reasoning was based on the nearly identical first ionisation enthalpies of molecular oxygen (1175 kJ mol^{-1}) and xenon (1170 kJ mol^{-1}).
III. Compounds of radon have been fully isolated and characterised in the laboratory.
IV. No true compounds of argon, neon or helium are yet known.

(1) I, II, III and IV (2) I, III and IV only (3) I, II and IV only (4) II and IV only

(b) Xenon-Fluorine Compounds

SKILL: Analytical Ability

Q21. XeF_6 is prepared at 573 K and 60–70 bar with a 1:20 $Xe:F_2$ ratio, while XeF_2 is prepared at 673 K and only 1 bar with Xe in excess. Which of the following best explains why XeF_6 requires a dramatically higher pressure and a much greater proportion of F_2, even though the temperature is actually lower? [JEE]

(1) XeF_6 is more stable than XeF_2, so it requires gentler conditions; the higher pressure is merely coincidental and plays no chemical role

(2) Higher pressure and excess F_2 are needed for XeF_6 because the product is a gas, and high pressure prevents the gas from escaping the reaction vessel before it can be collected

(3) XeF_6 actually requires a higher temperature than XeF_2; the 573 K value shown for XeF_6 is a typographical error in the table

(4) Incorporating six fluorine atoms into one xenon atom requires a very large excess of F_2 in the mixture (achieved by high pressure and a 1:20 ratio) to drive the equilibrium toward the fully fluorinated product; the lower temperature simultaneously helps stabilise XeF_6 once formed, preventing it from reverting to less fluorinated species

SKILL: Conceptual Clarity

Q22. Xenon difluoride undergoes hydrolysis even by traces of water: $2XeF_2(s) + 2H_2O(l) \rightarrow 2Xe(g) + 4HF(aq) + O_2(g)$. What does this reaction reveal about the chemical nature of XeF_2? [NEET]

(1) XeF_2 is thermally very stable at 298 K since it is a crystalline solid; hydrolysis by water is just a negligible side reaction

(2) The hydrolysis shows that XeF_2 is a strong reducing agent since it loses fluorine atoms and the xenon oxidation state decreases

(3) XeF_2 is readily attacked even by traces of water, showing it is moisture-sensitive; it acts as a powerful fluorinating agent — donating fluorine to water to produce HF and O_2 while itself being reduced back to elemental xenon gas

(4) Water absorbs XeF_2 into solution without any chemical reaction; the equation shown describes the reverse (endothermic) reaction only

SKILL: Application Skills

Q23. Using VSEPR theory, the structures of the three xenon fluorides can be deduced from the number of bonding and lone electron pairs around xenon. Which of the following correctly matches each xenon fluoride to its experimentally observed shape? [NEET]

(1) XeF_2: bent; XeF_4: distorted octahedral; XeF_6: square planar

(2) XeF_2: square planar; XeF_4: linear; XeF_6: distorted octahedral

(3) XeF_2: square planar; XeF_4: square planar; XeF_6: linear

(4) XeF_2: linear (3 lone pairs on Xe); XeF_4: square planar (2 lone pairs on Xe); XeF_6: distorted octahedral in the gas phase (1 lone pair on Xe)

SKILL: Diagram-Based Visual Literacy

Q24. The table below summarises the preparation conditions for the three xenon fluorides. Based on this data, which statement is correctly supported? [JEE]

Compound	Reaction	Temperature	Pressure / Ratio
XeF_2	$Xe + F_2 \longrightarrow XeF_2$	673 K	1 bar; Xe excess
XeF_4	$Xe + {}_2F_2 \longrightarrow XeF_4$	873 K	7 bar; 1:5
XeF_6	$Xe + {}_3F_2 \longrightarrow XeF_6$	573 K	60–70 bar; 1:20

(1) Both temperature and pressure increase proportionally as more fluorine is incorporated going from XeF_2 to XeF_6

(2) Moving from XeF_2 to XeF_6, the pressure required rises dramatically (1→7→60–70 bar) and the F_2 proportion increases greatly (Xe excess→1:5→1:20), showing that higher fluorine concentrations are needed for the more fluorinated product; temperature does not follow a simple increasing trend

(3) XeF_6 requires the mildest overall conditions since it is formed at the lowest temperature (573 K)

(4) All three xenon fluorides require the same ratio of Xe to F_2; only the temperature differs between them

SKILL: Time Management and Strategic Thinking

Q25. Consider the following statements about xenon-fluorine compounds and select the option with the correct combination of true statements: [JEE]

I. XeF_2, XeF_4 and XeF_6 are colourless crystalline solids that sublime readily at 298 K and are powerful fluorinating agents.
II. XeF_6 has seven electron pairs (6 bonding and 1 lone pair) and therefore has a distorted octahedral structure in the gas phase.
III. XeF_2 undergoes hydrolysis even by traces of water, producing Xe gas, HF and O_2.
IV. XeF_6 reacts with alkali metal fluorides (MF, where M = Na, K, Rb or Cs) to form cationic species $[XeF_5]^+$.

(1) I, II and III only (2) I, II, III and IV (3) II, III and IV only (4) I and IV only

(c) Xenon-Oxygen Compounds

SKILL: Analytical Ability

Q26. Hydrolysis of XeF_4 gives XeO_3 along with elemental Xe and O_2 ($6XeF_4 + 12H_2O \rightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$), while hydrolysis of XeF_6 gives only XeO_3 ($XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$). Which of the following best explains why XeF_4 disproportionates but XeF_6 does not? [JEE]

(1) In XeF_4, xenon is in the $+4$ state; hydrolysis forces some Xe to be reduced to 0 (elemental Xe) and some to be oxidised to $+6$ (in XeO_3) — disproportionation occurs because $+4$ is unstable for Xe in an aqueous environment. In XeF_6, Xe is already at $+6$ and simply transfers bonding from F to O without any change in oxidation state

(2) XeF_4 disproportionates because it has four fluorine atoms while XeF_6 has six; more fluorine atoms always prevent disproportionation, so XeF_6 gives a cleaner product

(3) Both XeF_4 and XeF_6 produce exactly the same mixture of products; the different equations shown in the passage are simplified versions of the same overall reaction

(4) XeF_4 disproportionates because it is a solid while XeF_6 is a liquid; physical state alone determines whether disproportionation occurs during hydrolysis

SKILL: Conceptual Clarity

Q27. Which of the following correctly pairs each xenon-oxygen compound with its physical state and molecular structure? [NEET]

(1) XeO_3: colourless volatile liquid with a square pyramidal structure; $XeOF_4$: colourless explosive solid with a pyramidal structure

(2) XeO_3: colourless volatile liquid with a pyramidal structure; $XeOF_4$: colourless explosive solid with a square pyramidal structure

(3) XeO_3: colourless explosive solid with a pyramidal molecular structure; $XeOF_4$: colourless volatile liquid with a square pyramidal molecular structure

(4) Both XeO_3 and $XeOF_4$ are colourless explosive solids and both have square pyramidal molecular structures

SKILL: Application Skills

Q28. Partial hydrolysis of XeF_6 produces different products depending on the amount of water used: $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$ and $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$. What happens to the number of F atoms on xenon as more water is used, and which product forms with one mole versus two moles of water per mole of XeF_6? [NEET]

(1) One mole of water gives XeO_2F_2; two moles of water give $XeOF_4$ — water replaces fluorines one at a time, first giving the more substituted product

(2) One mole of water gives XeO_3; two moles of water give XeO_2F_2 — complete hydrolysis occurs regardless of water quantity

(3) Both one mole and two moles of water give the same product $XeOF_4$ since there is always excess F_2 to compensate

(4) One mole of water gives $XeOF_4$ (one O replaces two F, releasing 2HF); two moles of water give XeO_2F_2 (two O atoms replace four F atoms, releasing 4HF) — progressively more oxygen substitution occurs with increasing water

SKILL: Diagram-Based Visual Literacy

Q29. The table below lists the molecular structures of five xenon compounds as deduced from VSEPR theory and confirmed experimentally (Fig. 7.9). Based on this data, which statement is correctly supported? [JEE]

Compound	Structure	Lone pairs on Xe
XeF_2	Linear	3
XeF_4	Square planar	2
XeF_6	Distorted octahedral	1
$XeOF_4$	Square pyramidal	1 (Xe bonded to 4F + 1O)
XeO_3	Pyramidal	1 (Xe bonded to 3O)

(1) As the number of lone pairs on Xe decreases from 3 (XeF_2) to 1 (XeF_6), the geometry changes from linear to square planar to distorted octahedral; $XeOF_4$ is square pyramidal and XeO_3 is pyramidal,

both reflecting the influence of oxygen-containing substituents combined with one lone pair

(2) XeO_3 has a linear structure because its three oxygen atoms arrange themselves at 180° to minimise repulsion

(3) All five xenon compounds share the same basic octahedral geometry and differ only in the lengths of their bonds

(4) XeF_4 has a distorted octahedral structure due to its two lone pairs, while XeF_6 has a square planar structure

SKILL: Time Management and Strategic Thinking

Q30. Consider the following statements about xenon-oxygen compounds and select the option with the correct combination of true statements: [JEE]

I. Complete hydrolysis of XeF_6 gives XeO_3 and HF: $XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$.
II. Partial hydrolysis of XeF_6 with one mole of water gives $XeOF_4$, and with two moles of water gives XeO_2F_2.
III. XeO_3 is a colourless volatile liquid with a pyramidal molecular structure.
IV. $XeOF_4$ is a colourless volatile liquid with a square pyramidal molecular structure.

(1) I, II, III and IV (2) I and II only (3) II, III and IV only (4) I, II and IV only

NCERT Examples (7.20–7.22) & In-Text Questions (7.32–7.34)

SKILL: Analytical Ability

Q31. [*NCERT Intext 7.33*] Balance the following equation: $XeF_6 + H_2O \rightarrow XeO_2F_2 + HF$. Which of the following gives the correctly balanced version? [NCERT]

(1) $XeF_6 + H_2O \rightarrow XeO_2F_2 + HF$ (equation as given; no balancing needed)

(2) $XeF_6 + 3H_2O \rightarrow XeO_2F_2 + 6HF$

(3) $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

(4) $2XeF_6 + H_2O \rightarrow 2XeO_2F_2 + 2HF$

SKILL: Conceptual Clarity

Q32. [*NCERT Example 7.22*] Does the hydrolysis of XeF_6 to give $XeOF_4$ and XeO_2F_2 constitute a redox reaction? Which of the following correctly identifies the oxidation states and uses them to answer the question? [NCERT]

(1) Yes — the hydrolysis is a redox reaction because xenon changes from $+6$ in XeF_6 to 0 in the products, as is the case whenever a fluorinated compound reacts with water

(2) No — in XeF_6 the oxidation states are Xe = $+6$, F = -1; in the products $XeOF_4$ and XeO_2F_2, Xe remains $+6$, F remains -1, and O is -2 (the same as in water) — no element changes its oxidation state, so no redox reaction occurs

(3) Yes — oxygen changes oxidation state from -2 in water to $+2$ in the products, making this an oxidation of oxygen

(4) No — xenon compounds can never undergo redox reactions because xenon is a noble gas and noble gases are always chemically inert

SKILL: Application Skills

Q33. [*NCERT Intext 7.34*] Why has it been difficult to study the chemistry of radon? [NCERT]

(1) Radon is a gas at room temperature, and gaseous elements are always more difficult to study chemically than solids or liquids

(2) Radon has a very small atomic size, which prevents it from forming bonds with other elements under any conditions

(3) Radon is highly radioactive; its most stable isotope (^{222}Rn) has a very short half-life (about 3.8 days), meaning it decays faster than stable compounds can typically be prepared, isolated and characterised — making detailed chemical study extremely challenging

(4) Radon does not dissolve in any known solvent, which makes it impossible to study in solution and therefore impossible to characterise chemically

SKILL: Diagram-Based Visual Literacy

Q34. The table below pairs NCERT questions (Examples 7.20–7.22 and Intext 7.32–7.34) with their key answers. Based on this, which statement correctly follows from the table? [NCERT]

Source	Question	Key answer
Ex. 7.20	Why called noble gases?	Completely filled valence shell orbitals; react only under certain conditions
Ex. 7.21	Why low boiling points?	Monoatomic; only weak dispersion forces
Ex. 7.22	Is XeF_6 hydrolysis redox?	No — all oxidation states unchanged
Int. 7.34	Why hard to study Rn?	Highly radioactive; very short half-life

(1) XeF_6 hydrolysis is a redox reaction since the table confirms that Xe must change oxidation state when fluorine is replaced by oxygen

(2) The low boiling points of noble gases and the name "noble gases" both trace back to the same root cause — completely filled valence shells; this makes them monoatomic (so only weak dispersion forces exist $\rightarrow$ low BP) and chemically unreactive (noble behaviour)

(3) Helium is used in diving because it is the densest noble gas and settles at the diver's depth most efficiently

(4) Radon is the easiest noble gas to study since, being the heaviest, it forms the most stable and long-lived compounds

SKILL: Time Management and Strategic Thinking

Q35. Consider the following statements (drawn from NCERT Examples 7.20–7.22 and Intext Questions 7.32–7.34) and select the correct combination of true statements: [NCERT]

I. The balanced equation for partial hydrolysis of XeF_6 is $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$; this reaction is not a redox reaction since all oxidation states remain unchanged in the products.
II. Noble gases have very low boiling points because, being monoatomic, the only interatomic interactions are weak dispersion forces.
III. Radon is difficult to study chemically because it is a highly reactive element that immediately reacts with any reagent used.
IV. Group 18 elements are called noble gases because their valence shell orbitals are completely filled, allowing them to react only under certain conditions.

(1) I, II and IV only (2) I, II, III and IV (3) II, III and IV only (4) I and IV only

— Answers & solutions are provided separately. —