WEIRD CHEMIST

Group 16 Elements — The Oxygen Family

Chapter: p-Block Elements

DPP-9

TOPIC 1 Introduction

(a) Elements, Nature & Occurrence

Q1. The term "chalcogens" for Group 16 elements is derived from a Greek word associated with a particular metal, since most ores of that metal contain oxygen or sulphur (or the other group members) combined with it.

(1) The term originates from the Greek word for brass, since most copper minerals contain either oxygen or sulphur along with the other members of the group

(2) The term originates from the Greek word for iron, since haematite and other iron ores are the principal source of oxygen compounds in nature

(3) The term originates from the Greek word for gold, since native gold deposits are frequently associated with sulphide minerals

(4) The term originates from the Greek word for lead, since galena (PbS) is the most economically important chalcogen-bearing ore

Q2. Regarding the nature of Group 16 elements, which statement correctly describes their metallic/non-metallic character?

(1) All five elements — oxygen, sulphur, selenium, tellurium and polonium — are typical non-metals

(2) Oxygen is a non-metal while all the remaining four elements are metals

(3) Oxygen and sulphur are non-metals, selenium and tellurium are metalloids, while polonium is a radioactive metal

(4) Metallic character decreases steadily down the group, making polonium the most non-metallic member

Q3. Oxygen constitutes about 46.6% by mass of the earth's crust, while sulphur's crustal abundance is only 0.03–0.1%. Taking the upper limit of sulphur's range, approximately how many times more abundant is oxygen than sulphur in the earth's crust?

(1) about 50 times (2) about 150 times (3) about 250 times (4) about 470 times

Q4. Consider the following mineral–formula pairs, all cited as natural sources of combined sulphur. Identify the pair that is INCORRECTLY matched.

(1) Gypsum — $CaSO_4 \cdot {}_2H_2O$

(2) Copper pyrites — $CuFe_2S_3$

(3) Epsom salt — $MgSO_4 \cdot {}_7H_2O$

(4) Zinc blende — ZnS

Q5. Which statement about the natural occurrence of selenium, tellurium and polonium is CORRECT?

(1) Selenium and tellurium occur abundantly as free elements in nature, while polonium occurs only in combined form

(2) Selenium, tellurium and polonium are all synthetically produced and have no natural mineral sources

(3) Selenium and tellurium occur as metal selenides and tellurides in sulphide ores, while polonium occurs in nature as a decay product of thorium and uranium minerals

(4) Polonium occurs abundantly in the earth's crust, comparable to sulphur, while selenium and tellurium are exceedingly rare

TOPIC 2 Atomic Properties

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

Q6. Group 16 elements share the general outer electronic configuration ns^2np^4. Which option correctly gives tellurium's ($Z=_{52}$) electronic configuration along with the correct reasoning for why all Group 16 members terminate in np^4?

(1) $[Kr]4d^{10}5s^25p^4$, because all Group 16 elements possess six electrons in the outermost shell, filling the ns and np subshells as ns^2np^4

(2) $[Kr]4d^{10}5s^25p^4$, because all Group 16 elements achieve a stable filled p-subshell configuration by having four electrons in the outermost p-orbital

(3) $[Kr]4d^{10}5s^25p^2$, because tellurium's atomic number places it two electrons short of a filled p-subshell

(4) $[Xe]4f^{14}5d^{10}6s^26p^4$, because tellurium adopts the electronic configuration of the next member, polonium

Q7. Which statement correctly explains the trend in atomic and ionic radii of Group 16 elements?

(1) Atomic and ionic radii decrease from oxygen to polonium due to increasing nuclear charge

(2) Atomic and ionic radii increase from oxygen to polonium because of an increase in the number of shells down the group, with oxygen's atomic size being exceptionally small

(3) Atomic and ionic radii remain nearly constant across the group since electron shielding compensates for the added shells

(4) Ionic radii decrease down the group even though atomic radii increase, due to greater electron–electron repulsion in the larger anions

Q8. The ionisation enthalpy values (in $kJmol^{-1}$) for O, S, Se, Te and Po are 1314, 1000, 941, 869 and 813 respectively. Approximately what percentage decrease in ionisation enthalpy occurs from oxygen to polonium?

(1) about 15% (2) about 25% (3) about 32% (4) about 38%

Q9. The electron gain enthalpy values (in $kJmol^{-1}$) for O, S, Se, Te and Po are -141, -200, -195, -190 and -174 respectively. Which statement correctly interprets this trend?

(1) Electron gain enthalpy becomes progressively more negative from oxygen to polonium, following the expected group trend

(2) Sulphur has the most negative electron gain enthalpy in the group; oxygen (despite being smallest) is less negative than sulphur due to strong electron–electron repulsion in its compact $2p$ orbitals, and the values become progressively less negative from sulphur onwards to polonium

(3) Oxygen has the most negative electron gain enthalpy of all Group 16 elements, consistent with its small atomic size

(4) Electron gain enthalpy values remain nearly constant across the group after sulphur, showing no significant variation among Se, Te and Po

Q10. Which of the following statements about the electronegativity of Group 16 elements is CORRECT?

(1) Polonium has the highest electronegativity in the group, exceeded only by fluorine among all elements

(2) Electronegativity increases down the group from oxygen to polonium, paralleling the increase in metallic character

(3) Oxygen has the highest electronegativity in the group (second only to fluorine among all elements), and electronegativity decreases down the group as metallic character increases

(4) Electronegativity values are identical for all Group 16 elements since they share the same general electronic configuration

TOPIC 3 Physical Properties

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

Property	O	S	Se	Te	Po
Density / gcm^{-3} (298 K)	1.32	2.06	4.19	6.25	—
Melting point / K	55	393	490	725	520
Boiling point / K	90	718	958	1260	1235

Q11. The passage states that melting and boiling points of Group 16 elements increase with atomic number down the group. Based on the exact data in Table 7.6 above, which statement correctly identifies where this general trend breaks down?

(1) The trend holds true without exception across all five elements for both melting and boiling points

(2) Only the melting point trend breaks down at polonium, while the boiling point continues to rise smoothly

(3) Both melting point and boiling point rise smoothly from oxygen through tellurium, but polonium is an exception — its melting point (520 K) and boiling point (1235 K) are both lower than tellurium's (725 K and 1260 K respectively)

(4) Only the boiling point trend breaks down at polonium, while the melting point continues to rise smoothly

Q12. Which statement correctly describes the physical state and nature of Group 16 elements at room temperature (298 K)?

(1) Oxygen exists as a gas at room temperature (boiling point 90 K, per Table 7.6 above), while sulphur, selenium, tellurium and polonium are all solids, consistent with oxygen and sulphur being non-metals, selenium and tellurium being metalloids, and polonium being a radioactive metal

(2) All five elements exist as gases at room temperature, similar to the trend seen in Group 15 hydrides

(3) Oxygen and sulphur are both gases at room temperature, while selenium, tellurium and polonium are liquids

(4) All five elements are solids at room temperature, since none of their melting points falls below 298 K

Q13. Using the melting and boiling point data in Table 7.6 above, calculate the liquid range (boiling point − melting point) for each element. Which element has the LARGEST liquid range?

(1) Sulphur (2) Selenium (3) Tellurium (4) Polonium

Q14. Based on the density values in Table 7.6 above, arrange oxygen, sulphur, selenium and tellurium in increasing order of density. (Polonium's density is not listed.)

(1) Te<Se<S<O

(2) S<O<Te<Se

(3) O<Se<S<Te

(4) O<S<Se<Te

Q15. The large difference between the melting and boiling points of oxygen and sulphur is best explained by which of the following?

(1) Oxygen has stronger metallic bonding than sulphur, requiring more energy to melt

(2) Oxygen exists as a diatomic molecule (O_2) while sulphur exists as a polyatomic molecule (S_8), giving sulphur much stronger intermolecular forces and hence a far higher melting and boiling point

(3) Oxygen is radioactive while sulphur is not, altering their thermal stability

(4) The difference arises purely from oxygen's smaller atomic radius, unrelated to molecular structure

TOPIC 4 Chemical Properties

(a) Oxidation States

Q16. Oxygen almost always shows an oxidation state of -2 in its compounds, owing to its very high electronegativity. Which option correctly identifies the well-known exception to this rule described in

the text, along with the reason for it?

(1) In OF_2, oxygen shows an oxidation state of $+2$ because fluorine is more electronegative than oxygen, forcing oxygen into a positive oxidation state

(2) In H_2O_2, oxygen shows an oxidation state of -1 because each oxygen is bonded to another oxygen as well as to hydrogen — this is the sole exception, and it has nothing to do with electronegativity

(3) In OF_2, oxygen shows an oxidation state of -2 as usual, since fluorine's electronegativity has no effect on oxygen's oxidation state

(4) In SO_2, oxygen shows an oxidation state of $+4$ because sulphur is less electronegative than oxygen

Q17. Which statement correctly describes the trend and stability of the -2 oxidation state across Group 16?

(1) The stability of the -2 oxidation state increases down the group, making polonium exhibit -2 most readily among all Group 16 elements

(2) The stability of the -2 oxidation state remains constant across the group, since all members have the same ns^2np^4 configuration

(3) The stability of the -2 oxidation state decreases down the group, and polonium hardly shows the -2 oxidation state at all

(4) Only oxygen and sulphur can show the -2 oxidation state; selenium, tellurium and polonium cannot form -2 compounds under any circumstances

Q18. In sodium thiosulphate ($Na_2S_2O_3$), assuming both sulphur atoms exist in the same (average) oxidation state, calculate this oxidation state of sulphur.

(1) $+1$ (2) $+2$ (3) $+4$ (4) $+6$

Q19. Which statement correctly describes how the relative stabilities of the $+4$ and $+6$ oxidation states change down Group 16, and identifies the underlying cause?

(1) Stability of $+6$ increases and stability of $+4$ decreases down the group, due to greater shielding by inner d and f electrons

(2) Both $+4$ and $+6$ oxidation states become progressively more stable down the group, since larger atoms can accommodate higher oxidation states more easily

(3) Neither $+4$ nor $+6$ oxidation states show any stability trend down the group; both remain equally stable throughout

(4) Stability of $+6$ decreases down the group while stability of $+4$ increases down the group, an effect attributed to the inert pair effect

Q20. Which of the following correctly states the common oxidation states shown by sulphur, selenium and tellurium in their compounds with oxygen and with fluorine respectively?

(1) $+4$ with oxygen and $+6$ with fluorine

(2) $+6$ with oxygen and $+4$ with fluorine

(3) $+2$ with oxygen and $+2$ with fluorine

(4) $+4$ with both oxygen and fluorine, since oxidation state does not depend on the other element

(b) Reactivity with Hydrogen

Property	H_2O	H_2S	H_2Se	H_2Te
m.p. / K	273	188	208	222
b.p. / K	373	213	232	269
H–E distance / pm	96	134	146	169
H–E–H angle / °	104	92	91	90
$\Delta_f H$ / kJmol^{-1}	-286	-20	73	100
$\Delta_{diss}H$(H–E) / kJmol^{-1}	463	347	276	238
Dissociation constant	1.8×10^{-16}	1.3×10^{-7}	1.3×10^{-4}	2.3×10^{-3}

Q21. The text states that acidic character of Group 16 hydrides increases from H_2O to H_2Te, while thermal stability decreases over the same series. Which option correctly explains how a single underlying factor accounts for both trends?

(1) Acidic character is governed by bond dissociation enthalpy, while thermal stability is governed entirely by molecular mass, so the two trends are unrelated

(2) Both trends arise from increasing electronegativity of E down the group, which strengthens the H–E bond and makes the hydride both more acidic and more thermally stable

(3) Both trends arise from the same decrease in H–E bond dissociation enthalpy down the group — a weaker H–E bond breaks more easily to release H^+ (increasing acidity) and also decomposes more easily on heating (decreasing thermal stability)

(4) The two trends are coincidental; increasing acidic character and decreasing thermal stability down the group have no common cause according to the passage

Q22. Regarding the reducing property of Group 16 hydrides, which statement is correct?

(1) All Group 16 hydrides except water show reducing property, and this character increases from H_2S to H_2Te

(2) All Group 16 hydrides, including water, show reducing property, and this property increases from H_2O to H_2Te

(3) All Group 16 hydrides except water show reducing property, and this character decreases from H_2S to H_2Te

(4) Only water and hydrogen sulphide show reducing property; H_2Se and H_2Te do not

Q23. Using the $\Delta_{diss}H$(H–E) values from Table 7.7 above (H_2O=463, H_2Te=238 kJmol^{-1}), calculate the approximate percentage decrease from H_2O to H_2Te.

(1) about 20% (2) about 30% (3) about 40% (4) about 49%

Q24. Based on the H–E–H bond angle data in Table 7.7 above (H_2O=104°, H_2S=92°, H_2Se=91°, H_2Te=90°), which statement correctly interprets this trend?

(1) The bond angle increases steadily from H_2O to H_2Te, approaching the ideal tetrahedral angle of $109.5°$

(2) The bond angle remains constant at $104°$ for all Group 16 hydrides since they share the same central atom hybridisation

(3) The bond angle is largest for H_2Te because tellurium is the largest atom in the series

(4) The bond angle decreases from H_2O to H_2Te, approaching close to $90°$, consistent with reduced s–p orbital mixing (hybridisation) in the heavier hydrides

Q25. Which of the following correctly represents the general formula and full hydride series formed by Group 16 elements, as stated in the text?

(1) H_2E type; H_2O, H_2S, H_2Se, H_2Te, H_2Po

(2) HE_2 type; HO_2, HS_2, HSe_2, HTe_2, HPo_2

(3) H_3E type; H_3O, H_3S, H_3Se, H_3Te, H_3Po

(4) HE type; HO, HS, HSe, HTe, HPo

Q26. Melting and boiling points would be expected to fall steadily from H_2Te down to H_2O based on van der Waals forces alone (lighter molecules, weaker forces). However, Table 7.7 above shows m.p./b.p. of H_2O (273 K / 373 K) are anomalously higher than H_2S (188 K / 213 K). Which option correctly explains this anomaly?

(1) Water's higher m.p./b.p. arises because oxygen has a larger atomic radius than sulphur, increasing van der Waals forces

(2) Water's higher m.p./b.p. arises because the H–O bond dissociation enthalpy is lower than the H–S bond enthalpy

(3) Water's higher m.p./b.p. arises due to extensive hydrogen bonding between H_2O molecules, a factor not present to the same extent in H_2S and heavier hydrides

(4) Water's higher m.p./b.p. arises purely from its higher molecular mass compared to H_2S

Q27. Which statement correctly describes the thermal stability trend of Group 16 hydrides?

(1) Thermal stability increases from H_2O to H_2Po due to increasing H–E bond dissociation enthalpy down the group

(2) Thermal stability decreases from H_2O to H_2Po, owing to a decrease in H–E bond dissociation enthalpy down the group

(3) Thermal stability remains constant across the series since all hydrides share the same H_2E formula

(4) Thermal stability depends only on molecular mass and shows no correlation with bond dissociation enthalpy

Q28. Using the dissociation constants in Table 7.7 above (H_2O: 1.8×10^{-16}; H_2Te: 2.3×10^{-3}), by approximately how many orders of magnitude is H_2Te more acidic (larger K_a) than H_2O?

(1) about 8 (2) about 13 (3) about 18 (4) about 23

Q29. Based on the H–E distance values in Table 7.7 above (H_2O=96 pm, H_2S=134 pm, H_2Se=146 pm, H_2Te=169 pm), which statement correctly interprets this trend and its relation to the decreasing H–E bond dissociation enthalpy down the group?

(1) H–E bond distance decreases down the group, which explains the increasing bond dissociation enthalpy from H_2O to H_2Te

(2) H–E bond distance increases down the group as the size of E increases; the resulting longer, weaker H–E bond is consistent with the decreasing bond dissociation enthalpy seen down the group

(3) H–E bond distance remains constant across the series since bond dissociation enthalpy alone determines the bond length

(4) H–E bond distance and bond dissociation enthalpy are unrelated properties for Group 16 hydrides

Q30. Which of the following correctly represents the increasing order of acidic character of Group 16 hydrides, as described in the text?

(1) $H_2Te<H_2Se<H_2S<H_2O$

(2) $H_2O<H_2Te<H_2S<H_2Se$

(3) $H_2O<H_2S<H_2Se<H_2Te$

(4) $H_2S<H_2O<H_2Se<H_2Te$

(c) Reactivity with Oxygen

Q31. The text states that oxides of Group 16 elements follow the general formulas EO_2 and EO_3. Which option correctly identifies which elements this classification applies to, and correctly interprets the mention of ozone (O_3) in the same sentence?

(1) E refers only to S, Se, Te and Po (oxygen is excluded from its own oxide classification); ozone is mentioned merely as a physical-state comparison (a gas), not as an EO_2-type oxide

(2) E includes all five elements (O, S, Se, Te, Po); ozone itself is classified as the EO_2-type oxide of oxygen

(3) E refers only to S and Se; Te and Po do not form oxides according to the text

(4) Ozone is classified as an EO_3-type oxide of oxygen, analogous to SO_3

Q32. Which statement correctly describes the trend in reducing/oxidising behaviour of the EO_2-type oxides down Group 16?

(1) Reducing property increases from SO_2 to TeO_2; SO_2 is an oxidising agent while TeO_2 is a strong reducing agent

(2) Both SO_2 and TeO_2 behave identically as strong reducing agents, showing no trend down the group

(3) Reducing property is unrelated to the position of E in the group and depends only on the oxide's physical state

(4) Reducing property decreases from SO_2 to TeO_2; SO_2 behaves as a reducing agent while TeO_2 behaves as an oxidising agent

Q33. Using the rule that oxygen has an oxidation state of -2 in oxides, calculate the oxidation state of E in the EO_3-type oxide SO_3, and identify whether this matches the earlier-established fact that $+4$ and $+6$ are the more common oxidation states for these elements.

(1) $+4$, consistent with the passage

(2) $+6$, consistent with the passage

(3) $+2$, consistent with the passage

(4) $+6$, but this contradicts the earlier-established common oxidation states

Q34. Based on the physical states mentioned in the text, which of the following oxide–state pairs is CORRECTLY matched?

(1) SeO_2 — solid
(2) O_3 — solid
(3) SO_2 — solid
(4) SO_3 — gas

Q35. Which of the following statements about EO_3-type oxides of Group 16 elements is CORRECT?

(1) All five elements (O, S, Se, Te, Po) form EO_3-type oxides
(2) Only sulphur forms an EO_3-type oxide; selenium and tellurium form only EO_2-type oxides
(3) Sulphur, selenium and tellurium form EO_3-type oxides (SO_3, SeO_3, TeO_3); the text does not mention an EO_3-type oxide of polonium
(4) EO_3-type oxides are basic in nature, unlike the acidic EO_2-type oxides

(d) Reaction with Halogens

Q36. Sulphur hexafluoride (SF_6) is described as "exceptionally stable for steric reasons" among Group 16 hexahalides. Which option correctly explains the basis of this stability, and correctly identifies why other hexahalides (like hexachlorides) of Group 16 elements are not similarly stable?

(1) SF_6 is unstable, and the text states that no hexahalides of Group 16 elements are stable
(2) SF_6 is stable because sulphur has the highest electronegativity in the group, forming the strongest possible S–F bonds
(3) SF_6 is stable purely due to thermodynamic favourability; the reaction of SF_6 with water is highly exothermic
(4) SF_6 is stable because sulphur's small atomic size allows the six fluorine atoms (the smallest halogen) to pack tightly around it, sterically shielding the sulphur atom from chemical attack; larger halogens like chlorine cannot achieve this close octahedral packing around sulphur or other Group 16 elements

Q37. Which statement correctly describes the general stability trend of Group 16 halides?

(1) Halide stability decreases in the order F>Cl>Br>I; among hexahalides, only hexafluorides are stable
(2) Halide stability increases in the order F<Cl<Br<I; among hexahalides, only hexaiodides are stable
(3) Halide stability is identical across all four halogens; hexahalides of all halogens are equally stable
(4) Halide stability decreases in the order F>Cl>Br>I; among hexahalides, only hexachlorides are stable

Q38. In the disproportionation reaction $2Se_2Cl_2 \rightarrow SeCl_4 + 3Se$, calculate the oxidation state of selenium in Se_2Cl_2 (the reactant), and identify into which two oxidation states it disproportionates.

(1) Se is $+2$ in Se_2Cl_2; it disproportionates into Se($+4$) in $SeCl_4$ and Se(0) as elemental selenium
(2) Se is $+1$ in Se_2Cl_2; it disproportionates into Se($+6$) in $SeCl_4$ and Se(-2) as elemental selenium
(3) Se is -1 in Se_2Cl_2; it disproportionates into Se($+4$) in $SeCl_4$ and Se(0) as elemental selenium
(4) Se is $+1$ in Se_2Cl_2; it disproportionates into Se($+4$) in $SeCl_4$ and Se(0) as elemental selenium

Q39. Which option correctly matches each halide type with its hybridisation and molecular geometry, as described in the text?

(1) Tetrafluorides (EF_4): sp^3 hybridisation, tetrahedral geometry; Dihalides (EX_2): sp^3d hybridisation, see-saw geometry

(2) Tetrafluorides (EF_4): sp^3d hybridisation, see-saw geometry (trigonal bipyramidal with one equatorial lone pair); Dihalides (EX_2): sp^3 hybridisation, tetrahedral geometry

(3) Both tetrafluorides and dihalides adopt sp^3d^2 hybridisation with octahedral geometry

(4) Tetrafluorides (EF_4): sp^3d hybridisation, octahedral geometry; Dihalides (EX_2): sp^3 hybridisation, see-saw geometry

Q40. Which of the following correctly states the physical states of the Group 16 tetrafluorides at room temperature, as given in the text?

(1) SF_4 — solid; SeF_4 — liquid; TeF_4 — gas

(2) SF_4 — liquid; SeF_4 — gas; TeF_4 — solid

(3) All three tetrafluorides (SF_4, SeF_4, TeF_4) are gases at room temperature

(4) SF_4 — gas; SeF_4 — liquid; TeF_4 — solid

Q41. The text states that all Group 16 elements except one form dichlorides and dibromides. Which option correctly identifies this exception, and connects it to a fact established earlier about this element's oxidation states?

(1) Oxygen is the exception; this is consistent with oxygen almost always showing only the -2 oxidation state (except in OF_2), making it unable to easily form OX_2-type dihalides with the same positive-oxidation-state pattern as the other elements

(2) Polonium is the exception, since it is radioactive and its halides decompose rapidly

(3) Tellurium is the exception, since it is a metalloid rather than a non-metal

(4) All Group 16 elements, including oxygen, form dichlorides and dibromides equally readily

Q42. Which of the following is NOT one of the dimeric monohalides mentioned in the text?

(1) S_2F_2 (2) S_2Cl_2 (3) Te_2Cl_2 (4) Se_2Br_2

Q43. Verify the balanced disproportionation equation $2Se_2Cl_2 \rightarrow SeCl_4 + 3Se$ by counting atoms of Se and Cl on each side. Which option correctly confirms the balance?

(1) LHS: 2 Se, 4 Cl; RHS: 4 Se, 4 Cl — the equation is NOT balanced for Se

(2) LHS: 4 Se, 2 Cl; RHS: 1 Se, 4 Cl — the equation is NOT balanced for either element

(3) LHS: 4 Se, 4 Cl; RHS: 3 Se, 4 Cl — the equation is NOT balanced for Se

(4) LHS: 4 Se, 4 Cl; RHS: 4 Se, 4 Cl — the equation is correctly balanced

Q44. Which option correctly describes the structure and physical state of Group 16 hexafluorides, as given in the text?

(1) Tetrahedral structure, all liquids at room temperature

(2) Octahedral structure, all gaseous in nature

(3) Trigonal bipyramidal (see-saw) structure, all solids

(4) Octahedral structure, but physical states vary unpredictably across the series

Q45. Which of the following correctly ranks the stability of Group 16 halides in DECREASING order, as stated in the text?

(1) I>Br>Cl>F (2) Br>I>F>Cl (3) F>Cl>Br>I (4) Cl>F>I>Br

TOPIC 5 Anomalous Behaviour of Oxygen

Anomalous Behaviour of Oxygen

Q46. The anomalous behaviour of oxygen compared to other Group 16 elements is attributed to two structural factors. Which option correctly identifies these factors and connects them to the specific example given in the text?

(1) The two factors are its high metallic character and large atomic radius; these explain why H_2O has a higher boiling point than H_2S

(2) The two factors are its small size and high electronegativity; together these explain the presence of strong hydrogen bonding in H_2O, which is absent in H_2S

(3) The two factors are its low ionisation enthalpy and large atomic radius; these explain oxygen's preference for the -2 oxidation state

(4) The two factors are the presence of d-orbitals and high electronegativity; these explain why oxygen's covalency commonly exceeds four

Q47. Which statement correctly describes the covalency of oxygen and how it differs from other Group 16 elements?

(1) Oxygen's covalency is limited to a theoretical maximum of four (due to the absence of d-orbitals) and in practice rarely exceeds two; other Group 16 elements can expand their valence shells using d-orbitals, so their covalency can exceed four

(2) Oxygen's covalency is unlimited due to the presence of accessible d-orbitals, exceeding six in most compounds

(3) All Group 16 elements, including oxygen, have identical covalency limits since they share the same general electronic configuration

(4) Oxygen's covalency exceeds four in practice because of its small size, while other Group 16 elements are limited to a covalency of two

Q48. Based on the passage, which of the following species would represent an IMPOSSIBLE scenario for oxygen due to its covalency limitation?

(1) H_2O, where oxygen has a covalency of 2

(2) H_3O^+, where oxygen has a covalency of 3

(3) OF_6, where oxygen would need a covalency of 6, exceeding its maximum theoretical covalency of four due to the absence of d-orbitals

(4) OF_2, where oxygen has a covalency of 2

Q49. Which option correctly explains, at the orbital level, why sulphur (period 3) can expand its valence shell to accommodate a covalency greater than four, whereas oxygen (period 2) cannot?

(1) Sulphur has empty $3d$ orbitals energetically accessible for bonding, allowing valence shell expansion; oxygen's second shell has no d-orbitals at all, so it cannot expand beyond its s and p orbitals

(2) Sulphur has a larger atomic radius than oxygen, and atomic radius alone (independent of orbital availability) determines maximum covalency

(3) Oxygen has $3d$ orbitals available but chooses not to use them due to its high electronegativity

(4) Both oxygen and sulphur have equal access to d-orbitals, so the difference in covalency arises purely from electronegativity differences

Q50. Which of the following correctly identifies where strong hydrogen bonding is present among Group 16 hydrides, as stated in the text?

(1) Present in H_2S; absent in H_2O

(2) Present in both H_2O and H_2S equally

(3) Absent in both H_2O and H_2S

(4) Present in H_2O; absent in H_2S