I.14 Main Group Chemistry

Civil Services 2016–2026: **30** parts, **310** marks · IFoS 2016–2025: **1** parts, **8** marks

Syllabus. Boranes, borazines, phosphazenes and cyclic phosphazene, silicates and silicones, interhalogen compounds; sulphur– nitrogen compounds, noble gas compounds.

Marks	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CSE	25	30	30	45	15	30	20	30	30	30	25
IFoS	0	0	8	0	0	0	0	0	0	0	

How to use this chapter. Read every question once and mark the ones that repeat. Pick three, write them by hand against the clock (about 7 minutes for 10 marks), then compare with the model answers on vkcscience.com.

2026

CSE 2026 · Q5(i) Borazine, the "inorganic benzene" [5 marks]

What is inorganic benzene? Explain it with structure.

CSE 2026 · Q8(b) Structure and bonding of diborane; Classification of silicates; SiO_4^{4-}, $Si_2O_7^{6-}$ and $Si_3O_9^{6-}$ [20 marks]

(i) Describe the structure and bonding in diborane.

(ii) How are silicates classified? Predict the names and structures of the following silicates :

(1) SiO_4^{4-} ion, (2) $Si_2O_7^{6-}$ ion, (3) $Si_3O_9^{6-}$ ion

2025

CSE 2025 · Q5(g) Completing five p-block reactions [10 marks]

Complete the following reactions:

(i) $S_4N_4 \xrightarrow{SbCl_5}$ (ii) $XeF_6 \xrightarrow{PtF_5}$ (iii) $B_2H_6 \xrightarrow[-120\,^\circ C]{NH_3}$ (iv) $8\,KrF_2 + 2\,Au \longrightarrow$ (v) $XeOF_4 + XeO_3 \longrightarrow$

CSE 2025 · Q8(a) Structures of four sulphur nitrides and I_2Cl_6 [10 marks]

Draw the structures of S_2N_2, S_4N_2, $S_{11}N_2$, S_5N_6 and I_2Cl_6.

CSE 2025 · Q8(b) Silicones, hexamethyldisiloxane and chain stopping [10 marks]

What are silicones? Mention some of their uses. How will you prepare hexamethyldisiloxane? Draw its structure. What happens if some $(CH_3)_3SiCl$ is mixed with $(CH_3)_2SiCl_2$ and hydrolysed?

2024

CSE 2024 · Q8(a) Why all F atoms of PF_5 look alike in the ^{19}F NMR spectrum [10 marks]

'All the F atoms appear indistinguishable in the ^{19}F NMR spectrum of sp^3d hybridized PF_5 molecule.' Explain how.

CSE 2024 · Q8(b) Possible arrangements and shape of ClF_3; Structure and bonding of B_2H_6 [20 marks]

(i) Draw all the possible structural dispositions of ClF_3 molecule. Establish logically which will be the most favoured disposition. Comment on the shape of ClF_3 molecule. *10*

(ii) Draw the structure of B_2H_6. Explain the bonding in B_2H_6 on the basis of hybridization approach. *10*

2023

CSE 2023 · Q4(d) Pyroxenes, amphiboles and phyllosilicates [10 marks]

Pyroxenes, amphiboles and phyllosilicates are well-known groups of silicates that occur in crust of the earth. Write the empirical formulae and draw the basic structural units of the above-mentioned silicates.

CSE 2023 · Q6(a) Completing five reactions of p-block compounds [10 marks]

Complete the following reactions and draw the structure of the major product(s) formed:

(i) $2\,XeF_6 + SiO_2 \xrightarrow{50\ ^\circ C}$ ____ (ii) $NH_4NO_3 \xrightarrow{520\,K}$ ____ + ____ (iii) $N_2O + NaNH_2 \xrightarrow{470\,K}$ ____

(iv) $2\,B_2H_6 + 6\,NH_3 \xrightarrow{180\ ^\circ C}$ ____ + ____ (v) $6\,SCl_2 + 16\,NH_3 \longrightarrow$ ____ + ____ + ____

CSE 2023 · Q6(e) Framework electrons and structures of three borane anions [10 marks]

Predict the number of framework bonding electrons and the structure of the following boranes:

(i) $B_7H_7^{2-}$ (ii) $B_{11}H_{13}^{2-}$ (iii) $B_2H_7^-$

2022

CSE 2022 · Q5(e) Lower cyclosiloxanes: synthesis and structure of $(Me_2SiO)_3$ [10 marks]

Write the general synthetic procedure of lower cyclosiloxanes like cyclic dimethylsiloxane trimer $[(Me_2SiO)_3]$. Draw its structure. Why $MeSiCl_3$ is not used as starting material for its synthesis?

CSE 2022 · Q6(d) Separating XeF_6; diborane with NH_3 and with Me_3N [10 marks]

(i) How XeF_6 can be separated from a mixture of XeF_2, XeF_4 and XeF_6?

(ii) Write the products with explanation

$$B_2H_6 + 2\,NH_3 \longrightarrow\ ? \qquad B_2H_6 + 2\,Me_3N \longrightarrow\ ?$$

2021

CSE 2021 · Q5(e) Completing five reactions of xenon compounds [10 marks]

Complete the following reactions :

(i) $XeF_4 + 12\,H_2O \longrightarrow$ _____

(ii) $XeF_6 +$ _____ $\longrightarrow XeOF_4 + PF_5$

(iii) $XeOF_4 +$ _____ $\longrightarrow 2\,XeO_2F_2$

(iv) $3\,XeF_2 + 2\,(SO_3)_3 \longrightarrow$ _____

(v) _____ $+ XeF_2 \longrightarrow (C_6H_5)_2SF_2 + Xe$

CSE 2021 · Q6(a) Bonding in cyclic phosphazene, benzene and borazine [10 marks]

How does the bonding in cyclic phosphazene differ from that of benzene and borazine?

CSE 2021 · Q8(a) BrF_3 as an aprotic solvent: acids, bases and neutralisation [10 marks]

Justify that the interhalogen compound BrF_3 acts as an aprotic solvent and undergoes acid-base and neutralization reactions by giving examples.

2020

CSE 2020 · Q7(b)(i) Borazine, the "inorganic benzene" [5 marks]

What is inorganic benzene? Write down its structural formula.

CSE 2020 · Q7(b)(ii) Order of reactivity of five interhalogens [10 marks]

What is the order of reactivity of the following interhalogens?

ClF_3, IF_7, ClF, BrF_5, IF

2019

CSE 2019 · Q2(c) Preparation of XeO_3; reactions of $HXeO_4^-$ and Ba_2XeO_6 [10 marks]

Suggest a method for the preparation of Xenontrioxide. Complete the following reactions by balancing of atoms.

$H{\times}eO_4^- + OH^- \longrightarrow$

$Ba_2{\times}eO_6 + H_2SO_4 \xrightarrow[-5\,^\circ C]{}$

CSE 2019 · Q4(c)(ii) Borazine (inorganic benzene): preparation and reactivity [10 marks]

What is inorganic benzene? How is it prepared? Compare and contrast the reactivities of inorganic benzene and benzene.

CSE 2019 · Q5(a) Octafluoroxenate(VI): preparation, structure and bonding [10 marks]

How would you prepare octafluoroxenate? Describe its structure and bonding.

CSE 2019 · Q6(c) Tetrasulfur tetranitride: preparation, structure, action of chlorine [15 marks]

How tetrasulphur tetranitride (S_4N_4) is prepared? Present its structure. What happens when S_4N_4 is subjected to chlorine?

2018

CSE 2018 · Q5(d) S_4N_4 from S_2Cl_2 and NH_3; S_2N_2 and $(SN)_x$ [10 marks]

Identify the products and draw the structure of A.

$S_2Cl_2 + NH_3$ (1 : 2.67 ratio) $\xrightarrow[CCl_4]{320\ K}$ A

A $\xrightarrow{490\ K,\ over\ Ag\ wool}$ B (colourless solid)

A $\xrightarrow{550\ K,\ over\ quartz\ wool}$ C (golden-yellow solid)

CSE 2018 · Q6(d) Diborane: industrial synthesis, structure and B–H bonds [10 marks]

How diborane can be synthesized industrially? Draw the structure of diborane. Comment on the nature of boron-hydrogen bond present in it.

CSE 2018 · Q8(a)(i) Products of four interhalogen reactions [10 marks]

Predict the product of the following reactions with justification:

(A) $ClF + BF_3 \longrightarrow$ (B) $ClF + CsF \longrightarrow$ (C) $ClF_3 + BF_3 \longrightarrow$ (D) $I_2 + Br_2 \longrightarrow$

IFoS 2018 · Q5(d) Inertness of N_2 towards reactive metals [8 marks]

Although N_2 is available in atmosphere in plenty ($\sim$ 78% by volume), it does not react with some of the reactive metals easily. Give three reasons for inert nature of N_2 towards the metals mentioned above.

2017

CSE 2017 · Q7(c) Silicones: preparation, properties and uses [15 marks]

What are silicones? How are they obtained? Discuss the important properties and applications of organosilicon polymers.

CSE 2017 · Q8(c) Phosphazenes: ring and chain types; substitution reactions [15 marks]

Define phosphazenes with formulae for ring and chain types. Write two examples of substitution reactions of cyclophosphazenes.

2016

CSE 2016 · Q6(a)(i) Interhalogen compounds; preparation and structure of IF_7 [15 marks]

What are the main reasons for the formation of interhalogen compounds? Give one example of each type. Give the method of formation of IF_7 and draw its structure.

CSE 2016 · Q8(a)(ii) Peroxomonosulfuric acid (Caro's acid) [10 marks]

What is peroxomonosulphuric acid? Give its method of preparation, properties and structure.