I.16 Non-aqueous Solvents

Civil Services 2016–2026: **0** parts, **0** marks · IFoS 2016–2025: **18** parts, **170** marks

Syllabus. Reactions in liquid NH_3, HF, SO_2 and H_2SO_4. Failure of solvent system concept, coordination model of non-aqueous solvents. Some highly acidic media, fluorosulphuric acid and super acids.

Marks	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CSE	0	0	0	0	0	0	0	0	0	0	0
IFoS	20	10	8	30	20	8	23	23	10	18	

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.

2025

IFoS 2025 · Q5(e) Reactions in nonaqueous media [8 marks]

Predict the product(s) in the following reactions:

(i) $PbI_2 + KNH_2 \xrightarrow{\text{liq. } NH_3}$ (ii) $NaClO_4 + TlF \xrightarrow{\text{anhy. HF}}$

(iii) $C_{12}H_{22}O_{11} \xrightarrow{H_2SO_4}$ (iv) $2\,KI + SOCl_2 \xrightarrow{\text{liq. } SO_2}$

IFoS 2025 · Q8(c) Conductance of metal–ammonia solutions; Blue colour in liquid ammonia [10 marks]

Justify the following:

(i) The conductivity of the solution decreases with increasing alkali metal concentration in liquid ammonia. [5]

(ii) The colour of the alkali metal in liquid ammonia is independent of the metal involved. [5]

2024

IFoS 2024 · Q6(c) Products in nonaqueous solvents [10 marks]

Predict the product(s) in the following reactions: 5×2=10

(i) $RCO_2H + HF$ (liquid) $\longrightarrow$

(ii) $BF_3 + HF$ (liquid) $\longrightarrow$

(iii) $[Pt(NH_3)_4]^{2+} + Na \xrightarrow{\text{in liquid } NH_3}$

(iv) $SO_3 + H_2SO_4$ (liquid) $\longrightarrow$

(v) $Cl_2 + NH_3$ (liquid) $\longrightarrow$

2023

IFoS 2023 · Q5(e) Amphoteric salts in liquid sulfur dioxide [8 marks]

Give one reaction each to show the amphoteric behaviour of Zn(II) and Al(III) salts in sulfur dioxide.

IFoS 2023 · Q8(b) Reactions in liquid ammonia [15 marks]

Discuss the following reactions with suitable example in liquid ammonia:

(i) Acid-base reaction (ii) Ammonolysis (iii) Redox reaction

2022

IFoS 2022 · Q5(e) Fluorosulfuric acid and magic acid [8 marks]

Write an equation to show self-ionization of fluorosulphuric acid. What happens when it is mixed with SbF_5? Write the equation. By what name is the mixture known and why? How does the mixture react with Me_3CH?

IFoS 2022 · Q8(b) Sodium solutions in liquid ammonia; Reducing reactions of sodium–ammonia [15 marks]

(i) A small piece of Na is dissolved in liquid NH_3 and then the solution was made saturated by dissolving more and more Na. In relation to the above experiment, answer the following: 10

I. What are the colours of the dilute solution and the concentrated solution?

II. What is the composition of the dilute solution?

III. How does the molar conductivity and magnetic susceptibility change from dilute to saturated solution? Give possible explanation for the changes.

(ii) What happens when the dilute solution of Na in NH_3 is reacted with (I) O_2, and (II) $Fe(CO)_5$? Give equations. 5

2021

IFoS 2021 · Q5(e) Acids behaving as bases in sulfuric acid [8 marks]

Acetic acid is a weak acid in aqueous solution and nitric acid a strong acid, but both behave as bases in sulphuric acid. Why?

2020

IFoS 2020 · Q6(c) Conductivity of alkali metals in liquid ammonia with concentration [10 marks]

Electrical conductivity of solutions of alkali metals in liquid ammonia initially decreases with increase in concentration of the metal but again increases at higher concentration. Explain why.

IFoS 2020 · Q8(b) $AlCl_3$ and K_2SO_3 in liquid SO_2: amphoteric behaviour [10 marks]

Addition of K_2SO_3 to a solution of $AlCl_3$ in liquid SO_2 forms a white precipitate which dissolves in excess K_2SO_3. The precipitate reappears on adding $SOCl_2$. Elucidate the results with necessary equations.

2019

IFoS 2019 · Q7(c) Blue and bronze phases of alkali metals in liquid ammonia [10 marks]

How do you interpret the formation of blue colour and bronze coloured phase separation when an alkali is added to liquefied ammonia?

IFoS 2019 · Q8(a) HF as a non-aqueous solvent; isomers of $[Co(NH_3)_2(H_2O)_2Cl_2]^+$ [20 marks]

(i) State the special properties of HF and show that it is a good non-aqueous solvent. 10

(ii) Sketch all possible isomers of

$$[Co(NH_3)_2(H_2O)_2Cl_2]^+.$$

10

2018

IFoS 2018 · Q5(e) Superacids and the reaction with neopentane [8 marks]

What is a super acid? How can one prepare super acid? The super acid upon reaction with neopentane gives an intermediate that on further decomposition afforded $Me_3C^{\oplus}$ and CH_4. Identify the intermediate.

2017

IFoS 2017 · Q8(c) Liquid HF as a non-aqueous solvent [10 marks]

Discuss the merits and demerits of liquid hydrogen fluoride as a non-aqueous solvent. Give the chemical reactions which take place in this solvent.

2016

IFoS 2016 · Q8(a)(i) Liquid ammonia as a solvent [10 marks]

Discuss the solvent behaviour of liquid NH_3 in respect of the following :
(1) Alkali metals (2) Urea (3) BF_3 (4) Amides (—NH_2) (5) $Zn(NH_2)_2 + 2\,NH_4Cl$

IFoS 2016 · Q8(a)(ii) Superacids [10 marks]

What is 'superacid'? Give two chemical properties to justify this nomenclature.