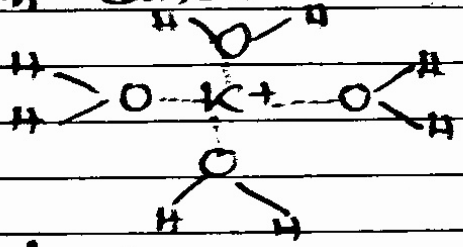
$I^- > Br^- > Cl^- > F^-$ (Nucleophilicity) in protic solvents.

↓ least solvated due to larger size → most nucleophilic

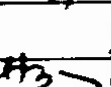
↓ most solvated due to its small size → least nucleophilic

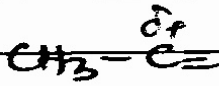
After solvation size increases so mobility decreases.

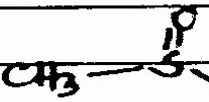
During solvation Oxygen atom make hydrogen bond with cation.



Polar Aprotic Solvent : It can solvate to cations only it can not solvate to anion due to lack of H which can go for H-bonding.

ie 
Acetone

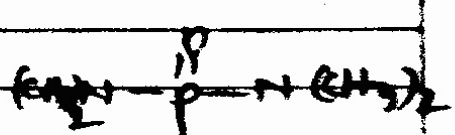

Acetonitrile


Dimethyl sulphoxide
DMSO

Polar aprotic solvent have strong dipole moment to enhance solubility.


Tetrahydrofuran
THF


Dimethyl formamide
DMF


Hexamethyl phosphoramide
(HMPA)

These all are aprotic solvents which can not solvate to anion due to lack of such H which can make H-bond.

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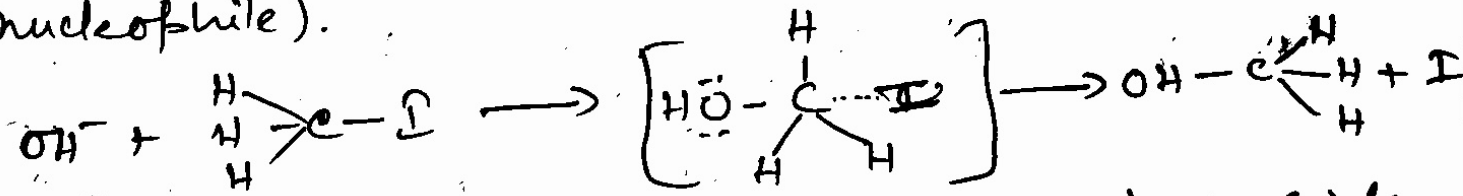
S_N2 reaction: Nucleophilic Substitution reaction having order of reaction Two or Bi-order- nucleophilic substitution reaction. In S_N2 reaction the concentration of substrate and reagent both changes with time thats why order of reaction becomes second. ~~order reaction~~. This reaction take place in presence of Polar aprotic solvent.

Rate of reaction $\propto [R-X][Nu^-]$

↓ It must be Strong

It is Single step mechanism for the reaction. In S_N2 reaction 1° Alkyl halide > 2° Alkyl halide > 3° Alkyl halide. During reaction Strong nucleophile attack on Substrate (1° Alkyl halide) from the back (because in front side one more nucleophile is present so it will repel to coming nucleophile).



As the nucleophile attack from back side it will start to bond with carbon of halide (Substrate), so with the same value I^- bond will be weak, means OH is trying to bond with C of halide & I^- is trying to leave the group but there is a transition state where for some moment carbon shows the valency five, after on the molecule go for inversion and ultimately OH (or incoming nucleophile) will be bonded from back side in product & leaving nucleophile will be separated.

leaving group $I^- > Br^- > Cl^- > F^-$

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If alkyl halide is the substrate then during nucleophilic substitution reaction product changes with change in nucleophile. i.e

Reagent	Substrate	Product	Class of Product
OH^-	R-Cl.	R-OH	Alcohol.
OR^-	R-Cl	R-O-R	Ether
$\ddot{N}H_3$	R-Cl	$R-NH_2$	Amine
CN^-	R-Cl	$R-C\equiv N$	Alk. Cyanide
NO_2^-	R-Cl	$R-NO_2$	Alk. Nitrite
$R-COO^-$	R-Cl	R-COOR	Ester.
R^-	R-Cl	R-R'	Alkane.
I^-	R-Cl	R-I	Alk. Iodide

Now in the above examples the product formed during nucleophilic substitution reaction depends on type of nucleophiles. Mechanism of reaction will depend on type of nucleophile, type of substrate, Concentration, temperature, Medium of reaction (Means the medium is polar protic or polar aprotic) Although reaction mechanism is a theoretical or hypothetical approach, means in a reaction if you don't know the type of product formed then you can not predict it's mechanism.

Note: The role of reaction mechanism is how the reaction has proceed it does not say that what product will form during the chemical reaction.

Note: 1. Vinyl & Aryl halide do not show S_N1 or S_N2 reaction.
11. α-Carboxyl shows faster S_N2 reaction.

Teacher's Signature