SOLUTIONS

Problem 01
Give the major organic product(s) of the following reaction, assign absolute configuration to ALL asymmetric centers in both the reactant(s) and the product(s). Will a solution of the product(s) be optically active? Give a BRIEF explanation.

DMF is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified.

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them.

Problem 02
Give the major organic product(s) of the following reaction, assign absolute configuration to ALL asymmetric centers in both the reactant(s) and the product(s). Will a solution of the product(s) be optically active? Give a BRIEF explanation.

HMPA is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified.

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them.
Problem 03
Give the major organic substitution product of the following reaction, assign absolute configuration to ALL asymmetric centers in both the reactant and the product. Will a solution of the product be optically active? Give a BRIEF explanation.

HMPA is a polar aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified.

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them.

other polar aprotic solvents include DMF (dimethylformamide), CH₃CN (acetonitrile), HMPA (hexamethylphosphoramide) and others....

Problem 04
Give the major substitution organic product of the following reaction, pay close attention to stereochemistry. Will a solution of the product be optically active? Give a BRIEF explanation.

this is one of the more important reactions that we will use later in the course for making new carbon-carbon bonds.

*NO solvent is specified here, it is not a requirement that the solvent be specified in SN2 reactions, you should get used to seeing examples such as this
Problem 05
Give the major organic product(s) of the following reaction, pay close attention to stereochemistry. Will a solution of the product(s) be optically active? Give a BRIEF explanation.

1° iodide, fast SN2 expected

* even though the nucleophile/Lewis base is NOT CHARGED in this case, it is still nucleophilic enough to do the SN2 reaction

we will use this reaction later in the course when we study the amine functional group

* NO solvent is specified here, it is not a requirement that the solvent be specified in SN2 reactions, you should get used to seeing examples such as this

Problem 06
Give the major organic product(s) of the following reaction, assign absolute configuration to ALL asymmetric centers in both the reactant(s) and the product(s). Will a solution of the product(s) be optically active? Give a BRIEF explanation.

1° bromide, fast SN2 expected

SN2 is fast at a primary carbon AND -Br is a good leaving group

HMPA is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them
Problem 07
Give the major organic product(s) of the following substitution reaction, pay close attention to stereochemistry. Will a solution of the product(s) be optically active? Give a BRIEF explanation. (1 Equivalent means that there are the same number of molecules on the reagent on the arrow as reactant molecules, i.e., there is only enough reagent to do one SN2 reaction).

benzylic position, SN2 faster here
2° position, SN2 much slower here

there is ONE EQUIVALENT, which means that the FASTER of the two possible SN2 reactions will occur, i.e. reaction will only occur at the BENZYLIC carbon indicated since the transition state at this carbon is resonance stabilized which results in a lower energy transition state

NOTE: even though reaction occurred at only one of the asymmetric centers the product is still a single enantiomer, it is a single enantiomer of the product structure

DMF is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them

Problem 08
Give the major organic product(s) of the following reaction, assign absolute configuration to ALL asymmetric centers in both the reactant(s) and the product(s). Will a solution of the product(s) be optically active? Give a BRIEF explanation.

allyl bromide, fast SN2 expected.

SN2 is fast at an allylic carbon, AND iodide is a good leaving group

* DMF is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them
Problem 09
Give the major organic product(s) of the following reaction (do not include the counterion in your drawing for this problem!), pay close attention to stereochemistry. Will a solution of the product(s) be optically active? Give a BRIEF explanation.

* even though the nucleophile/Lewis base is NOT CHARGED in this case, it is still nucleophilic enough to do the SN2 reaction

HMPA is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could be specified

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them

Problem 10
Give the product(s) of the following reaction, pay close attention to stereochemistry. Will a solution of the product(s) be optically active? Give a BRIEF explanation.

* even though the nucleophile/Lewis base is NOT CHARGED in this case, it is still nucleophilic enough to do the SN2 reaction

Acetonitrile, CH₃CN, is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could be specified

There is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them

* Why is the iodide leaving group shown here when we often don't bother to balance organic reactions? The product in this case is, unusually, IONIC, and so the iodide leaving group is alons the counterion to the organic cation product. It isn't essential to include the counterion for an organic ionic product of a reaction, but it is conventional to do so and a bit more informative about what occurred in the reaction, which is why it is shown here as part of the product
Problem 11

Give the major organic product(s) of the following reaction, pay close attention to stereochemistry. Will a solution of the product(s) be optically active? Give a BRIEF explanation. (1 Equivalent means that there are the same number of molecules on the reagent on the arrow as reactant molecules, i.e., there is only enough reagent to do one SN2 reaction).

\[ \text{1 Br is a better leaving group than Cl}^-; \text{ the -Br is also on a 1° carbon, which is good for SN2} \]

1 Equivalent of nucleophile, so only 1 substitution is possible
SN2 is faster at the primary carbon AND -Br is a better leaving group than Cl-

\[ \text{NaN}_3 = \text{sodium azide} \]
\[ \text{N=N=N} = \text{the azide anion, being an anion it is quite a good nucleophile (Lewis base)} \]

DMF is a polar Aprotic solvent, any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could also be specified

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them
Problem 12

Give the product(s) of the following reaction, pay close attention to stereochemistry. Will a solution of the product(s) be optically active? Give a BRIEF explanation.

[Chemical structure image]

allylic, specifically BENZYLIC tosylate
tosylate excellent leaving group, fast SN2

\[ \text{Na}^+ - N_3 = \text{sodium azide} \]
\[ \text{azide anion} = \text{::N} = \text{N} = \text{N} : \]

DMF is a polar aprotic solvent. any polar aprotic solvent could be used, or even a polar protic solvent (although that would slow the reaction down) or no solvent at all could be specified.

there is no "rule" that a polar aprotic needs to be specified for an SN2 reaction, such solvents are specified in these problems to give you practice in recognizing them.