Answers to Exercise 11.2
Nucleophiles and Electrophiles

1. In organic chemistry, a nucleophile is an electron pair donor and an electrophile is an electron pair acceptor. The electrophile may contain a leaving group, a group that must leave so that an atom in the electrophile can form a new bond.

   When we use curved arrows to show the movement of electrons in a reaction, the arrows show the flow of electrons from the nucleophile to the electrophile. This means that the arrow drawn between these two reactants points from an atom or bond in the nucleophile to an atom in the electrophile.

2. *There are many valid answers to each of these questions. This answer key will identify categories of molecules or ions that would be appropriate and give a few examples.*

(a) Answers should include either a nonpolar pi bond or an atom with a lone pair.

e.g. any amine, any alkene (where the alkene isn't part of a benzene ring), any alkyne, any thiol (RSH where R is any carbon chain), etc.

While alcohols are capable of acting as nucleophiles, they are not very good nucleophiles because the oxygen atom is relatively electronegative and therefore does not readily share its electrons. They are acceptable answers to this question, but keep this in mind if you want to use them in reactions; they will only react with very good electrophiles.

(b) All answers must be anions.

e.g. I^-, Br^-, Cl^-, HO^-, any alkoxide (RO^- where R is any carbon chain), any thiolate (RS^- where R is any carbon chain), any carbanion (e.g. H_3C^-), etc.

(c) Answers should include either a polar pi bond (so that the less electronegative atom can make a new bond by pushing a pair of pi bonding electrons onto the more electronegative atom as a lone pair) or a carbon atom attached to a leaving group (so that the carbon atom can make a new bond by breaking the bond to the leaving group).

e.g. CO_2, any ketone, any aldehyde, any ester, any carboxylic acid, most other carbonyl-containing compounds, any nitrile, most alkyl halides in which the halogen is attached to a tetrahedral carbon atom ("most" because the halogen cannot be F), etc.

Cl_2, Br_2 and I_2 can also act as electrophiles. We see this in the "Addition of X_2" topic. In this case, one halogen atom acts as the electron pair acceptor and the other as the leaving group. This is analogous to a carbon atom with a leaving group attached. Mixed halogens (e.g. ICl, $BrCl$, IBr) can therefore also act as electrophiles.

(d) All answers must be cations where the positively charged atom has the capacity to form another bond. This means that species like H_3O^+ are not considered to be "electrophiles" because you can only remove H^+; you can't make an extra bond to O^+.

e.g. any carbocation