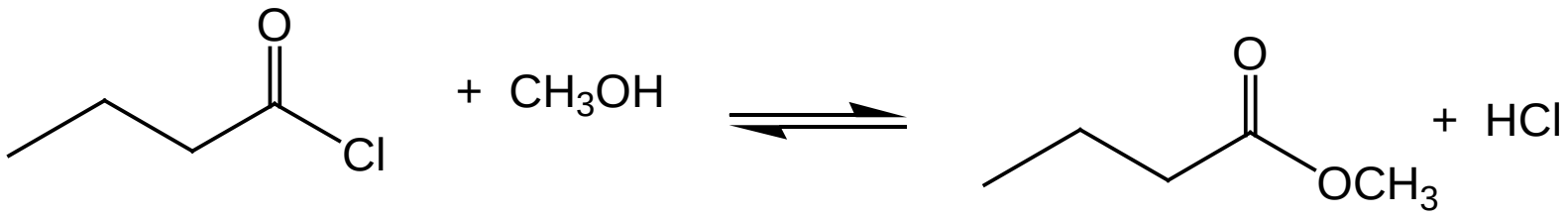
Chemistry 201

Laboratory safety

NC State University

Safety in chemical laboratories

The reaction of acyl chlorides with alcohols can make esters, but produces hydrochloric acid in the process. How much HCl gas is produced when produced when 5.3 grams of butyl acyl chloride are reacted with 1.6 grams of methanol in 100.0 mL of toluene?



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5.3 grams of butyl acyl chloride are reacted with 1.6 grams of methanol

Solution: Step 1. Calculate the molar mass of butyl acyl chloride and methanol.

M_m (butyl acyl Cl) = 4(12) + 16 + 35.5 + 7 = 106.5 amu

M_m (methanol) = 12 + 16 + 4 = 32 amu

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5.3 grams of butyl acyl chloride are reacted with 1.6 grams of methanol

Step 2. Calculate the number of moles of each reactant.

$$n = \frac{m}{M_m} = \frac{5.3\ g}{106.5\ g/mol} = 0.05\ moles$$

$$n = \frac{m}{M_m} = \frac{1.6\ g}{32\ g/mol} = 0.05\ moles$$

Here we conclude that there is no limiting reagent since both have equal numbers of moles.

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We could calculate molarity in this problem, but it is not necessary since we need the total volume of product.

Step 3. Calculate the volume of HCl

$$V = \frac{nRT}{P} = \frac{(0.05\,mol)\left(0.08206\frac{Latm}{molK}\right)(298\,K)}{1\,atm}$$

V = 1.22 L