

- b. The reaction of 1.19 mol of A produces 1.41 mol of D.
 c. The reaction of 189 mol of B produces 39 mol of D.
 d. The reaction of 3500 mol of B produces 1700 mol of C.
222. Elemental phosphorus can be produced by heating calcium phosphate from rocks with silica sand (SiO_2) and carbon in the form of coke. The following reaction takes place:
- $$\text{Ca}_3(\text{PO}_4)_2 + 3\text{SiO}_2 + 5\text{C} \rightarrow 3\text{CaSiO}_3 + 2\text{P} + 5\text{CO}$$
- a. If 57 mol of $\text{Ca}_3(\text{PO}_4)_2$ is used and 101 mol of CaSiO_3 is obtained, what is the percentage yield?
 b. Determine the percentage yield obtained if 1280 mol of carbon is consumed and 622 mol of CaSiO_3 is produced.
 c. The engineer in charge of this process expects a yield of 81.5%. If 1.4×10^5 mol of $\text{Ca}_3(\text{PO}_4)_2$ is used, how many moles of phosphorus will be produced?
223. Tungsten (W) can be produced from its oxide by reacting the oxide with hydrogen at a high temperature according to the following equation:
- $$\text{WO}_3 + 3\text{H}_2 \rightarrow \text{W} + 3\text{H}_2\text{O}$$
- a. What is the percentage yield if 56.9 g of WO_3 yields 41.4 g of tungsten?
 b. How many moles of tungsten will be produced from 3.72 g of WO_3 if the yield is 92.0%?
 c. A chemist carries out this reaction and obtains 11.4 g of tungsten. If the percentage yield is 89.4%, what mass of WO_3 was used?
224. Carbon tetrachloride, CCl_4 , is a solvent that was once used in large quantities in dry cleaning. Because it is a dense liquid that does not burn, it was also used in fire extinguishers. Unfortunately, its use was discontinued because it was found to be a carcinogen. It was manufactured by the following reaction:
- $$\text{CS}_2 + 3\text{Cl}_2 \rightarrow \text{CCl}_4 + \text{S}_2\text{Cl}_2$$
- The reaction was economical because the byproduct disulfur dichloride, S_2Cl_2 , could be used by industry in the manufacture of rubber products and other materials.
- a. What is the percentage yield of CCl_4 if 719 kg is produced from the reaction of 410. kg of CS_2 ?
 b. If 67.5 g of Cl_2 are used in the reaction and 39.5 g of S_2Cl_2 is produced, what is the percentage yield?
 c. If the percentage yield of the industrial process is 83.3%, how many kilograms of CS_2 should be reacted to obtain 5.00×10^4 kg of CCl_4 ? How many kilograms of S_2Cl_2 will be produced, assuming the same yield for that product?
225. Nitrogen dioxide, NO_2 , can be converted to dinitrogen pentoxide, N_2O_5 , by reacting it with ozone, O_3 . The reaction of NO_2 takes place according to the following equation:
- $$2\text{NO}_2(\text{g}) + \text{O}_3(\text{g}) \rightarrow \text{N}_2\text{O}_5(\text{s or g}) + \text{O}_2(\text{g})$$
- a. Calculate the percentage yield for a reaction in which 0.38 g of NO_2 reacts and 0.36 g of N_2O_5 is recovered.
 b. What mass of N_2O_5 will result from the reaction of 6.0 mol of NO_2 if there is a 61.1% yield in the reaction?
226. In the past, hydrogen chloride, HCl , was made using the *salt-cake* method as shown in the following equation:
- $$2\text{NaCl}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{s}) + 2\text{HCl}(\text{g})$$
- If 30.0 g of NaCl and 0.250 mol of H_2SO_4 are available, and 14.6 g of HCl is made, what is the percentage yield?
227. Cyanide compounds such as sodium cyanide, NaCN , are especially useful in gold refining because they will react with gold to form a stable compound that can then be separated and broken down to retrieve the gold. Ore containing only small quantities of gold can be used in this form of “chemical mining.” The equation for the reaction follows:
- $$4\text{Au} + 8\text{NaCN} + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{NaAu}(\text{CN})_2 + 4\text{NaOH}$$
- a. What percentage yield is obtained if 410 g of gold produces 540 g of $\text{NaAu}(\text{CN})_2$?
 b. Assuming a 79.6% yield in the conversion of gold to $\text{NaAu}(\text{CN})_2$, what mass of gold would produce 1.00 kg of $\text{NaAu}(\text{CN})_2$?
 c. Given the conditions in (b), what mass of gold ore that is 0.001% gold would be needed to produce 1.00 kg of $\text{NaAu}(\text{CN})_2$?
228. Diiodine pentoxide is useful in devices such as respirators because it reacts with the dangerous gas carbon monoxide, CO , to produce relatively harmless CO_2 according to the following equation:
- $$\text{I}_2\text{O}_5 + 5\text{CO} \rightarrow \text{I}_2 + 5\text{CO}_2$$
- a. In testing a respirator, 2.00 g of carbon monoxide gas is passed through diiodine pentoxide. Upon analyzing the results, it is found that 3.17 g of I_2 was produced. Calculate the percentage yield of the reaction.
 b. Assuming that the yield in (a) resulted because some of the CO did not react, calculate the mass of CO that passed through.
229. Sodium hypochlorite, NaClO , the main ingredient in household bleach, is produced by bubbling chlorine gas through a strong lye (sodium hydroxide, NaOH) solution. The following equation shows the reaction that occurs:
- $$2\text{NaOH}(\text{aq}) + \text{Cl}_2(\text{g}) \rightarrow \text{NaCl}(\text{aq}) + \text{NaClO}(\text{aq}) + \text{H}_2\text{O}(\text{l})$$
- a. What is the percentage yield of the reaction if 1.2 kg of Cl_2 reacts to form 0.90 kg of NaClO ?
 b. If a plant operator wants to make 25 metric tons of NaClO per day at a yield of 91.8%, how many metric tons of chlorine gas must be on hand each day?
 c. What mass of NaCl is formed per mole of chlorine gas at a yield of 81.8%?
 d. At what rate in kg per hour must NaOH be replenished if the reaction produces 370 kg/h of NaClO at a yield of 79.5%? Assume that all of the NaOH reacts to produce this yield.
230. Magnesium burns in oxygen to form magnesium oxide. However, when magnesium burns in air, which is only about one-fifth oxygen, side reactions form other products, such as magnesium nitride, Mg_3N_2 .