1. Determine the oxidation number of the following:
   a. S in $\text{H}_2\text{S}$
   b. Cr in $\text{CrO}_4^{2-}$
   c. V in $\text{V}_2\text{O}_5$
   d. Cl in $\text{ClO}^-$
   e. Ru in $\text{CaRuO}_4$
   f. C in $\text{HCOOH}$

4. Determine the oxidation state of P in each of the following, and give the name of each.
   a. $\text{P}_4$
   b. $\text{HPO}_3^2-$
   c. $\text{Na}_3\text{PO}_4$
   d. $\text{P}_4\text{O}_6$
   e. $\text{Na}_3\text{P}$
   f. $\text{H}_3\text{PO}_4$

4. The following "equations" represent only part of a chemical reaction. Indicated whether each reactant shown is being oxidized or reduced, or neither.
   a. $\text{H}_2\text{O} \rightarrow \text{H}_2$
   b. $\text{Cl}_2 \rightarrow \text{Cl}^-$
   c. $\text{C}_2\text{H}_4\text{O} \rightarrow \text{C}_2\text{H}_4\text{O}_2$

5. Green grapes are exceptionally sour because of a high concentration of tartaric acid. As the grapes ripen, this compound is converted to glucose.
   $$\text{C}_4\text{H}_6\text{O}_2 \rightarrow \text{C}_6\text{H}_12\text{O}_6$$
   tartaric acid glucose

   Is the tartaric acid being oxidized or reduced?

6. Which of the following are redox reactions? Explain
   a. $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$ (g)
   b. $\text{Pb(NO}_3)_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{PbSO}_4$ (s) + 2 $\text{NaNO}_3$
   c. $\text{CuO} + \text{CO}$ (g) $\rightarrow$ $\text{Cu} + \text{CO}_2$ (g)
   d. $\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2$

7. When copper metal is placed in concentrated nitric acid, the liquid turns green and amber-colored nitrogen dioxide gas, $\text{NO}_2$ (g) is produced. $\text{Cu}$ (s) + 4 $\text{HNO}_3$ (aq) $\rightarrow$ $\text{Cu(NO}_3)_2$ (aq) + 2 $\text{NO}_2$ (g) + 2 $\text{H}_2\text{O}$
   a. What element is oxidized?
   b. What element is reduced?
   c. What is the oxidizing agent?
   d. What is the reducing agent?

3. Give the oxidizing agent and the reducing agent for each reaction. Explain your answer.
   a. $\text{Cl}_2 + 2 \text{Br}^- \rightarrow 2 \text{Cl}^- + \text{Br}_2$
   b. $2 \text{Ag}^+ + \text{Mg} \rightarrow 2 \text{Ag} + \text{Mg}^{2+}$
   c. $6 \text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} + 14 \text{H}^+ \rightarrow 6 \text{Fe}^{3+} + 2 \text{Cr}^{3+} + 7 \text{H}_2\text{O}$
# 1. Determine the oxidation number of the following:

(a) S in $\text{H}_2\text{S}$ $\quad S = -2$

(b) Cr in $\text{CrO}_4^{2-}$ $\quad \text{Cr} = +7$

(c) V in $\text{V}_2\text{O}_5^2$ $\quad \text{V} = +3$

(d) Cl in $\text{ClO}_3^-$ $\quad \text{Cl} = +1$

(e) Ru in $\text{CrRuO}_3^4$ $\quad \text{Ru} = +4$

(f) C in $\text{H}_2\text{CO}_2\text{H}$ $\quad \text{C} = +2$

# 2. Determine the oxidation state of P in each of the following and give the name of each:

(a) $\text{P}_4$ $\quad \text{P}=0$ \hspace{1cm} \text{Phosphorus}

(b) $^{\text{+}1}\text{H}_2\text{PO}_4^-$ $\quad \text{P}=+3$ \hspace{1cm} \text{Hydrogen phosphate} \quad \text{IF} \quad ^{\text{+}1}\text{H}_2\text{PO}_4^- \quad \text{P}=+1

(c) $\text{Na}_3\text{PO}_4$ $\quad \text{P}=+5$ \hspace{1cm} \text{Sodium phosphate}

(d) $\text{P}_4\text{O}_{10}$ $\quad \text{P}=+3$ \hspace{1cm} \text{Tetraphosphorus hexoxide}

(e) $\text{Na}_3\text{P}$ $\quad \text{P}=-3$ \hspace{1cm} \text{Sodium phosphide}

(f) $\text{H}_3\text{PO}_4$ $\quad \text{P}=+5$ \hspace{1cm} \text{Phosphoric Acid}

# 3. The following "equations" represent only part of a chemical reaction. Indicate whether each reactant shown is being oxidized, reduced, or neither.

(a) $\text{H}_2\text{O} \rightarrow \text{H}_2 \quad \text{H gains e}^- \quad \text{so it is reduced}$

(b) $\text{Cl}_2 \rightarrow \text{Cl}^- \quad \text{Cl gains e}^- \quad \text{so it is reduced}$

(c) $\text{C}_2\text{H}_4\text{O}_2 \rightarrow \text{C}_2\text{H}_4\text{O}_2^+ \quad \text{C loses e}^- \quad \text{so it is oxidized}$

# 4. Green grapes are exceptionally sour because of a high concentration of tartaric acid. As the grapes ripen, this compound is converted to glucose.

$$\text{C}_4\text{H}_6\text{O}_6 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6$$

Is the tartaric acid being oxidized or reduced?

[tartaric acid is reduced]
#5. Which of the following are redox reactions? Explain.

(a) \[
\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2\text{O}
\]

- There are changes in oxidation states, so the reaction is a redox reaction.

(b) \[
\text{Pb(NO}_3\text{)}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{NaNO}_3
\]

- There is no change in oxidation states, so this is not a redox reaction.

(c) \[
\text{CuO} + \text{CO}_2 \rightarrow \text{Cu} + \text{CO}_2\text{(g)}
\]

- There is a change in oxidation states, so the reaction is a redox reaction.

(d) \[
\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}
\]

- There is no change in oxidation states, so this is not a redox reaction.

#6. When copper metal is placed in concentrated nitric acid, the liquid turns green and amber-colored nitrogen dioxide gas, \(\text{NO}_2\) (g), is produced.

\[
\text{Cu(s)} + 4\text{HNO}_3\text{(aq)} \rightarrow \text{Cu(NO}_3\text{)}_2\text{(aq)} + 2\text{NO}_2\text{(g)} + 2\text{H}_2\text{O(l)}
\]

- \(\text{Cu}\) is oxidized, losing an electron.
- \(\text{N}\) is oxidized, gaining an electron.

(a) What element is oxidized? \(\text{Cu}\)
(b) What element is reduced? \(\text{N}\)
(c) What is the oxidizing agent? \(\text{HNO}_3\)
(d) What is the reducing agent? \(\text{Cu}\)

#7. Give the oxidizing agent and the reducing agent for each reaction. Explain your answer.

(a) \[
\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2
\]

- \(\text{Cl}_2\) is the oxidizing agent.
- \(\text{Br}^-\) is the reducing agent.

(b) \[
2\text{Ag}^+ + \text{Mg} \rightarrow 2\text{Ag} + \text{Mg}^{2+}
\]

- \(\text{Ag}^+\) is the oxidizing agent.
- \(\text{Mg}\) is the reducing agent.

(c) \[
6\text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \rightarrow 6\text{Fe}^{3+} + 2\text{Cr}^{3+} + 7\text{H}_2\text{O}
\]

- \(\text{Fe}^{2+}\) is the reducing agent.
- \(\text{Cr}_2\text{O}_7^{2-}\) is the oxidizing agent.