

33. Which substance is oxidized in each reaction?
- $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2 \text{H}_2\text{O}(\text{l})$
  - $4 \text{Al}(\text{s}) + 3 \text{O}_2(\text{g}) \longrightarrow 2 \text{Al}_2\text{O}_3(\text{s})$
  - $2 \text{Al}(\text{s}) + 3 \text{Cl}_2(\text{g}) \longrightarrow 2 \text{AlCl}_3(\text{s})$
35. For each reaction, identify the substance being oxidized and the substance being reduced.
- $2 \text{Sr}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow 2 \text{SrO}(\text{s})$
  - $\text{Ca}(\text{s}) + \text{Cl}_2(\text{g}) \longrightarrow \text{CaCl}_2(\text{s})$
  - $\text{Ni}^{2+}(\text{aq}) + \text{Mg}(\text{s}) \longrightarrow \text{Mg}^{2+}(\text{aq}) + \text{Ni}(\text{s})$
39. Based on periodic trends, which elements would you expect to be good oxidizing agents?
- potassium
  - fluorine
  - iron
  - chlorine
43. For each redox reaction, identify the substance being oxidized, the substance being reduced, the oxidizing agent, and the reducing agent.
- $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2 \text{NO}(\text{g})$
  - $2 \text{CO}(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2 \text{CO}_2(\text{g})$
  - $\text{SbCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \longrightarrow \text{SbCl}_5(\text{g})$
45. Assign an oxidation state to each element or ion.
- V
  - $\text{Mg}^{2+}$
  - $\text{Cr}^{3+}$
  - $\text{O}_2$
47. Assign an oxidation state to each atom in each compound.
- NaCl
  - $\text{CaF}_2$
  - $\text{SO}_2$
  - $\text{H}_2\text{S}$
48. Assign an oxidation state to each atom in each compound.
- $\text{CH}_4$
  - $\text{CH}_2\text{Cl}_2$
  - $\text{CuCl}_2$
  - HI
49. What is the oxidation state of nitrogen in each compound?
- NO
  - $\text{NO}_2$
  - $\text{N}_2\text{O}$
50. What is the oxidation state of Cr in each compound?
- CrO
  - $\text{CrO}_3$
  - $\text{Cr}_2\text{O}_3$
51. Assign an oxidation state to each atom in each polyatomic ion.
- $\text{CO}_3^{2-}$
  - $\text{OH}^-$
  - $\text{NO}_3^-$
  - $\text{NO}_2^-$

52. Assign an oxidation state to each atom in each polyatomic ion.
- $\text{CrO}_4^{2-}$
  - $\text{Cr}_2\text{O}_7^{2-}$
  - $\text{PO}_4^{3-}$
  - $\text{MnO}_4^-$
53. What is the oxidation state of Cl in each ion?
- $\text{ClO}^-$
  - $\text{ClO}_2^-$
  - $\text{ClO}_3^-$
  - $\text{ClO}_4^-$
57. Assign an oxidation state to each element in each reaction and use the change in oxidation state to determine which element is being oxidized and which element is being reduced.
- $\text{SbCl}_5(\text{g}) \longrightarrow \text{SbCl}_3(\text{g}) + \text{Cl}_2(\text{g})$
  - $\text{CO}(\text{g}) + \text{Cl}_2(\text{g}) \longrightarrow \text{COCl}_2(\text{g})$
  - $2 \text{NO}(\text{g}) + \text{Br}_2(\text{g}) \longrightarrow 2 \text{BrNO}(\text{g})$
  - $\text{H}_2(\text{g}) + \text{CO}_2(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{g}) + \text{CO}(\text{g})$
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59. Use oxidation states to identify the oxidizing agent and the reducing agent in the redox reaction.
- $$2 \text{Na}(\text{s}) + 2 \text{H}_2\text{O}(\text{l}) \longrightarrow 2 \text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$$
71. Which metal has the least tendency to be oxidized?
- Ag
  - Na
  - Ni
  - Pb
73. Which metal cation has the greatest tendency to be reduced?
- $\text{Mn}^{2+}$
  - $\text{Cu}^{2+}$
  - $\text{K}^+$
  - $\text{Ni}^{2+}$
- 
75. Which metal is the best reducing agent?
- Mn
  - Al
  - Ni
  - Cr
77. Determine whether each redox reaction occurs spontaneously in the forward direction.
- $\text{Ni}(\text{s}) + \text{Zn}^{2+}(\text{aq}) \longrightarrow \text{Ni}^{2+}(\text{aq}) + \text{Zn}(\text{s})$
  - $\text{Ni}(\text{s}) + \text{Pb}^{2+}(\text{aq}) \longrightarrow \text{Ni}^{2+}(\text{aq}) + \text{Pb}(\text{s})$
  - $\text{Al}(\text{s}) + 3 \text{Ag}^+(\text{aq}) \longrightarrow 3 \text{Al}^{3+}(\text{aq}) + 3 \text{Ag}(\text{s})$
  - $\text{Pb}(\text{s}) + \text{Mn}^{2+}(\text{aq}) \longrightarrow \text{Pb}^{2+}(\text{aq}) + \text{Mn}(\text{s})$
79. Suppose you wanted to cause  $\text{Ni}^{2+}$  ions to come out of solution as solid Ni. What metal could you use to accomplish this?
81. Which metal in the activity series reduces  $\text{Al}^{3+}$  ions but not  $\text{Na}^+$  ions?

83. Which metals dissolve in HCl? For those metals that do dissolve, write a balanced redox reaction showing what happens when the metal dissolves.

- (a) Ag
- (b) Fe
- (c) Cu
- (d) Al

85. Make a sketch of an electrochemical cell with the overall reaction shown here. Label the anode, the cathode, and the salt bridge. Indicate the direction of electron flow.  
*Hint:* When drawing electrochemical cells, the anode is usually drawn on the left side.

