O\_\_\_\_\_ - R\_\_\_\_\_

* \_\_\_\_\_ (oxidation-reduction) reactions result from the competition for \_\_\_\_\_ between atoms. This is indicated by a change in \_\_\_\_\_ numbers of atoms. Which of the following (or both) is a Redox reaction?

H+Cl- + Na+O-2H+1 🡪 Na+Cl- + H+1O-2H+1

* + *This is* \_\_\_\_\_ *a REDOX reaction … \_\_\_ change in oxidation numbers.*



* + \_\_\_\_\_ reaction 🡪 notice the \_\_\_\_\_ in oxidation numbers for both Ca (\_\_\_ to \_\_\_) and Cl (\_\_\_ to \_\_\_).

R\_\_\_\_\_

* An abbreviation that combines the concepts of “Reduction” and “Oxidation.”



* Oxidation and reduction occur \_\_\_\_\_ and cannot occur one without the other [*laws of conservation of mass and charge*].

Review of Oxidation Numbers

* + An oxidation number is the \_\_\_\_\_ an atom or ion possesses to indicate its degree of oxidation or reduction.
	+ As a general rule, a bonded atom’s oxidation number is the charge that it would have if the \_\_\_\_\_ in the bond were assigned to the atom of the more \_\_\_\_\_ element.

Summary of Rules for determining Oxidation State of Atoms

1. The oxidation number for an atom in its elemental (unbonded) form is always \_\_\_\_\_ (*includes “Professor* \_\_\_\_\_*” elements*). Na\_\_, Fe\_\_, S\_\_ (*give oxidation states*)

2. The oxidation number of a \_\_\_\_\_ ion = charge of the monatomic ion. Na\_\_, Fe\_\_, S\_\_

3. Oxygen’s oxidation number is \_\_\_ (except in “peroxides”)

  i.e. H+1O-2H+1 i.e. H2+1O2-1

4. Hydrogen’s oxidation number is \_\_\_ (except in “hydrides”)

 i.e. H+1O-2H+1 i.e. Na+1H-1

5. Group \_\_\_ (1) metals [*alkali metals*] always have an oxidation state of \_\_\_ in a compound.

6. Group \_\_\_ (2) metals [*alkaline earth metals*] always have an oxidation number of \_\_\_ in a compound

7. \_\_\_\_\_ [VIIA (17)] always has an oxidation number of \_\_\_ in a compound.

8. The algebraic sum of oxidation states in a compound = \_\_\_.

9. The algebraic sum of the \_\_\_\_\_ states in a \_\_\_\_\_ ion equals the \_\_\_\_\_ on the ion (see Reference Table 1, Chart F or Polyatomic Ion Chart).

R\_\_\_\_\_

* Any chemical change in which there is a \_\_\_\_\_ in \_\_\_\_\_ number of an atom (*formerly defined by the loss of oxygen*).
* There is a \_\_\_\_\_ of \_\_\_\_\_ from an atom in the reaction.



* The oxidation number of S \_\_\_\_\_ from \_\_\_ to \_\_\_.
* The element S \_\_\_\_\_ two electrons.
* S is “\_\_\_\_\_” in the redox reaction.
* The particle or atom that \_\_\_\_\_ in oxidation number is said to be \_\_\_\_\_. The more \_\_\_\_\_ atom is reduced.
* The particle or atom that is reduced acts as an \_\_\_\_\_ agent in a Redox reaction.
* S is \_\_\_\_\_ in the redox reaction.
* S is the \_\_\_\_\_ agent in the redox reaction, meaning that Na0 will be \_\_\_\_\_.

O\_\_\_\_\_

* Any chemical change in which there is an \_\_\_\_\_ in \_\_\_\_\_ number of an atom (*formerly defined by the gain of oxygen*).
* There is a \_\_\_\_\_ of \_\_\_\_\_ from an atom in the reaction.



The element Na \_\_\_\_\_ two electrons total.

* The oxidation number of Na increases from \_\_\_ to \_\_\_.
* Na is \_\_\_\_\_ in the redox reaction.
* The particle or atom that \_\_\_\_\_ in oxidation number is said to be \_\_\_\_\_.
* The particle or atom that is oxidized acts as a \_\_\_\_\_ agent in a Redox reaction.
* Na is \_\_\_\_\_ in the redox reaction.
* Na is the \_\_\_\_\_ agent in the redox reaction, meaning that S0 will be \_\_\_\_\_.

Oxidation - Reduction

**REDOX**

* Redox reactions result from the \_\_\_\_\_ for \_\_\_\_\_ between atoms to produce the most stable configuration.
* For covalent compounds the more \_\_\_\_\_ atom \_\_\_\_\_.
* This is indicated by a \_\_\_\_\_ in the expected \_\_\_\_\_ numbers of atoms as they progress from reactants to products.
* An oxidation-reduction reaction occurs when \_\_\_\_\_ are transferred from one substance to another: \_\_\_\_\_.
* The substance that is \_\_\_\_\_ is called the \_\_\_\_\_ agent (\_\_\_\_\_ electrons to other substance).
* The substance that is \_\_\_\_\_ is called the \_\_\_\_\_ agent (\_\_\_\_\_ electrons from other substance).

Oxidizing and Reducing Agents

* In the formation of NaCl, a sodium atom \_\_\_\_\_ an electron (becoming a \_\_\_\_\_) to a chlorine atom (becoming an \_\_\_\_\_).
* Sodium gets \_\_\_\_\_ and acts as the \_\_\_\_\_ agent and \_\_\_\_\_ its single valence electron to the chlorine ion.
* Chlorine is \_\_\_\_\_ as the \_\_\_\_\_ agent, and \_\_\_\_\_ an electron to allow both ions to lose their charges.

Describe Oxidation-Reduction Reactions

* Determine which species is oxidized and which is reduced. Which is the oxidizing agent and which is the reducing agent? Explain.



* Oxygen atoms are \_\_\_\_\_ because they \_\_\_\_\_ electrons. Oxygen is the \_\_\_\_\_ agent because it accepts electrons \_\_\_\_\_ hydrogen.
* Hydrogen atoms are \_\_\_\_\_ because they \_\_\_\_\_ electrons. Hydrogen is the \_\_\_\_\_ agent because it transfers electrons \_\_\_\_\_ oxygen.

H\_\_\_\_\_ Reactions

* REDOX reactions are considered in \_\_\_ parts.
* Each reaction of the 2 parts is called a ½ reaction (\_\_\_\_\_ rxn)



* \_\_\_\_\_ half reaction Mg0 🡪 Mg+2 + \_\_\_\_\_
* \_\_\_\_\_ half reaction S0 + \_\_\_\_\_ 🡪 S-2
* REDOX reactions are driven by \_\_\_\_\_.
* The \_\_\_\_\_ number must be \_\_\_\_\_ for both \_\_\_\_\_ reactions.
	+ If one half reaction loses e- (\_\_\_\_\_), the other must \_\_\_\_\_ e-.
	+ If one half reaction gains e- (\_\_\_\_\_), the other must \_\_\_\_\_ e-.
* In this redox reaction, \_\_\_\_\_ are lost & gained overall.

Examples of Oxidation-Reduction Reaction. Oxidation-reduction reactions include:

* C\_\_\_\_\_
* P\_\_\_\_\_
* Many reactions of metals (tarnish)
* Many biochemical reactions, including metabolic reactions.



* Metal trash cans made from uncoated steel would \_\_\_\_\_ or rust if left outside in the rain.
* Silverware and silver cups can \_\_\_\_\_ as shown to the right.

C\_\_\_\_\_

* What happens when you leave your bike, skateboard, or wagon outside for a period of time?
* Many \_\_\_\_\_ corrode, tarnish, or \_\_\_\_\_ when exposed to weather.
* Can you identify the common chemical characteristic of all metal corrosion?
* Electron transfer from the metal to an oxidizing agent. The \_\_\_\_\_ gets \_\_\_\_\_ and the oxidizing agent (often oxygen) is reduced.



* \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and exposure all accelerate corrosion.
* Coating the metal, reducing exposure, and replacing metal with plastic or alloys decreases \_\_\_\_\_.

Balancing Redox Equations

E\_\_\_\_\_ T\_\_\_\_\_ – Oxidation Number Method

1. Write \_\_\_\_\_ for products and reactants in “\_\_\_\_\_” (unbalanced) equations.

HNO3(aq) + H3PO3(aq) 🡪 NO(aq) + H3PO4(aq) + H2O(l)

2. Assign \_\_\_\_\_ numbers (states) to each element on both sides of the equation.

H+1**N+5**O3-2(aq) + H3+1**P+3**O3-2(aq) 🡪 **N+2**O-2(aq) + H3+1**P+5**O4-2(aq) + H2+1O-2(l)

* *Notice that Nitrogen and Phosphorus change oxidation states from reactants to products. This reveals the* \_\_\_\_\_ *reaction*.



 3. Select the atom that is \_\_\_\_\_ (\_\_\_\_\_ e-, \_\_\_\_\_ oxidation number from \_\_\_\_\_ to \_\_\_\_\_) and select the atom that is \_\_\_\_\_ (\_\_\_\_\_ e-, \_\_\_\_\_ in oxidation number from reactants to products).

 \_\_\_\_\_ half reaction P+3 🡪 P+5 + 2 e-

 \_\_\_\_\_ half reaction N+5 + 3 e- 🡪 N+2

4. Write \_\_\_\_\_ half-reactions (oxidation and reduction)

5. Inspect the half-reactions, checking for conservation of mass (same number of atoms on both sides) and conservation of charge (same total charge on both sides)

6. \_\_\_\_\_ the half-reactions so that the number of \_\_\_\_\_ lost in \_\_\_\_\_ equals the number of electrons \_\_\_\_\_ in \_\_\_\_\_

Oxidation half reaction \_ ( P+3 🡪 P+5 + 2 e- ) … \_\_\_\_\_ lost

\_P+3 🡪 \_P+5 + \_ e-

Reduction half reaction \_\_ ( N+5 + 3 e- 🡪 N+2 ) … \_\_\_\_\_ gained

\_\_N+5 + \_\_ e- 🡪 \_\_N+2

7. Return to the overall chemical equation and add in appropriate coefficients (based on the half-reactions) to atoms that were oxidized and reduced.

**2**HNO3(aq) + **3**H3PO3(aq) 🡪 **2**NO(aq) + **3**H3PO4(aq) + H2O (l)

8. Finish by \_\_\_\_\_ the entire chemical equation ensuring conservation of mass & \_\_\_\_\_ for all atoms (reactants & products).

* \_\_\_ hydrogen atoms, \_\_\_ nitrogen atoms, \_\_\_ phosphorus atoms, and \_\_\_ oxygen atoms on each side of the equation

\_\_\_\_\_ Reaction Method



* \_\_\_\_\_ half reaction

**\_\_\_** ( S-2 🡪 S+4 + 6e- ) = \_\_\_S-2 🡪 \_\_\_S+4 + **\_\_\_ e-**

* \_\_\_\_\_ half reaction

**\_\_\_** ( O20 + 4e- 🡪 2O-2 ) = \_\_\_O20 + **\_\_\_ e-** 🡪 \_\_\_O-2

* In this redox reaction, \_\_\_\_\_ are lost & gained overall.
* Use the moles from the ½ reactions to balance the overall chemical equation:

\_\_\_H2S(g) + \_\_\_O2(g) 🡪 \_\_\_SO2(g) + \_\_\_H2O(l)