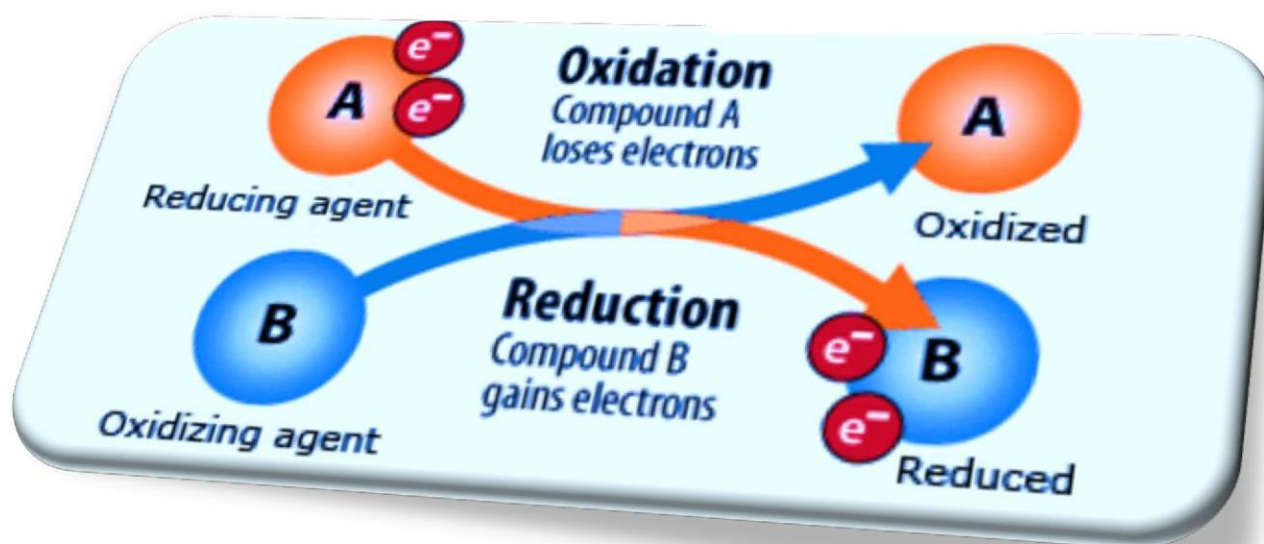# Oxidation and Reduction

Grade 12 General

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1- When is the oxidation number of oxygen not -2?

A)in oxyacids

B)in peroxide

C)in sulfuric acid

D)c. in peroxide

2- Select the compound in which chlorine has the highest possible oxidation number

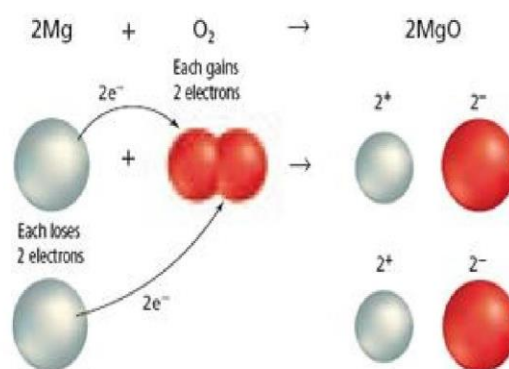A)HCl

B)HClO

C)$HClO_3$

D)$HClO_4$

3-The most electronegative atom in a compound has a charge that is…………..

A)positive

B)negative

C)neutral

D)zero

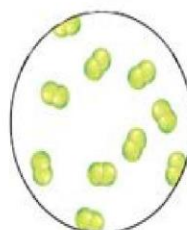## 4- What is the oxidation number of magnesium after it is burned?

A)0

B)1

C)2

D)3

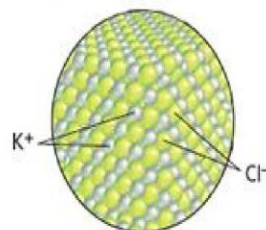## 5- What are the oxidation numbers of K and Cl after the reaction?

A)K = -1, Cl = 1

B)K = 0, Cl = 0

C)K = 1, Cl = -1

D)K = -1, Cl = -1

Potassium (solid)   Chlorine (gas)   Potassium chloride (solid)

6- Complete and balance the following redox equation. When properly balancedwith whole—number coefficients, the coefficient of S is _____.

$H_2S + HNO_3 \rightarrow S + NO + H_2O$

A)1

B)2

C)3

D)4

7- Balance the following ionic equation. What is the coefficient of the reducingagent in this reaction?

$Fe^{2+}_{(aq)} + MnO4^{-}_{(aq)} + H^{+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Mn^{2+}_{(aq)} + H_2O_{(l)}$

A)5

B)1

C)8

D)4

8- What is the net change in oxidation number of iodine in the following ionic reaction?

$$2MnO_4^- + I^- + H_2O \rightarrow 2MnO_2 + IO_3^- + 2OH^-$$

A)1

B)2

C)3

D)6

9- What is the oxidation number for each of these reactions before the reaction occurs?

A)-1

B)0

C)1

D)2

Overall Reaction (unbalanced)	Oxidation Half-Reaction	Reduction Half-Reaction
$Fe + O_2 \rightarrow Fe_2O_3$		$O_2 + 4e^- \rightarrow 2O^{2-}$
$Fe + F_2 \rightarrow FeF_3$		$F_2 + 2e^- \rightarrow 2F^-$
$Fe + HBr \rightarrow H_2 + FeBr_3$	$Fe \rightarrow Fe^{3+} + 3e^-$	$2H^+ + 2e^- \rightarrow H_2$
$Fe + AgNO_3 \rightarrow Ag + Fe(NO_3)_3$		$Ag^+ + e^- \rightarrow Ag$
$Fe + CuSO_4 \rightarrow Cu + Fe_2(SO_4)_3$		$Cu^{2+} + 2e^- \rightarrow Cu$

10- Balance the following equation with the smallest whole—numbercoefficients. How many moles of zinc will react with 6 moles of cobalt(III) chloride?

$$Zn_{(s)} + CoCl_{3(aq)} \rightarrow ZnCl_{2(aq)} + Co_{(s)}$$

A)2

B)3

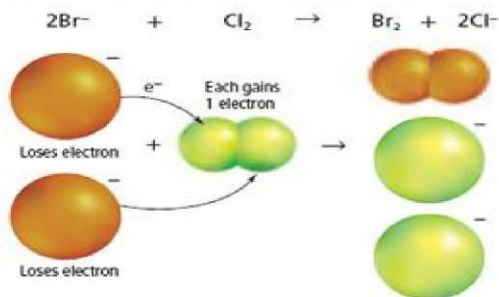C)6

D)9

11- What is the oxidation number of Group 17 nonmetals?

A)-1

B)0

C)1

D)3

12- Oxidation is _____.

A)the loss of electrons and an increase in charge

B)the loss of electrons and a decrease in charge

C)the gain of electrons and an increase in charge

D)the gain of electrons and a decrease in charge

13- What is the oxidation number of O in Na2SO4?

A)6

B)1

C)2

D)-2

14- In the following reaction, which chemical species is the oxidizing agent?

$$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

A)H_2O_2

B)MnO_4^-

C)H^+

D)Mn^{2+}

15- What element is oxidized in the following reaction?

$3Cu + 8HNO_3 \rightarrow Cu(NO_3)_2 + 2NO + 4H_2O$
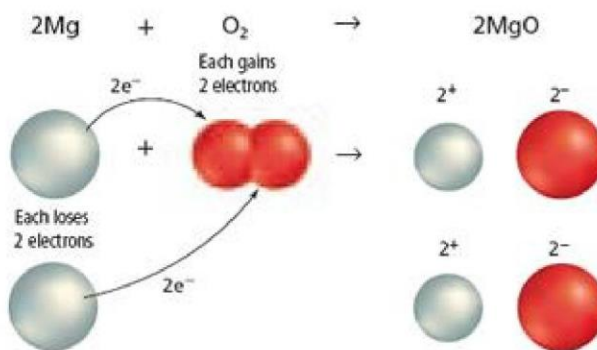
A)Cu

B)H

C)N

D)O

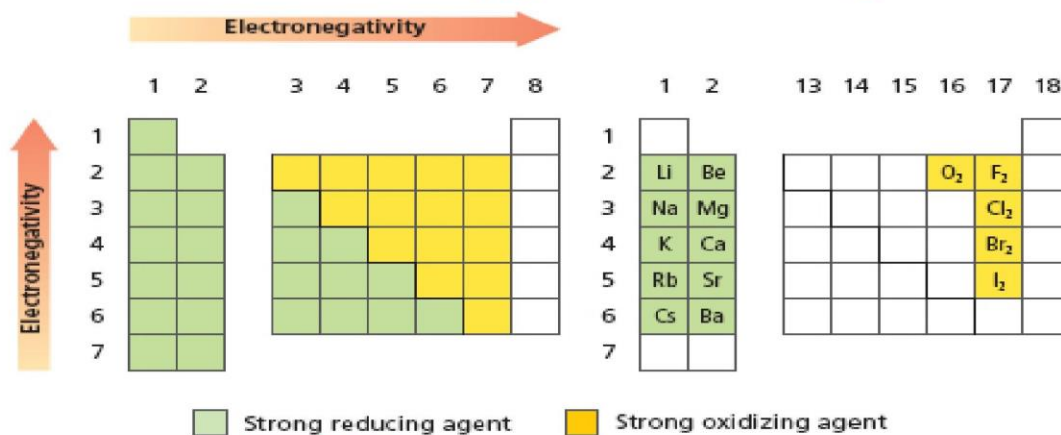**16- Group 1A metal ions have an oxidation number of _____.**

A)1

B)2

C)3

D)-1

17- What is the oxidation number of magnesium before it is burned in oxygen?

A)0

B)1

C)2

D)3

18- Which of the elements is the strongest oxidizing agent?

A)oxygen

B)fluorine

C)chlorine

D)iodine

19- Name the spectator ion in the following equation, including the correct coefficient:

$Cu_{(s)} + 4HNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2NO_2 + 2H_2O_{(l)}$
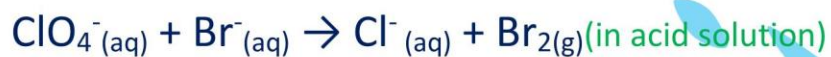
A)$2NO_2$

B)$3NO_2$

C)$2NO_3$

D)$3NO_3$

20 - Determine the net change in oxidation number of chlorine in the followingreaction:

$ClO_4^-{}_{(aq)} + Br^-{}_{(aq)} \rightarrow Cl^-{}_{(aq)} + Br_{2(g)}$(in acid solution)

A)-8

B)-7

C)7

D)8

21- When the following equation is balanced what is the coefficient of Sn?

$Sn + HNO_3 \rightarrow SnO_2 + NO_2 + H_2O$

A)1

B)2

C)3

D)4

22- A balanced reaction that shows only the oxidation process is a _____

A)balanced chemical equation

B)single-replacement reaction

C)half-reaction

D)synthesis reaction

23- Complete and balance the following chemical reaction with the smallest set of coefficients. What is the coefficient for iodine in this reaction?

$$HI + HNO_3 \rightarrow I_2 + NO + H_2O$$

A)1

B)2

C)3

D)4

24- Balance the reaction shown. What will be the coefficient of Ag?

$$Fe + AgNO_3 \text{ yields } Ag + Fe(NO_3)_3$$

A)1

B)2

C)3

D)4

25- Which of the following half-reactions represents oxidation?

A)$O2 + 4e^- \rightarrow 2O^{2-}$

B)$Fe^{3+} + 3e^- \rightarrow Fe$

C)$Fe \rightarrow Fe^{2+} + 2e^-$

D)$Cu^{2+} + 2e^- \rightarrow Cu$

26-Determine the oxidation number of each atom in the following substances

NF_3

K_2CO_3

NO_3^-

HIO_4

27- Identify each of the following changes as either oxidation or reduction Recall that e- is the symbol for an electron

a. $I_2 + 2e^- \rightarrow 2I^-$

b. $K \rightarrow K^+ + e^-$

c. $Fe^{2+} \rightarrow Fe^{3+} + e^-$

d. $Ag^+ + e^- \rightarrow Ag$

28-Identify what is oxidized and what is reduced in the following processes.

a. $2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$

b. $2Ce + 3Cu^{2+} \rightarrow 3Cu + 2Ce^{3+}$

c. $2Zn + O_2 \rightarrow 2ZnO$

d. $2Na + 2H^+ \rightarrow 2Na^+ + H_2$
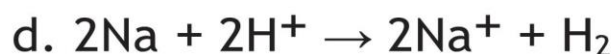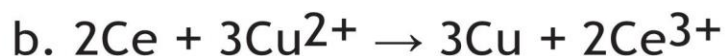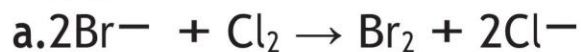
29-Identify the oxidizing agent and the reducing agent in the following equation. Explain your answer.

$Fe(s) + Ag + (aq) \rightarrow Fe^{2+}(aq) + Ag(s)$

30-Challenge Identify the oxidizing agent and the reducing agent in each reaction.

b. $Mg + I_2 \rightarrow MgI_2$

c. $H_2S + Cl_2 \rightarrow S + 2HCl$
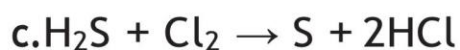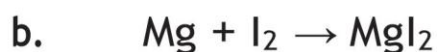
31-Determine the oxidation number of the boldface element in the following formulas for compounds.

$NaClO_4$	$AlPO_4$	HNO_2
NH_4^+	$AsO_4{}^{3-}$	$CrO_4{}^{2-}$
NH_3	KCN	N_2H_4

32-Challenge Determine the net change of oxidation number of each of the elements in these redox equations.

a. $C + O_2 \rightarrow CO_2$

b. $Cl_2 + ZnI_2 \rightarrow ZnI_2 + I_2$

c. $CdO + CO \rightarrow Cd + CO_2$
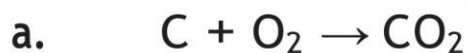
33-Determine the oxidation number of the boldface element in these compounds

HNO_3	CaN_2	Sb_2O_5
CaN	$CuWO_4$	IO_4^-
MnO_4^-	NH_2^-	$B_4O_7^{2-}$

34- Identify the species oxidized and the species reduced in each of these redox equations.

    1. $3Br_2 + 2Ga \rightarrow 2GaBr_3$

    2. $HCl + Zn \rightarrow ZnCl_2 + H_2$

    3. $Mg + N_2 \rightarrow Mg_3N_2$
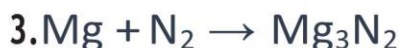
35-Identify the oxidizing agent and the reducing agent in each of these redox equations.

    a. $N_2 + 3H_2 \rightarrow 2NH_3$

    b. $2Na + I_2 \rightarrow 2NaI$

36-What is the reducing agent in this balanced equation?

$$8H^+ + Sn + 6Cl^- + 4NO_3^{-1} \rightarrow SnCl_6^{-2} + 4NO_2 + 4H_2O$$

....

37-What is the oxidation number of manganese in $KMnO_4$?

....
....
....
....

38- Determine the oxidation number of the boldface element in these substances and ions.

CaCrO_4

N$O_2{}^-$

NaH**S**O_4

Br$O_3{}^-$

39- Identify each of these half-reactions as either oxidation or reduction.

$$Al \rightarrow Al^{3+} + 3e^-$$

$$Cu^{2+} + e^- \rightarrow Cu^+$$
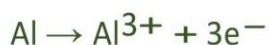
40- Which of these equations does not represent a redox reaction? Explain your answer.

a. $LiOH + HNO_3 \rightarrow LiNO_3 + H_2O$

b. $MgI_2 + Br_2 \rightarrow MgBr_2 + I_2$
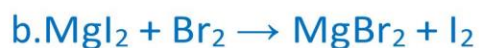
41- Determine the oxidation number of nitrogen in each of these molecules or ions.

A..NO_3 b. N_2O c. NF_3
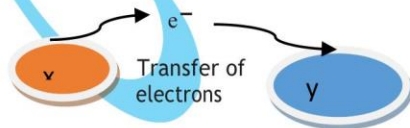
42-Determine the oxidation number of each element in these compounds or ions.

a.$Au_2(SeO_4)_3$ (gold (III) selenate)

b.$Ni(CN)_2$ (nickel (II) cyanide)

Rule	Example	$n$element
1. The oxidation number of an uncombined atom is zero.	Na, O_2, Cl_2, H_2	0
2. The oxidation number of a monatomic ion is equal to the charge of the ion.	Ca^{2+}	+2
	Br^-	−1
3. The oxidation number of the more-electronegative atom in a molecule or a complex ion is the same as the charge it would have if it were an ion.	N in NH_3	−3
	O in NO	−2
4. The oxidation number of the most-electronegative element, fluorine, is always −1 when it is bonded to another element.	F in LiF	−1
5. The oxidation number of oxygen in compounds is always −2 except in peroxides, such as hydrogen peroxide (H_2O_2), where it is −1. When it is bonded to fluorine, the only element more electro- negative than oxygen, the oxidation number of oxygen is positive.	O in NO_2	−2
	O in H_2O_2	−1
6. The oxidation number of hydrogen in most of its compounds is +1, except in metal hydrides; then, the oxidation number is −1.	H in NaH	−1
7. The oxidation numbers of group 1 and 2 metals and aluminum are positive and equal to their number of valence electrons.	K	+1
	Ca	+2
	Al	+3
8. The sum of the oxidation numbers in a neutral compound is zero.	$CaBr_2$	$(+2) + 2(−1) = 0$
9. The sum of the oxidation numbers of the atoms in a polyatomic ion is equal to the charge of the ion.	SO_3^{2-}	$(+4) + 3(−2) = −2$

1-is defined as the loss of electrons from atoms of a substance (.........................)

2- is the gain of electrons by atoms of a substance

 (..)

3- A reaction in which electrons are transferred from one atom to another(...)

4- . The substance that oxidizes another substance by accepting its electron(...)

5- . The substance that reduces another substance by losing electrons is called a(..)

Process	e⁻ Transfer of electrons
Oxidation • A reactant loses an electron. • Reducing agent is oxidized. • Oxidation number increases.	• X loses an electron. • X is the reducing agent and becomes oxidized. • The oxidation number of X increases.
Reduction • Other reactant gains an electron. • Oxidizing agent is reduced. • Oxidation number decreases.	• Y gains an electron. • Y is the oxidizing agent and becomes reduced. • The oxidation number of Y decreases.

Redox and Electronegativity

The chemistry of oxidation-reduction reactions is not limited to atoms of an element changing to ions or the reverse. Some redox reactions involve changes in molecular substances or polyatomic ions in which atoms are covalently bonded to other atoms. For example, the following equation represents the redox reaction used to manufacture ammonia (NH_3).

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

This process involves neither ions nor any obvious transfer of electrons. The reactants and products are all molecular compounds. Yet, it is still a redox reaction in which nitrogen is the oxidizing agent and hydrogen is the reducing agent.

In situations such as the formation of ammonia, where two atoms share electrons, how is it possible to say that one atom lost electrons and was oxidized, while the other atom gained electrons and was reduced? To answer this, you need to know which atom attracts electrons more strongly, or, in other words, which atom is more electronegative. You might find it helpful to review the discussion of electronegativity trends in Chapters 6 and 8. **Figure 19.4** shows that electronegativity increases left to right across a period and generally decreases down a group.

Elements with low electronegativity (Groups 1 and 2) are strong reducing agents, and those with high electronegativity (Group 17 and oxygen in Group 16) are strong oxidizing agents.

reduced (partial gain of e-)

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

oxidized (partical loss of e-)

Hydrogen has an electronegativity of 2.20, and nitrogen's electronegativ- ity is 3.04. For the purpose of studying oxidation-reduction reactions, the more-electronegative atom (in this case nitrogen) is treated as if it had been reduced by gaining electrons from the other atom (hydrogen). Conversely, the less-electronegative atom (hydrogen) is treated as if it had been oxidized by losing electrons to the other atom (nitrogen).

. **Figure 19.4** The electronega- tivity of elements increases from left to right across the periodic table, and it decreases going down a group. Elements with low electronegativity are strong reducing agents, and ele- ments with high electronegativity are strong oxidizing agents. **Predict *which element would be the strongest oxidizing agent. Which is the strongest reducing agent?***