Ionization

IONIZATION

57. Atoms combine to form small particles called molecules. A molecule contains two or more atoms.
The molecule O2 contains how many atoms of oxygen? _____

2

58. EAch molecule of glucose, C6H12O6, contains:
_____ atoms of carbon
_____ atoms of hydrogen
_____ atoms of oxygen

6, 12, 6

59. The "1" for one atom of an element is understood and not written in the formula. Each molecule of carbon dioxide, CO2, contains 1 atom of carbon and (how may?) _____ atoms of oxygen.

2

60. A water molecule is composed of two hydrogen atoms and one oxygen atom.
Write the formula for a water molecule: _____

H2O

61. When you want to represent more than one molecule of a compound, the number of molecules precedes the symbols. Thus, 6CO2 indicates how many molecules of carbon dioxide? _____

How would eight molecules of water be represented? _____

6; 8 H2O

62. The symbol H indicates: (check one)
___ 1 molecule of hydrogen
___ 1 atom of hydrogen

1 atom of hydrogen

63. The formula H2 indicates one _____ of _____, composed of how many atoms? _____

molecule; hydrogen; 2

64. The formula 2H2 indicates _____ of hydrogen.

two molecules.

IONS AND IONIC BONDS

65. Atoms normally contain equal numbers of protons and electrons. Thus, atoms are normally

___ (a) electropositive
___ (b) electronegative
___ (c) electrically neutral

(c) electrically neutral

66. The electron is a (negatively/positively) _____ charged particle. So if, an atom loses an electron it will then have an overall (negative/positive) _____ charge.

negatively; positive

67. If an atom were to gain an extra electron, it would then have an overall _____ charge.

negative

68. An ion is an atom that has acquired an electrical charge either by losing or gaining an _____

electron

69. Note that electrons, which are located outside the nucleus, or gained in the formation of ions. The nucleus, which contains protons and neutrons, does not take part in the formation of ions.

If a hydrogen atom loses its electron, it becomes an _____. If it loses an electron, it is a (negatively/positively charged ion.

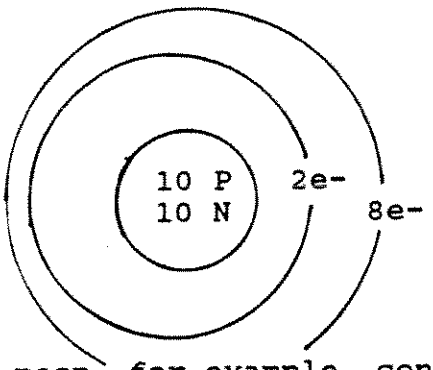
_____

ion
positively

70. Any atom that has lost or gained an electron is an _____
(a) If an atom gains an electron, it becomes a _____ charged ion.
(b) If an atom loses an electron, it becomes a _____ charged ion.

ion; (a) negatively; (b) positively

71. Most atoms reach their most stable state when they have 8 electrons in their outer shell - called the valence shell.



NEON

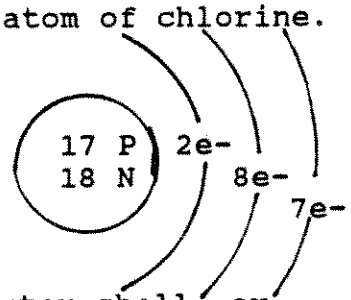
this atom of neon, for example, contains 10 electrons. Two of the electrons fill the first shell, and the remaining 8 electrons are in the second shell. So the second shell of neon would be called its _____ shell.

valence

72. Neon has a completed valence shell - it can hold no more electrons. Thus, neon is a very (stable/unstable) _____ _____ atom. Such elements are usually unreactive.

stable

73. Look at this atom of chlorine.



CHLORINE

In chlorine, the outer shell, or _____ shell, is the _____ shell. It contains 7 electrons. Thus, to attain a stable state of chlorine atom needs to gain how many electrons? _____
What is the symbol for chlorine? _____

valence; third; 1; Cl

74. Suppose that an atom of chlorine does gain the one electron it needs to become stable. Since it has gained an electron, it is now a charged atom, called an _____.

Would it have a positive or negative charge? _____

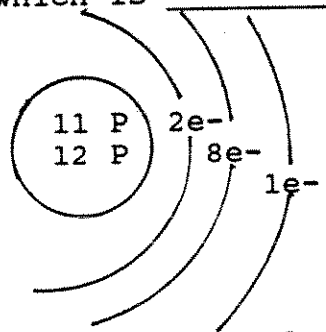
ion; negative

75. Which of these symbols stands for the chlorine ion (a chlorine atom that has gained one electron)? (cl, Cl+1, Cl-1)

_____

Cl-1

76. For the chlorine atom to gain an electron, there must be some other atom that has lost the electron. This atom could be sodium, the symbol for which is _____



SODIUM

The sodium atom has how many electrons in its valence shell?

_____

To become stable it will have to

___ gain one electron
___ lose one electron

Na; 1; lose one electron

77. When the sodium atom loses one electron it becomes a (positively/negatively) _____ charged _____

_____

positively; ion

78. Which symbol should we use for the sodium ion? _____
(Na, Na+1, Na-1)

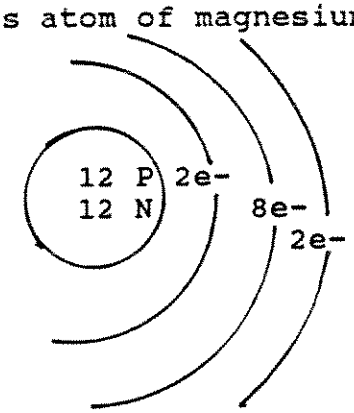
Na+1

Na + Cl --> Na+1 + Cl-1
(reaction of sodium and chlorine)

79. When a sodium atom reacts with a chlorine atom, the sodium atom (gains/loses) _____ one electron to form a sodium ion with a _____ charge of (how many?) _____
At the same time, the chlorine atom (gains/loses) _____ one electron to form an ion with a _____ charge of (how many?) _____

loses; positive; one; gains; negative; one.

80. Look at this atom of magnesium. Its symbol is _____



MAGNESIUM

It has _____ electrons in is valence shell. So to gain stability it will have to (gain/lose) _____ (how many?) electrons _____

The symbol for the magnesium ion is (Mg-2, Mg, Mg+2) _____

Mg
2; lose 2; Mg+2

81. The reaction between magnesium and chlorine may be written as:

$$Mg + 2Cl \rightarrow Mg^{+2} + 2Cl^{-1}$$

This reaction shows that two chlorine atoms react with on magnesium atom to form two chlorine ions, each with a charge of _____ and one magnesium ion with a charge of _____

-1; +2

82. The hydrogen atom, atomic number 1, has _____ electron(s) in its valence shell.

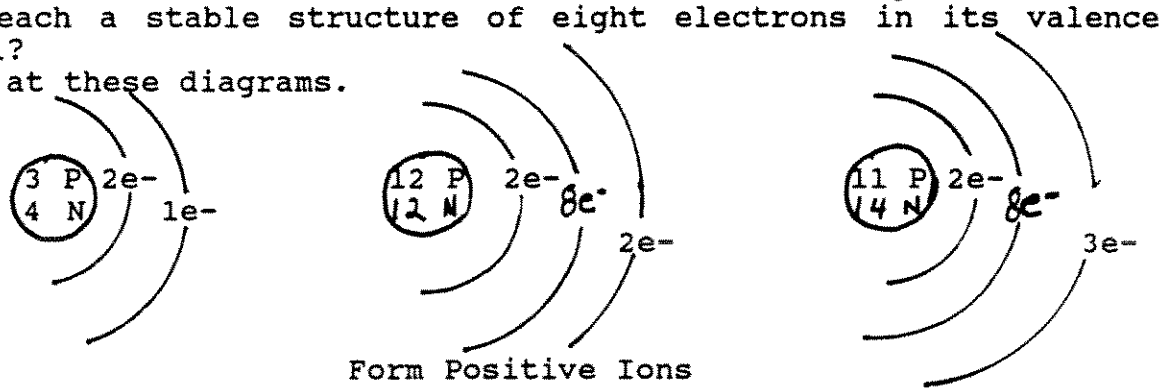
1

83. The oxygen atom, atomic number 8, has how many shells?

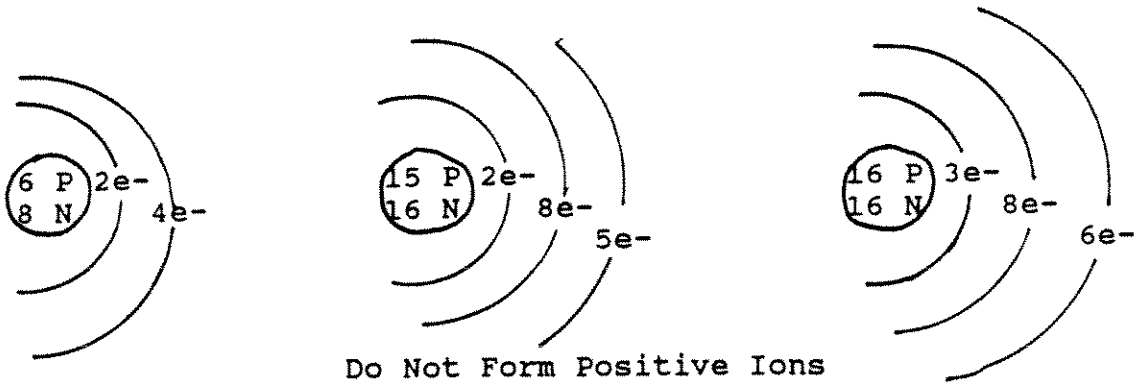
(a) How many electrons are in its valence shell? _____
(b) If an oxygen atom gains two electrons to fill its valence shell, it will have a charge of _____
(c) The symbol for the oxygen ion is _____

2; (a)6; (b)-2; (c)O-2

84. How can we tell whether an atom will lose or gain electrons to reach a stable structure of eight electrons in its valence shell?
look at these diagrams.



Form Positive Ions

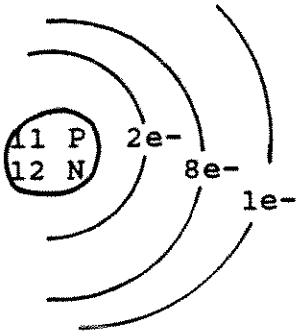


Do Not Form Positive Ions

In general, an atom with (how many?) _____ electrons in its valence shell tends to lose electrons and to form a (positively/negatively) _____ charged ion.

1, 2, or 3, (or equivalent answer); positively

85. Sodium has atomic number 11. How many electron(s) does it have in its valence shell? _____ The sodium ion, therefore, is formed by the (loss/gain) _____ of one electron.

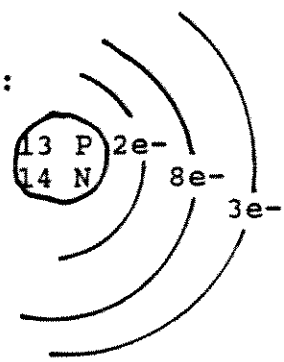


SODIUM

The symbol for the sodium ion is _____

1; loss
Na+1

86. Here is an aluminum atom:



ALUMINUM

Its valence shell contains _____ electrons. The

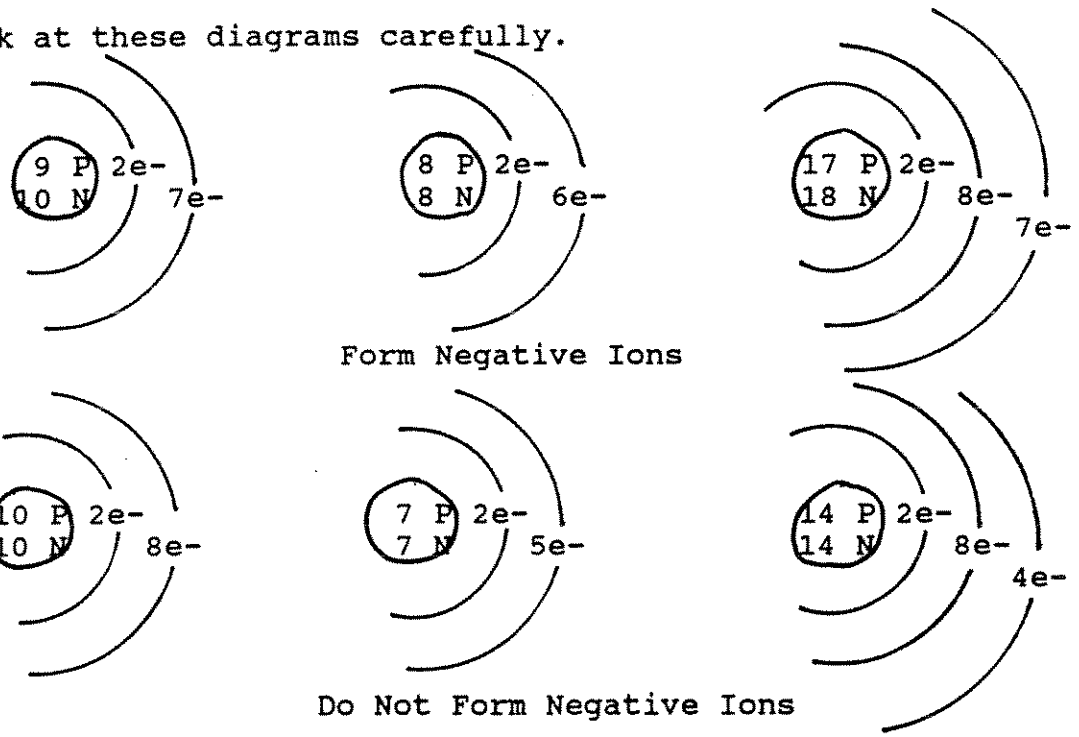
aluminum ion is formed by the (loss/gain) _____ of 3 electrons.
The symbol for the aluminum ion is _____

three; loss; Al+3

87. Magnesium, atomic number 12, forms a magnesium ion that may be represented as _____.

Mg+2

88. Look at these diagrams carefully.



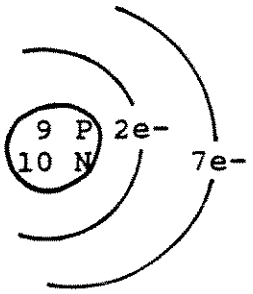
In general, atoms that have _____ (or) _____ electrons in their valence shell form negatively charged ions.

6 or 7

89. When an atom gains electrons to fill its valence shell, it forms _____ charged ions.

negatively

90. Fill in the following table for the fluorine (F) atom:

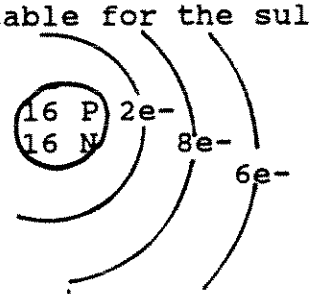


FLUORINE

Atomic number = _____
Number of valence electrons = _____
Ion formed by (gain/loss) _____ of _____ electron(s)
Symbol for ion: _____

9; 7; gain; one; F-1

91. Complete the table for the sulfur atom.



SULFUR

The symbol for sulfur is _____
Atomic number = _____
Atomic weight = _____
Symbol of ion = _____

S; 16; 32; S-2

92. What ions are formed from the following atoms?

Oxygen-atomic number 8 _____
Chlorine-atomic number 17 _____
Hydrogen-atomic number 1 _____
Sodium-atomic number 11 _____

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

93. Atoms with four or five electrons in their valence shell usually do not form ions. These we shall discuss later.

Atoms with eight electrons in their valence shells are stable. They do not have to gain or lose electrons. So you would expect these stable atoms to be:

____ very reactive
____ inert (unreactive)

inert (unreactive)

94. The sodium atom, atomic number 11, has how many electron(s) in its valence shell? _____.
The sodium atom will tend to lose the one electron in its valence shell to form an ion with a charge of _____.

1; +1

95. The chlorine atom, which has the symbol _____, has atomic number 17. It has how many electrons in its valence shell? _____

The chlorine atom will tend to gain (how many?) _____ electron(s) to form an ion with a charge of _____.

Cl; 7
1; -1

96. Fill in the diagram to show the reaction between sodium and chlorine.

_____ + _____ ----> _____ + _____

Na + Cl ---> Na+1 + Cl-1

97. The sodium ion and the chlorine ion are oppositely charged. These ions are held together by the attraction of their opposite charges. We say that there is an ionic bond between the sodium ion and the chlorine ion.

An ionic bond is produced whenever one atom loses an electron or electrons and another atom _____ the electron or electrons.

gains

98. In the reaction

Zn + S ---> Zn+2 + S-2

the zinc ion and the sulfur ion are held together by an _____ _____

ionic bond

99. When a sodium atom combines with a chlorine atom, according to the following equation:

Na + Cl ---> Na+1 + Cl-1

a compound containing a positively charged sodium _____ and a _____ charged chlorine _____ is formed.

This compound (sodium chloride) is usually written as NaCl, with the charges being understood and not written.

ion; negatively; ion

100. When the compound NaCl is placed in water, the ionic bond holding the sodium ion and the chlorine ion together is weakened, so that these ions are free to move throughout the solution.

Therefore, NaCl in water produces a solution containing sodium ions (Na+1) and _____ ions (_____).

chlorine; Cl-1

101. When the compound HCl is placed in water, it produces _____ _____ ions (_____) and _____

_____ ions (_____).

When the compound H2SO4 is placed in water, it forms _____ _____ ions and SO4-2 ions.

hydrogen, H+1, chlorine, Cl-1
hydrogen (H+1)

102. Any substance that yields hydrogen ions (H+1) in solution is called acid.

HCl ----> H+1 + Cl-1
H2SO4 ---> 2H+1 + SO4-2
HNO3 ----> H+1 + NO3-1

HNO3 is an acid because it yields _____ inn solution.

hydrogen ions or H+1

103. When the compound NaOH (sodium hydroxide) is placed in water, it forms sodium ions (Na+1) and hydroxide ions (OH-1).

When the compound KOH (potassium hydroxide) is placed in water, it forms potassium ions (_____) and _____ ions (_____).

Complete the reaction:

KOH ----> _____ + _____

K+1, hydroxide, OH-1
KOH --> K+1 + OH-1

104. The compounds KOH and NaOH

___ are acids because they yield hydrogen ions in solution
___ are not acids because they do not yield hydrogen ions in solution

are not acids because they do not yield hydrogen ions in solution.

105. Compounds that yield hydroxide ions (OH-1) in solution are called bases.

$HNO_3 \longrightarrow H^{+1} + NO_3^{-1}$

This compound is (a base/an acid) _____ because it yields _____ ions in solution.

an acid, hydrogen

106.

$Ca(OH)_2 \longrightarrow Ca^{+2} + 2OH^{-1}$

This compound is (a base/an acid) _____ because it yields _____ ions in solution.

base, hydroxide

107. When the compound NaCl is placed in water, it yields _____ _____ ions and _____ ions.

sodium, chlorine

108. The solution of NaCl in water would not be considered as acid because:

___ (a) it yields OH ions
___ (b) it doesn't break up into ions
___ (c) it yields no hydrogen ions

(c) it yields no hydrogen ions

109. Compounds that yield hydrogen ions in solution are called _____

Compounds that yield hydroxide ions in solution are called _____

acids, bases

110. A compound that yields ions other than hydrogen ions or hydroxide ions is called a salt.

The following compounds yield ions in solution as indicated. Are they acids, bases, or salts?

(a) NA2CO3 ----> 2Na+1 + CO3-2 (a) _____
(b) Ca(OH)2 ---> Ca+2 + 2OH-1 (b) _____
(c) MgCl2 -----> Mg+2 + 2Cl-1 (c) _____
(d) H2SO4 -----> 2H+1 + SO4-2 (d) _____
(e) KOH -------> K+1 + OH-1 (e) _____
(f) NH4OH -----> NH4+1 + OH-1 (f) _____

(a)salt; (b)base; (c)salt; (d)acid; (e)base; (f)base

ELECTROLYTES AND NON-ELECTROLYTES

111. We have discussed three kinds of compounds that produce ions in solution:

(a) H+1 ions are produced by compounds called _____
(b) OH-1 ions are produced by compounds called _____
(c) Compounds that produce ions other than H+1 and OH-1 are called _____.

(a) acids; (b) bases; (c) salts

112. A solution that contains ions is called an electrolyte because it conducts electricity.

Would a solution of HCl, and acid, be an electrolyte? _____

$$HCl \text{ ----> } H^{+1} + Cl^{-1}$$

yes

113. Not all compounds produce ions in solution. Because these solutions with no ions do not conduct electricity, they are called non-electrolytes.

Here what happens when magnesium chloride is put in solution:

$$MgCl_2 \text{ -----> } Mg^{+2} + 2Cl^{-1}$$

Does the solution of $MgCl_2$ contain ions? _____
The solution is: (check one)

___ an electrolyte
___ a non-electrolyte

Would this solution conduct electricity? _____

Is $MgCl_2$ an acid, a base, or a salt? _____
(if necessary check frames 109 and 110)

yes; an electrolyte; yes; salt

114. Since acids, bases, and salts yield ions in solution, they are called _____

Alcohol does not yield ions in solution, so it is called _____ _____

electrolytes; a non-electrolyte

pH

115. The acid or basic strength of a solution may be expressed in terms of a number called the pH of that solution. The pH scale expresses the concentration of hydrogen ions (and hydroxide ions) in solution.

The pH range is from 0 to 14, with a pH of 7 indicating a neutral solution. A pH below 7 indicates an acid solution.

(a) A pH of 3 indicates a (n) _____ solution
(b) A pH of 7 indicates a (n) _____ solution
(c) A pH of 6 indicates a (n) _____ solution

(a) acid; (b) neutral; (c) acid

116. Although all pH's below 7 indicate acid solutions, there is a definite progression of acid strengths according to pH values.

pH's between 5 and 7 indicate weak acid solutions; 2 and 5 indicate moderately strong acid solutions; 0 and 2 indicate strong acid solutions.

117.(a) Which of the following pH's indicates a solution containing a strong acid?
4,7,1,6 _____
(b) Which of the following pH's indicates a solution containing a moderately strong acid?
4,7,1,6 _____
(c) A pH of 0 indicates what strength acid solution? _____ _____
(d) A pH of 3 indicates what strength acid solution? _____ _____

(a) 1; (b) 4; (c) strong; (d) moderately strong,

118. pH values may be indicated as decimal values as well as whole numbers. Thus, a pH of 2.56 indicates a solution whose pH lies between 2 and 3, and so is a

___ (a) strong acid solution
___ (b) weak acid solution
___ (c) moderately strong acid solution

(c) moderately strong acid solution

119. Among the following pH's, which solution contains a weak acid?

___ 1.72 ___ 2.00

___ 3.75 ___ 6.27

6.27

120. Among the following pH's, which solution contains a strong acid?

___ 1.72 ___ 5.00

___ 3.75 ___ 6.38

___ 7.00

1.72

121. Of solutions with these pH's, which one is neutral?

___ 2.70 ___ 5.00

___ 4.65 ___ 7.00

7.00

122. A solution whose pH is above 7 is called a basic solution.

A solution whose pH is between 7 and 9 is called a weak basic solution; 9 and 12 is called a moderately strong basic solution; 12 and 14 is called a strong basic solution.

Of the following pH's, which indicates a strong basic solution?

___ 3.5 ___ 13.9

___ 7.0 ___ 6.4

___ 9.5

13.9

123. Of the following pH's, which indicates a weak basic solution?

___ 2.7 ___ 10.8

___ 8.3 ___ 14.0

___ 4.2

8.3

124. Which of the following pH's indicates a moderately strong basic solution?

___ 2.2 ___ 11.1

___ 4.7 ___ 13.7

11.1

125. The pH of saliva lies between 5.5 and 6.9, indicating a _____ solution.

weak acid

126. Bile has a pH range of 7.8 to 8.6, so it is a _____ _____ solution.

weak basic

127. Urine has a pH range of 5.5 to 6.9, so it is a _____ _____ solution.

weak acid

128. The gastric juices have a pH range of 1.6 to 1.8, so they are a _____ solution.

strong acid

129. Blood has a pH range of 7.35 to 7.45, so it is a _____ _____ solution.

weak basic

130. The pancreatic juices have a pH range of 7.5 to 8.0, so they are a _____ solution.

weak basic

CATALYSTS AND ENZYMES

131. Look at these two chemical reactions.

$2\ KClO_3 \xrightarrow{heat} 2\ KCl + 3\ O_2$ (slow reaction)
$2\ KClO_3 + MnO_2 \xrightarrow{heat} 2\ KCl + 3\ O_2 + MnO_2$ (fast reaction)

In the second reaction, is the MnO_2 changed or used up? _____
_____

Does the MnO_2 affect the speed of the reaction (since all the other factors are the same)? _____

MnO_2 is called a catalyst

no; yes

132. A catalyst is a substance that changes the speed of a chemical reaction without being used up itself. Catalysts are usually nonspecific - they can change the speed of many different reactions.

Catalysts are important in reactions involving both substances that are not living or not derived from living organisms and those that are living or are so derived. The specific catalysts for living organisms are called enzymes.

Pepsin is an enzyme found in the gastric juices. It speeds up the reaction for the digestion of protein in the stomach. Note that pepsin is an enzyme for a particular substance - protein. In general, enzymes are highly specific; catalysts are nonspecific.