WELCOME

The publishers of this Aviation Maintenance Technician Certification Series welcome you to the world of aviation maintenance. As you move towards EASA certification, you are required to gain suitable knowledge and experience in your chosen area. Qualification on basic subjects for each aircraft maintenance license category or subcategory is accomplished in accordance with the following matrix. Where applicable, subjects are indicated by an "X" in the column below the license heading.

For other educational tools created to prepare candidates for licensure, contact Aircraft Technical Book Company.

We wish you good luck and success in your studies and in your aviation career!

REVISION LOG

VERSION	EFFECTIVE DATE	DESCRIPTION OF CHANGE
001	2018 12	Module Creation and Release
002	2020 05	Clarified formulas for Buoyant Force (page 2.7) and Vibration (page 2.11)
002.1	2021 05	Corrected formulas for Pendular Movement and Vibration. Sub-Module 02, page 2.11 and page 2.12
002.2	2022 06	Clarified number of electrons in orbital shells. Sub-Module 01, pages 1.2-1.3

MODULE EDITIONS AND UPDATES

ATB EASA Modules are in a constant state of review for quality, regulatory updates, and new technologies. This book's edition is given in the revision log above. Update notices will be available Online at www.actechbooks.com/revisions.html
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MEASUREMENT STANDARDS

SI Units

Measurements in this book are presented with International System of Units (SI) standards in all cases except when otherwise specified by ICAO (for example, altitude expressed in feet or performance numbers as specified by a manufacturer). The chart below can be used should your studies call for conversions into imperial numbers.

Number Groups

This book uses the International Civil Aviation Organization (ICAO) standard of writing numbers. This method separates groups of 3 digits with a space, versus the European method by periods and the American method by commas. For example, the number one million is expressed as:

ICAO Standard	1 000 000
European Standard	1.000.000
American Standard	1,000,000

Prefixes

The prefixes in the table below form names of the decimal equivalents in SI units.

MULTIPLICATION FACTOR	PREFIX	SYMBOL
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deca	da
0.1 = 10^{-1}	deci	d
0.0 1 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	µ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

COMMON CONVERSIONS

IMPERIAL SYSTEM	TO	SI (METRIC)
Distance		
1 Inch	is equal to	2.54 Centimeters
1 Foot	is equal to	0.304 Meters
1 (Statute) Mile	is equal to	1.609 Kilometers
Weight		
1 Pound	is equal to	0.454 Kilograms
Volume		
1 Quart	is equal to	0.946 Liters
1 Gallon	is equal to	3.785 Liters
Temperature		
˚0 Fahrenheit	is equal to	(-)17.778 Celsius (˚C)
˚0 Fahrenheit	is equal to	255.37 Kelvin (K)
Area		
1 Square Inch	is equal to	6.451 Square Centimeters
1 Square Foot	is equal to	0.093 Square Meters
1 Square Mile	is equal to	2.59 Square Kilometers
Velocity		
1 Foot Per Second	is equal to	0.304 Meters Per Second
1 Square Inch	is equal to	1.609 Kilometers Per Hour
1 Square Inch	is equal to	1.852 Kilometers Per Hour

SI (METRIC)	TO	IMPERIAL SYSTEM
Distance		
1 Centimeter	is equal to	0.394 Inches
1 Meter	is equal to	3.28 Feet
1 Kilometer	is equal to	0.621 Miles
Weight		
1 Kilogram	is equal to	2.204 Pounds
Volume		
1 Liter	is equal to	1.057 Quarts
1 Liter	is equal to	0.264 Gallons
Temperature		
˚0 Celsius (˚C)	is equal to	33.8˚ Fahrenheit
˚0 Kelvin (K)	is equal to	(-)437.87 Fahrenheit
Area		
1 Square Centimeter	is equal to	0.155 Square Inches
1 Square Meter	is equal to	10.764 Square Feet
1 Square Kilometer	is equal to	0.386 Square Miles
Velocity		
1 Meter Per Second	is equal to	3.281 Feet Per Second
1 Kilometer Per Hour	is equal to	0.621 Miles Per Hour
1 Kilometer Per Hour	is equal to	0.540 Knots

Pressure		
pounds per square inch (psi)	kiloPascals (kPa)	6.988
pounds per square inch (psi)	Pascals (Pa)	6.895

2.1 - MATTER

Matter is the foundation for any discussion of physics. Matter is what all things are made of; whatever occupies space, has mass, and is perceptible to the senses in some way. According to the Law of Conservation, matter cannot be created or destroyed, but it is possible to change its physical state. When liquid gasoline vaporizes and mixes with air, and then burns, it might seem that this piece of matter has disappeared and no longer exists. Although it no longer exists in the state of liquid gasoline, the matter still exists in the form of the gases given off by the burning fuel.

NATURE OF MATTER

All matter is made up of atoms. An atom is the smallest unit of matter that establishes the unique characteristics of a substance. There are over 100 different kinds of matter each made up of atoms with different physical attributes. These varied and unique kinds of matter are called elements. They cannot be further broken down into simpler substances without losing their unique identity.

Atoms of different elements are similar to each other in that they contain the same basic parts. An atom has a nucleus within the nucleus are subatomic particles. One or more protons are found at the nucleus of all atoms. The proton has a positive electrical charge. One or more neutrons are also found at the nucleus of all atoms. A neutron has no electrical charge. Orbiting around the nucleus is a third kind of subatomic particle called an electron. An electron has a negative electrical charge. Electrons are configured around the nucleus in orderly, concentric rings known as shells. ***Figure 1-1*** illustrates the basic structure and components of atoms.

Generally, each atom contains the same number of electrons and neutrons as the atom has protons. However, the number of these particles that each atom contains is what causes the elements to be different. For example, an atom of hydrogen, has one proton, one neutron and one electron. It is the simplest element. An atom of Oxygen, has eight protons, eight neutrons and eight electrons. Copper has 29 of each of these subatomic particles and so forth. The number of subatomic particles that each atom contains defines the type of element it is and its inherent properties. The mass of an atom is related to how many characteristic subatomic particles make up the atom of each element.

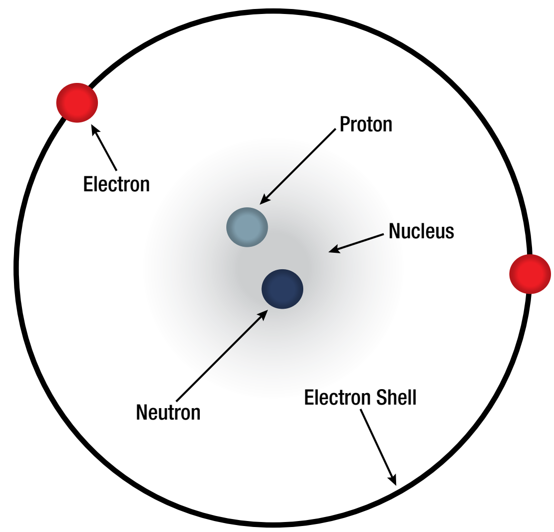

Figure 1-1. An atom and its sub-atomic particles.

Elements are assigned an atomic number according to how many protons are found at the nucleus of their atoms. Each element also has a distinctive 1, 2, or 3 letter abbreviation. The elements are arrange in a table known as the periodic table of elements. The table groups the elements by periods horizontally and by groups vertically to show similar characteristics of the elements. (***Figure 1-2***)

Atoms of the same or different elements may chemically bond to form a molecule. When two or more atoms of the same element bond to form a molecule, it will have the inherent properties of that element. When atoms of different elements bond to form a molecule, the molecule has properties and characteristics completely different than those of each individual elements that comprise it. A water molecule, for example, is made up of two hydrogen atoms and one oxygen atom. Water has its own unique properties that are completely different than those of hydrogen or oxygen alone.

When atoms bond to form molecules, they share electrons. In most cases, the closest shell to the nucleus can only contain two electrons. If the atom has more than two electrons, those are found in the next orbital shell away from the nucleus. The second shell can only hold eight electrons. If the atom has more than 10 electrons (2 + 8), they orbit a third shell further out from the nucleus which can hold a maximum of 18 electrons. If the atom has more than 28 electrons (2 + 8 + 18) a

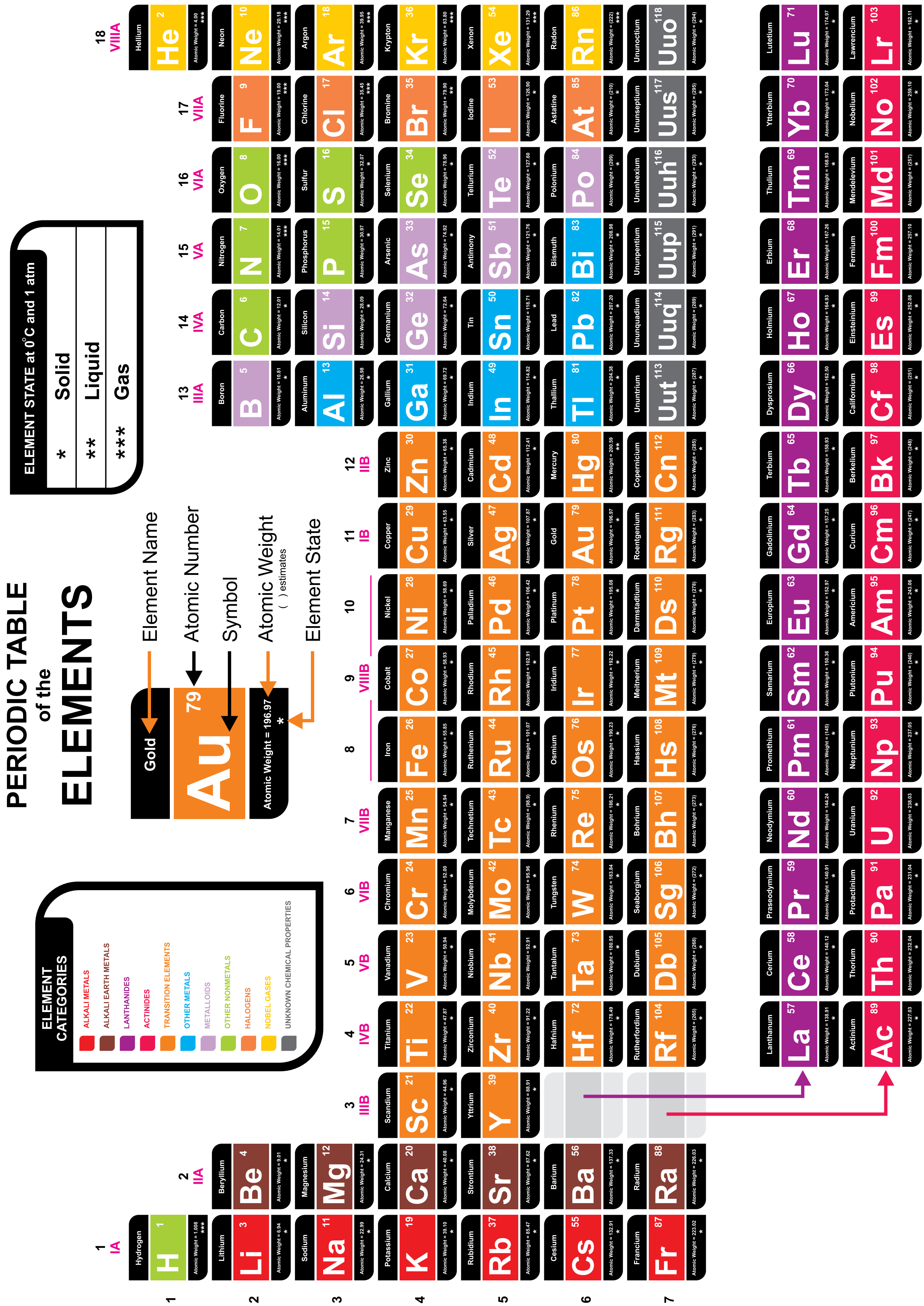

Figure 1-2. The periodic table of elements.

fourth shell forms which can hold up to 32 electrons, etc. (***Figure 1-3***)

The outer most orbital shell of any atom's electrons is called the valence shell. The number of electrons in the valence shell determines the chemical bonding properties of the material as well as other characteristics such as conductivity. When the valence shell has the maximum number of electrons, it is complete and the electrons tend to be bound strongly to the nucleus. Materials with this characteristic are chemically stable. It takes a large amount of force to move the electrons in this situation from one atom valence shell to that of another. Since the movement of electrons is called electric current, substances with complete valence shells are known as good insulators because they resist the flow of electrons (electricity). (***Figure 1-4***)

In atoms with an incomplete valence shell, that is, those without the maximum number of electrons in their valence shell, the electrons are bound less strongly to the nucleus. The material is chemically disposed to combine with other materials or other identical atoms to fill in the unstable valence configuration and bring the number of electrons in the valence shell to maximum. Two or more substances may share the electrons in their valence shells and form a covalent bond. A covalent bond is the method by which atoms complete their valence shells by sharing valence electrons with other atoms. Molecules are formed this way.

Shell or Orbit Number	1	2	3	4	5
Maximum Number Of Electrons	2	8	18	32	50

Figure 1-3. Maximum number of electrons in each orbital shell of an atom.

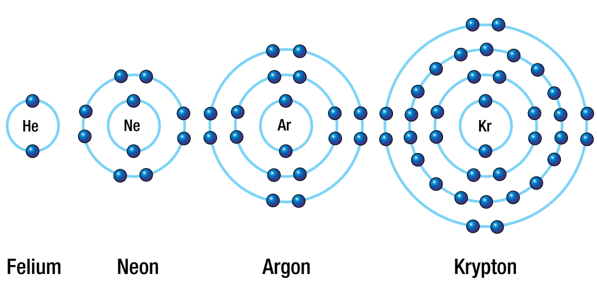

Figure 1-4. Elements with full valence shells are good insulators. Most insulators used in aviation are compounds of two or more elements that share electrons to fill their valence shells.

Electrons in incomplete valence shells may also move freely from valence shell to valence shell of different atoms or compounds. In this case, these are known as free electrons. As stated, the movement of electrons is known as electric current or current flow. When electrons move freely from atom to atom or compound to compound, the substance is known as a conductor. (***Figure 1-5***)

ISOTOPES

When atoms of the same element have different numbers of neutrons, they are called isotopes. Because of the differing numbers of neutrons, various isotopes of the same element have different masses. Mass is the word for how much matter something has and therefore how much it weighs. Because different isotopes have different numbers of neutrons, they do not all weigh the same. Different isotopes of the same element have the same atomic number because they have the same number of protons. The atomic number is decided by the number of protons. (***Figure 1-6***)

Isotopes of the same element also have the same number of electrons and the same electronic structure. Because how an atom acts is decided by its electronic structure, isotopes are almost the same chemically, but they are different physically because of their different masses.

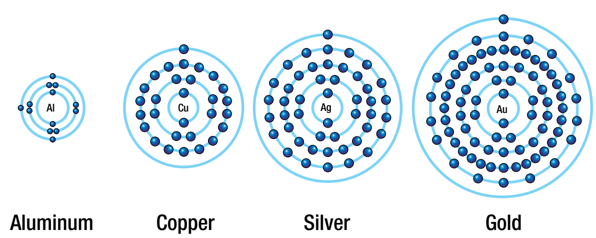

Figure 1-5. The valence shells of elements that are common conductors have one (or three) electrons.

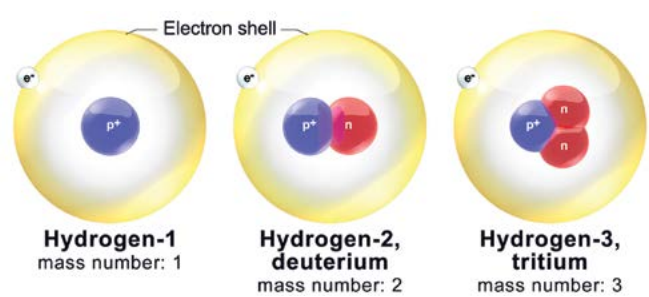

Figure 1-6. Isotopes of hydrogen.