High School Chemistry
2019 - 2020

Instructional Packet Set II
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ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.6) **Science concepts.** The student knows and understands the historical development of atomic theory. The student is expected to (A) understand the experimental design and conclusions used in the development of modern atomic theory, including Dalton's Postulates, Thomson's discovery of electron properties, Rutherford's nuclear atom, and Bohr's nuclear atom;

STANDARD REVIEW

When they develop an explanation for observations about the natural world, scientists begin by proposing a hypothesis that is consistent with recorded data. The hypothesis is a testable explanation that must be supported by additional evidence. If the hypothesis is well-supported, it is expanded into a theory; if it is not supported, scientists look for other explanations. Even when a theory is well-established, a new type of experiment may provide data that are not consistent with the theory. Scientists then propose new hypotheses to explain the inconsistency and begin to modify, or even replace, the theory.

The development of the modern atomic theory has followed this course, beginning with Dalton's original theory and model of the atom. Over time, new observations have caused scientists to review the atomic theory and make changes. The modern model of the atom, consistent with the current observations, is very different from Dalton's model. At each step of the process, new hypotheses were needed.

John Dalton, a British chemist and schoolteacher, published his atomic theory in 1803. Based on how elements combine with one another, Dalton's theory stated that atoms are small particles that cannot be created, divided, or destroyed. Dalton imagined atoms as solid spheres.

In 1897, a British scientist named J. J. Thomson discovered evidence of particles within an atom. Thomson discovered the negatively-charged particles that are now called electrons. Because the electrons have a negative charge, but atoms are electrically neutral, Thomson proposed a new model of the atom. This model, sometimes called the plum-pudding model, represents the atom as a mass of positively-charged material embedded with small negatively-charged electrons.

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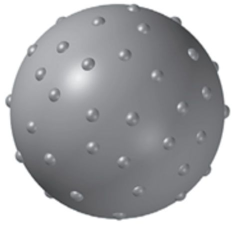
TEKS 2.C.6.A Chemistry

In 1911, British physicist Ernest Rutherford determined that the positively-charged part of the atom is a tiny, extremely dense nucleus. He proposed a new atomic model in which most of the volume of the atom consists of electrons moving rapidly around this nucleus.

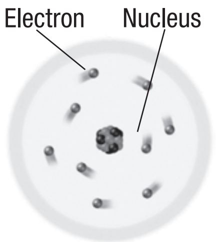
In 1913, Niels Bohr, a Danish scientist, studied the way that atoms react to light. Bohr's results led him to propose that electrons move around the nucleus in certain paths, or energy levels. In Bohr's model, there are no paths between the levels. But electrons can jump from a path in one level to a path in another level with the emission or absorption of energy as light.

In the 1920s, an Austrian physicist named Erwin Schrödinger and a German physicist named Werner Heisenberg developed the theory further, determining that electrons do not travel in definite paths. The exact path of an electron cannot be determined. According to the current theory, there are regions inside the atom where electrons are likely to be found. These regions are called electron clouds.

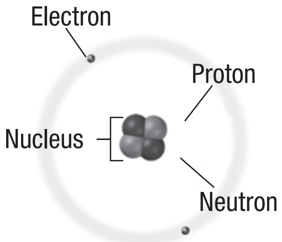
The models below represent the historical development of atomic structure. James Chadwick discovered the neutron in 1932. Scientists then realized that the number of neutrons in an atom's nucleus was what distinguished an element's different isotopes.



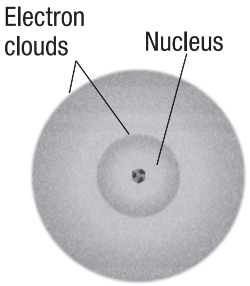
Plum-pudding model



Rutherford's model



Bohr's model



Electron-cloud model

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TEKS 2.C.6.A **Chemistry**

STANDARD PRACTICE

1 Why did Thomson's discovery of the electron mean that new hypotheses needed to be developed to explain atoms?

A It showed that the atom was made up of smaller particles.

B It showed that the atom has an electric charge.

C It showed that atoms are not the basic component of an element.

D It showed that atoms have a nucleus surrounded by electrons.

2 What causes an atom to emit the light that is detected in its emission spectrum?

A Raising an electron to a higher energy level

B Rearrangement of the particles in the nucleus

C Loss of an electron from its highest energy level

D Movement of an electron from a higher energy level to a lower level

3 What major change in understanding the atomic structure could have led to the difference between Thomson's model and Rutherford's model?

A The atom has a dense, negatively-charged nucleus.

B The atom has a dense, positively-charged nucleus.

C Electrons are located at discrete locations far from the nucleus.

D Electrons are not negatively-charged particles orbiting the nucleus, but rather they are cloudlike.

4 An atom of potassium has 19 protons and 20 neutrons. According to the current atomic theory, how many electrons does the potassium atom have?

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TEKS 2.C.6.B Chemistry

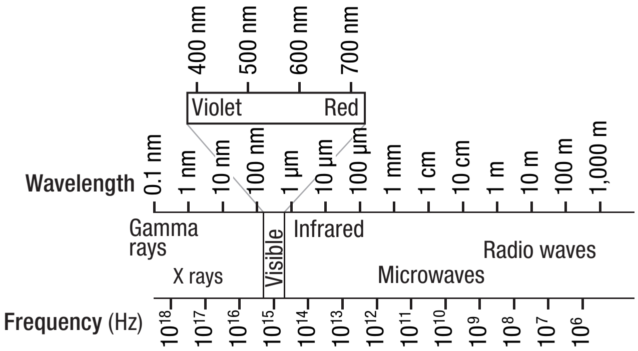
ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.6) **Science concepts.** The student knows and understands the historical development of atomic theory. The student is expected to (B) understand the electromagnetic spectrum and the mathematical relationships between energy, frequency, and wavelength of light;

STANDARD REVIEW

Waves transfer energy as they travel, and waves can do work. For a long time, scientists thought that the universe was filled with a medium that carried light waves, just as matter carries sound waves. We now know that the energy of an electromagnetic wave is carried by the interaction of magnetic and electrical fields. The amount of energy carried by a wave is related to its frequency (the number of cycles in a period of time) and to the wavelength (distance from crest to crest of the wave). For a particular type of wave, an increase in frequency increases the amount of energy that the wave carries. Since an increase in the frequency of waves also means a decrease in the wavelength of waves, the shorter the wave, the more energy it carries.



The speed of a wave is its frequency multiplied by its wavelength. The speed of light (c) is 300,000,000 meters per second (3.00×10^8 m/s), so wavelength (λ) and frequency (f) can be calculated using the formulas.

$$\lambda = c/f$$

$$f = c/\lambda$$

Units for wavelength are meters, and units for frequency are reciprocal seconds (1/s) or hertz, (Hz).

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TEKS 2.C.6.B **Chemistry**

STANDARD PRACTICE

1 Which of these types of waves carries the most energy?

- **A** Gamma rays
- **B** Microwaves
- **C** Ultraviolet light
- **D** Visible light

2 Which of these colors of visible light carries the least energy?

- **A** Violet ($\lambda = 420$ nm)
- **B** Blue ($\lambda = 475$ nm)
- **C** Green ($\lambda = 540$ nm)
- **D** Yellow ($\lambda = 580$ nm)

3 What causes a wave of light to propagate?

- **A** Disturbance of a medium as energy passes through it
- **B** Interaction of a magnetic field and an electrical field
- **C** Conversion of matter into energy
- **D** Effects of an electrical field on a vacuum

4 What is the wavelength, in meters, of an electromagnetic wave that has a frequency of 1.5×10^5 Hz?

TEKS 2.C.6.C Chemistry

ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.6) **Science concepts.** The student knows and understands the historical development of atomic theory. The student is expected to (C) calculate the wavelength, frequency, and energy of light using Planck's constant and the speed of light;

STANDARD REVIEW

As with any wave, light waves transfer energy. The amount of energy carried by light is a function of its wavelength and frequency. Because the speed of light (in a vacuum) is constant, these properties are directly related to one another. The energy of light is calculated using wavelength, frequency, the speed of light, and a factor, known as Planck's constant, which relates energy and frequency. The following values and equations are used to calculate the energy of light.

Constants and variables:

Frequency of light (Hz or s^{-1})	v
Wavelength of light (m)	λ
Energy (J)	E
Speed of light (m/s)	$c = 3.00\times 10^8$ m/s
Energy (electron volts)	eV (1 eV = 1.60×10^{-19} J)
Planck's constant	$h = 6.63 \times 10^{-34}$ J•s

Equations:

Energy of a Quantum of Light:	$E_{photon} = hv$
Light Wave Speed Equation:	$c = f\lambda$
Combined Quantum of Light and Light Wave Speed Equation:	$E = hc/\lambda$

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TEKS 2.C.6.C Chemistry

STANDARD PRACTICE

1 A photon of UV light has an energy of 3.94 eV. What is its frequency?

A 7.61×10^{7} Hz

B 9.51×10^{14} Hz

C 3.83×10^{32} Hz

D 5.94×10^{33} Hz

2 Radiation emitted from a hot object reaches its peak at $\lambda = 850$ nm. What is the frequency of this radiation?

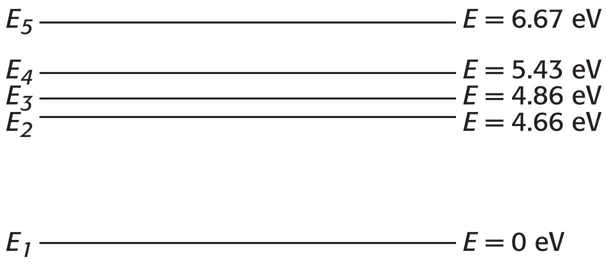
A 1.5×10^{0} Hz

B 3.5×10^{5} Hz

C 5.3×10^{12} Hz

D 3.5×10^{14} Hz

3 This figure shows the energy-level diagram for the first five energy levels for mercury vapor. The energy of E_1 is defined as zero. (Note: The figure is not to scale.)



What is the frequency of the photon emitted when an electron drops from energy level E_3 to E_1 in a mercury atom?

A 4.83×10^{13} Hz

B 1.12×10^{15} Hz

C 1.17×10^{15} Hz

D 1.61×10^{15} Hz

4 To three significant figures, what is the energy, in eV, of a photon of red light whose wavelength is 667 nm ($1 \text{ nm} = 10^{-9}$ m)?

Name____ Date____________

TEKS **2.C.6.D** **Chemistry**

ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.6) **Science concepts.** The student knows and understands the historical development of atomic theory. The student is expected to (D) use isotopic composition to calculate average atomic mass of an element;

STANDARD REVIEW

Atoms of the same element that have different numbers of neutrons, and therefore different atomic masses, are called isotopes. The calculation for the average atomic mass of an element uses both the mass and the relative abundance of each isotope of the element. The atomic mass of each isotope is multiplied by the decimal that represents the isotope's relative abundance. The products of all of these calculations are then added to find the weighted average value, which is the average atomic mass of the element.

Some isotopes are more stable than others. In general, light elements have about the same number of protons as neutrons. Heavier elements, however, generally need more neutrons than protons to provide stability to the nucleus. The number of stable isotopes varies from one isotope for a few elements to ten stable isotopes for tin. In addition many elements have unstable isotopes. Unstable isotopes are radioactive and decay over time.

To find the average atomic mass, multiply the mass of each isotope by the decimal fraction of its abundance. For example, copper has two stable isotopes, with masses of 62.9 u and 64.9 u. The relative abundance of copper-63 is 69.15%, or 0.6915, and the relative abundance of copper-65 is 30.85% or 0.0385. The average atomic mass of copper is:

$$(0.6915 \times 62.9) + (0.3085 \times 64.9\ ) = 43.5 + 20.0 = 63.5\ \text{u}$$

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TEKS 2.C.6.D Chemistry

STANDARD PRACTICE

1 Chlorine has two natural isotopes, chlorine-35 (34.97 u) and chlorine-37 (36.97 u), whose relative abundances are 75.8% and 24.2%. What is the average atomic mass of chlorine?

A 26.5 u

B 35.5 u

C 36.0 u

D 36.5 u

2 Magnesium has three stable isotopes, magnesium-24 (23.99 u), magnesium-25 (24.99 u), and magnesium-26 (25.98 u), whose relative abundances are 78.9%, 10.0%, and 11.1%. What is the average atomic mass of magnesium?

A 24.3 u

B 24.8 u

C 25.0 u

D 25.7 u

3 Potassium has three stable isotopes, potassium-39 (38.96 u), potassium-40 (39.96 u), and potassium-41 (40.96 u), whose relative abundances are 93.26%, 0.012%, and 6.73%. What is the average atomic mass of potassium?

A 38.9 u

B 39.1 u

C 39.8 u

D 40.1 u

4 Gallium has two natural isotopes, gallium-69 (68.93 u) and gallium-71 (70.92 u), whose relative abundances are 60.1% and 39.9%. What is the average atomic mass of gallium?

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TEKS 2.C.6.E Chemistry

ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.6) **Science concepts.** The student knows and understands the historical development of atomic theory. The student is expected to (E) express the arrangement of electrons in atoms through electron configurations and Lewis valence electron dot structures.

STANDARD REVIEW

The arrangement of the electrons around the nucleus can be shown using electron configuration notation. The number of electrons in a sublevel is shown by adding a superscript to the sublevel designation. The hydrogen configuration is represented by $1s^1$. The superscript indicates that one electron is present in hydrogen's 1*s* orbital. The helium configuration is represented by $1s^2$. Here the superscript indicates that there are two electrons in helium's 1*s* orbital.

As more electrons are added, the notation is extended. Because the energy of the 3*d* orbitals is slightly higher than the energy of the 4*s* orbitals, the order in which the orbitals are filled is as follows:

$$1s < 2s < 2p < 3s < 3p < 4s < 3d$$

For example, sulfur has sixteen electrons. Its electron configuration is written as $1s^22s^22p^63s^23p^4$. This line of symbols tells us about these sixteen electrons. Two electrons are in the 1*s* orbital, two electrons are in the 2*s* orbital, six electrons are in the 2*p* orbitals, two electrons are in the 3*s* orbital, and four electrons are in the 3*p* orbitals. Each element's configuration builds on the previous elements' configurations. To save space, one can write this configuration by using a configuration of a noble gas. The noble gas electron configurations that are often used are the configurations of neon, argon, krypton, and xenon. The neon atom's configuration is $1s^22s^22p^6$, so the electron configuration of sulfur can be written $[\mathrm{Ne}]3s^23p^4$.

Name____ Date____________

TEKS 2.C.6.E Chemistry

The electrons above the noble gas configurations are valence electrons. Valence electrons are important in chemical reactions. They are often shown in Lewis structures as shown on the table.

Element	Electron configuration	Number of valence electrons	Lewis structure (for bonding)
Li	$1s^2 2s^1$	1	$\mathrm{Li}\cdot$
Be	$1s^2 2s^2$	2	$\overset{\cdot}{\mathrm{Be}}\cdot$
B	$1s^2 2s^2 2p^1$	3	$\overset{\cdot}{\underset{\cdot}{\mathrm{B}}}\cdot$
C	$1s^2 2s^2 2p^2$	4	$\cdot\overset{\cdot}{\underset{\cdot}{\mathrm{C}}}\cdot$
N	$1s^2 2s^2 2p^3$	5	$:\overset{\cdot}{\underset{\cdot}{\mathrm{N}}}\cdot$
O	$1s^2 2s^2 2p^4$	6	$:\overset{\cdot\cdot}{\underset{\cdot}{\mathrm{O}}}\cdot$
F	$1s^2 2s^2 2p^5$	7	$:\overset{\cdot\cdot}{\underset{\cdot\cdot}{\mathrm{F}}}\cdot$
Ne	$1s^2 2s^2 2p^6$	8	$:\overset{\cdot\cdot}{\underset{\cdot\cdot}{\mathrm{Ne}}}:$

Name____ Date____________

STANDARD PRACTICE

1 Argon is the third period noble gas. What is the electron configuration of argon?

A $1s^22s^22p^63s^2$

B $1s^22s^22p^63s^8$

C $1s^22s^22p^63s^23p^6$

D $1s^22s^22p^63s^23p^8$

2 The electron configuration of an element is $1s^22s^22p^63s^23p^3$. How many valence electrons does this element have?

A 2

B 3

C 5

D 11

3 The Lewis structure for chlorine is shown below. What do you know about chlorine based on this structure?

A The atomic number of chlorine is seven.

B Chlorine has seven valence electrons.

C Chlorine has seven electrons in its level 4 orbital.

D Chlorine does not have any electrons in *p* suborbitals

4 How many electrons can be contained in the second energy level of an atom: 2, 6, 8, or 18?

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TEKS 2.C.12.A Chemistry

ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.12) **Science concepts.** The student understands the basic processes of nuclear chemistry. The student is expected to (A) describe the characteristics of alpha, beta, and gamma radiation;

STANDARD REVIEW

Certain isotopes of many elements undergo a process called radioactive decay. During radioactive decay, the unstable nuclei of these isotopes emit particles, or release energy, to become stable isotopes. After radioactive decay, the element changes into a different isotope of the same element or into an entirely different element. The table shows four kinds of radiation that can be emitted during nuclear decay.

Radiation type	Symbol	Mass (kg)	Charge (electronic charge)
Alpha particle	$^{4}_{2}\mathrm{He}$	6.646×10^{-27}	+2
Beta particle	$^{0}_{-1}e$	9.109×10^{-31}	-1
Gamma ray	γ	none	0
Neutron	$^{1}_{0}n$	1.675×10^{-27}	0

Alpha particles are the most massive form of radiation resulting from nuclear decay. They consist of two neutrons and two protons. Some reactions emit neutrons. These particles have only one fourth of the mass of an alpha particle and have no charge. Beta particles are the same as an electron in charge and mass. When a beta particle is emitted, a neutron in the nucleus is simultaneously converted to a proton. Gamma rays have neither mass nor charge.

Although nuclear radiation has many uses, there are also risks, because nuclear radiation interacts with living tissue. Alpha and beta particles, as well as gamma rays, can ionize molecules in the cells and tissues of living things. This process may form substances that are harmful to life. The risk of damage from nuclear radiation depends on both the type and the amount of radiation exposure. The ability to penetrate matter differs among different types of nuclear radiation. A layer of clothing or an inch of air can stop alpha particles. Beta particles are lighter and faster than alpha particles. Beta particles can penetrate a fraction of an inch in solids and liquids and can travel several feet in air. Several feet of material may be required to protect you from high-energy gamma rays.

Name____ Date____________

STANDARD PRACTICE

1 Based on the information in the table on the previous page, which type of radiation can be considered identical to the nucleus of a helium atom?

A Alpha particle

B Beta particle

C Gamma ray

D Neutron

2 Which of the following is identical to a beta particle?

A Proton

B Electron

C Helium nucleus

D Neutron

3 Which electromagnetic waves are produced during some nuclear reactions?

A Gamma rays

B Microwaves

C Radio waves

D Ultraviolet radiation

4 An atom of barium-140 has 56 protons and 84 neutrons. If the atom emits a beta particle from its nucleus, it becomes an atom of lanthanum. What is the mass number of the lanthanum atom?

Name____ Date_____________

TEKS 2.C.12.B Chemistry

ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.12) **Science concepts.** The student understands the basic processes of nuclear chemistry. The student is expected to (B) describe radioactive decay process in terms of balanced nuclear equations;

STANDARD REVIEW

The symbol for the nuclear structure of an element consists of the element's symbol with a subscript and superscript to its left, representing the nuclear charge (number of protons) and the nuclear mass (number of protons + number of neutrons) of the atom. The nuclear symbols for all of the isotopes of an element have the same subscript but different superscripts. For example, carbon-12 is represented as ${}^{12}_{6}C$ while carbon-14 is represented as ${}^{14}_{6}C$.

Equations representing nuclear reactions show the atomic numbers and mass numbers, the total of which must be equal on both sides of the equation. For example:

$${}^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$$

The symbol ${}^{1}_{0}n$ represents a neutron with a mass of one and a charge of zero. The total masses on the left and on the right sides of this nuclear equation are 13; the total charges are 6. Therefore, the equation is balanced.

Notice that when the atomic number changes, the identity of the element changes. Identity is determined by the charge number, because this is the number of protons in the nucleus. These equations represent reactions that take place in the nucleus, so the electronic charge on the atom is not indicated. That means the symbol ${}^{4}_{2}He$ is used both for a helium atom and for an alpha particle, which is a helium nucleus with no electrons and a double positive charge. The symbol for a beta particle, identical to an electron, is ${}^{0}_{-1}e$. This symbol indicates that the beta particle has no mass (relative to the mass of a neutron or proton) and a –1 charge.

Name____ Date____________

TEKS 2.C.12.B Chemistry

STANDARD PRACTICE

1 Which of the following correctly completes the nuclear equation?

$$^{87}_{37}\text{Rb} \rightarrow\, ^{87}_{38}\text{Sr} + \underline{\qquad}$$

A $^{0}_{1}e$

B $^{0}_{-1}e$

C $^{1}_{0}n$

D $^{0}_{1}n$

2 Which of the following is a correctly balanced nuclear equation?

A $^{212}_{84}\text{Po} + {}^{4}_{2}\text{He} \rightarrow {}^{208}_{82}\text{Pb}$

B $^{238}_{92}\text{U} + {}^{1}_{0}n \rightarrow {}^{237}_{92}\text{U}$

C $^{13}_{6}\text{C} \rightarrow {}^{12}_{6}\text{N} + {}^{1}_{0}n$

D $^{43}_{19}\text{K} \rightarrow {}^{43}_{20}\text{Ca} + {}^{0}_{-1}e$

3 Which of the following is a product when the nucleus of $^{135}_{55}\text{Cs}$ undergoes beta decay?

A $^{131}_{55}\text{I}$

B $^{134}_{55}\text{Cs}$

C $^{135}_{56}\text{Ba}$

D $^{136}_{55}\text{Cs}$

4 How many neutrons are produced in this fission reaction?

$$^{235}_{92}\text{U} + {}^{1}_{0}n \rightarrow {}^{93}_{36}\text{Kr} + {}^{140}_{56}\text{Ba} + ?{}^{1}_{0}n$$

Name____ Date______________

TEKS 2.C.12.C Chemistry

ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY

The student will demonstrate an understanding of atomic theory and nuclear chemistry.

(C.12) **Science concepts.** The student understands the basic processes of nuclear chemistry. The student is expected to (C) compare fission and fusion reactions.

STANDARD REVIEW

Nuclear fission and nuclear fusion are changes that involve the nucleus of the atom. During nuclear reactions, nuclei change into more stable forms. At the same time, a very small amount of the mass of the nucleus is converted to energy. This conversion releases enormous amounts of energy – enough to run nuclear power plants and to keep stars burning for billions of years.

The process of splitting heavier nuclei into lighter nuclei is called fission. The combined mass of the two lighter nuclei is slightly less than the mass of the original nucleus. When the nucleus splits, both neutrons and energy are released. A released neutron can cause another nucleus to split. One reaction triggers another fission reaction, causing a nuclear chain reaction. Nuclear reactors use the energy produced by nuclear chain reactions, and are used in dozens of countries to generate electricity. Uranium is a common fuel for nuclear fission.

$$^{236}_{92}\mathrm{U} \rightarrow {}^{144}_{56}\mathrm{Ba} + {}^{89}_{36}\mathrm{Kr} + 3\,^{1}_{0}n + \text{Energy}$$

The sun uses the nuclear fusion of hydrogen atoms into helium atoms to produce energy. Hydrogen nuclei come together to form a helium nucleus. Because the helium nucleus is slightly less massive than the original hydrogen nuclei, the reaction releases large amounts of energy. In the cores of stars, conditions exist that cause nuclei larger than hydrogen to fuse together. Scientists think that all of the elements with nuclei larger than helium were formed inside stars by nuclear fusion. Because fusion requires that the electric repulsion between protons be overcome, these reactions are difficult to produce in the laboratory. However, scientists are conducting many experiments in the United States, Japan, and Europe to learn how people can exploit fusion to create a clean source of power that uses fuels extracted from ordinary water. Some scientists estimate that 1 kg of hydrogen in a fusion reactor could release as much energy as 16 million kg of burning coal. The fusion reaction itself releases very little waste or pollution. In the equation below, the Greek letter β represents a positron, a particle with the mass of an electron but having a positive charge.

$$4\,^{1}_{1}\mathrm{H} \longrightarrow {}^{4}_{2}\mathrm{He} + 2\,^{0}_{+1}\beta + \text{energy}$$

Name____ Date_____________

TEKS 2.C.12.C Chemistry

STANDARD PRACTICE

1 What is a major advantage of using hydrogen fusion for energy generation?

A It takes place at extremely high temperatures.

B It is a very advanced and complex scientific process.

C Its major byproduct is helium, a safe and stable element.

D It decreases the amount of hydrogen on Earth.

2 What is the source of the energy produced by the fission of uranium in a nuclear power plant?

A Mass is converted to energy as the uranium nucleus and the neutron combine.

B Energy is released as heat, because the products have more particles than the reactants.

C Protons and electrons release energy as they come together to form the three neutrons.

D Due to the mass defect, the reactants have more mass than the products, and the difference is converted to energy.

3 What is the source of energy emitted by the sun?

A Nuclear fusion

B Nuclear fission

C Nuclear radiation

D Nuclear chain reaction

4 Hydrogen nuclei fuse into larger helium nuclei in the sun's core. How would a similar process explain the formation of all the other chemical elements?

A Larger elements can fuse with each other, creating even larger new elements.

B Fused elements can break apart by a process called fission, creating new elements.

C Other elements are generated as byproducts of the fusion of hydrogen into helium.

D Helium and hydrogen can be mixed in chemical compounds to create new elements.

Name____ Date____________

TEKS 1.C.4.A Chemistry

MATTER AND THE PERIODIC TABLE

The student will demonstrate an understanding of the properties of matter and the periodic table.

(C.4) **Science concepts.** The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to (A) differentiate between physical and chemical changes and properties;

STANDARD REVIEW

A physical change is any change in which the physical properties of a substance change but the identity of the substance does not. Changes of state, for example, are physical changes because the chemical nature of the substance remains the same and the substance can be returned to its original form by another change of state. Physical properties and changes can be used to separate a mixture of the solids sulfur and sodium chloride (table salt). Water is added to the mixture. The salt dissolves in water, while the sulfur floats on top. The salt can be recovered by evaporation of the water.

Chemical changes happen when bonds between atoms are broken, or when new bonds are formed to make new substances. These changes are called chemical reactions. An example is the burning of wood, which has the chemical property of flammability. As wood and oxygen react, they change into new substances that have different properties from the original wood and oxygen. A variety of clues indicates chemical changes.

To know for certain that a chemical reaction has taken place requires evidence that one or more substances have undergone a change in identity. Absolute proof of such a change can be provided only by chemical analysis of the products. However, certain easily observed changes usually indicate that a chemical reaction has occurred:

- **Release of energy as heat and light.** A change in matter that releases energy as both heat and light is strong evidence that a chemical reaction has taken place. Heat or light by itself is not necessarily a sign of chemical change, because many physical changes also involve either heat or light.
- **Production of a gas.** The evolution of gas bubbles when two substances are mixed is often evidence of a chemical reaction.
- **Formation of a precipitate.** Many chemical reactions take place between substances that are dissolved in liquids. If a solid appears after two solutions are mixed, a chemical reaction has likely occurred.
- **Color change.** A change in color is often an indication of a chemical reaction.

Name____ Date______________

TEKS 1.C.4.A Chemistry

STANDARD PRACTICE

1 Carbonated seltzer water is a solution of water and carbon dioxide gas. A glass of seltzer water is left on a table. Bubbles of carbon dioxide leave the water, and the seltzer goes flat. What kind of change is this an example of, and how do you know?

A It is a chemical change, because a gas was formed.

B It was a chemical change, because two substances were mixed.

C It was a physical change, because there was no change in color.

D It was a physical change, because the water and carbon dioxide did not change.

2 A solid that forms in a solution during a chemical reaction is called a(n)–

A element

B precipitate

C mixture

D bond

3 Which of the following is an example of a chemical change?

A Nitrogen and oxygen mix to form air.

B Hydrogen and nitrogen form ammonia.

C Salt dissolves in a glass of water.

D A liquid changes into a gas when it is heated.

4 Which of these observations would likely be an indication of a chemical change?

A A change in odor when two substances are mixed

B A change in temperature when a hot substance is left standing in air

C A change in volume as a substance is heated

D The disappearance of a liquid as it boils

Name____ Date____________

TEKS 1.C.4.B Chemistry

MATTER AND THE PERIODIC TABLE

The student will demonstrate an understanding of the properties of matter and the periodic table.

(C.4) **Science concepts.** The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to (B) identify extensive and intensive properties;

STANDARD REVIEW

The physical properties of chemical substances can be described as extensive properties or as intensive properties. An extensive property is one that is directly proportional to amount of material. Examples of extensive properties include mass, number of atoms or molecules, and volume under given conditions. You can identify extensive properties by the behavior of the material when the amount changes. If you double the amount of gas in an expandable container, but keep the pressure and temperature constant, the volume of gas will double. If you triple the number of molecules of gas, the volume will triple, as will the mass. Therefore, volume and mass are extensive properties.

Intensive properties are those that remain constant when the amount of material changes. Many intensive properties can be used to identify a substance. Melting point, freezing point, specific heat capacity, concentration of a solution, and ductility of a metal are intensive properties. If you double the amount of water in a container, it will freeze at the same temperature, 0°C. Another intensive property is density. Doubling the amount of material changes its extensive properties, mass and volume. The intensive property of the material, density, is mass per unit volume. As mass and volume both double, the density remains constant.

You know that heat and temperature are different because you know that when two samples at different temperatures are in contact, energy can be transferred as heat. Heat and temperature differ in other ways. Temperature is an intensive property, which means that the temperature of a sample does not depend on the amount of the sample. However, heat is an extensive property, which means that the amount of energy transferred as heat by a sample depends on the amount of the sample. So, water in a glass and water in a pitcher can have the same temperature. But the water in the pitcher can transfer more energy as heat to another sample because the water in the pitcher has more particles than the water in the glass.

Name____ Date____________

TEKS 1.C.4.B Chemistry

STANDARD PRACTICE

1 Which of the following is an example of an intensive property?

A Mass

B Density

C Weight

D Volume

2 How can you determine whether a measured value of a substance represents an extensive property?

A Its value will double as the density of the material doubles.

B Its value is directly proportional to the specific heat capacity of the material.

C Its value is constant even though the volume of material is changed.

D Its value will be reduced as the number of moles of the material is reduced.

3 Which of the following is an example of an extensive property?

A Density

B Color

C Length

D Freezing point

4 Molar heat capacity is an intensive property of a material. If the molar heat capacity of 1.0 g of silver is 25.3 J/K•mol, what is the molar heat capacity, in J/K•mol, of 2.0 g of silver?

Name____ Date______________

TEKS 1.C.4.C Chemistry

MATTER AND THE PERIODIC TABLE

The student will demonstrate an understanding of the properties of matter and the periodic table.

(C.4) **Science concepts.** The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to (C) compare solids, liquids, and gases in terms of compressibility, structure, shape, and volume;

STANDARD REVIEW

Matter is generally found in three different states. The kinetic molecular theory is based on the idea that particles of matter are always in motion. The theory can be used to explain the properties of solids, liquids, and gases in terms of the energy of particles and the forces that act between them.

Gases do not have a definite shape or a definite volume. They completely fill any container in which they are enclosed, and they take its shape. A gas transferred from a one-liter vessel to a two-liter vessel will quickly expand to fill the entire two-liter volume. Gas particles move rapidly in all directions without significant attraction between them so, gas particles glide easily past one another. The density of a gaseous substance at atmospheric pressure is about 1/1000 the density of the same substance in the liquid or solid state because the particles are so much farther apart. Gases are compressible, which means the volume of a given sample of a gas can be greatly decreased by increasing the pressure, or forcing the particles closer together. Gases spread out and mix with one another, even without being stirred, due to the random and continuous motion of atoms or molecules. This mixing process is called diffusion.

A liquid has a definite volume and takes the shape of its container. As in a gas, particles in a liquid are in constant motion, but the particles in a liquid are closer together than the particles in a gas. Attractive forces between particles in a liquid are more effective than those between particles in a gas. This attraction between liquid particles is caused by intermolecular forces: dipole-dipole forces, London dispersion forces, and hydrogen bonding. Liquids are more ordered than gases because of the stronger intermolecular forces and the lower mobility of the liquid particles. The particles are not bound together in fixed positions so they move about constantly. Liquids are much denser than gases because of the close arrangement of liquid particles. Liquids are much less compressible than gases because liquid particles are more closely packed together. The constant, random motion of particles causes diffusion in liquids, as it does in gases, but at a much slower rate.

Name____ Date_____________

TEKS 1.C.4.C Chemistry

The particles of a solid are more closely packed than those of a gas, and usually more closely packed than those of a liquid. Intermolecular forces such as dipole-dipole attractions, London dispersion forces, and hydrogen bonding exert stronger effects in solids than in the corresponding liquids or gases. These attractive forces tend to hold the particles of a solid in relatively fixed positions, with only vibrational movement around fixed points. Because the motions of the particles are restricted in this way, solids are more ordered than liquids and are much more ordered than gases. Unlike liquids and gases, solids can maintain a definite shape without a container. Solids have definite volume because their particles are packed closely together. For practical purposes, solids can be considered incompressible.

Name____ Date____________

TEKS 1.C.4.C Chemistry

STANDARD PRACTICE

1 Which process could cause a material to change state from gas to liquid?

A Removing energy from the molecules

B Reducing the pressure on its molecules

C Increasing the distance between molecules

D Increasing the temperature of the molecules

2 Which of these substances is a liquid at room temperature and standard pressure?

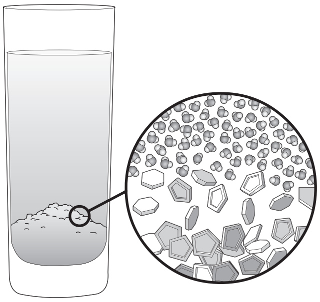
A Gold

B Oxygen

C Table salt

D Water

3 In the figure of molecules below, what is occurring?



A Nitrogen and oxygen mix to form air.

B Hydrogen and nitrogen form ammonia.

C Sugar dissolves in a glass of water.

D A liquid changes into a gas when it is heated.

4 About how many times as much volume does a gas occupy compared to the same substance as a liquid or solid under normal conditions?

Name____ Date_____________

MATTER AND THE PERIODIC TABLE

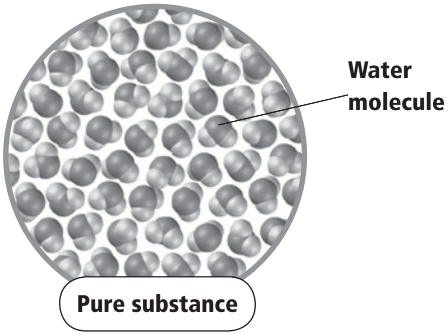
The student will demonstrate an understanding of the properties of matter and the periodic table.

(C.4) **Science concepts.** The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to (D) classify matter as pure substances or mixtures through investigation of their properties.

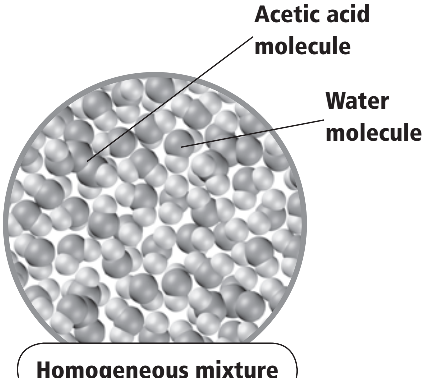
STANDARD REVIEW

A pure substance is matter that has a fixed composition and definite properties. Pure substances include elements and compounds. An element is a substance that cannot be broken down into simpler substances by chemical means. A compound is a pure substance composed of two or more elements that are chemically combined. Elements combine by reacting, or undergoing a chemical change, with one another. A chemical change, or reaction, happens when one or more substances are changed into one or more new substances that have new and different properties and different arrangements of atoms.

A mixture is a blend of two or more kinds of matter, each of which retains its own identity and properties. The parts, or components, of a mixture are simply mixed together physically and can usually be separated. Because mixtures are not chemically combined, each part of a mixture has the same chemical makeup that it had before the mixture was formed. Elements and compounds are pure substances, but mixtures are not. A mixture can be physically separated into its parts, while the parts of a pure substance are chemically combined and cannot be physically separated.



Pure substance



Homogeneous mixture

Mixtures are defined by how well their substances are mixed. The vegetables in a salad are not evenly distributed. One spoonful may contain tomatoes. Another spoonful may have cucumber slices. A mixture such as a salad is a heterogeneous mixture. The substances in a heterogeneous mixture are not evenly distributed. In a homogeneous mixture, the components are evenly distributed. The mixture is the same throughout. For example, vinegar is a homogeneous mixture of evenly-distributed water molecules and acetic acid molecules.

Name____ Date____________

TEKS 1.C.4.D Chemistry

STANDARD PRACTICE

1 Which of the following materials should be classified as a mixture?

A Air

B Carbon

C Salt

D Water

2 A bottle of dish washing detergent contains a clear, viscous liquid. The label has a long list of ingredients, including water, sodium lauryl sulfate, fragrance, and Yellow dye #5. What can you infer about the material in the bottle from this label and the appearance of the liquid?

A It is a pure substance.

B It is a compound.

C It is a heterogeneous mixture.

D It is a homogeneous mixture.

3 How can you determine whether nitrogen dioxide is a compound or a mixture?

A Nitrogen, oxygen, and nitrogen dioxide are gases, so nitrogen dioxide is a mixture.

B Nitrogen, oxygen, and nitrogen dioxide are gases, so nitrogen dioxide is a compound.

C The properties of nitrogen dioxide are different from nitrogen and oxygen, so it is a mixture.

D The properties of nitrogen dioxide are different from nitrogen and oxygen, so it is a compound.

4 In a mixture, which of the following is always true?

A It is a liquid.

B It contains dissolved solids.

C It is composed of two or more pure substances.

D It cannot be separated into individual components.

Name____ Date_____________

TEKS 1.C.5.A Chemistry

MATTER AND THE PERIODIC TABLE

The student will demonstrate an understanding of the properties of matter and the periodic table.

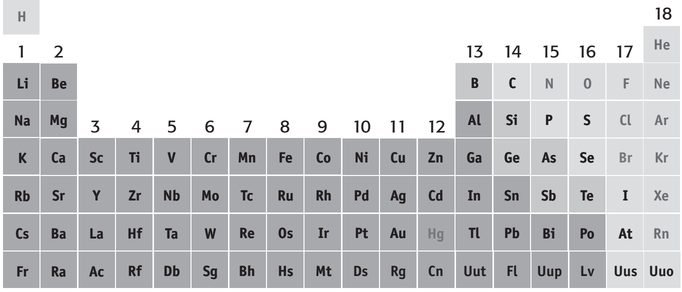
(C.5) **Science concepts.** The student understands the historical development of the Periodic Table and can apply its predictive power. The student is expected to (A) explain the use of chemical and physical properties in the historical development of the Periodic Table;

STANDARD REVIEW

Dmitri Mendeleev, a Russian chemist, made a scientific contribution by discovering a pattern to the elements in 1869. Mendeleev saw that when the elements were arranged in order of increasing atomic mass, those that had similar properties fell into a repeating pattern. That is, the pattern was periodic. Periodic means "happening at regular intervals." The days of the week are periodic. They repeat in the same order every seven days. Similarly, Mendeleev found that the elements' properties followed a pattern that repeated every seven elements. His table became known as the periodic table of the elements. The elements were arranged based on increasing atomic mass, starting with the most abundant (in the universe) and least massive element, hydrogen.

An important confirmation of the table occurred as new elements were discovered that fit into gaps that Mendeleev left in the table and whose properties matched those predicted by Mendeleev. Chemists found the periodic table very useful for predicting properties, because elements that are in a column share similar properties.

The structure of the atom was not known when Mendeleev developed his periodic table. Although the modern table, shown below, is different from Mendeleev's original table, it follows the same principle—the periodic repetition of physical and chemical properties. As scientists learned more about atoms, they discovered that the properties of elements are related to the arrangement of electrons around an atom's nucleus. The number of electrons in the outer shell increases across periods 1, 2, 13, 14, 15, 16, 17, and 18. There is a similar correlation to valence electron structure in the center of the table, periods 3–12.



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Fl	Uup	Lv	Uus	Uuo

Name____ Date____________

TEKS 1.C.5.A Chemistry

STANDARD PRACTICE

1 Why did scientists accept the periodic table as a useful way to organize information about the elements?

A Mendeleev was a well-respected scientist.

B The table was demonstrated to have predictive value.

C There was no other way to organize the information, and so chemists used the table.

D The description of atomic structure was presented better in the table than in other tools.

2 How did Mendeleev decide which elements should be placed in the same group of the periodic table?

A He grouped elements with similar chemical and physical properties.

B He grouped together elements with the same number of valence electrons.

C He ordered the elements by atomic number, and the pattern appeared.

D He arranged the elements across the table from most reactive to least reactive.

3 Calcium is a metal. On the periodic table, calcium is in Group 2 and Period 4. Which of the following elements is most likely to have properties similar to calcium?

A Scandium, in Group 3 and Period 4

B Potassium, in Group 1 and Period 4

C Aluminum, in Group 13 and Period 3

D Magnesium, in Group 2 and Period 3

4 The noble gases were not known when Mendeleev made his periodic table, so a new group had to be added when they were discovered. Which group number on the modern table includes the noble gases?

Name____ Date____________

TEKS **1.C.5.B** **Chemistry**

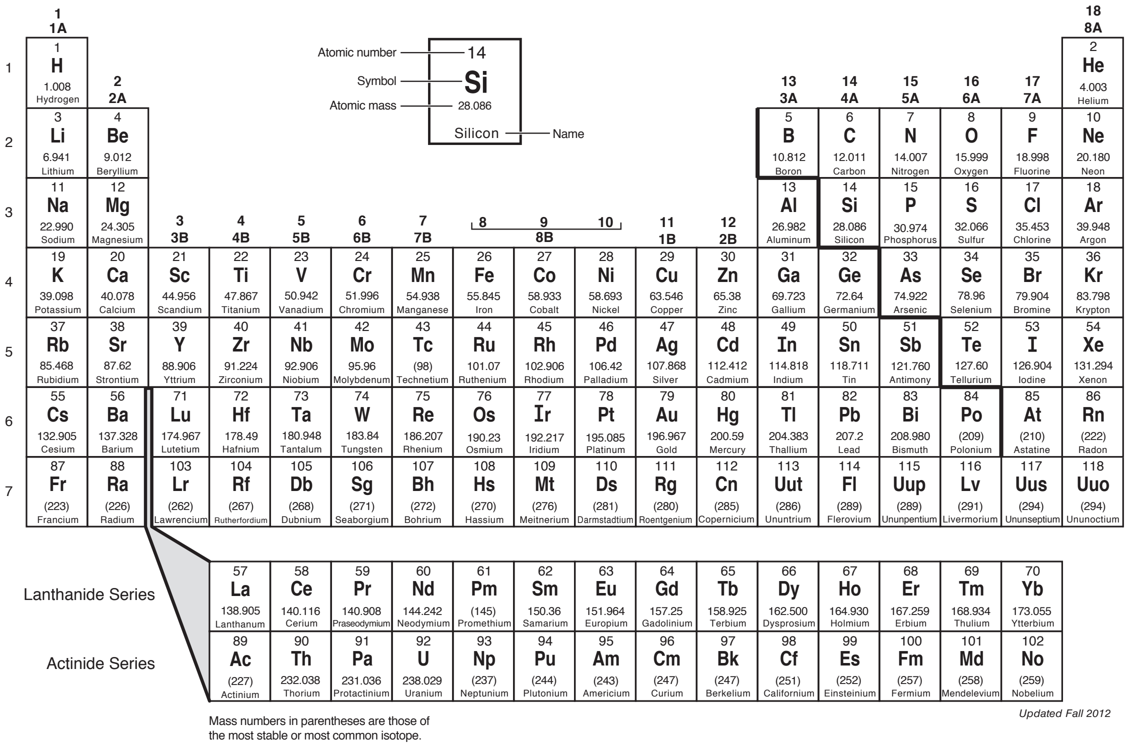
MATTER AND THE PERIODIC TABLE

The student will demonstrate an understanding of the properties of matter and the periodic table.

(C.5) **Science concepts.** The student understands the historical development of the Periodic Table and can apply its predictive power. The student is expected to (B) use the Periodic Table to identify and explain the properties of chemical families, including alkali metals, alkaline earth metals, halogens, noble gases, and transition metals;

STANDARD REVIEW

The elements are organized into a chart called the periodic table of elements. Each horizontal row of elements on the periodic table is called a period. The physical and chemical properties of elements in a row follow a repeating pattern across the period. Each vertical column of elements on the periodic table is called a group. Elements in the same group generally have similar chemical and physical properties.



	1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 **H** 1.008 Hydrogen																	2 **He** 4.003 Helium
2	3 **Li** 6.941 Lithium	4 **Be** 9.012 Beryllium											5 **B** 10.812 Boron	6 **C** 12.011 Carbon	7 **N** 14.007 Nitrogen	8 **O** 15.999 Oxygen	9 **F** 18.998 Fluorine	10 **Ne** 20.180 Neon
3	11 **Na** 22.990 Sodium	12 **Mg** 24.305 Magnesium											13 **Al** 26.982 Aluminum	14 **Si** 28.086 Silicon	15 **P** 30.974 Phosphorus	16 **S** 32.066 Sulfur	17 **Cl** 35.453 Chlorine	18 **Ar** 39.948 Argon
4	19 **K** 39.098 Potassium	20 **Ca** 40.078 Calcium	21 **Sc** 44.956 Scandium	22 **Ti** 47.867 Titanium	23 **V** 50.942 Vanadium	24 **Cr** 51.996 Chromium	25 **Mn** 54.938 Manganese	26 **Fe** 55.845 Iron	27 **Co** 58.933 Cobalt	28 **Ni** 58.693 Nickel	29 **Cu** 63.546 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.723 Gallium	32 **Ge** 72.64 Germanium	33 **As** 74.922 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.904 Bromine	36 **Kr** 83.798 Krypton
5	37 **Rb** 85.468 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.906 Yttrium	40 **Zr** 91.224 Zirconium	41 **Nb** 92.906 Niobium	42 **Mo** 95.96 Molybdenum	43 **Tc** (98) Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.906 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.868 Silver	48 **Cd** 112.412 Cadmium	49 **In** 114.818 Indium	50 **Sn** 118.711 Tin	51 **Sb** 121.760 Antimony	52 **Te** 127.60 Tellurium	53 **I** 126.904 Iodine	54 **Xe** 131.294 Xenon
6	55 **Cs** 132.905 Cesium	56 **Ba** 137.328 Barium	71 **Lu** 174.967 Lutetium	72 **Hf** 178.49 Hafnium	73 **Ta** 180.948 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.207 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.217 Iridium	78 **Pt** 195.085 Platinum	79 **Au** 196.967 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.383 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.980 Bismuth	84 **Po** (209) Polonium	85 **At** (210) Astatine	86 **Rn** (222) Radon
7	87 **Fr** (223) Francium	88 **Ra** (226) Radium	103 **Lr** (262) Lawrencium	104 **Rf** (267) Rutherfordium	105 **Db** (268) Dubnium	106 **Sg** (271) Seaborgium	107 **Bh** (272) Bohrium	108 **Hs** (270) Hassium	109 **Mt** (276) Meitnerium	110 **Ds** (281) Darmstadtium	111 **Rg** (280) Roentgenium	112 **Cn** (285) Copernicium	113 **Uut** (286) Ununtrium	114 **Fl** (289) Flerovium	115 **Uup** (289) Ununpentium	116 **Lv** (291) Livermorium	117 **Uus** (294) Ununseptium	118 **Uuo** (294) Ununoctium

Lanthanide Series	57 **La** 138.905 Lanthanum	58 **Ce** 140.116 Cerium	59 **Pr** 140.908 Praseodymium	60 **Nd** 144.242 Neodymium	61 **Pm** (145) Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.964 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.925 Terbium	66 **Dy** 162.500 Dysprosium	67 **Ho** 164.930 Holmium	68 **Er** 167.259 Erbium	69 **Tm** 168.934 Thulium	70 **Yb** 173.055 Ytterbium
Actinide Series	89 **Ac** (227) Actinium	90 **Th** 232.038 Thorium	91 **Pa** 231.036 Protactinium	92 **U** 238.029 Uranium	93 **Np** (237) Neptunium	94 **Pu** (244) Plutonium	95 **Am** (243) Americium	96 **Cm** (247) Curium	97 **Bk** (247) Berkelium	98 **Cf** (251) Californium	99 **Es** (252) Einsteinium	100 **Fm** (257) Fermium	101 **Md** (258) Mendelevium	102 **No** (259) Nobelium

Mass numbers in parentheses are those of the most stable or most common isotope.

Updated Fall 2012

Name____ Date____________

TEKS 1.C.5.B Chemistry

Elements are classified as metals, nonmetals, and metalloids, according to their properties. The zigzag line on the periodic table indicates which elements are metals and which are nonmetals or metalloids. Metals are found to the left of the zigzag line on the periodic table. Atoms of most metals have few electrons in their outer energy level. Most metals are solid at room temperature. Nonmetals are found to the right of the zigzag line on the periodic table. Atoms of most nonmetals have an almost complete set of electrons in their outer level. More than half of the nonmetals are gases at room temperature. The elements that border the zigzag line on the periodic table, except aluminum and astatine, are metalloids. Atoms of metalloids have about half of a complete set of electrons in their outer energy level. Metalloids have some properties of metals and some properties of nonmetals. All of the elements in groups 3–12 are known as transition metals.

The most reactive metals are found in the first group of the periodic table. These are elements that easily lose one electron. The most reactive nonmetals are in group 17. These are the elements that easily gain a single electron to fill their outer energy levels. In general, reactivity of elements tends to decrease moving inward from these groups. The least reactive elements are the noble gases, group 18. These elements have outer energy levels that are complete, so they do not tend to react with other atoms except under extreme conditions.

Name____ Date____________

STANDARD PRACTICE

1 Based on its position on the periodic table, which of these atoms has three electrons available to share with or to transfer to other atoms?

A Helium

B Lithium

C Boron

D Oxygen

2 Based on the arrangement of elements in the periodic table, what can you predict about the properties of a synthetic element that has an atomic number of 118?

A Element number 118 would be very reactive and have metallic properties.

B Element number 118 would be a nonmetallic element that readily forms salts with metallic elements.

C Element number 118 would be a nonmetallic gas whose atoms are unlikely to react with other atoms.

D Element number 118 would be a metalloid with some properties of both metals and nonmetals.

3 Which of these features of an atom determines how it reacts with other atoms?

A The number of electrons

B The number of valence electrons

C The number of protons in its nucleus

D The number of protons and neutrons in its nucleus

4 What is the atomic number of aluminum?

Name____ Date____________

MATTER AND THE PERIODIC TABLE

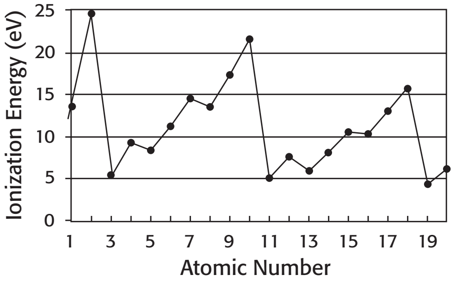
The student will demonstrate an understanding of the properties of matter and the periodic table.

(C.5) **Science concepts.** The student understands the historical development of the Periodic Table and can apply its predictive power. The student is expected to (C) use the Periodic Table to identify and explain periodic trends, including atomic and ionic radii, electronegativity, and ionization energy.

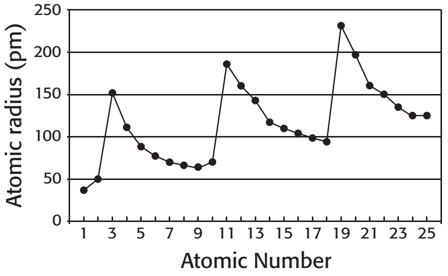
STANDARD REVIEW

The arrangement of the periodic table reveals trends in the properties of the elements. Ionization energy tends to decrease down a group. Each element has more occupied energy levels than the one above it has. Therefore, the outermost electrons are farthest from the nucleus in elements near the bottom of a group. Inner electrons shield the outermost electrons from the full attractive force of the nucleus. This causes the outermost electrons to be held less tightly to the nucleus. Ionization energy tends to increase as you move from left to right across a period.

Ionization Energies of the First Twenty Elements



Atomic Radii of the First Twenty-Five Elements



Atomic radius increases as you move down a group because the addition of another level of electrons increases the size. Because of electron shielding, the effective nuclear charge acting on the outer electrons is almost constant as you move down a group. As a result, the outermost electrons are not pulled closer to the nucleus. As you move from left to right across a period, the effective nuclear charge acting on the outer electrons increases. This increasing nuclear charge pulls the outermost electrons closer and closer to the nucleus and thus reduces the size of the atom.

Electronegativity values generally decrease as you move down a group. Electronegativity usually increases as you move left to right across a period. As you proceed across a period, each atom has one more proton and one more electron—in the same principal energy level—than the atom before it has. Therefore, the effective nuclear charge increases across a period. As this increases, electrons are attracted much more strongly, resulting in an increase in electronegativity.

Name____ Date______________

TEKS 1.C.5.C Chemistry

STANDARD PRACTICE

1 Bromine, which is located in the same period as calcium, has an atomic number that is greater than calcium's. How does the ionization energy of bromine compare with that of calcium?

A Bromine has the same ionization energy as calcium has, because for elements in the same period, an increase in atomic number has no effect on the ionization energy.

B Bromine ionizes more easily than calcium does, because when elements are located in the same period, an increase in atomic number corresponds to a decrease in ionization energy.

C Bromine has a higher ionization energy than calcium has because, within a period, ionization energy increases as atomic number increases.

D The relationship cannot be determined from the information provided, because the two elements are in different groups on the periodic table.

2 Which of the following corresponds to an increase in the shielding of outer electrons?

A Increase in the number of protons

B Increase in the number of valence electrons

C Increase in the period number of the periodic table

D Increase in the ionization energy of the atom

3 An arsenic atom is more massive than a phosphorus atom is, and the elements are located in the same group. Which of the following statements about arsenic and phosphorus is true?

A Arsenic and phosphorus have the same number of valence electrons.

B The diameter of an arsenic atom is smaller than the diameter of a phosphorus atom.

C Because they are in the same group, the two elements have the same ionization energy.

D More energy is required to remove an electron from an arsenic atom than to remove an electron from a phosphorus atom.

4 What is the radius, in picometers, of an atom of titanium (atomic number = 22)?