Section 5: Matter

The following maps the videos in this section to the Texas Essential Knowledge and Skills for Science TAC §112.35(c).

5.01 Matter
- Chemistry (4)(C)
- Chemistry (4)(D)

5.02 Properties of Matter
- Chemistry (4)(A)
- Chemistry (4)(B)

5.03 Dalton's Atomic Theory of Matter
- Chemistry (6)(A)

5.04 Structure of the Nuclear Atom
- Chemistry (6)(A)

5.05 Shorthand Notation and Isotopes
- N/A

5.06 Calculating Atomic Mass
- Chemistry (6)(D)

5.07 The Periodic Table
- Chemistry (5)(A)

5.08 Bonding in Elements
- Chemistry (7)(D)

5.09 Naming Ions
- Chemistry (7)(A)
- Chemistry (7)(B)

5.10 Naming Ionic Compounds
- Chemistry (7)(A)
- Chemistry (7)(B)

5.11 Naming Covalent Compounds
- Chemistry (7)(A)
- Chemistry (7)(B)

5.12 Naming Acids and Bases

- Chemistry (7)(A)
- Chemistry (7)(B)

Note: Unless stated otherwise, any sample data is fictitious and used solely for the purpose of instruction.

Safety Note: Any chemicals mentioned in these videos are potentially harmful and should be handled with the appropriate safety precautions.

5.01

Matter

Matter is anything that occupies space and has mass.

- The ***mass*** of an object is a measure of the amount of matter the object contains.
- The ***volume*** of an object is a measure of the amount of space the object occupies.

Matter has three states:

- A ***solid*** is a form of matter that has a fixed shape and volume, which makes it almost incompressible.
- A ***liquid*** is a form of matter that has a variable shape with a fixed volume. Liquids are almost incompressible, but they tend to expand slightly when heated.
- A ***gas*** is a form of matter that takes both the shape and the volume of its container.
    - Gas particles are much farther away from each other than the particles in a liquid. This space between the particles is what makes gases compressible.
    - ***Vapor*** describes the gaseous state of a substance that is generally a liquid or solid at room temperature.

1. Matter in the liquid state is __________ and has a __________ shape.

    A. incompressible; fixed
    B. compressible; variable
    C. incompressible; variable
    D. compressible; fixed

Composition of Matter

- Matter that has a uniform and definite composition is called a ***pure substance***.
  - An ***element*** is the simplest form of matter that has a unique set of properties.
  - A ***compound*** is a substance that contains two or more elements chemically combined in a fixed proportion.
- A substance composed of two or more different types of atoms or molecules that can be combined in variable proportions is a ***mixture***.
  - A mixture in which the composition is not uniform throughout is a ***heterogeneous mixture***.
  - A mixture in which the composition is uniform throughout is a ***homogeneous mixture***.
  - A ***solution*** is another name for a homogeneous mixture.

Techniques for Separating Mixtures

- In ***filtration***, we separate a solid and a liquid by pouring the mixture through a filter that allows the liquid to pass, but not the solid.
- In ***distillation***, we separate miscible liquids (for example, liquids that mix together equally in all proportions) by boiling off the one with a lower boiling point.

2. Which of the following is/are true?
   i. Air is a heterogeneous mixture.
   ii. Contact lens solution is a homogeneous mixture.
   iii. Chrome is an element.
   iv. Magnesium is an element.

   A. i and ii
   B. ii and iii
   C. iv only
   D. ii and iv

5.02

Properties of Matter

Physical property – A quality or condition of a substance that can be observed or measured without changing the substance's composition

- An ***extensive property*** depends on the amount of matter in a sample.
    - Mass
    - Volume
- An ***intensive property*** depends on the type of matter in a sample, not the amount.
    - Absorbency
    - Density

A ***physical change*** occurs when there is a change in the state of the substance and not the composition of the material. Physical changes are either reversible or irreversible.

- Melting ice is a reversible physical change.
- Cracking an egg is an irreversible physical change.

Chemical property – A property that a substance displays only by changing its composition via a chemical change

A ***chemical change*** is a change that produces matter with a different composition from the original matter.

1. Identify each of the following as either a chemical or physical change.

    i. Hammering copper (Cu) into wire: _______________

    ii. Rust forming on a metal bench: _______________

    iii. Making a solid hot enough to go straight to the gas phase: _______________

    iv. Hydrogen gas and oxygen gas combining to make water: _______________

2. Four important properties of an inorganic compound are (i) melting point, (ii) corrosiveness, (iii) length, and (iv) reactivity with acids. Which choice below correctly classifies these properties as extensive physical (EP), intensive physical (IP), or chemical (C)?

    A. i = EP, ii = C, iii = IP, iv = C
    B. i = IP, ii = IP, iii = EP, iv = C
    C. i = C, ii = C, iii = EP, iv = C
    D. i = IP, ii = C, iii = EP, iv = C

5.03

Dalton's Atomic Theory of Matter

The English chemist John Dalton (1766–1844) made conclusions about the nature of matter that became known as ***Dalton's atomic theory***, or Dalton's postulates.

1. All matter is made of atoms. Atoms are indivisible and indestructible.
2. All atoms of a given element are identical both in mass and in chemical properties. The atoms of any one element are different from those of any other element.
3. Atoms combine in simple, fixed, whole-number ratios to form compounds.
4. Chemical reactions occur when atoms are separated from each other, joined, or rearranged in a different combination. Atoms of one element, however, are never changed into atoms of another element through a chemical reaction.

Dalton's atomic theory led to three laws that helped explain compound formation and chemical reactions.

- ***Law of definite proportions*** – Samples of any chemical compound maintain the same proportions of their constituent elements.
- ***Law of multiple proportions*** – Whenever the same two elements combine to form more than one compound, the different masses of one element that combine with the same mass of the other element are in the ratio of small whole numbers.
- ***Law of conservation of mass*** – In a chemical process, atoms cannot be created, destroyed, or changed—only rearranged into different combinations.

1. Which of the following statements is **not** a part of John Dalton's atomic theory?

   A. All atoms of a given element have the same mass and other properties that distinguish them from the other elements.
   B. Atoms combine in simple, whole-number ratios to form compounds.
   C. The atom has a nucleus surrounded by electrons.
   D. Each element is composed of tiny indestructible particles called atoms.

5.04

Structure of the Nuclear Atom

Dalton's atomic theory is widely accepted today, with one important change. We now know that atoms can be divided into smaller particles. The three kinds of subatomic particles are ***electrons***, ***protons***, and ***neutrons***.

- ***Electrons*** are negatively charged subatomic particles.
- ***Protons*** are positively charged subatomic particles.
- ***Neutrons*** are subatomic particles with no charge but with a mass nearly equal to that of protons.

Each element has its own unique properties. However, on an atomic scale, elements are essentially the same.

- Every atom is an electrically neutral, spherical entity.
- An atom is composed of a central core of protons and neutrons, called the ***nucleus***, that is surrounded by electrons.
- A neutral atom contains equal numbers of electrons and protons, but this ratio changes when atoms become ions.

Nuclear Atom Discoveries

In 1897, J. J. Thomson (1856–1940) discovered the first subatomic particle, the negatively charged electron, with the help of a modified cathode ray tube. As a result, Thomson proposed the "plum-pudding model" of the atom. In this model, electrons were evenly distributed throughout an atom that was filled uniformly with positively charged material.

- A ***cathode ray tube*** consists of two electrodes sealed in a glass container with gas at low pressure.
    - When a voltage is applied to the cathode, a glowing beam, or cathode ray, travels from the cathode to the anode.
    - In his experiment, Thomson placed a positively charged plate on one side of the cathode ray and a negatively charged plate on the other side.
    - The cathode ray was attracted to the positively charged plate. Thomson hypothesized that the cathode ray was a stream of negatively charged particles moving at high speed.
    - After testing his hypothesis, he concluded that electrons are a component of the atoms of all elements.

The plum-pudding model was short-lived. In 1911, Ernest Rutherford (1871–1937) discovered a positively charged subatomic particle, the proton. He used the gold-foil experiment to prove his conclusions.

- The gold-foil experiment used a narrow beam of alpha particles (i.e., particles with a double positive charge) directed at a very thin sheet of gold foil.
    - Most of the alpha particles went straight through the gold foil or were slightly deflected.
    - A small fraction of the alpha particles bounced off the gold foil at very large angles.
- Rutherford used the results of his gold-foil experiment to determine that the atom was mostly empty space, since most of the alpha particles passed straight through the gold foil, but that it had a very dense nucleus, which deflected some of the alpha particles.

In 1932, James Chadwick (1891–1974) confirmed the existence of another subatomic particle, the neutron.

1. Select the true statement from the choices below.

    A. The charge of a proton is equal in magnitude but opposite in sign to that of a neutron.
    B. The gold-foil experiment led to the discovery that each atom contains a tiny, positively charged, massive center called the nucleus.
    C. The mass of a proton is close to that of an electron.
    D. The gold-foil experiment led to the discovery of the electron.

5.05
Shorthand Notation and Isotopes

Shorthand Notation

Elements are different from one another because they contain different numbers of protons. An element's ***atomic number*** is the number of protons in the nucleus of an atom of that element.

Most of an atom's mass is concentrated in the nucleus. The mass depends on the number of protons and electrons. The total number of protons and neutrons in an atom is called the ***mass number***.

The composition of any atom can be represented in shorthand notation using the mass number and the atomic number.

$$^{A}_{Z}X$$

In the example above, *X* is the element symbol, *A* is the mass number, and *Z* is the atomic number.

Isotopes

An ***isotope*** is a variation of an element that has the *same number of protons and electrons* but a *different number of neutrons*.

Isotopes have varying numbers of neutrons, which means they have different mass numbers. ^{14}N and ^{15}N are both isotopes of nitrogen because they have the same atomic number but different mass numbers.

1. Complete the following table:

${}^{A}_{Z}X$	**Atomic Number**	**Number of Neutrons**
${}^{56}_{26}Fe$		
	45	59

2. How many protons (p^{+1}), neutrons (n^0), and electrons (e^{-1}) does the isotope ^{55}Mn have?

   A. 30 p^{+1}, 25 n^0, 25 e^{-1}
   B. 24 p^{+1}, 33 n^0, 22 e^{-1}
   C. 25 p^{+1}, 30 n^0, 25 e^{-1}
   D. 25 p^{+1}, 25 n^0, 30 e^{-1}

5.06

Calculating Atomic Mass

Calculating the mass of elements is difficult because their masses are very small.

Relative Masses of Subatomic Particles

The mass of an atom is measured from the nucleus.

- Protons and neutrons have approximately the same mass of 1 ***atomic mass unit (amu)***. 1 amu equals 1.67×10^{-24} g.
- Electrons have relatively no mass—about 0.00055 amu or 9.109×10^{-28} g.

Chemists have devised a system to compare relative masses of atoms using carbon-12 as a reference isotope. Carbon has been assigned a mass of exactly 12 atomic mass units. An atomic mass unit is defined as 1/12 of the mass of a carbon-12 atom.

Since most of the mass of an atom is in the nucleus, the relative system above would seem to indicate that the atomic mass of an element should be a whole number, but this is not usually the case.

In nature, most elements occur as a mixture of two or more isotopes. The ***atomic mass***, sometimes called the average atomic mass, of an element is a weighted average mass of the atoms in a naturally occurring sample of the element.

To calculate the atomic mass of an element, multiply the mass of each isotope by its natural abundance, expressed as a decimal, and then add the products.

$$Atomic\ Mass = (1^{st}\ Isotope\ Mass)(Natural\ Abundance) + (2^{nd}\ Isotope\ Mass)(Natural\ Abundance) \ldots$$

1. Element Z has three isotopes: Z-31, Z-32, and Z-29. Z-29 has a mass of 28.98 amu and is 24.44% abundant in nature. Z-32 has a mass of 32.12 amu and is 32.65% abundant in nature. Z-31 has a mass of 31.23 amu. Calculate the atomic mass of element Z.

5.07

The Periodic Table

Elements are the fundamental building blocks that make up all matter.

- The ***periodic table*** is a compilation of all the discovered elements.
  - The rows in a periodic table are referred to as ***periods***.
  - Columns of the periodic table are called ***groups***.
- Scientists have discovered over 116 elements. Each element has its own unique chemical and physical properties.
- Early chemists used the chemical and physical properties of elements to sort them into groups.

In the mid-19th century, the Russian chemist Dmitri Mendeleev noticed that certain groups of elements had similar properties. Mendeleev proposed a table that arranged elements periodically—that is, in sets with repeating patterns—in order of increasing atomic mass.

In the modern periodic table, elements are arranged in order of increasing atomic number because there were inconsistencies with Mendeleev's periodic table. When elements are arranged in order of increasing atomic number, moving left to right across a period, the elements have different chemical and physical properties. However, the pattern of properties within a period repeats as you move from one period to the next. This is referred to as the ***periodic law***.

Broad Classes of Elements

- ***Metals*** are generally good conductors of heat and electric current. Most metals have a high luster and are ductile and malleable.
- ***Nonmetals*** are poor conductors of heat and electric current. Most nonmetals are brittle, but in general, physical properties vary more among nonmetals than among metals.
- ***Metalloids*** have properties of both metals and nonmetals. The behavior of metalloids depends on the conditions.

1. Classify each of the following as either a metal (M) or a nonmetal (N).

   i. Bromine (Br)   ii. Cobalt (Co)   iii. Boron (B)   iv. Potassium (K)

Classifying Elements in the Periodic Table

Because of the periodic law, elements that have similar properties end up in the same column in the periodic table. These columns have special names, listed below, because of the similarity of the chemical properties of those elements within the column.

- Elements in groups 1A through 7A are called ***representative elements*** because they display a wide range of chemical and physical properties.
- The metallic elements in groups 1A through 7A of the periodic table are called ***main group metals***.
- The elements in group B are called ***transition elements***.
  - The ***transition metals*** are the group B elements that are usually displayed in the main body of a periodic table. These include copper, silver, and iron.
  - The ***inner transition metals*** are the group B elements that appear below the main body of the periodic table. These include uranium and plutonium.

Group	Name	Elements	Properties
1A	Alkali Metals	Li, Na, K, Rb, Cs, and Fr	Solids at room temperature and react violently with water
2A	Alkaline Earth Metals	Be, Mg, Ca, Sr, Ba, and Ra	Solids at room temperature and react vigorously with oxygen
7A	Halogens	F, Cl, Br, I, and At	Mostly gases at room temperature and form salts when bonded to a metal
8A	Noble Gases	He, Ne, Ar, Kr, Xe, and Rn	Inert monatomic gases at room temperature

2. Which of the following elements belong to the alkaline earth metals?

A. F, Cl, Br, I, At
B. He, Ne, Ar, Kr, Xe, Rn
C. Li, Na, K, Rb, Cs, Fr
D. Be, Mg, Ca, Sr, Ba, Ra

5.08

Bonding in Elements

Elements bond to form compounds when their outer electrons interact. The bonding between the three broad classes of elements occurs in three general ways.

1. When a metal donates its outer electrons to a nonmetal, this creates an ***ionic bond***.
    - The resulting compound is called an ***ionic compound***.
    - The metal becomes a ***positive ion (cation)*** and the nonmetal becomes a ***negative ion (anion)***.
        - A cation is produced when an atom loses one or more outer electrons.
        - An anion is produced when an atom gains one or more outer electrons.
    - Although they are composed of ions, ionic compounds are electrically neutral.
    - An ionic compound is held together by the electrostatic forces between the oppositely charged cations and anions, which attract one another.
    - A ***formula unit*** is the lowest whole-number ratio of ions in an ionic compound.
2. When an atom shares its outer electrons with another atom's outer electrons, this creates a ***covalent bond***.
    - A ***molecule*** is a neutral group of atoms joined together by covalent bonds.
    - A ***diatomic molecule*** is a molecule that contains two atoms.
    - A compound composed of molecules is called a ***molecular compound***.
3. Metals bond in a special way because their outer electrons are mobile and drift freely from one part of the metal to another.
    - This creates a "sea" of electrons that are not tied down to any atom.
    - ***Metallic bonds*** are the forces of attraction between the free-floating outer electrons and the positively charged metal ions.

Metallic bonding explains many of the different metallic properties in a metal.

- ***Ductility*** – A property of a metal that enables it to be drawn into a wire
- ***Malleability*** – The ability of a metal to be hammered or pressed into shapes
- ***Electrical conductivity*** – A property that enables a substance to conduct an electric current through the flow of electrons
- ***Thermal conductivity*** – A property that enables a substance to transfer heat

1. Which of the following properties of metals is **<u>not</u>** explained by the “electron-sea” model of metallic bonding?

   A. Malleability
   B. Metallic luster (shine)
   C. Electrical conductivity
   D. Thermal conductivity
   E. Ductility

5.09

Naming Ions

Ionic compounds consist of positively charged ions and negatively charged ions combined in a proportion so that their charges add up to a net charge of zero.

Monatomic ion – A single atom with a positive or negative charge resulting from the loss or gain, respectively, of one or more outer electrons, called valence electrons

When the metals of groups 1A, 2A, and 3A lose electrons, they form cations with positive charges equal to their group number. The names of the cations are the same as the name of the metal, followed by the word *ion* or *cation*.

- Al^{3+} is the aluminum ion
- Na^{+} is the sodium ion

Nonmetals tend to gain electrons to form anions, so the charge of a nonmetallic ion is negative. The charge of any ion of a group A nonmetal is determined by subtracting 8 from the group number.

- S^{2-} is the sulfur ion
- N^{3-} is the nitrogen ion

The name of an anion is not the same as the element's name. Anion names start with the stem of the element name and end in *-ide*.

1. Name the ions formed by the following elements.

   i. Barium

   ii. Oxygen

   iii. Chlorine

Many of the transition metals (groups 1B–8B) form multiple cations that have different ionic charges. The charges of the cations of many transition metal ions must be determined from the number of electrons lost.

There are two methods to name transition metals with different ionic charges.

- ***Stock system*** – A Roman numeral in parentheses after the name of the element indicates the numerical value of the charge.
- ***Classical system*** – One of two suffixes, attached to the root of the Latin name for the ion, indicates whether the ion has a higher or lower ionic charge.
    - The suffix -*ous* is used to name the cation with the lower of the two ionic charges.
    - The suffix -*ic* is used to name the cation with the higher of the two ionic charges.

Element	Ion Formula	Stock Name	Classical Name
Chromium	Cr^{2+}	chromium(II)	chromous
	Cr^{3+}	chromium(III)	chromic
Copper	Cu^{+}	copper(I)	cuprous
	Cu^{2+}	copper(II)	cupric
Iron	Fe^{2+}	iron(II)	ferrous
	Fe^{3+}	iron(III)	ferric
Mercury	Hg_2^{2+}	mercury(I)	mercurous
	Hg^{2+}	mercury(II)	mercuric
Tin	Sn^{2+}	tin(II)	stannous
	Sn^{4+}	tin(IV)	stannic

2. How many electrons were lost or gained to form these ions?

    i. Mn^{4+}

    ii. Zn^{2+}

    iii. As^{3-}

Polyatomic ion – An ion composed of more than one atom, which behaves as a unit and carries a charge

Naming polyatomic ions requires some memorization of the number of atoms in and the overall charge of each ion.

- ClO^- is hypo–chlor–ite.
- ClO_2^- is chlor–ite.
- ClO_3^- is chlor–ate.
- ClO_4^- is per–chlor–ate.

STUDY EDGE TIP

Remember the ions with an *-ate* ending. These ions are very common in ionic compounds and offer a systematic way to name other ions.

Some polyatomic ions have different endings that do not fit the pattern above:

- CN^- is the cyanide anion.
- OH^- is the hydroxide anion.
- NH_4^+ is the ammonium cation.

When the formula for a polyatomic ion begins with H (hydrogen), you can think of the H as representing a hydrogen ion (H^+) combined with another polyatomic ion.

- HCO_3^- is hydrogen carbonate.
- $H_2PO_4^-$ is dihydrogen phosphate.

Name	Formula
ammonium	NH_4^+
hydroxide	OH^-
cyanide	CN^-
nitrate	NO_3^-
ethanoate	CH_3COO^- or $C_2H_3O_2^-$
chlorate	ClO_3^-
bromate	BrO_3^-
iodate	IO_3^-
sulfate	SO_4^{2-}
hydrogen sulfate	HSO_4^-
carbonate	CO_3^{2-}
hydrogen carbonate	HCO_3^-
phosphate	PO_4^{3-}
hydrogen phosphate	HPO_4^{2-}
dihydrogen phosphate	$H_2PO_4^-$
permanganate	MnO_4^-
chromate	CrO_4^{2-}
dichromate	$Cr_2O_7^{2-}$
oxalate	$C_2O_4^{2-}$
silicate	SiO_3^{2-}

3. Write the symbol or chemical formula (including charge) for each of the following ions.

   i. Nitrite ion

   ii. Hydrogen sulfite ion

   iii. Perbromate ion

5.10

Naming Ionic Compounds

Binary compound – A compound composed of two elements. Binary compounds can be ionic compounds or molecular compounds.

To write the formula of a binary ionic compound, first write the symbol of the cation and then that of the anion. Then, add subscripts as needed to balance the charges.

Another method is the "crisscross" method:

- Cross out the charge of each ion and make it the subscript for the other ion.
- Drop the charges.
- The formula is correct because the overall charge of the formula is zero, and the subscripts are expressed as the lowest whole-number ratio.

1. Write the chemical formulas for the compounds formed by the following pairs of ions.

   i. Al^{3+} and Cl^{-}

   ii. Mg^{2+} and SO_4^{2-}

   iii. Cr^{6+} and N^{3-}

2. Write the chemical formula for each of the following ionic compounds.

   i. Sodium sulfide

   ii. Aluminum phosphate

Tips for Naming Ionic Compounds

- Place the cation name first, followed by the anion name.
- If the metallic element in the compound has more than one common ionic charge, a Roman numeral must be included in the cation name.
- Whenever more than one polyatomic ion is needed to balance the charges in an ionic compound, use parentheses to set off the polyatomic ion in the formula.

3. Name the following ionic compounds.

   i. ZnO

   ii. Ag_2Se

   iii. $Al_2(SO_4)_3$

4. Write chemical formulas for the following compounds.

   i. Sodium hydrogen sulfate

   ii. Nickel(II) sulfite

5.11

Naming Molecular Compounds

Molecular compounds, or covalent compounds, are composed of molecules, not ions, so ionic charges cannot be used to write their formulas or to name them.

The prefixes below are used in the names of molecular compounds to help distinguish compounds containing different numbers of atoms. The prefixes tell how many atoms of an element are present in each molecule of the compound.

Prefix	Number
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

To name a molecular compound:

1. Write the names of the elements in the order listed in the formula.
2. Use prefixes appropriately to indicate the number of each kind of atom.
    - Omit the prefix “mono-” if just one atom of the first element is present.
    - The vowel at the end of a prefix is sometimes dropped when the name of the element begins with a vowel.
3. End the name of the second element with the suffix -*ide*.

1. Name the following molecular compounds.

   i. Cl_2O_7

   ii. SO_3

   iii. CO

2. Write the formulas for these molecular compounds.

   i. Oxygen difluoride

   ii. Tetraphosphorous decoxide

5.12

Naming Acids and Bases

An ***acid*** is a compound that contains one or more hydrogen atoms and produces hydrogen ions when dissolved in water.

When naming an acid, consider it to be an anion with as many hydrogen ions needed to make the compound electrically neutral. The chemical formulas of acids are in the general form H_nX, where *X* is a monatomic or polyatomic anion and *n* is a subscript indicating the number of hydrogen ions that are combined with the anion.

Acid nomenclature depends on the suffix an ion has:

- If the anion name ends in *-ide*, the acid name begins with the prefix *hydro-*. This prefix is attached to the stem of the anion with the suffix *-ic*, followed by the word *acid*.
- If the anion name ends in *-ite*, the acid name is the stem of the anion with the suffix *-ous*, followed by the word *acid*.
- If the anion name ends in *-ate*, the acid name is the stem of the anion with the suffix *-ic*, followed by the word *acid*.

When writing the chemical formula for an acid, use the rule for writing the name of the acids in reverse. Be sure to balance the ionic charges just as you would for any ionic compound.

Common Acids			
Anion Formula	**Anion Name**	**Acid Name**	**Acid Formula**
Br^-	Bromide	Hydrobromic acid	HBr
ClO_3^{1-}	Chlorate	Chloric acid	$HClO_3$
SO_3^{2-}	Sulfite	Sulfurous acid	H_2SO_3

A ***base*** is generally an ionic compound that produces hydroxide ions when dissolved in water.

- Use the rules for naming ionic compounds to name bases.
- When writing the chemical formula for a base, write the metal cation first, followed by the formula for the hydroxide ion.
- Balance the ionic charges as you would for any ionic compound.

1. Name each acid or base below.

   i. HCl

   ii. HNO_3

   iii. $Sr(OH)_2$

   iv. CsOH

2. Write formulas for the following acids and bases.

   i. Hydrosulfuric acid

   ii. Perchloric acid

   iii. Aluminum hydroxide

   iv. Iron(II) hydroxide

PERIODIC TABLE OF THE ELEMENTS

Period	1A 1	2A 2	3B 3	4B 4	5B 5	6B 6	7B 7	<--- 8	8B 9	---> 10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1	1 H 1.008																	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Ha (262)	106 (263)	107 (262)	108	109									

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)