Senior 1

Appendices:
Cluster 2
Atoms and Elements

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Vocabulary

Atomic Structure	Periodic Table	Elements and Compounds	Properties and Changes of Matter
· Particle Theory of Matter	· Periodic Table	· Pure Substance	· Physical Change
· Dalton's Atomic Theory	· Period	· Mixture	· Chemical Change
· Greek Philosophers	· Group	· Atom	· Physical Property
· Alchemist	· Chemical Family	· Element	· Chemical Property
· Atom	· Electron Shell	· Compound	· Precipitate
· Element	· Mendeleev	· Molecule	· Combustion
· Element Symbol	· Moseley	· Stable Octet	· Oxidation
· Nucleus	· Periodic Law	· Chemical Formulas	· Corrosion
· Subatomic Particles [electron, proton, neutron]	· Alkali Metals	· Electrolysis	
· Electron Shells	· Alkaline Earth Metals		
· Electron Cloud	· Halogens		
· Bohr's Model	· Chalcogens		
· Bohr Atomic Model Diagrams	· Noble Gases		
· Thomson's Model	· Valence Electrons		
· Rutherford's Model	· Metals		
· Dalton's Model	· Nonmetals		
· Quantum Model	· Metalloids		
· Atomic Mass	· Ductile		
· Atomic Number	· Malleable		
· Standard Atomic Notation	· WHMIS		
· Atomic Mass Unit (A.M.U.)	· MSDS		
	· Reactivity		
	· Metallurgy		

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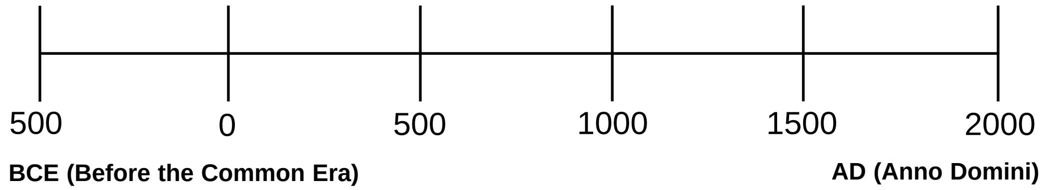
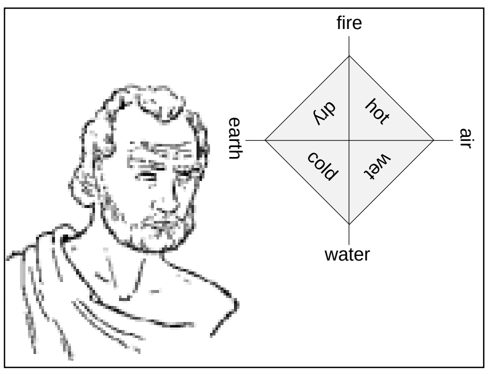
Historical Ideas About the Nature of Matter



Ancient Greek Philosophers:

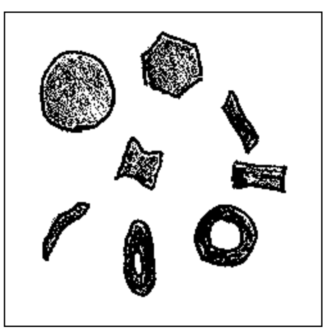
- The ancient Greek philosophers wondered why matter behaves as it does and manipulated ideas in their minds but did almost no experimentation.

Empedocles



- 450 BCE
- Empedocles proposed that matter was composed of four elements: Earth, Water, Air, Fire.

Democritus



- 400 BCE
- Democritus suggested matter was made of tiny particles that could not be broken down further. He called these particles "atomos," which means indivisible.

Aristotle

- 350 BCE
- After the death of Democritus, Aristotle and Socrates rejected the atomic model and adopted Empedocles' "four element" model. This model influenced and dominated scientific thinking for almost 2000 years.

Alchemists

- 500–1600 AD
- The alchemists were the first people to perform hands-on experimentation. They were part philosopher, mystic, magician, and chemist.
- They had three main beliefs:
  i. They believed that some elements could be changed into others. They attempted to change base metals (lead, tin) into valuable ones like gold, but in the process discovered new elements as well as many facts about existing materials.
  ii. They believed they could find a substance that would give them eternal life.
  iii. They believed they could produce a universal solvent that would dissolve all substances.

Modern Chemists:

- 1600–Present
- These chemists used the scientific method to investigate the physical world. This began in the 17th and 18th centuries where the focus was on determining the properties of pure substances and attempting to explain their composition.

Sir Francis Bacon (1600s)

- Bacon was one of the first scientists to develop new knowledge as a result of experimentation.

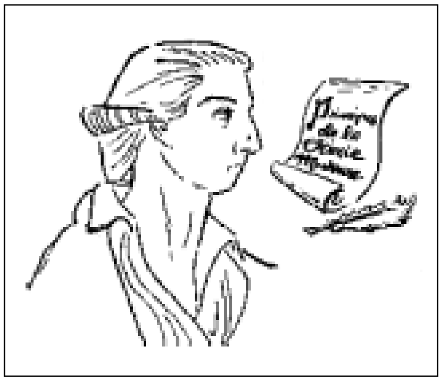
Robert Boyle (1650)

- Boyle believed that the Greek philosophers' "four element" theory could be improved upon. He published "The Skeptical Chemist" in which he defined an element as "certain simple unmingled bodies…." Boyle also helped lay the foundation for the concepts of elements and compounds. He recognized that elements could be combined to form compounds. Boyle also believed that air was not an element but a mixture.

Joseph Priestly (late 1700s)

- Priestly was the first person to isolate oxygen scientifically, but did not know that oxygen was an element.

Antoine de Lavoisier (late 1700s)



- Lavoisier defined the term “element” as a pure substance that cannot be chemically broken down into simpler substances.
- He discovered and identified 23 elements. He based his investigations on careful measurement and observations.
- He recognized mixtures exist and identified air as a mixture of oxygen and some other gas. (Air is at least two gases: one that does not burn and one that does).

Henry Cavendish (late 1700s)

- Cavendish experimented by mixing metal with acid, which produced a flammable gas (hydrogen). He discovered that his gas would burn in oxygen and produce water. Until that time, water was thought to be an element.

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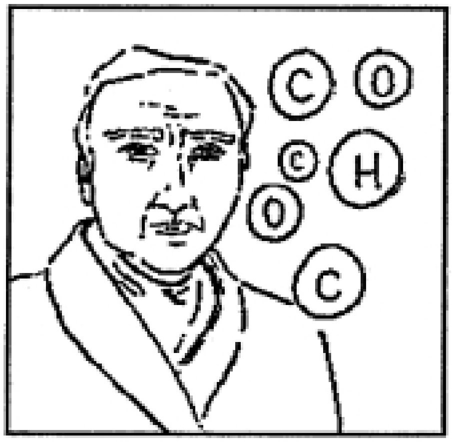
Models of Atomic Structure

Dalton's Model of the Atom (early 1800s):



The model that resulted from Dalton's theory is referred to as a "billiard ball" model.

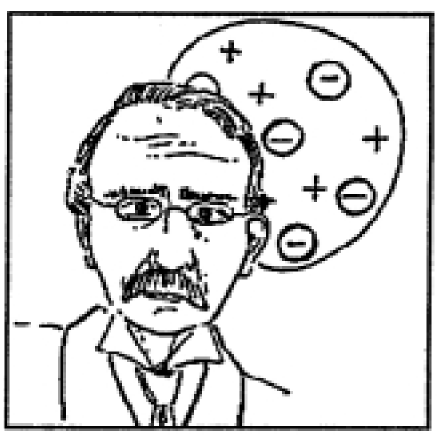
Dalton proposed the following:

- The atom is a solid, indivisible, indestructible sphere.
- The atom contains no subatomic particles.

Dalton's Atomic Theory:

1. All elements are composed of atoms. Atoms are indivisible and indestructible particles.
2. Atoms of the same element are exactly alike. They all have the same mass and chemically behave the same way.
3. Each element is characterized by the mass of its atoms. Different elements have atoms that differ in mass and chemical properties from the atoms of every other element. Atoms of different elements are different.
4. The joining of atoms of two or more elements forms compounds.
5. Atoms are neither created nor destroyed in a chemical change.

Thomson's Model of the Atom (1904):



The model that resulted from Thomson's theory is referred to as the "raisin bun" or "plum pudding" model.

Thomson's experiments with a Crook's tube, while he was studying the passage of an electric current through a gas, led to his discovery of very light negative particles called electrons. This disproved Dalton's theory that the atom was indivisible.

Thomson's further experiments with gas discharge tubes led to the discovery of much heavier positive particles, later identified as protons.

Thomson proposed the following:

- Electrons have a small mass and a negative charge.
- An atom is a sphere of positive electricity.
- Negative electrons are embedded in the positive sphere, so that the resulting atom is neutral or uncharged.

Rutherford's Model of the Atom (1911):

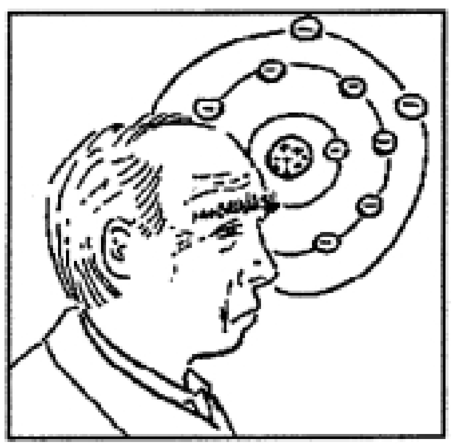
The model that resulted from Rutherford's theory is referred to as the "nuclear" model.

Rutherford attempted to test Thomson's model with radioactivity in an experiment using gold foil and a type of radiation called alpha particles. He discovered the existence of a dense, positively charged core in the atom called the nucleus.

Rutherford proposed the following:

- The nucleus is a very tiny, dense, and positively charged core of an atom.
- All of the atom's positively charged particles, called protons, are contained in the nucleus.
- The nucleus is surrounded by mostly empty space.
- Rapidly moving, negatively charged electrons are scattered outside the nucleus around the atom's edge in what is referred to as an electron cloud.

Bohr's Model of the Atom (1913):



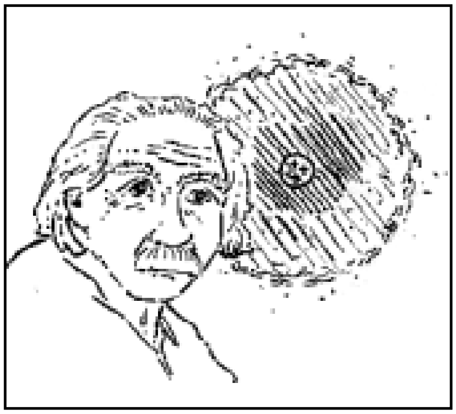
The model that resulted from Bohr's theory is referred to as the "planetary" model.

Bohr proposed an improvement on Rutherford's model by placing electrons in specific orbits about the nucleus.

Bohr proposed the following:

- Electrons move around the nucleus in nearly circular paths called orbits, much like how the planets circle the Sun.
- Each electron in an orbit has a definite amount of energy. Electrons can move within these energy levels without loss of energy.
- The further the electron is from the nucleus, the greater its energy.
- Electrons cannot exist between these orbits, but can move up or down from one orbit to another if excited by heat, light, or electrical energy.
- Each orbit or energy level is located at a certain distance from the nucleus.
- Electrons are more stable when they are at lower energy levels, closer to the nucleus.
- The order of filling the first three orbits with electrons is 2, 8, and 8.

Quantum Model of the Atom:



The model that resulted from several discoveries in the field of physics by various scientists is referred to as the “wave” model.

Bohr’s model worked well in explaining the behaviour of simple atoms, such as hydrogen, that contained few electrons, but it did not explain the more complex atoms.

The discovery that particles sometimes exhibit wave properties, called the wave-particle duality, has led to the currently accepted theory of atomic structure called quantum mechanics.

The Quantum model proposed the following:

- According to the theory of wave mechanics, electrons do not move about the atom’s nucleus in a definite path like planets around the Sun.
- It is impossible to determine the exact location of an electron.
- The probable location of an electron is based on its energy.
- Energy levels are divided into four sublevels, and each sublevel is made up of several pairs of electrons called orbitals.
- The quantum model of the atom shows how electrons move randomly in electron clouds called orbitals.

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Student Learning Activity

Chemical Symbol Bingo

Arrange element symbols randomly on the bingo card. Any element symbol shown below can be used only once.

H	**He**	**Li**	**Be**	**B**	**C**	**N**	**O**
F	**Ne**	**Na**	**Mg**	**Al**	**Si**	**P**	**S**
Cl	**Ar**	**K**	**Ca**	**Fe**	**Ni**	**Cu**	**Zn**
I	**Ag**	**Sn**	**Au**	**W**	**Hg**	**Pb**	**U**

B	I	N	G	O

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Chemical Symbol Bingo (Teacher Support)

Call out the name for the elements and ask students to locate the symbol on the bingo card. Bingo cards can be designed by randomly placing elements in open squares. When a row of element symbols is covered, "bingo" is called and a student wins.

H	**He**	**Li**	**Be**	**B**	**C**	**N**	**O**
F	**Ne**	**Na**	**Mg**	**Al**	**Si**	**P**	**S**
Cl	**Ar**	**K**	**Ca**	**Fe**	**Ni**	**Cu**	**Zn**
I	**Ag**	**Sn**	**Au**	**W**	**Hg**	**Pb**	**U**

B	I	N	G	O
He	Cu	P	Si	K
B	Cl	Au	U	F
Ar	C	Ca	Be	W
Mg	I	Ne	Zn	Sn
H	S	Hg	N	Fe

SLA
Student Learning Activity

Determining the Number of Atomic Particles

1. Each row in the table represents a different element. Use the information provided to fill in the required information for that element.

Number of protons in the atom	Number of electrons in the atom	Number of neutrons in the atom	Atomic mass of the atom	Atomic number of the atom	Element name	Chemical symbol
7	7					
5	5	6				
1	1	0				
						Ca
30		35				
	13		27	13		
9			19			
	23	28			Vanadium	V
	17		35	17		
	3					Li
	79					Au
	11		23	11		
	33			33		
					tin	
	19					K

2. Create a similar exercise to the one above and exchange with one of your classmates.

Protons	Electrons	Neutrons	Atomic mass	Atomic number	Element name	Chemical symbol

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Teacher Support Material

Determining the Number of Atomic Particles (Teacher Version with Answers)

1. Each row in the table represents a different element. Use the information provided to fill in the required information for that element.

Number of protons in the atom	Number of electrons in the atom	Number of neutrons in the atom	Atomic mass of the atom	Atomic number of the atom	Element name	Chemical symbol
7	7	7	14	7	Nitrogen	N
5	5	6	11	5	Boron	B
1	1	0	1	1	Hydrogen	H
20	20	20	40	20	Calcium	Ca
30	30	35	65	30	Zinc	Zn
13	13	14	27	13	Aluminum	Al
9	9	10	19	9	Fluorine	F
23	23	28	51	23	Vanadium	V
17	17	18	35	17	Chlorine	Cl
3	3	4	7	3	Lithium	Li
79	79	118	197	79	Gold	Au
11	11	12	23	11	Sodium	Na
33	33	42	75	33	Arsenic	As
50	50	69	119	50	Tin	Sn
19	19	20	39	19	Potassium	K

2. Create a similar exercise to the one above and exchange with one of your classmates.

Protons	Electrons	Neutrons	Atomic mass	Atomic number	Element name	Chemical symbol
		Answers will vary				

Bohr Model Diagrams

Examples of Bohr Model Diagrams:

FLUORINE $^{19}_{9}\mathrm{F}$

Step 1: Determine the number of fundamental particles found in the element.

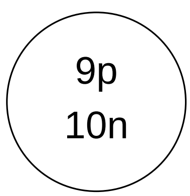
- Number of electrons is equal to the number of protons in a neutral atom. This value is equal to the atomic number.
- Number of neutrons is calculated using the equation: atomic mass minus atomic number.

Number of protons = 9 (equal to atomic number)

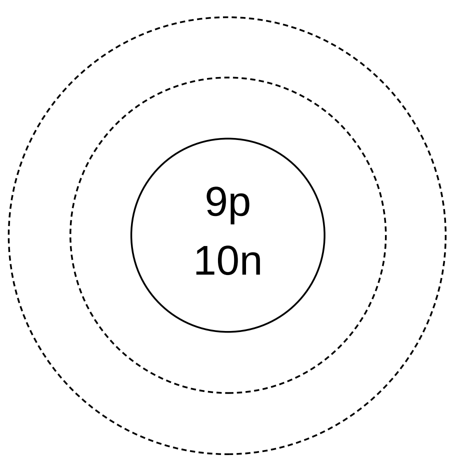
Number of electrons = 9 (equal to atomic number)

Number of neutrons = 10 (atomic mass – atomic number)

Step 2: Draw a circular nucleus with the correct number of and symbol for both protons and neutrons. The nucleus contains both neutrons and protons.



Step 3: Draw the correct number of electron shells. The number of shells/orbits is equal to the period of the element on the periodic table. Therefore, fluorine is found in period #2 and contains two electron shells.

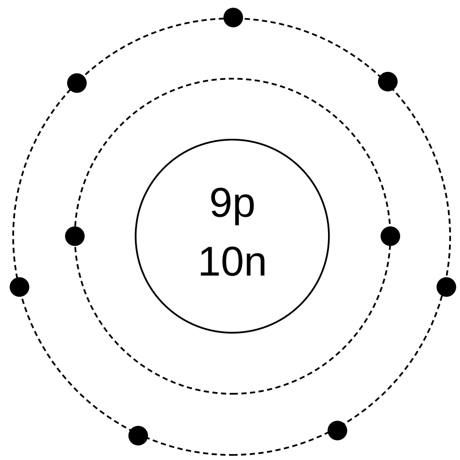


Step 4: Represent electrons as dots and position electrons in orbits or energy levels/shells.

- The electrons will fill the orbit of lowest energy first (i.e., first electron shell closest to nucleus). The first shell can hold a maximum of two electrons.
- An electron shell must be filled with its maximum number of electrons before any subsequent electron shell can be filled.
- Electrons should be distributed equally and symmetrically throughout shell.

Therefore, in the fluorine atom, the first shell contains two electrons, and the second shell contains seven electrons.

Notice that the number of valence electrons or outer shell electrons is equal to the Roman Numeral (A VII) of the group in which the fluorine is located.



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Drawing Bohr Model Diagrams

Element Name : ________________

Chemical Symbol : ______ Atomic Number : ______

Diagram the Bohr atom which contains:

protons neutrons electrons

Element Name : ________________

Chemical Symbol : ______ Atomic Number : ______

Diagram the Bohr atom which contains:

protons neutrons electrons

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Drawing Bohr Model Diagrams (Teacher Version with Answers)

Element Name : ____Beryllium____

Chemical Symbol : __Be__ Atomic Number : __4___

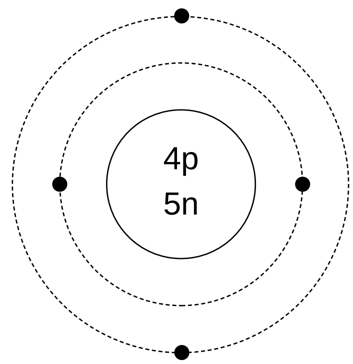

Diagram the Bohr atom which contains:

4 protons 5 neutrons 4 electrons

Element Name : ___Potassium_____

Chemical Symbol : __K ___ Atomic Number : __19__

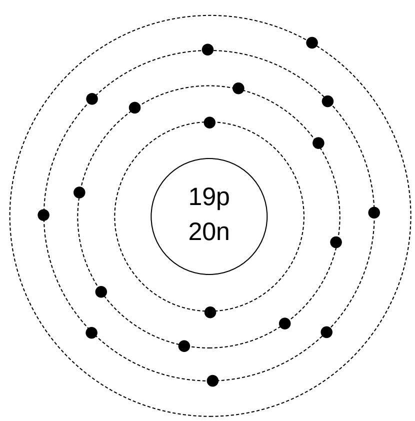

Diagram the Bohr atom which contains:

19 protons 20 neutrons 19 electrons

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Development of the Periodic Table

Early Attempts at Classification:

Dobereiner → Newlands → Meyer → Mendeleev → Moseley
1817 1863 1865 1869 1901

Both Dobereiner and Newlands observed that the atomic masses of elements seemed to be related to their chemical properties.

Meyer proposed there was some repeating pattern of the properties when they were arranged in order of atomic mass.

Dmitri Mendeleev (1869):

- systematically placed the elements into an organized table.
- stated that the properties of elements are a periodic function of their **atomic masses** and that the relationship among the elements is called **periodic law**.
- arranged the 63 elements known at that time in order of their atomic mass so that elements with the same valence (outermost electron) appeared in the same row. He found that with repeating rows, vertical columns contained elements with similar properties. He called those related elements **families or groups**.

Not all the elements had been discovered at that time, but once Mendeleev had established a pattern, he left spaces for undiscovered elements, correctly predicting that elements would be found to fill those spaces. Mendeleev's periodic table was instrumental in the discovery of 23 new elements during the three decades following its publication.

Mendeleev's First Periodic Table:

			Ti = 50	Zr = 90	? = 180
			V = 51	Nb = 94	Ta = 182
			Cr = 52	Mo = 96	W = 186
			Mn = 55	Rh = 104.4	Pt = 197.4
			Fe = 56	Rn = 104.4	Ir = 198
			Ni = Co = 59	Pl = 106.6	Os = 199
			Cu = 63.4	Ag = 108	Hg = 200
H = 1	Be = 9.4	Mg = 24	Zn = 65.2	Cd = 112	
	B = 11	Al = 27.4	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210
	O = 16	S = 32	Se = 79.4	Te = 128?	
	F = 19	Cl = 35.3	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85.4	Cs = 138	Tl = 204
		Ca = 40	Sr = 87.6	Ba = 137	Pb = 207
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		

Henry Moseley (1901):

- stated that physical and chemical properties are a periodic function of their atomic number, rather than mass. This better explained the gaps in the table.
- created the modern periodic table in which each succeeding element has one more proton and electron than the former element.

Today, we know that it is the electron that determines properties, with the number of electrons directly related to atomic number not atomic mass.

Period:

- Horizontal rows on the periodic table, with the numbering system 1-7 from top to bottom of the table.
- Each period represents an energy level in the quantum model of the atom.

Groups:

- Vertical columns on the periodic table.
- International Union of Pure and Applied Chemistry (IUPAC) labelling/numbering system 1–18 from left to right across the table.
- Old labelling system: Roman Numerals I–VIII followed by the letter “A” or “B”.
- Groups contain elements with similar chemical properties.
- The elements in a group all have the same number of electrons in their outermost shell/level. Electrons found in the outermost shell are called **valence electrons**.
- Roman numeral group number = number of valence electrons.
- Groups are sometimes referred to as families.

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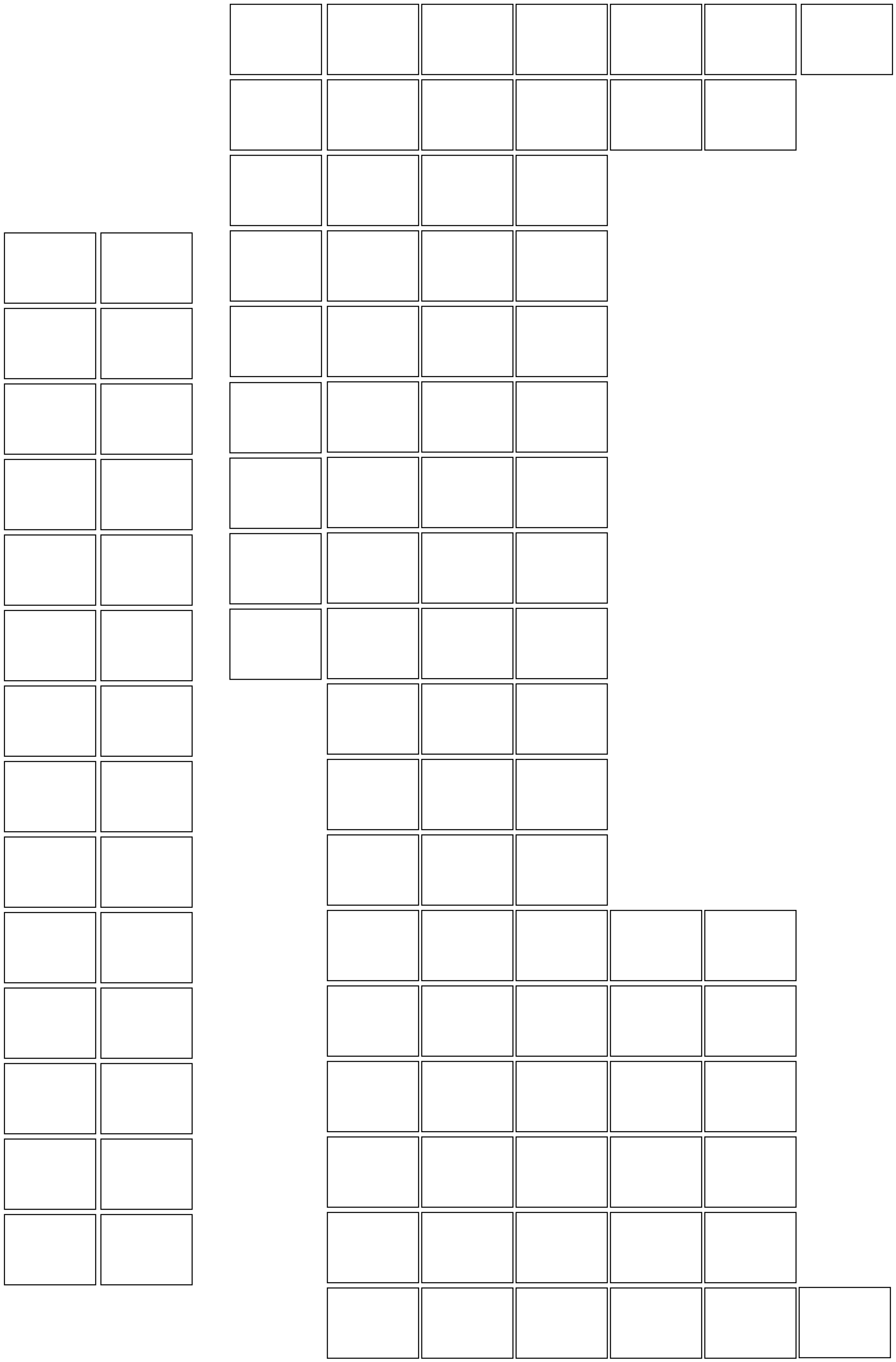
Blank Periodic Table



Chemical Families of Elements

- Alkali Metals
- Alkaline earth metals
- Lanthanides
- Actinides
- Transition Metals
- Chalcogens
- Halogens
- Noble Gases

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	103 Lr	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une									
			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	
			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	

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Organization of the Periodic Table

Groups

Periods

Period	IA	IIA	IIA	IVB	VB	VIB	VIIB	VIIIB	VIIIB	VIIIB	IB	IIB	IIIA	IVA	VA	VIA	VIIA	IIIA
1	1 **H** Hydrogen 1.0079																	2 **He** Helium 4.00260
2	3 **Li** Lithium 6.941	4 **Be** Berylium 9.01218											5 **B** Boron 10.82	6 **C** Carbon 12.011	7 **N** Nitrogen 14.0067	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9964	10 **Ne** Neon 20.179
3	11 **Na** Sodium 22.98977	12 **Mg** Magnesium 24.305											13 **Al** Aluminum 26.98154	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.97376	16 **S** Sulphur 32.06	17 **Cl** Chlorine 35.453	18 **Ar** Argon 39.948
4	19 **K** Potassium 39.0983	20 **Ca** Calcium 40.06	21 **Sc** Scandium 44.9559	22 **Ti** Titanium 47.90	23 **V** Vanadium 50.9414	24 **Cr** Chromium 51.996	25 **Mn** Manganese 54.9380	26 **Fe** Iron 55.847	27 **Co** Cobalt 58.9332	28 **Ni** Nickel 58.70	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.36	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.59	33 **As** Arsenic 74.9216	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.9059	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.9064	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium 96.90639	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.9055	46 **Pd** Palladium 106.4	47 **Ag** Silver 107.868	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.69	51 **Sb** Antimony 121.75	52 **Te** Tellurium 127.60	53 **I** Iodine 126.9045	54 **Xe** Xenon 131.30
6	55 **Cs** Cesium 132.9054	56 **Ba** Barium 137.34	71 **Lu** Lutetium 174.97	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.85	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.2	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.09	79 **Au** Gold 196.9665	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.37	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.9804	84 **Po** Polonium 208.9624	85 **At** Astatine 209.987	86 **Rn** Radon 222
7	87 **Fr** Francium 223.09176	88 **Ra** Radium 226	103 **Lr** Lawrencium 256.099	104 **Unq** 261	105 **Unp** 262	106 **Unh** 263	107 **Uns** 262	108 **Uno** 265	109 **Une** 266									

Period														
6	57 **La** Lanthanum 138.9055	58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.9077	60 **Nd** Neodymium 144.24	61 **Pm** Promethium 144.9127	62 **Sm** Samarium 150.4	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.9254	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.9304	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.9342	70 **Yb** Ytterbium 173.04
7	89 **Ac** Actinium 227.0274	90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.0359	92 **U** Uranium 238.029	93 **Np** Neptunium 237.0481	94 **Pu** Plutonium 244.0642	95 **Am** Americum 243.061	96 **Cm** Curium 247.0703	97 **Bk** Berkelium 247.0703	98 **Cf** Californium 251.0796	99 **Es** Einsteinium 254.088	100 **Fm** Fermium 257.0951	101 **Md** Mendelevium 258	102 **No** Nobelium 255.093

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Student Learning Activity

"What Element Am I?"

Respond to each statement by writing the symbol of the element best matching the clue.

Statement	Element Symbol
1. The element found in Period 3, Group VIIA.	
2. The element used in weather balloons.	
3. The element found in cheaper light bulbs.	
4. The element used in water purification.	
5. The element used in photographic film.	
6. The element used in dental crowns.	
7. A liquid element sometimes used in thermometers.	
8. The element used as a radiation shield.	
9. The element most used as an electrical conductor.	
10. The element once used as an antiseptic.	
11. The element found in Period 2, Group 13.	
12. The element used in the production of fertilizers.	
13. The metal element used in electroplating.	
14. The element used in pencil leads (not lead).	
15. The element used to absorb heat in spacecrafts.	
16. The element used in modern batteries.	
17. The gas element used in deep-sea diving.	
18. The element found in Period 4, Group 12.	
19. The element used in the making of steel.	
20. The element used as a fuel component in nuclear reactors.	

TSM
Teacher
Support
Material

"What Element Am I?"
(Teacher Version with Answers)

Statement	Element Symbol
1. The element found in Period 3, Group VIIA.	Cl
2. The element used in weather balloons.	He
3. The element found in cheaper light bulbs.	Ne
4. The element used in water purification.	Cl
5. The element used in photographic film.	Ag
6. The element used in dental crowns.	Au
7. A liquid element sometimes used in thermometers.	Hg
8. The element used as a radiation shield.	Pb
9. The element most used as an electrical conductor.	Cu
10. The element once used as an antiseptic.	I
11. The element found in Period 2, Group 13.	B
12. The element used in the production of fertilizers.	P
13. The metal element used in electroplating.	Ni
14. The element used in pencil leads (not lead).	C
15. The element used to absorb heat in spacecrafts.	Be
16. The element used in modern batteries.	Li
17. The gas element used in deep-sea diving.	He
18. The element found in Period 4, Group 12.	Zn
19. The element used in the making of steel.	O
20. The element used as a fuel component in nuclear reactors.	U

Metals — Nonmetals — Metalloids

Metals | Nonmetals | Transition Elements

IA	IIA	IIA	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	Noble Gases IIIA
1 **H** Hydrogen 1.0079																	2 **He** Helium 4.00260
3 **Li** Lithium 6.941	4 **Be** Berylium 9.01218											5 **B** Boron 10.82	6 **C** Carbon 12.011	7 **N** Nitrogen 14.0067	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9964	10 **Ne** Neon 20.179
11 **Na** Sodium 22.98977	12 **Mg** Magnesium 24.305											13 **Al** Aluminum 26.98154	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.97376	16 **S** Sulphur 32.06	17 **Cl** Chlorine 35.453	18 **Ar** Argon 39.948
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.06	21 **Sc** Scandium 44.9559	22 **Ti** Titanium 47.90	23 **V** Vanadium 50.9414	24 **Cr** Chromium 51.996	25 **Mn** Manganese 54.9380	26 **Fe** Iron 55.847	27 **Co** Cobalt 58.9332	28 **Ni** Nickel 58.70	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.36	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.59	33 **As** Arsenic 74.9216	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.9059	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.9064	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium 96.90639	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.9055	46 **Pd** Palladium 106.4	47 **Ag** Silver 107.868	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.69	51 **Sb** Antimony 121.75	52 **Te** Tellurium 127.60	53 **I** Iodine 126.9045	54 **Xe** Xenon 131.30
55 **Cs** Cesium 132.9054	56 **Ba** Barium 137.34	71 **Lu** Lutetium 174.97	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.85	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.2	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.09	79 **Au** Gold 196.9665	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.37	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.9804	84 **Po** Polonium 208.9624	85 **At** Astatine 209.987	86 **Rn** Radon 222
87 **Fr** Francium 223.09176	88 **Ra** Radium 226	103 **Lr** Lawrencium 256.099	104 **Unq** ___ 261	105 **Unp** ___ 262	106 **Unh** ___ 263	107 **Uns** ___ 262	108 **Uno** ___ 265	109 **Une** ___ 266									

*Metalloids lie along this heavy stairstep line and shaded in.

Metalloids

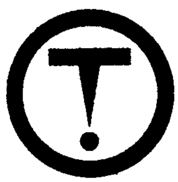
Series														
Larthanide Series	57 **La** Lanthanum 138.9055	58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.9077	60 **Nd** Neodymium 144.24	61 **Pm** Promethium 144.9127	62 **Sm** Samarium 150.4	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.9254	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.9304	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.9342	70 **Yb** Ytterbium 173.04
Actinide Series	89 **Ac** Actinium 227.0274	90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.0359	92 **U** Uranium 238.029	93 **Np** Neptunium 237.0481	94 **Pu** Plutonium 244.0642	95 **Am** Americum 243.061	96 **Cm** Curium 247.0703	97 **Bk** Berkelium 247.0703	98 **Cf** Californium 251.0796	99 **Es** Einsteinium 254.088	100 **Fm** Fermium 257.0951	101 **Md** Mendelevium 258	102 **No** Nobelium 255.093

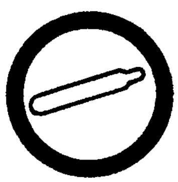
BLM Blackline Master

SLA
Student Learning Activity

WHMIS Symbols

In the space provided, give the meaning of the following symbols:





TSM
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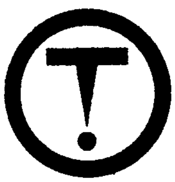
Material

WHMIS Symbols (Teacher Version with Answers)

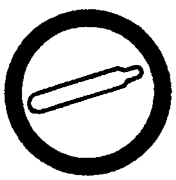
In the space provided, give the meaning of the following symbols:

Flammable and combustible material

Dangerously reactive material



Poisonous and infectious material causing other toxic effects



Compressed gas

Oxidizing material

Corrosive material

Biohazard infectious material

SLA
Student Learning Activity

Chemical Formulas

For each of the molecules in the left column, answer the questions that appear in the other columns.

Chemical Formula	a) How many different kinds of atoms are in this molecule? b) How many atoms of each kind are in this molecule? c) What is the total number of all atoms in this molecule?	What does this molecule represent?
Na_2O	a) b) c)	❑ a pure substance ❑ a compound ❑ a monatomic element ❑ a diatomic element ❑ a polyatomic element
H_2	a) b) c)	❑ a pure substance ❑ a compound ❑ a monatomic element ❑ a diatomic element ❑ a polyatomic element
Al	a) b) c)	❑ a pure substance ❑ a compound ❑ a monatomic element ❑ a diatomic element ❑ a polyatomic element
S_8	a) b) c)	❑ a pure substance ❑ a compound ❑ a monatomic element ❑ a diatomic element ❑ a polyatomic element
H_3PO_4	a) b) c)	❑ a pure substance ❑ a compound ❑ a monatomic element ❑ a diatomic element ❑ a polyatomic element

TSM
Teacher Support Material

Chemical Formulas (Teacher Version with Answers)

For each of the molecules in the left column, answer the questions that appear in the other columns.

Chemical Formula	a) How many different kinds of atoms are in this molecule? b) How many atoms of each kind are in this molecule? c) What is the total number of all atoms in this molecule?	What does this molecule represent?
Na_2O	a) 2 kinds of atoms b) Na = 2, O = 1 c) 3 atoms total	☐ a pure substance ☑ a compound ☐ a monatomic element ☐ a diatomic element ☐ a polyatomic element
H_2	a) 1 kind of atom b) H = 2 c) 2 atoms total	☑ a pure substance ☐ a compound ☐ a monatomic element ☑ a diatomic element ☐ a polyatomic element
Al	a) 1 kind of atom b) Al = 1 c) 1 atom total	☐ a pure substance ☐ a compound ☑ a monatomic element ☐ a diatomic element ☐ a polyatomic element
S_8	a) 1 kind of atom b) S = 8 c) 8 atoms total	☐ a pure substance ☐ a compound ☐ a monatomic element ☐ a diatomic element ☑ a polyatomic element
H_3PO_4	a) 3 kinds of atoms b) H = 3, P = 1, O = 4 c) 8 atoms total	☐ a pure substance ☑ a compound ☐ a monatomic element ☐ a diatomic element ☐ a polyatomic element

SLA
Student Learning Activity

Physical and Chemical Changes

Classify each of the following changes as either physical or chemical. Provide an explanation for your choice.

SITUATION	TYPE OF CHANGE	EXPLANATION
1. A piece of dry ice (solid carbon dioxide) is dropped into hot water. Large amounts of white vapour bubble out of the water.	__ Physical __ Chemical	
2. When George's father makes wine from crabapples, bubbles form on the surface of the yeast and fruit mixture.	__ Physical __ Chemical	
3. When margarine is left in a warm place for an extended period of time, it tastes sour.	__ Physical __ Chemical	
4. Jane's father opens up a new deodorant product. The room quickly smells like fresh flowers.	__ Physical __ Chemical	
5. During a school volleyball game, Jennifer sprains her ankle. Her coach squeezes a bag at room temperature that quickly becomes very cold.	__ Physical __ Chemical	