

## EXPERIMENT 0

# Atoms and elements

### A. Goal

The goal of this laboratory experiment is to practice unit conversions and carry out calculations with the correct number of significant figures.

### B. Materials

- ☐ Display of different elements (Al, C, Cu, Fe, Mg, Ni, N, O, P, Si, S, Sn, Zn)

### C. Background

#### ***The periodic table***

The periodic table (see Figure 1) is a chart containing all known elements arranged in increasing number of electrons per atom in a way that elements with similar chemical and physical properties are located together. The periodic table contains all existing elements—some of them are synthetic others are natural—that form the matter arranged in columns and rows. Every element has a different name accompanied by a symbol that represents its name. The tabular arrangement of elements in the form of rows and columns allows further classification of the elements according to their properties. This section will cover the different features of the periodic table.

#### ***Elements and Symbols***

Elements cannot be broken down into simpler substances. For example, aluminum is an element only made of aluminum atoms and if you analyze the composition of a piece of this metal you would only find aluminum atoms. Chemical symbols are one- or two-letter abbreviations that represent the names of the elements. Only the first letter is capitalized and if a second letter exists in the element's name, the second letter should be lowercase. For example, the chemical symbol for aluminum is Al, written as capital A and lowercase l.

#### ***Periods and groups***

The periodic table (see Figure 1) contains all elements arranged in rows and columns. The horizontal rows are called *periods* and the vertical columns are called *groups or families*. For example, the first period contains hydrogen (H) and helium (He), whereas the second group contains Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba) and Radium (Ra). There are seven periods (periods 1-7) and 18 groups. Some of the groups are labeled with an A (e.g. group 8A) whereas others are labeled with a B (e.g. group 8B). Group numbers can be found written with roman numbers and a letter (A or B) or with a more modern group numbering of 1-18 going across the periodic table. For example, group 2 (Mg-Ra) can also be called IIA, and group 13 (B-Tl) is also known as IIIA.

#### ***Properties in the periodic table***

The physical and chemical properties of some elements of the table (see Figure 1) are similar, and these similarities led to the organization of the periodic table. Elements in the same group share properties and for example, oxygen and sulfur

have similar properties: both are reactive elements. Differently, the properties across periods change going from metals to nonmetals. For example, the properties of Li and Ne are very different, and lithium is a reactive metal whereas neon is a nonreactive gas.

### ***Metals, Nonmetals, and Metalloids***

Overall, the elements of the periodic table (see Figure 1) can be classified as metals, nonmetals, and metalloids. Metals are those elements on the left of the table and nonmetals are the elements on the right of the table. The elements between metals and nonmetals are called metalloids and include only B, Si, Ge, As, Sb, Te, Po, and At. Metals are shiny solids and usually melt at higher temperatures. Some examples of metals are Gold (Au) or Iron (Fe). Nonmetals are often poor conductors of heat and electricity with low melting points. They also tend to be matt (non-shiny), malleable, or ductile. Some examples of nonmetals are Carbon (C) or Nitrogen (N). Metalloids are elements that share some properties with metals and others with nonmetals. For example, they are better conductors of heat and electricity than nonmetals, but not as good conductors as metals. Metalloids are semiconductors because they can act as both conductors and insulators under certain conditions. An example of metalloids is Silicon (Si) which should not be confused with silicone, a chemical employed in prosthetics.

### ***Classification of elements in terms of groups***

Some of the groups in the periodic table (see Figure 1) have specific names such as alkali metals, alkaline earth metals, transition metals, chalcogens, halogens, or noble gases. Alkali metals are the group 1A elements: lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs), and francium (Fr). Alkali elements are soft and shiny metals, and they are also good conductors of heat and electricity, with low melting points. Alkali earth metals are group 2A (2) elements: beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra). Transition metals are the elements from groups 3 to 12 and they are located in the middle of the table. Chalcogens are group 6A (16) elements: oxygen (O), sulfur (S), selenium (Se), tellurium (Te), and polonium (Po). Halogens are group 7A (17) elements: fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At). Halogens are very reactive elements. Finally, noble gases are group 8A (18) elements: helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and radon (Rn). They are inert and rarely combine with other elements in the periodic table, like a noble family: have you ever met a royal?

### ***How to classify Hydrogen***

At first sight, hydrogen (H) may seem to be put in the wrong spot on the periodic table (see Figure 1). Although it is located at the top of Group 1A (1), it is not an alkali metal, as it has very different properties. Thus hydrogen does not belong to the alkali metals, being nonmetal.

#### **Sample Problem 1**

Answer the following questions: (a) Give the group and period of the following elements, and give the name: Ca, Ir, and C. (b) Classify as alkali metal, alkali earth metal, transition metal, halogen or noble gas, and give the name: Mg, Li, Co, He, F. (c) Classify as metal, nonmetal or metalloid, and give the name: Ba, N, Si.

#### **SOLUTION**

(a) The period and group of Ca (Calcium) is 4 and 2 (2A), respectively. The period and group of Ir (Iridium) is 6 and 9 (8B), respectively. The period and group of C (Carbon) is 2 and 14 (IVA), respectively. (b) Mg (Magnesium) is an alkali earth metal, whereas Li (Lithium) is an alkali metal. Co (Cobalt) is a transition metal. He (Helium) is a noble gas. F (Fluorine) is a halogen. (c) Ba (Barium) is a metal. N (Nitrogen) is a nonmetal. Si (Silicon) is a metalloid.

#### **STUDY CHECK**

Answer the following questions: (a) Give the group and period of the following elements, and give the name: Cl. (b) Classify as alkali metal, alkali earth metal, transition metal, halogen or noble gas, and give the name: Ne. (c) Classify as metal, nonmetal or metalloid, and give the name: W.

►Answer: (a) Chlorine: G 17 (VIIA) P3; (b) Neon Noble gas ; (c) Tungsten metal.

## The atom

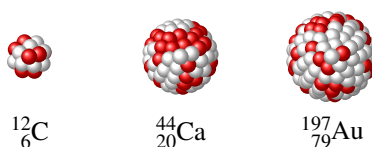
Atoms are the smallest piece of an element that retains their characteristics. They are the building blocks of matter. This section covers the structure of the atom. You will learn how to calculate the number of subatomic particles that made an atom and how to differentiate atoms of an element—all atoms of an element are not equal.

1 IA	1	1.0079	1	H	Hydrogen	2 IIA	4	9.0122	2	He	Helium	18 VIIA	2	4.0026	18	Ne	Neon
	3	6.941	3	Li	Lithium		5	10.811	5	B	Boron	13 IIIA	5	10.811	13	Al	Aluminum
	6	12.011	6	C	Carbon		7	14.007	7	N	Nitrogen	14 IVA	6	12.011	14	Si	Silicon
	9	15.999	9	O	Oxygen		8	15.999	8	O	Oxygen	15 VA	7	14.007	15	P	Phosphorus
	10	18.998	10	F	Fluorine		16	32.065	16	S	Sulphur	16 VIA	8	15.999	16	S	Sulphur
	11	20.180	11	Ne	Neon		17	35.453	17	Cl	Chlorine	17 VIIA	9	18.998	17	Cl	Chlorine
	12	24.305	12	Mg	Magnesium		18	39.948	18	Ar	Argon		10	39.948	18	Ar	Argon
	13	26.982	13	Al	Aluminum		14	28.086	14	Si	Silicon		11	26.982	13	Al	Aluminum
	15	30.974	15	P	Phosphorus		16	32.065	16	S	Sulphur		12	30.974	15	P	Phosphorus
	17	35.453	17	Cl	Chlorine		18	39.948	18	Ar	Argon		13	35.453	17	Cl	Chlorine
	19	39.098	19	K	Potassium		20	40.078	20	Ca	Calcium		14	39.098	19	K	Potassium
	21	44.956	21	Sc	Scandium		22	47.867	22	Ti	Titanium		15	44.956	21	Sc	Scandium
	23	50.942	23	V	Vanadium		24	51.996	24	Cr	Chromium		16	50.942	23	V	Vanadium
	25	54.938	25	Mn	Manganese		26	55.845	26	Fe	Iron		17	54.938	25	Mn	Manganese
	27	58.933	27	Co	Cobalt		28	58.693	28	Ni	Nickel		18	58.933	27	Co	Cobalt
	29	63.546	29	Cu	Copper		30	65.39	30	Zn	Zinc		19	63.546	29	Cu	Copper
	31	69.723	31	Ga	Gallium		32	72.64	32	Ge	Germanium		20	69.723	31	Ga	Gallium
	33	74.922	33	As	Arsenic		34	78.96	34	Se	Selenium		21	74.922	33	As	Arsenic
	35	79.904	35	Br	Bromine		36	83.8	36	Kr	Krypton		22	79.904	35	Br	Bromine
	37	85.468	37	Rb	Rubidium		38	87.62	38	Sr	Strontium		23	85.468	37	Rb	Rubidium
	39	88.906	39	Y	Yttrium		40	91.224	40	Zr	Zirconium		24	88.906	39	Y	Yttrium
	41	92.906	41	Nb	Niobium		42	95.94	42	Mo	Molybdenum		25	92.906	41	Nb	Niobium
	43	96	43	Tc	Technetium		44	101.07	44	Ru	Ruthenium		26	96	43	Tc	Technetium
	45	102.91	45	Rh	Rhodium		46	106.42	46	Pd	Palladium		27	102.91	45	Rh	Rhodium
	47	107.87	47	Ag	Silver		48	112.41	48	Cd	Cadmium		28	107.87	47	Ag	Silver
	49	114.82	49	In	Indium		50	118.71	50	Sn	Tin		29	114.82	49	In	Indium
	51	121.76	51	Sb	Antimony		52	127.6	52	Te	Tellurium		30	121.76	51	Sb	Antimony
	53	126.9	53	I	Iodine		54	131.29	54	Xe	Xenon		31	126.9	53	I	Iodine
	55	132.91	55	Cs	Cesium		56	137.33	56	Ba	Barium		32	132.91	55	Cs	Cesium
	57-71		57-71	La-Lu	Lanthanide		72	178.49	72	Hf	Hafnium		33	137.33	56	Ba	Barium
	73	180.95	73	Ta	Tantalum		74	183.84	74	W	Tungsten		34	180.95	73	Ta	Tantalum
	75	186.21	75	Re	Rhenium		76	190.23	76	Os	Osmium		35	186.21	75	Re	Rhenium
	77	192.22	77	Ir	Iridium		78	195.08	78	Pt	Platinum		36	192.22	77	Ir	Iridium
	79	196.97	79	Au	Gold		80	200.59	80	Hg	Mercury		37	196.97	79	Au	Gold
	81	204.38	81	Tl	Thallium		82	207.2	82	Pb	Lead		38	204.38	81	Tl	Thallium
	83	208.98	83	Bi	Bismuth		84	209	84	Po	Polonium		39	208.98	83	Bi	Bismuth
	85	210	85	At	Astatine		86	210	86	Rn	Radon		40	210	85	At	Astatine
	87	223	87	Fr	Francium		88	226	88	Ra	Radium		41	223	87	Fr	Francium
	89-103		89-103	Ac-Lr	Actinide		104	261	104	Rf	Rutherfordium		42	226	88	Ra	Radium
	105	262	105	Db	Dubnium		106	266	106	Sg	Seaborgium		43	262	105	Db	Dubnium
	107	264	107	Bh	Bohrium		108	277	108	Hs	Hassium		44	264	106	Sg	Seaborgium
	109	268	109	Mt	Mitrium		110	281	110	Ds	Darmstadtium		45	268	107	Bh	Bohrium
	111	280	111	Rg	Roentgenium		112	285	112	Uub	Ununbium		46	280	108	Hs	Hassium
	113	284	113	Uut	Ununtrium		114	289	114	Uuq	Ununquadium		47	285	109	Mt	Mitrium
	115	288	115	Uup	Ununpentium		116	293	116	Uuh	Ununhexium		48	289	110	Ds	Darmstadtium
	117	292	117	Uus	Ununseptium		118	294	118	Uuo	Ununoctium		49	293	111	Rg	Roentgenium
	119	294	119	Uue	Ununennium		120	297	120	Uub	Ununbium		50	294	112	Uub	Ununbium
	121	298	121	Uut	Ununtrium		122	301	122	Uuq	Ununquadium		51	298	113	Uut	Ununtrium
	123	302	123	Uup	Ununpentium		124	305	124	Uuh	Ununhexium		52	302	114	Uuq	Ununquadium
	125	306	125	Uus	Ununseptium		126	309	126	Uuh	Ununhexium		53	306	115	Uup	Ununpentium
	127	310	127	Uue	Ununennium		128	313	128	Uub	Ununbium		54	310	116	Uuh	Ununhexium
	129	312	129	Uue	Ununennium		130	315	130	Uub	Ununbium		55	312	117	Uus	Ununseptium
	131	314	131	Uue	Ununennium		132	317	132	Uub	Ununbium		56	314	118	Uuo	Ununoctium
	133	316	133	Uue	Ununennium		134	319	134	Uub	Ununbium		57	316	119	Uue	Ununennium
	135	320	135	Uue	Ununennium		136	323	136	Uub	Ununbium		58	320	120	Uub	Ununbium
	137	322	137	Uue	Ununennium		138	325	138	Uub	Ununbium		59	322	121	Uut	Ununtrium
	139	324	139	Uue	Ununennium		140	327	140	Uub	Ununbium		60	324	122	Uuq	Ununquadium
	141	326	141	Uue	Ununennium		142	329	142	Uub	Ununbium		61	326	123	Uup	Ununpentium
	143	328	143	Uue	Ununennium		144	331	144	Uub	Ununbium		62	328	124	Uuh	Ununhexium
	145	330	145	Uue	Ununennium		146	333	146	Uub	Ununbium		63	330	125	Uus	Ununseptium
	147	332	147	Uue	Ununennium		148	335	148	Uub	Ununbium		64	332	126	Uue	Ununennium
	149	334	149	Uue	Ununennium		150	337	150	Uub	Ununbium		65	334	127	Uue	Ununennium
	151	336	151	Uue	Ununennium		152	339	152	Uub	Ununbium		66	336	128	Uub	Ununbium
	153	340	153	Uue	Ununennium		154	343	154	Uub	Ununbium		67	340	129	Uut	Ununtrium
	155	342	155	Uue	Ununennium		156	345	156	Uub	Ununbium		68	342	130	Uuq	Ununquadium
	157	344	157	Uue	Ununennium		158	347	158	Uub	Ununbium		69	344	131	Uup	Ununpentium
	159	346	159	Uue	Ununennium		160	349	160	Uub	Ununbium		70	346	132	Uuh	Ununhexium
	161	348	161	Uue	Ununennium		162	351	162	Uub	Ununbium		71	348	133	Uus	Ununseptium
	163	350	163	Uue	Ununennium		164	353	164	Uub	Ununbium		72	350	134	Uue	Ununennium
	165	352	165	Uue	Ununennium		166	355	166	Uub	Ununbium		73	352	135	Uue	Ununennium
	167	354	167	Uue	Ununennium		168	357	168	Uub	Ununbium		74	354	136	Uub	Ununbium
	169	356	169	Uue	Ununennium		170	359	170	Uub	Ununbium		75	356	137	Uut	Ununtrium
	171	358	171	Uue	Ununennium		172	361	172	Uub	Ununbium		76	358	138	Uuq	Ununquadium
	173	360	173	Uue	Ununennium		174	363	174	Uub	Ununbium		77	360	139	Uup	Ununpentium
	175	362	175	Uue	Ununennium		176	365	176	Uub	Ununbium		78	362	140	Uuh	Ununhexium
	177	364	177	Uue	Ununennium		178	367	178	Uub	Ununbium		79	364	141	Uus	Ununseptium
	179	366	179	Uue	Ununennium		180	369	180	Uub	Ununbium		80	366	142	Uue	Ununennium
	181	368	181	Uue	Ununennium		182	371	182	Uub	Ununbium		81	368	143	Uub	Ununbium
	183	370	183	Uue	Ununennium		184	373	184	Uub	Ununbium		82	370	144	Uut	Ununtrium
	185	372	185	Uue	Ununennium		186	375	186	Uub	Ununbium		83	372	145	Uuq	Ununquadium
	187	374	187	Uue	Ununennium		188	377	188	Uub	Ununbium		84	374	146	Uup	Ununpentium
	189	376	189	Uue	Ununennium		190	379	190	Uub	Ununbium		85	376	147	Uuh	Ununhexium
	191	378	191	Uue	Ununennium		192	381	192	Uub	Ununbium		86	378	148	Uus	Ununseptium
	193	380	193	Uue	Ununennium		194	383	194	Uub	Ununbium		87	380	149	Uue	Ununennium
	195	382	195	Uue	Ununennium		196	385	196	Uub	Ununbium		88	382	150	Uub	Ununbium
	197	384	197	Uue	Ununennium		198	387	198	Uub	Ununbium		89	384	151	Uut	Ununtrium
	199	386	199	Uue	Ununennium		200	389	200	Uub	Ununbium		90	386	152	Uuq	Ununquadium
	201	388	201	Uue	Ununennium		202	391	202	Uub	Ununbium		91	388	153	Uup	Ununpentium
	203	390	203	Uue	Ununennium		204	393	204	Uub	Ununbium		92	390	154	Uuh	Ununhexium
	205	392	205	Uue	Ununennium		206	395	206	Uub	Ununbium		93	392	155	Uus	Ununseptium
	207	394	207	Uue	Ununennium		208	397	208	Uub</							

different elements differ. For example, Carbon has an atomic number of  $Z=6$ , whereas Oxygen has an atomic number of  $Z=8$ . The mass number ( $A$ ) of an element indicates the combined number of protons and neutrons. Mass numbers can not be found in the periodic table. More importantly, different atoms of the same element can have different mass numbers. For example, a Carbon atom made of 6 neutrons and 6 protons has a mass number of  $A=12$ . Both  $A$  and  $Z$  for an atom  $X$  are indicated in the following form called isotope notation:

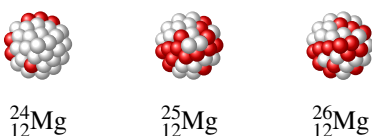


As an example, the notation  ${}^{24}_{12}\text{Mg}$  means that the atomic number of Mg is  $Z=12$  and the mass number is  $A=24$ . Using the isotope notation, one can quickly identify the number of protons, neutrons, and electrons in an atom. As the atomic number is always indicated on the bottom part (e.g. Mg has 12 electrons). At the same time, the number of electrons and protons in a neutral atom is the same—neutral means an atom without a charge. The number of neutrons of an isotope can be computed by subtracting the atomic number from the mass number. Below you can find three different atoms, an atom of Carbon with 12 protons and neutrons, a larger atom of Calcium with 44 protons and neutrons, and an even larger atom of Gold with 197 protons and neutrons.



## Isotopes

All atoms of an element have the same atomic number but may differ in terms of mass number. Isotopes are atoms of the same element with different numbers of neutrons and therefore with different mass numbers but with the same atomic number. For example:  ${}^{24}_{12}\text{Mg}$ ,  ${}^{25}_{12}\text{Mg}$  and  ${}^{26}_{12}\text{Mg}$  are three isotopes of Mg.  ${}^{27}_{12}\text{Mg}$  is heavier than  ${}^{24}_{12}\text{Mg}$  as it contains more neutrons and protons in the nucleus. Most elements occur in nature in a particular isotopic composition, and each of the isotopes has a specific proportional abundance. For example, the abundance of  ${}^{24}_{12}\text{Mg}$  is 79%, and the abundance of  ${}^{25}_{12}\text{Mg}$  and  ${}^{26}_{12}\text{Mg}$  is 10% and 11%, respectively. This means,  ${}^{24}_{12}\text{Mg}$  is more abundant than for example  ${}^{26}_{12}\text{Mg}$ .



Another example of isotopes can be found in Carbon, with two naturally occurring isotopes. In the case of charged atoms, we have the cations have fewer electrons than their corresponding atom, whereas anions have more electrons, both based on their charge. The mass of an atom is measured relative to the mass of an atomic standard, the Carbon-12 atom, whose mass is defined as 12 atomic units of mass, amu. For example, the mass of  ${}^1\text{H}$  is 1.008 amu. The term atomic unit of mass has been renamed to dalton (Da). Therefore, the mass of  ${}^1\text{H}$  is 1.008 amu or 1.008 Da. The atomic mass is a relative unit of mass equivalent to  $1.66054 \times 10^{-24}\text{g}$ .

## Average atomic mass

As atoms are made of numerous isotopes—this means different atoms of the same element but with a different number of neutrons and hence different weights. The average atomic mass (also called atomic weight) represents the mass of the atoms of an element and results from all existing isotopes taking into account their abundance. It is the average of the masses of the naturally occurring isotope weighted according to their abundance expressed in atomic mass units or daltons. We can think of % *relative abundance*, and for example, the % relative abundance of  ${}^1\text{H}$  is 99%. But we can also think of *fractional abundance*, that in the case of  ${}^1\text{H}$  would be 0.99. For an element with  $n$  isotopes each with different masses ( $A_1, A_2, \dots, A_n$ ) and different fractional abundances ( $f_1, f_2, \dots, f_n$ ), the atomic mass is given by

$$\text{Atomic mass} = \sum_{i=1}^n A_i \cdot f_i = A_1 \cdot f_1 + A_2 \cdot f_2 + \dots + A_n \cdot f_n$$

Note that when adding the fractional abundances of all isotopes, one should obtain a value of one:

$$\sum_{i=1}^n f_i = f_1 + f_2 + \cdots + f_n = 1$$

Atomic masses can be simply found in any periodic table (see Figure 1) for each element. For example, the atomic mass of oxygen (O) is 15.999 amu and the atomic mass of nitrogen (N) is 14.007 amu. The atomic mass found in the periodic table is an average that results from including the mass of the different isotopes and their abundance. Table ?? lists the relative abundance of a series of common isotopes.

#### Sample Problem 2

Calculate the number of protons, neutrons and electrons of the following atoms:

- (a)  ${}^{27}_{12}\text{Mg}$  (b)  ${}^{22}_{10}\text{Ne}$  (c)  ${}^{20}_{10}\text{Ne}$

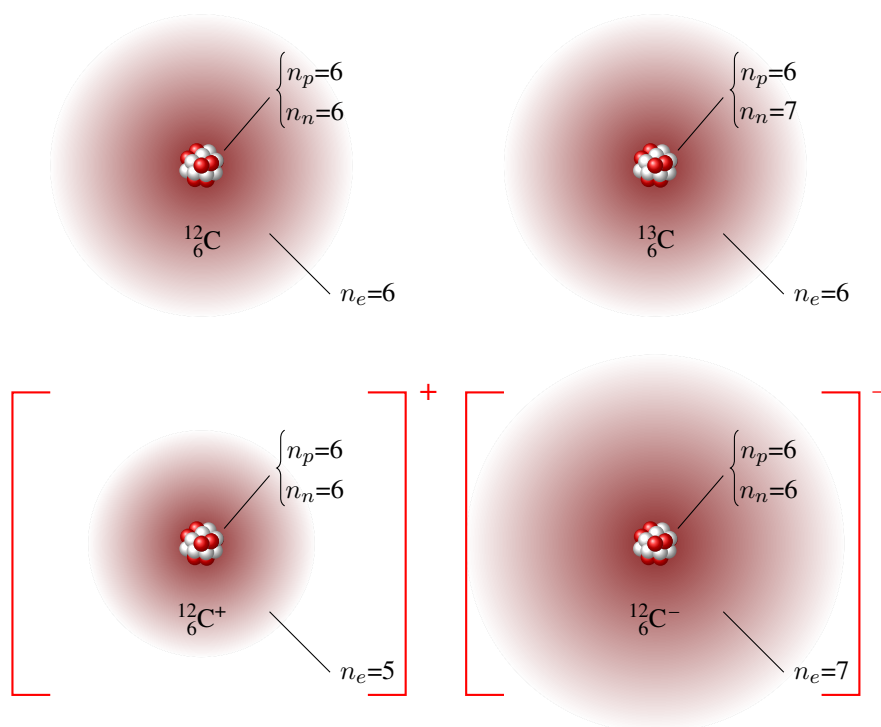
#### SOLUTION

(a)  ${}^{27}_{12}\text{Mg}$  has 12 electrons ( $Z=12$ ) and 12 protons as well (the number of electrons and protons are the same if the atom is neutral), and 15 neutrons, as  $27-12=15$ . (b)  ${}^{22}_{10}\text{Ne}$  has 10 electrons and 10 protons, and 12 neutrons. (c)  ${}^{20}_{10}\text{Ne}$  has 10 electrons and 10 protons, and 10 neutrons as well.

#### STUDY CHECK

Calculate the number of protons, neutrons and electrons of the following atoms: (a)  ${}^{32}_{16}\text{S}$  (b)  ${}^{34}_{16}\text{S}$  (c)  ${}^{36}_{16}\text{S}$

►Answer: (a) 16p, 16e and 16n; (b) 16p, 16e and 18n; (c) 16p, 16e and 20n.



**Figure 2** Representations of four different atoms, two neutral atoms on top and two ions on the bottom.

## D. Procedure

### Appearance of some chemical elements

*Step 1:* – Write the chemical symbol and describe the color of the elements listed below.

*Step 2:* – Describe the luster of the elements listed below (shiny/dull).

*Step 3:* – Based on your observations, describe the elements as metals, nonmetals or metalloids.

**Good Lab Practice**

 Be gentle when handling the display of chemical elements.



### ***The atom and its composition***

*Step 1:* – Fill the table below indicating the number of electrons, protons and neutrons of the following neutral isotopes.

### ***Neutral isotopes***

*Step 1:* – Fill the table below indicating the number of electrons, protons and neutrons of the following neutral isotopes.

### ***Charged isotopes***

*Step 1:* – Fill the table below indicating the number of electrons, protons and neutrons of the following charged isotopes.

### ***Average atomic masses***

*Step 1:* – For the element below calculate the average atomic mass by multiplying the mass of the different isotopes by its abundance and adding the contributions.

### ***Atomic spectrum***

*Step 1:* – Your instructor will show you the light spectra for a set of elements and compounds.

*Step 2:* – Describe the light color for each.

**STUDENT INFO**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**Pre-lab Questions**

# Atoms and elements

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1. The mass number of an atom is equal to the number of: (a) electrons (b) neutrons (c) neutrons plus protons (d) protons
2. Consider a neutral atom with 30 protons and 34 neutrons. The mass number of the element is: (a) 30 (b) 32 (c) 34 (d) 64 (e) 94
3. Consider a neutral atom with 30 protons and 34 neutrons. The atomic number of the element is: (a) 30 (b) 32 (c) 34 (d) 64 (e) 94
4. In an atom, the nucleus contains: (a) an equal number of protons and electrons. (b) all the protons and neutrons (c) all the protons and electrons (d) only neutrons (e) only protons





Results  
EXPERIMENT

STUDENT INFO

Name: \_\_\_\_\_ Date: \_\_\_\_\_

# Atoms and elements

## Appearance of some chemical elements

Element	Symbol	Atomic number	Luster Shinny/dull	Metallic Character Metal/Nonmetal/ Metalloid
Aluminium	_____	_____	_____	_____
Carbon	_____	_____	_____	_____
Copper	_____	_____	_____	_____
Iron	_____	_____	_____	_____
Magnesium	_____	_____	_____	_____
Nickel	_____	_____	_____	_____
Nitrogen	_____	_____	_____	_____
Oxygen *	_____	_____	_____	_____
Phosphorus	_____	_____	_____	_____
Silicon	_____	_____	_____	_____
Silver*	_____	_____	_____	_____
Gold *	_____	_____	_____	_____
Sulfur	_____	_____	_____	_____
Tin	_____	_____	_____	_____
Zinc	_____	_____	_____	_____
Calcium	_____	_____	_____	_____

\* Not given

### ***The atom and its composition***

Name	Symbol	Atomic number, Z	Mass number, A	Protons	Neutrons	Electrons
	Fe				30	
			134			55
					32	28
Fluorine			18			
	C		12			

### ***Neutral isotopes***

Isotope	Protons	Neutrons	Electrons
$^{27}_{12}\text{Mg}$			
$^{64}_{29}\text{Cu}$			
$^{79}_{34}\text{Se}$			
$^{103}_{46}\text{Pd}$			

***Charged isotopes***

Isotope	Protons	Neutrons	Electrons
$^{27}_{12}\text{Mg}^{2+}$			
$^{64}_{29}\text{Cu}^{+}$			
$^{18}_{8}\text{O}^{2-}$			
$^{15}_{7}\text{N}^{3-}$			

***Average atomic masses***

Isotope	Isotopic mass (m)	Abundance (%)	Fractional Abundance (f)	$m \times f$
$^{32}_{16}\text{S}$	31.97207	95.0		
$^{33}_{16}\text{S}$	32.97146	0.76		
$^{34}_{16}\text{S}$	33.96786	4.22		
Average mass (amu)				

## ***Atomic spectrum***

Nitrogen

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Oxygen

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Helium

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Neon

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Argon

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**STUDENT INFO**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**Post-lab Questions**

# Atoms and elements

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1. The atomic mass of Ga is 69.72 amu. There are only two naturally occurring isotopes of gallium:  $^{69}\text{Ga}$ , with a mass of 69.0 amu, and  $^{71}\text{Ga}$ , with a mass of 71.0 amu. Calculate the natural abundance of the  $^{69}\text{Ga}$  isotope.
2. Magnesium contains three different isotopes: magnesium-24 with an abundance of 79% and a mass of 23.9850423 amu, magnesium-25 with an abundance of 10% and a mass of 24.9858374 amu, and magnesium-26 with a mass of 25.9825937 amu. Calculate the abundance of magnesium-26 and the average atomic mass of a sample of magnesium.