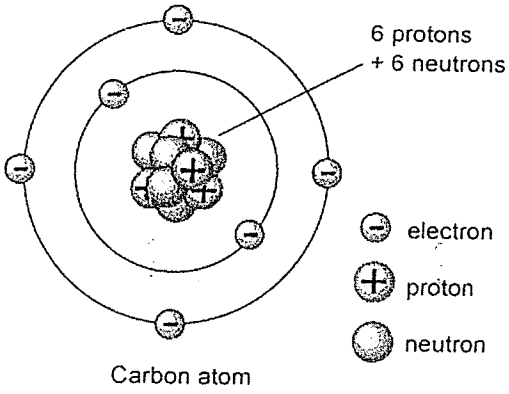
Key
2018-2019

Honors Chemistry
Unit 2: Atomic Structure



Carbon atom

Major Understanding	Skills (you should be able to...)
The modern model of the atom has evolved over a long period of time through the work of many scientists.	Relate experimental evidence to models of the atom
Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons.	Use models to describe the structure of an atom
Subatomic particles contained in the nucleus include protons and neutrons.	Determine the number of protons and neutrons in an atom
The proton is positively charged, and the neutron has no charge. The electron is negatively charged.	Indicate the mass, charge, and relative location of each of the subatomic particles
Protons and electrons have equal but opposite charges. The number of protons is equal to the number of electrons in an atom.	Determine the number of protons or electrons in an atom when given one of these values
The mass of each proton and each neutron is approximately equal to one atomic mass unit. An electron is much less massive than a proton or neutron.	Calculate the mass of an atom, the number of neutrons or the number of protons, given the other two values
Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element.	Define isotope and describe differences among isotopes

The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.	Given an atomic mass, determine the most abundant isotope Calculate the atomic mass of an element, given the masses and ratios of naturally occurring isotopes
A mole of any substance always contains Avogadro's number of representative particles, or 6.02×10^{23} particles.	Define the term mole
The molar mass (gram-formula mass) of a substance equals the mass of one mole of that substance.	Calculate the gram-formula mass Determine the number of moles of a substance given its mass Determine the mass of a given number of moles of a substance Determine the number of particles of a substance given a mass or molar quantity

Textbook Problems: Ch. 3 Atoms

p. 92 #2 a→ d (e, p, n)
#3 a, b, c (notation)

p. 93 #14 c,d (atomic #/mass #)

p. 93 #8c (Rutherford)
#10
#12 a,b,c (isotopes)

1. Which statement describes the distribution of charge in an atom?

A) A positively charged nucleus is surrounded by one or more positively charged electrons.
B) A neutral nucleus is surrounded by one or more positively charged electrons.
C) A positively charged nucleus is surrounded by one or more negatively charged electrons.
D) A neutral nucleus is surrounded by one or more negatively charged electrons.

2. As a result of the gold foil experiment, it was concluded that an atom

A) contains a small, dense nucleus
B) contains protons, neutrons, and electrons
C) is a hard, indivisible sphere
D) has positrons and orbitals

3. The gold foil experiment led to the conclusion that each atom in the foil was composed mostly of empty space because most alpha particles directed at the foil

A) remained trapped in the foil
B) were deflected by the nuclei in gold atoms
C) were deflected by the electrons in gold atoms
D) passed through the foil

4. Which conclusion was a direct result of the gold foil experiment?

A) An atom is mostly empty space with a dense, positively charged nucleus.
B) An atom is composed of at least three types of subatomic particles.
C) An electron has a positive charge and is located inside the nucleus.
D) An electron has properties of both waves and particles.

5. What was concluded about the structure of the atom as the result of the gold foil experiment?

A) A positively charged nucleus is surrounded by mostly empty space.
B) A negatively charged nucleus is surrounded by positively charged particles.
C) A negatively charged nucleus is surrounded by mostly empty space.
D) A positively charged nucleus is surrounded by positively charged particles.

6. Which sequence represents a correct order of historical developments leading to the modern model of the atom?

A) most of the atom is empty space → the atom is a hard sphere → electrons exist in orbitals outside the nucleus
B) most of the atom is empty space → electrons exist in orbitals outside the nucleus → the atom is a hard sphere
C) the atom is a hard sphere → most of the atom is empty space → electrons exist in orbitals outside the nucleus
D) the atom is a hard sphere → electrons exist in orbitals outside the nucleus → most of the atom is empty space

7. Experiments performed to reveal the structure of atoms led scientists to conclude that an atom's

A) positive charge is evenly distributed throughout its volume
B) negative charge is mainly concentrated in its nucleus
C) volume is mainly unoccupied
D) mass is evenly distributed throughout its volume

8. Compared to the entire atom, the nucleus of the atom is

A) larger and contains most of the atom's mass
B) smaller and contains most of the atom's mass
C) smaller and contains little of the atom's mass
D) larger and contains little of the atom's mass

9. Base your answer to the following question on Given the table below that shows student's examples of proposed models of the atom:

Proposed Models of the Atom

Model	Location of Protons	Location of Electrons
A	in the nucleus	specific shells
B	in the nucleus	regions of most probable location
C	dispersed throughout the atom	specific shells
D	dispersed throughout the atom	regions of most probable location

Which model correctly describes the locations of protons and electrons in the wave-mechanical model of the atom?

A) *A* B) *B* C) *C* D) *D*

10. An orbital of an atom is defined as the most probable location of

A) an electron B) a positron
C) a proton D) a neutron

11. According to the wave-mechanical model of the atom, electrons in an atom

A) travel in defined circles
B) are located in orbitals outside the nucleus
C) are most likely found in an excited state
D) have a positive charge

12. Which group of atomic models is listed in historical order from the earliest to the most recent?

A) electron-shell model, hard-sphere model, wave-mechanical model
B) hard-sphere model, wave-mechanical model, electron-shell model
C) hard-sphere model, electron-shell model, wave-mechanical model (planetary)
D) electron-shell model, wave-mechanical model, hard-sphere model

13. Which statement correctly describes the charge of the nucleus and the charge of the electron cloud of an atom?

A) The nucleus is negative and the electron cloud is negative.
B) The nucleus is positive and the electron cloud is negative.
C) The nucleus is positive and the electron cloud is positive.
D) The nucleus is negative and the electron cloud is positive.

14. In the late 1800s, experiments using cathode ray tubes led to the discovery of the

A) electron B) neutron
C) proton D) positron

15. A proton has a charge that is opposite the charge of

A) an alpha particle B) a neutron
C) an electron D) a positron

Name _____ Magic Square Atomic Structure and Theory

Directions: Put the number of the definition from the list below into the square with the appropriate term.)ck your answers by adding the numbers to see if all the sums of all rows, both across and down add up to the same number, the Magic #.

Democritus	Dalton	Thomson	Chadwick	Total
2	7	18	12	39
Rutherford	Proton	Atom	Bohr	
8	5	11	15	39
Wave Model	Neutron	Nucleus	Alpha particle	
13	17	6	3	39
Electron	Model	Energy levels	Electron cloud	
16	10	4	9	39
Total 39	39	39	39	

Magic Number 39!

1. Represented by a symbol; all are found on the Periodic Table
2. Made a mental model of the atom; Greek philosopher
3. Used by Rutherford in his experiment; made of two protons and two neutrons
4. The paths in which electrons circle the nucleus according to the Bohr model
5. The positive particle in the nucleus of an atom
6. The tiny positive core of an atom; contains protons and neutrons
7. Formed the atomic theory model of the atom; English schoolteacher
8. Discovered the nucleus using his gold foil experiment
9. Current explanation of where electrons might be found in the atom
10. Used by scientists to explain something we can not see or understand
11. The smallest particle of an element that has the properties of that element
12. Discovered the neutron
13. Current model of the atom; proposed by Schrodinger
14. Mass of protons and neutrons
15. Developed the model of the atom in which electrons orbit the nucleus in energy levels
16. The negative particle that circles the nucleus
17. The neutral particle in the nucleus of an atom
18. Proposed the "plum-pudding" model of the atom; discovered the electron

Atomic Theory- Neutral Atoms and their subatomic parts

How many **protons, neutrons, and electrons** are present in the following neutral atoms?

V-51

p: 23
n: 28
e: 23

K-39

p: 19
n: 20
e: 19

N-15

p: 7
n: 8
e: 7

Pt-195

p: 78
n: 117
e: 78

Ar-40

p: 18
n: 22
e: 18

He-4

p: 2
n: 2
e: 2

What is the name of the element that has neutral atoms that contain:

5 protons? boron

16 electrons? sulfur

17 protons? chlorine

32 electrons? germanium

25 protons? manganese

1 electron? hydrogen

82 protons? lead

8 electrons? oxygen

92 protons? uranium

2 electrons? helium

Atomic Structure Worksheet

****Assume all are neutral atoms!**

Fill in the blanks in the following worksheet. Please keep in mind that the isotope represented by each space may NOT be the most common isotope or the one closest in atomic mass to the value on the periodic table.

Atomic symbol	Atomic number	Protons	Neutrons	Electrons	Mass number
C	6	6	8	6	14
Mg	12	12	12	12	24
Ga	31	31	40	31	71
* Zr	40	40	49	40	89
Zn	30	30	35	30	65
Mo	42	42	56	42	98
W	74	74	109	74	183
Lu	71	71	105	71	176
Am	95	95	148	95	243
Cr	24	24	27	24	51
Bi	83	83	126	83	209
Th	90	90	142	90	232
Md	101	101	158	101	259
Se	34	34	46	34	80
* Zr	40	40	51	40	91

Notice there are two different atoms of zirconium (Zr) listed. They have Zr-91 and Zr-89 drastically different mass numbers. What are these two therefore considered to be in relation to one another? isotopes

Key

Draw a circle to represent the nucleus for each atom. Indicate the number of each subatomic particle is present in the atom by placing the number of each in its appropriate location. Use your Periodic Table if additional information is needed.

Example: ^{3}H (1p+ 2n°) 1e-

		Nuclear charge	Nucleons
1.) ^{16}O	8p+ 8n° 8e-	+8	16
2.) ^{35}Cl	17p+ 18n° 17e-	+17	35
3.) ^{31}P	15p+ 16n° 15e-	+15	31
4.) ^{19}F	9p+ 10n° 9e-	+9	19
5.) ^{64}Cu	29p+ 35n° 29e-	+29	64
6.) Ni-59	28p+ 31n° 28e-	+28	59
7.) Zn-65	30p+ 35n° 30e-	+30	65
8.) U-238	92p+ 146n° 92e-	+92	238

Name:_____ Period:__

Calculating Average Atomic Mass

1. Argon has three naturally occurring isotopes: argon-36, argon-38, and argon-40. Based on argon's reported atomic mass, which isotope do you think is the most abundant in nature? Explain.

The atomic mass of argon is 39.948 amu, so rounded to the nearest whole # is 40. This means that Ar-40 is the most abundant.

2. Bromine has two naturally occurring isotopes, Br-79 and Br-81. Bromine-79 has a mass of 79.00 amu and an abundance of 50.69%. Br-81 has a mass of 81.00 amu and an abundance of 49.31%. Using this information, calculate the average atomic mass of bromine.

Br-79 79.00 50.69%
Br-81 81.00 49.31%

AM = 79.00 (.5069) + 81.00 (.4931)
= 79.99 amu

3. Use the following table to calculate the average atomic mass of silicon.

Isotope	Atomic Mass (amu)	Percent Natural Abundance
Si-28	27.98	92.20%
Si-29	28.98	4.67%
Si-30	29.97	3.10%

AM = 27.98(.9220) + 28.98(.0467) + 29.97(.0310)
= 28.08 amu

4. Gallium has two naturally occurring isotopes. The mass of gallium-69 is 68.93 amu and it is 60.10% abundant. The mass of gallium-71 is 70.92 amu and it is 39.90% abundant. Find the atomic mass of gallium.

AM = 68.93(.6010) + 70.92(.3990)
= 69.72 amu

Calculate the atomic mass of each of the following isotopes. SHOW ALL WORK.

	Element	Mass	Percent Abundance
1)	copper-63	62.93 amu	69.17%
	copper-65	64.92 amu	30.83%

AM = 62.93(.6917) + 64.92(.3083)

= **63.54 amu**

2)	uranium-235	235.04 amu	0.72%
	uranium-238	238.05 amu	99.28%

AM = 235.04(.0072) + 238.05(.9928)

= **238.03 amu**

3)	hydrogen-1	1.00 amu	99.985%
	hydrogen-2	2.01 amu	0.015%

AM = 1.00(.99985) + 2.01(.00015)

= **1.00 amu**

4)	element Q-8	8.00 amu	10.0%
	element Q-9	9.00 amu	20.0%
	element Q-10	10.00 amu	70.0%

AM = 8.00(.100) + 9.00(.200) + 10.00(.700)

= **9.60 amu**

MOLE CALCULATIONS

1. Determine the mass in grams of each of the following:

a) 3.00 mol Al $\frac{3.00 \text{ mol Al}}{1} \times \frac{27.0 \text{ g Al}}{1 \text{ mol Al}} = 81.0 \text{ g Al}$

b) 4.25 mol Li $\frac{4.25 \text{ mol Li}}{1} \times \frac{6.9 \text{ g Li}}{1 \text{ mol Li}} = 29.3 \text{ g Li}$

c) 1.38 mol N $\frac{1.38 \text{ mol N}}{1} \times \frac{14.0 \text{ g N}}{1 \text{ mol N}} = 19.3 \text{ g N}$

d) 1.75×10^{-6} mol Hg $\frac{1.75 \times 10^{-6} \text{ mol Hg}}{1} \times \frac{200.6 \text{ g Hg}}{1 \text{ mol Hg}} = 3.51 \times 10^{-4}$ g Hg

2. How many moles of atoms in each of the following?

a) 40.1 g Ca $\frac{40.1 \text{ g Ca}}{1} \times \frac{1 \text{ mol}}{40.1 \text{ g Ca}} = 1.00 \text{ mol Ca}$

b) 150 g S $\frac{150 \text{ g S}}{1} \times \frac{1 \text{ mol S}}{32.1 \text{ g S}} = 4.7 \text{ mol S}$

c) 3.25×10^5 g Pb $\frac{3.25 \times 10^5 \text{ g Pb}}{1} \times \frac{1 \text{ mol Pb}}{207.2 \text{ g Pb}} = 1570$ mol Pb

d) 4.50×10^{-12} g O $\frac{4.50 \times 10^{-12} \text{ g O}}{1} \times \frac{1 \text{ mol}}{16.0 \text{ g O}} = 2.81 \times 10^{-13}$ mol O

3. Determine the number of atoms contained in each of the following:

a) 2.25 mol Zn 1.35×10^{24} atoms Zn

b) 8.42 mol Br 5.07×10^{24} atoms Br

a) $\frac{2.25 \text{ mol Zn}}{1} \times \frac{6.02 \times 10^{23} \text{ atoms Zn}}{1 \text{ mol Zn}} = 1.35 \times 10^{24}$ atoms Zn

b) $\frac{8.42 \text{ mol Br}}{1} \times \frac{6.02 \times 10^{23} \text{ atoms Br}}{1 \text{ mol Br}} = 5.07 \times 10^{24}$ atoms Br

c) $\frac{5.40 \text{ g B}}{1} \times \frac{1 \text{ mol B}}{10.8 \text{ g B}} \times \frac{6.02 \times 10^{23} \text{ atoms B}}{1 \text{ mol B}} = 3.01 \times 10^{23}$ atoms B

d) $\frac{0.02550 \text{ g Pt}}{1} \times \frac{1 \text{ mol Pt}}{195.1 \text{ g Pt}} \times \frac{6.02 \times 10^{23} \text{ atoms Pt}}{1 \text{ mol Pt}} =$

7.868×10^{19} atoms Pt

Review:

Key

Name: _____

D 1) Experimental evidence indicates that the nucleus of an atom
A) contains a small percentage of the mass of the atom
B) has no charge
C) has a negative charge
D) contains most of the mass of the atom

C 2) What Greek philosopher was the first person to propose the idea that matter is made of tiny individual particles called atoms?
A) Bohr B) Rutherford C) Democritus D) Dalton

A 3) Which of the following statements is a part of Dalton's atomic theory?
A) Different atoms combine in simple whole-number ratios to form compounds.
B) All atoms of a given element are not identical.
C) Atoms can be created or destroyed.
D) During a chemical reaction, atoms cannot be separated, combined, or rearranged.

B 4) In an experiment, alpha particles were used to bombard gold foil. As a result of this experiment, the conclusion was made that the nucleus of an atom is
A) larger than the atom and positively charged
B) smaller than the atom and positively charged
C) larger than the atom and negatively charged
D) smaller than the atom and negatively charged

C 5) Which particle has the *least* mass?
A) a proton 1 amu B) a deuteron C) an electron 0 amu D) a neutron 1 amu

D 6) What is the approximate mass of an electron?
A) $\frac{1}{12}$ of a C-12 atom
B) 1 atomic mass unit
C) $\frac{1,835}{1,836}$ of a proton
D) $\frac{1}{1,836}$ of a proton (negligible)

C 7) What particle has a mass of approximately one atomic mass unit and a unit positive charge? 1 amu +1
A) a beta particle
B) an alpha particle
C) a proton
D) a neutron

B 8) What particle is electrically neutral?
A) positron B) neutron C) electron D) proton

D 9) What particle has approximately the same mass as a proton? both 1 amu
A) alpha B) electron C) beta D) neutron

D 10) How many protons are in the nucleus of an atom of beryllium?
A) 9 B) 2 C) 5 D) 4
↓ atomic #

C 11) All atoms of an element have the same
A) number of neutrons
B) atomic mass
C) atomic number
D) number of nucleons

A 12) The atomic number of an atom is *always* equal to the total number of
A) protons in the nucleus
B) neutrons in the nucleus
C) neutrons plus protons in the atom
D) protons plus electrons in the atom

D 13) Two atoms will *always* have the same atomic number if they have the same
A) mass number
B) number of nucleons
C) number of neutrons
D) number of protons

B 14) Which atom has the *greatest* nuclear charge? ⇒ # of protons w/ a positive sign
A) $^{4}_{2}He$ B) $^{14}_{7}N$ C) $^{2}_{1}H$ D) $^{12}_{6}C$

B 15) Which atom contains exactly 15 protons?

A) oxygen-15 C) nitrogen-15

B) phosphorus-32 D) sulfur-32

atomic #

D 16) What is the number of protons present in the nucleus of the atom below?

$^{59}_{27}Co$

A) 59 B) 32 C) 86 D) 27

D 17) A particle of matter contains 6 protons, 7 neutrons, and 6 electrons. This particle must be a

A) positively charged carbon ion C) positively charged nitrogen ion

B) neutral nitrogen atom D) neutral carbon atom

7 Co

D 18) What is the symbol for an atom containing 20 protons and 22 neutrons?

A) $^{42}_{22}Ti$ B) $^{40}_{22}Ti$ C) $^{40}_{20}Ca$ D) $^{42}_{20}Ca$

mass # = 42

C 19) An atomic mass unit is defined as exactly

A) $\frac{1}{16}$ the mass of a ^{16}O atom C) $\frac{1}{12}$ the mass of a ^{12}C atom

B) $\frac{1}{16}$ the mass of a ^{12}C atom D) $\frac{1}{12}$ the mass of a ^{16}O atom

A 20) In which pair of atoms do *both* nuclei contain the same number of neutrons?

A) $^{40}_{20}Ca$ and $^{38}_{18}Ar$ (20, 20)

B) $^{7}_{3}Li$ and $^{9}_{4}Be$ (4, 5)

C) $^{14}_{7}N$ and $^{16}_{8}O$ (7, 8)

D) $^{40}_{19}K$ and $^{40}_{17}Cl$ (20, 23)

C 21) What is the mass number of an atom which contains 28 protons, 28 electrons, and 34 neutrons? 28 + 34 = 62

A) 90 B) 56 C) 62 D) 28

C 22) What is the total number of nucleons (protons and neutrons) in the atom below?

$^{79}_{34}Se$

A) 45 B) 34 C) 79 D) 113

C 23) Element *X* has two isotopes. If 72.0% of the element has an isotopic mass of 84.9 atomic mass units, and 28.0% of the element has an isotopic mass of 87.0 atomic mass units, the average atomic mass of element *X* is numerically equal to

A) $(72.0 + 84.9) \times (28.0 + 87.0)$ C) $\frac{(72.0 \times 84.9)}{100} + \frac{(28.0 \times 87.0)}{100}$

B) $(72.0 - 84.9) \times (28.0 + 87.0)$ D) $(72.0 \times 84.9) + (28.0 \times 87.0)$

B 24) Isotopes of the same element must also have the same

A) number of neutrons C) mass number

B) atomic number (same element) D) number of nucleons

D 25) Which pair of nuclei represent isotopes of the same element?

A) (10p, 10n) and (11p, 11n) C) (1p, 2n) and (2p, 1n)

B) (5p, 6n) and (7p, 6n) D) (3p, 3n) and (3p, 4n)

same protons, different # of neutrons

Review:

Name _____ Date _____ Key Class _____

Understanding Main Ideas (Part A)

Use the periodic table to identify each element described below.

1. atomic number 65 Tb
2. 78 protons Pt
3. 44 protons and 44 electrons Ru
4. atomic number 24 Cr
5. 21 protons Sc
6. atomic number 55 Cs

In the space at the left, write *true* if the statement is true; if the statement is false, change the italicized term to make it true.

False 7. An atom's nucleus contains its protons and ~~*electrons*~~ neutrons.

True 8. *Neutrons* have no ~~electrical charge~~.

False 9. ~~*Beta*~~ Alpha particles have a charge of 2+. ^4_2He 2p 2n

False 10. An alpha particle consists of two protons and two ~~*electrons*~~ neutrons.

Complete the table below.

Isotope	Symbolic Notation	Number of Protons	Number of Electrons	Number of Neutrons
11. Hydrogen-1	^1_1H	1	1	0
12. Hydrogen-3	^3_1H	1	1	2
13. Oxygen-18	$^{18}_8O$	8	8	10
14. Copper-65	$^{65}_{29}Cu$	29	29	36
15. Uranium-235	$^{235}_{92}U$	92	92	143

Complete the following table of proton, electron, and neutron characteristics.

Particle	Symbol	Location	Relative Charge	Relative Mass
Proton	p^+	inside the nucleus	+1	1 amu
neutron	n^0	inside the nucleus	0	1 amu
electron	e^-	outside nucleus in orbitals	-1	1/1836 ≈ 0 amu

Understanding Main Ideas (Part B) (Key)

For each description in Column A, write the letter of the matching symbol in Column B.

Column A		Column B
H	**1.** Isotope in which the number of neutrons is six more than the isotope's atomic number	a. $^{17}_{8}O$ 9n
B	**2.** Copper-63	b. $^{63}_{29}Cu$ 34n
F	**3.** Copper with seven neutrons more than its atomic number	c. $^{12}_{6}C$ 6n
A	**4.** Isotope that has one neutron more than its number of protons	d. $^{50}_{24}Cr$ 26n
C	**5.** Carbon with equal numbers of neutrons, protons, and electrons	e. $^{14}_{6}C$ 8n
E	**6.** Carbon with two more neutrons than its number of protons	f. $^{65}_{29}Cu$ 36n
D	**7.** Chromium with two more neutrons than its number of protons	g. $^{52}_{24}Cr$ 28n
G	**8.** Isotope in which the difference between the neutrons and number of protons is 4	h. $^{54}_{24}Cr$ 30n

Answer the following questions.

9. Calculate the atomic mass of gallium (Ga). Gallium has two isotopes: ^{69}Ga and ^{71}Ga. ^{69}Ga has a relative abundance of 60.12% and an atomic mass of 68.9257 amu. ^{71}Ga has a relative abundance of 39.88% and an atomic mass of 70.9249 amu. Show all your work.

$(68.9257 \times .6012) + (70.9249 \times 0.3988) =$ **69.7230 amu**

10. Calculate the atomic mass of the element *X*. Then use the periodic table to identify the element. Show all your work.

Isotope	Mass (amu)	Percent Abundance
^{27}X	27.977	92.23
^{28}X	28.976	4.67
^{29}X	29.974	3.10

$(27.977 \times 0.9223) + (28.976 \times 0.0467) + (29.974 \times .0310) =$

28.086 amu

X = silicon.

For each item in Column A, write the letter of the matching item in Column B.

Column A		Column B
C	**1.** Proposed the nuclear atomic model	a. Thomson
A	**2.** Determined the mass-to-charge ratio of an electron	b. Millikan
B	**3.** Calculated the mass of an electron	c. Rutherford

Name: _____ Key

D 1) In the electron cloud model of the atom, an orbital is defined as the *most* probable
A) charge of an electron
B) conductivity of an electron
C) mass of an electron
D) location of an electron

A 2) Which subatomic particles are located in the nucleus of a carbon atom? p+n
A) protons and neutrons
B) protons and electrons
C) protons, only
D) neutrons, only

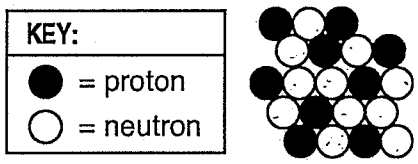
D 3) What is the charge on a neutral
A) -1 B) +2 C) +1 D) 0

B 4) The most common isotope of chromium has a mass number of 52. Which of the following notations represents a different isotope of chromium?
A) $^{24}_{54}Cr$ B) $^{54}_{24}Cr$ C) $^{52}_{24}Cr$ D) $^{24}_{52}Cr$
different mass #, same atomic #

C 5) What was concluded about the structure of the atom as the result of the gold foil experiment?
A) A negatively charged nucleus is surrounded by mostly empty space.
B) A negatively charged nucleus is surrounded by positively charged particles.
C) A positively charged nucleus is surrounded by mostly empty space.
D) A positively charged nucleus is surrounded by positively charged particles.

A 6) The gold foil experiment led to the conclusion that each atom in the foil was composed mostly of empty space because *most* alpha particles directed at the foil
A) passed through the foil
B) were deflected by the nuclei in gold atoms
C) remained trapped in the foil
D) were deflected by the electrons in gold atoms

C 7) The diagram below represents the nucleus of an atom.



P p+n
What are the atomic number and mass number of this atom?
A) The atomic number is 11 and the mass number is 19.
B) The atomic number is 9 and the mass number is 19.
C) The atomic number is 9 and the mass number is 20.
D) The atomic number is 11 and the mass number is 20.

B 8) The mass of a proton is approximately equal to the mass of
A) a positron
B) a neutron
C) an electron
D) an alpha particle

B 9) Which particle has a mass that is approximately the same as the mass of a proton?
A) a positron
B) a neutron
C) a beta particle
D) an alpha particle

A. 10) What is the total number of neutrons in an atom of O-18? 18 - 8 = 10

(A) 10 B) 8 C) 18 D) 16

D. 11) The mass of 12 protons is approximately equal to

A) the mass of 12 electrons
B) 1 atomic mass unit
C) the mass of 1 electron
(D) 12 atomic mass units

A. 12) What information is necessary to determine the atomic mass of the element chlorine?

(A) the atomic mass and the relative abundance of each naturally occurring isotope of chlorine
B) the relative abundance of each naturally occurring isotope of chlorine, only
the atomic mass and the relative abundance of each naturally occurring and artificially produced isotope of chlorine
D) the atomic mass of each artificially produced isotope of chlorine, only

C. 13) Which value of an element is calculated using *both* the mass and the relative abundance of each of the naturally occurring isotopes of this element?

A) atomic number
B) molar volume
(C) atomic mass
D) half-life

A. 14) A proton has a charge that is opposite the charge of +1

(A) an electron −1
B) an alpha particle
C) a positron
D) a neutron

D. 15) A sample of matter must be copper if

A) the sample can conduct electricity
B) the sample melts at 1,768 K
C) atoms in the sample react with oxygen
(D) each atom in the sample has 29 protons

C. 16) What subatomic particle is negatively charged?

A) neutron B) positron (C) electron D) proton

D. 17) Which two particles each have a mass approximately equal to one atomic mass unit?

A) electron and neutron
B) proton and electron
C) electron and positron
(D) proton and neutron

B. 18) The table below gives information about the nucleus of each of four atoms.

Nuclei of Four Atoms

Atom	Number of Protons	Number of Neutrons
A	6	6
D	6	7
E	7	7
G	7	8

How many different elements are represented by the nuclei in the table?

A) 1 (B) 2 C) 3 D) 4

4 19) Which mass contains 6.0×10^{23} atoms? ⇒ 1 mol

1) 6.0 g of carbon 0.5 mol C
2) 16 g of sulfur 0.5 mol S
3) 3.0 g of helium 0.75 mol He
4) 28 g of silicon

1 20) The total number of sodium atoms in 46.0 grams of sodium is $\frac{46.0\text{ g}}{23.0\text{ g}} = 2$ mol

1) 12.0×10^{23} $2\text{ mol}(6.02\times10^{23}) = 1.20\times10^{24}$
2) 24.0×10^{23}
3) 3.01×10^{23}
4) 6.02×10^{23}

2 21) The total number of calcium atoms in 80.0 grams of calcium is

1) 3.01×10^{23} $\frac{80.0\text{ g}}{40.0\text{ g}} = 2$ mol
2) 12.0×10^{23}
3) 24.0×10^{23}
4) 6.02×10^{23}

2 22) What is the total number of atoms in 1 mole of calcium?

1) $20(6 \times 10^{23})$
2) 6×10^{23}
3) 20
4) 1

4 23) What is the total number of atoms contained in 2.00 moles of nickel? $2.00(6.02\times10^{23}) = 1.20\times10^{24}$ atoms

1) 118
2) 6.02×10^{23}
3) 58.9
4) 1.20×10^{24}

3 24) What is the total number of moles of hydrogen gas contained in 9.03×10^{23} molecules?

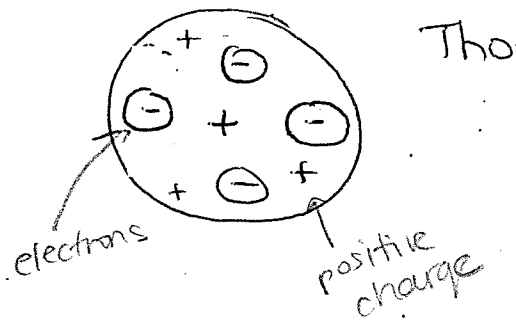
1) 9.03 moles $\frac{9.03\times10^{23}}{6.02\times10^{23}} =$
2) 2.00 moles
3) 1.50 moles
4) 6.02 moles

4 25) Approximately how many atoms are there in 3.0 moles of Al?

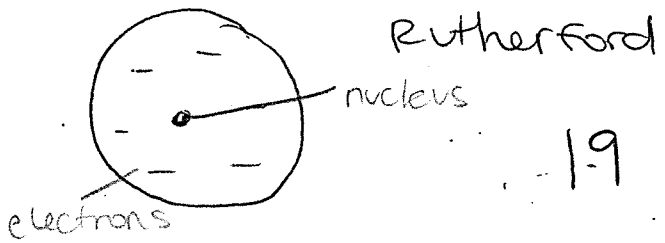
1) $4(6.0 \times 10^{23})$ $3.0\text{ mol}(6.02\times10^{23}\text{ atoms})$
2) $2(6.0 \times 10^{23})$
3) 6.0×10^{23}
4) $3(6.0 \times 10^{23})$

26) **Draw and label a diagram of each atomic model.**

a) **plum pudding model**



b) **nuclear atomic model**



Name: _____

Questions 1 and 2 refer to the following:

In the early 1800s, John Dalton proposed an atomic theory that was based on experimental observations made by several scientists. Three concepts of Dalton's atomic theory are stated below.

Statement *A*: Atoms are indivisible and cannot be destroyed or broken down into smaller parts.
Statement *B*: Atoms of one element cannot be changed into atoms of another element.
Statement *C*: All atoms of one element have the same mass.

1) Explain, in terms of particles, why statement *A* is no longer accepted.

Atoms are made up of protons, neutrons and electrons

2) Explain, in terms of particles in the atoms of an element, why statement *C* is false.

Atoms of an element differ in the # of neutrons

Questions 3 and 4 refer to the following:

In 1897, J. J. Thomson demonstrated in an experiment that cathode rays were deflected by an electric field. This suggested that cathode rays were composed of negatively charged particles found in all atoms. Thomson concluded that the atom was a positively charged sphere of almost uniform density in which negatively charged particles were embedded. The total negative charge in the atom was balanced by the positive charge, making the atom electrically neutral.

In the early 1900s, Ernest Rutherford bombarded a very thin sheet of gold foil with alpha particles. After interpreting the results of the gold foil experiment, Rutherford proposed a more sophisticated model of the atom.

3) Based on the reading passage, state *one* conclusion from Rutherford's experiment that contradicts *one* conclusion made by Thomson.

-The atom is NOT of uniform density. Rutherford found that most of the atom's mass is found in the nucleus.

4) Based on the reading passage, state *one* aspect of the modern model of the atom that agrees with a conclusion made by Thomson.

-Atoms contain negatively charged particles called electrons.

5) Naturally occurring boron is composed of two isotopes. The percent abundance and the mass of each isotope are listed below.

- 19.9% of the boron atoms have a mass of 10.013 atomic mass units.
- 80.1% of the boron atoms have a mass of 11.009 atomic mass units.

Calculate the atomic mass of boron. [*Your response must include both a correct numerical setup and the calculated result.*]

$10.013\left(\frac{19.9}{100}\right) + 11.009\left(\frac{80.1}{100}\right) =$ 10.811 amu

Questions 6 and 7 refer to the following:

The nucleus of one boron atom has five protons and four neutrons.

6) Based on the given information, determine the total charge of the boron nucleus.

+5

7) Based on the given information, determine the total number of electrons in a boron atom.

5

Questions 8 and 9 refer to the following:

The accepted values for the atomic mass and percent natural abundance of each naturally occurring isotope of silicon are given in the data table below.

Naturally Occurring Isotopes of Silicon

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance (%)
Si-28	27.98	92.22
Si-29	28.98	4.69
Si-30	29.97	3.09

8) Based on the given data table, determine the total number of neutrons in an atom of Si-29.

15

9) Based on the given data table, show a correct numerical setup for calculating the atomic mass of Si.

AM = 27.98(.9222) + 28.98(.0469) + 29.97(.0309) =

10) State, in terms of subatomic particles, how an atom of C-13 is different from an atom of C-12.

C-13 has one more neutron than C-12.