Unit 3: Atomic Theory

Subatomic Particles

WARM-UP QUIZ

- 1. What are the three subatomic particles?
- 2. Where are the particles located in the atom?
- 3. What are the charges of the particles?
- 4. What does amu stand for?
- 5. What is the mass (in amu) of each particle?
- 6. Which of the subatomic particles is the lightest?
- 7. What is the charge of the nucleus?
- 8. Where is virtually all of the mass of the atom located?
- 9. What effect do protons have on each other?
- 10. What effect do electrons have on each other?
- 11. What keeps the electrons in the atom?
- 12. What is the symbol for each particle?
- 13. What is the charge of an atom?
- 14. What does the charge of an atom tell us about the number of protons and electrons?
- 15. How is the nucleus of a hydrogen atom different from the nuclei of other elements?

Writing Activity #1

Due Date: _____

- \checkmark Create a table indicating the symbol, location, charge, and relative mass (in amu) of the three subatomic particles. Label the table *Document A*.
- ✓ In a well-developed writing, compare and contrast the three subatomic particles. Use the table that you created as a supporting document and refer to it in your writing.

Atomic Structure

- Atoms make up _____, which are _____
- Discovery of ______ elements have been reported.
- These elements are organized in the modern ______.
- The _____ in an element are _____ to each other and _____ from

those of all other elements.

• The Periodic Table (PT) provides information at	out each element an	d organizes the elements
in order of		
The atomic number appears		on the periodic table.
¤ Equal to		
	of t	he element. Electrons
are responsible for the chemical	and	of atoms.
¤ Since atoms are neutral,		
number = number of	= number of	f
• In the PT, the is given by the	ven underneath its na	me and atomic number,
followed by its		Helium el
🗹 Concept Check		9 2 atom
1. What determines the identity of an atom?	_	Не 5у
2. What is the atomic number of aluminum?	_	4.003atom
3. How many protons are in one atom of aluminum	?	
4. How many electrons are in one atom of aluminut	m?	
5. What is the symbol for fluorine? What is	s its atomic number?	
6. What is the symbol for sulfur? How mar	ny protons does sulfu	ır have?
7. What is the symbol for sodium? How ma	any electrons does so	odium have?
8. What is the element with atomic number 7?	What	t is its symbol?
How many protons and electrons does this eleme	ent have?	
9. What is the name of the 30 th element?	How many pro	otons and electrons does
this element have? What is the charge of	an atom of #30?	
10. What element is symbolized by K?	What is its ato	omic number?
	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •
sotopes		
The in an atom of	a particular element	is not always the same.
Protium Deuterium	Tritium	

• Definition:

	Same	; different		
	Same number of	and	; different number of	of
•]	Neutrons are			·
•]	lsotopes can be ident	ified by writing the	after the ele	ement name or symbol.
]	Examples:			
++ ت	····· Concent Check	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •
- 1		• .1 1•1 • 1	40	-
•	What element is show How many protons a	vn in the diagram to the right nd electrons are in each isot	nt? Note: Not all	Isotopes
	electrons are shown.	nd cicculous are in cach ison	ope: <u>1101e</u> . 1101 uli	
• `	What determines the	identity of the element?	Its behavior?	
■]	How many neutrons	are present in each isotope?		
•	What is the mass in a	mu for each isotope?		
••	Write the name for ea	ach isotope under its diagram	n.	
M	ass Number, Aton	nic Mass, and Average /	Atomic Mass	
1	The mass of an ator	n is made up of		; the
	mass of		·	
2	Therefore, mass number =	=		
	Mass number is alv	vays a numb	er and can be used wit	h
	to calculate the num	ber of		
	mass nu	mber =	+	
3	Mass number does	not indicate the	of an atom. The	e mass of atoms
	measured in	is extremely small.		Carbon - 12
4	More useful to work	k with atomi	c mass:	
	1 amu =		(nearly equal to ma	ss of proton or neutron)
4	The average atomic	e mass is the		
		Isotopes existin	ng in greater	have a greater
5	Due to weighted nat	ure, atomic masses are		·
	The average atomic	mass appears	_ the element symbol	on the Periodic Table.

© Rounding the average atomic mass to the	gives the
for the	isotope of the element.
⑦ The average atomic mass can be calculated when given	and
of an element's	naturally occurring isotopes.
Average Atomic Mass =	
	etc.
Example : Find the weighted average mass of a football team if	92.0% of the players weigh
200. lbs. and 8.00% weigh 180. lbs.	
Average mass = ()() + ())()
Average mass =	
62.9 amu. The percent abundance of copper-65 is 30.8%, and its ato	omic mass is 64.9 amu.
All carbon atoms contain protons because	
□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □	ss number of
(# protons + # neutrons). The isotope name for this isotope of	f carbon is written as
or	
⊐ The carbon isotope containing seven neutrons is	or
✓ Concept Check 1 What is the isotope name for potassium with 21 neutrons?	••••••
2. What is the isotope name for oxygen with 9 neutrons?	
3. What does nitrogen-13 (or N-13) mean?	
•••••••••••••••••••••••••••••••••••••••	• • • • • • • • • • • • • • • • • • • •
 Isotopic Notation Isotopic notation or isotope symbol: uses the element 	,, and
mass number 14	
atomic number C	[Carbon-14]
6	

Practice

- 1. For the carbon isotope above, find the
 - a. Atomic number: _____
 - b. Number of protons: _____
 - c. Number of electrons: _____
 - d. Number of neutrons: _____
- 2. Write the isotopic notation for neon-22.
- 3. Write the isotope symbol for calcium with 26 neutrons.

Charged Particles: lons

 The nucleus of 	an atom has a		_ charge. Why?
 Electrons are 		charged. Why i	is the atom electrically neutral?
• Definition of <i>io</i>	n:		
• Definition of <i>ar</i>	nion:		
Example: F	Atomic #	$_{-} = # of e^{-}$	F ⁻ one electron
• Definition of <i>ca</i>	ntion:		
Example: Mg	Atomic #	$_{-} = # of e^{-}$	Mg ²⁺ two electrons
 Isotopic notatio 	ns for ions show	the	mass number charge
in addition to th	e symbol,	number a	and 23 +
nu	mber.		atomic number symbol
****	• • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •
Practice	$\# n^+ =$	#e ⁻ =	#n ⁰ =
2. Al^{3+}	$p^{+} =$	#e ⁻ =	= =
3 N^{3-}	$p^{+} =$	#e ⁻ =	= =
4 Ω^{2-}	$\# p^{+} =$	#e ⁻ =	= =
5. F	$p^{+} p^{+} =$	#e ⁻ =	= =
6 P^{3-}	$p^{+} =$	#e ⁻ =	= =
5. Γ 7. Κ ⁺	$\# p^{+} =$	#e ⁻ =	= =
8. Cl ⁻	$p^{+} = p^{+} = p^{+}$	#e ⁻ =	$=$ $=$ $\#n^0 =$
•••••	·····		

Identifying Characteristics of Atoms

Using the square for silicon from the Periodic Table, identify the following:

- 1. Element Symbol
- 2. Atomic Number
- 3. Number of Protons
- 4. Number of Electrons
- 5. (Average) Atomic Mass
- 6. Mass Number (round atomic mass to the nearest whole number)
- 7. Number of Neutrons
- 8. Write the isotopic notation for the most common isotope of silicon.

Using the square for manganese from the Periodic Table, identify the following:

- 1. Element Symbol
- 2. Atomic Number
- 3. Number of Protons
- 4. Number of Electrons
- 5. (Average) Atomic Mass
- 6. Mass Number (round atomic mass to the nearest whole number)
- 7. Number of Neutrons
- 8. Write the isotopic notation for the most common isotope of manganese.

Calculating Average Atomic Mass

Using the isotope data in the table below, calculate the average atomic mass and determine the identity of the element.

Mass (amu)	Percent Abundance
49.946	4.3%
51.941	83.8%
52.941	9.5%
53.939	2.4%

Practice

What is the atomic number for thallium?	What is the element symbol?
How many protons are in an atom of radium?	How many electrons?
How many protons are in an atom of cerium?	How many neutrons?

Silicon	
14 Si 28.086	đ

Manganoco
wanganese
25
Mn
54.938

Explain (using complete sentences) how to determine the number of neutrons an atom contains if its mass number and atomic number are known.

What is the mass number of	potussium 59.			
• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	•••••••	• • • • • •	
 ✓ Concept Check 1. Lithium, which has Li₂6 and Li₂7. Whi 	s an atomic mass of 6.94 ch isotope occurs in grea)8 amu, has two naturally occurring isot	opes,	
 Chlorine has two n of chlorine is 35.45 	 Chlorine has two naturally occurring isotopes, Cl-35 and Cl-37. The average atomic ma of chlorine is 35.453 amu. Which isotope occurs in greater abundance? 			
3. How do you determ <i>abundance</i>)?	nine which isotope is in g	greater abundance (when not given perce	ent	
		Due Date:		
Writing Activity #2				
✓ Your assigned element:				
 Your assigned element: Your assigned element: In a well-developed wrinumber. Use your assig sure to include the num element would have. 	ting piece, explain the te ned element as a specific ber many protons, neutro	- rms atomic number, atomic mass, and n example to support your explanation. E ons, and electrons an atom of your assign	nass 3e ned	
 ✓ Your assigned element: ✓ In a well-developed wrinumber. Use your assig sure to include the num element would have. Writing Activity #3 	ting piece, explain the te ned element as a specific ber many protons, neutro	rms atomic number, atomic mass, and n e example to support your explanation. H ons, and electrons an atom of your assign Due Date:	nass 3e ned	
 Vriting Activity #2 Your assigned element: In a well-developed wrinumber. Use your assigns sure to include the numelement would have. Writing Activity #3 Compare the following 	ting piece, explain the te ned element as a specific ber many protons, neutro	rms atomic number, atomic mass, and n e example to support your explanation. F ons, and electrons an atom of your assign Due Date:	nass 3e ned	
 Viting Activity #2 Your assigned element: In a well-developed wrinumber. Use your assig sure to include the num element would have. Writing Activity #3 Compare the following 12 C 6 	ting piece, explain the tend element as a specific ber many protons, neutrons, neutrons isotopes: 13 C C 6	rms atomic number, atomic mass, and n example to support your explanation. H ons, and electrons an atom of your assign Due Date: 14 C 6	nass 3e ned	
 Viting Activity #2 Your assigned element: In a well-developed wrinumber. Use your assig sure to include the num element would have. Writing Activity #3 Compare the following 12 C Atomic # 	ting piece, explain the tend element as a specific ber many protons, neutrons, neutrons, neutrons isotopes:	- rms atomic number, atomic mass, and n e example to support your explanation. H ons, and electrons an atom of your assign Due Date:	nass Be ned	
 Viting Activity #2 Your assigned element: In a well-developed wrinumber. Use your assigns sure to include the numelement would have. Writing Activity #3 Compare the following ¹² ^C ⁶ Atomic # <u>Mass # </u> <u>Mass # </u> <u>Current Content Conten Content Content Content Conten Content Content Content Conte</u>	ting piece, explain the tend element as a specific ber many protons, neutrons, neutrons isotopes:	- rms atomic number, atomic mass, and n e example to support your explanation. H ons, and electrons an atom of your assign Due Date:	nass Be ned	
 Vriting Activity #2 Your assigned element: In a well-developed wrinumber. Use your assig sure to include the num element would have. Writing Activity #3 Compare the following ¹² C 6 Atomic # Mass # # Protons 	ting piece, explain the tend element as a specific ber many protons, neutrons, neutrons isotopes: $ \begin{array}{c} 13 \\ C \\ 6 \end{array} $ Atomic # Mass # # Protons	- rms atomic number, atomic mass, and n e example to support your explanation. H ons, and electrons an atom of your assign Due Date: 14 C 6 L Atomic # L Mass # L H Protons L Protons L H C C C C C C C C C C C C C C C C C C	nass Be ned	
 Vriting Activity #2 Your assigned element: In a well-developed wrinumber. Use your assig sure to include the numelement would have. Writing Activity #3 Compare the following ¹² C 6 Atomic # <u>Mass # </u># Protons <u>#</u> Neutrons <u></u> 	ting piece, explain the tend element as a specific ber many protons, neutrons isotopes: ${}^{13}C_6$ Atomic # Mass # # Protons # Neutrons	- rms atomic number, atomic mass, and n e example to support your explanation. H ons, and electrons an atom of your assign Due Date: 	nass Be ned	

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ESSENTIAL VOCABULARY			
ANION	ATOMIC NUMBER	ION	NEUTRON
ATOM	CATION	ISOTOPES	NUCLEUS
ATOMIC MASS	ELECTRON	MASS NUMBER	PROTON
ATOMIC MASS UNIT			