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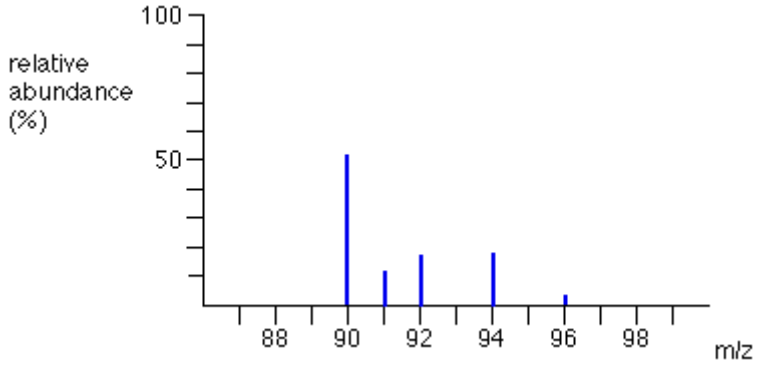
Average Atomic Mass Practice – Answer Key

Part I. Average Atomic Mass of Zirconium

A device known as a mass spectrometer can be used to determine the relative abundance of the isotopes of elements. The mass spectrometer generates a graph showing the relative amounts of each isotope found in the examined sample.

The Mass Spectrum of Zirconium



In the graph above, the isotopes of a sample of the element zirconium can be seen in their relative abundances.

Zirconium-90	52.3%
Zirconium-91	14.0%
Zirconium-92	15.7%
Zirconium-94	15.6%
Zirconium-96	2.4%

1. What is the difference in subatomic particles between these isotopes of Zirconium?
   neutrons

2. Using the graph and the relative abundances above, predict the average atomic mass of zirconium.
   Answers will vary – it is a prediction, but the value must fall between 90-96amu

3. Calculate the weighted average mass of zirconium using the provided data. Box your answer. *Give your answer as a number with a precision out to 3 decimal places. (example: 12.345)*

   90 * 0.523 = 47.07 amu
   91 * 0.14 = 12.74 amu
   92 * 0.157 = 14.44 amu
   93 * 0.156 = 14.66 amu

96 * 0.024 = 2.304 amu

47.07 + 12.74 + 14.44 + 14.66 + 2.304 = 91.22 amu

4. How does the value you calculated in question 2 compare to the average atomic mass listed on your periodic table?

   The periodic table reports 91.224 amu. This shows that you can use the periodic table to confirm your answer. It also goes to show that the atomic mass is not an arbitrary value, it is actually calculated.

Part II. Practice Calculations

5. Calculate the average atomic mass for the following elements. Box your answers.

a. Iodine-127 (60%), 127 * 0.6 = 76.2 amu	Iodine-126 (27%), 126 * 0.27 = 34.02 amu	Iodine-128 (13%) 128 * 0.13 = 16.64 amu
= 76.2 + 34.02 + 16.64 = 126.86 amu		
b. Gold-197 (70%), 197 * 0.7 = 137.9 amu	Gold-198 (30%) 198 * 0.30 = 59.4 amu	
= 137.9 + 59.4 = 197.3 amu		
c. Iron-55 (51%), 55 * 0.51 = 28.05 amu	Iron-56 (49%) 56 * 0.49 = 27.44 amu	
= 28.05 + 27.44 = 55.49 amu		
d. Hydrogen-1 (90%), 1 * 0.90 = 0.9 amu	Hydrogen-2 (1.8%), 2 * 0.018 = 0.036 amu	Hydrogen-3 (8.2%) 3 * 0.082 = 0.246 amu
= 0.9 + 0.036 + 0.246 = 1.182 amu		
e. Carbon-12 (89%), 12 * 0.89 = 10.68 amu	Carbon-11 (11%) 11 * 0.11 = 1.21 amu	
= 10.68 + 1.21 = 11.89 amu		

6. Uranium is used in nuclear reactors and is a rare element on earth. Uranium has three common isotopes. If the abundance of ^{234}U is 0.01%, the abundance of ^{235}U is 0.71%, and the abundance of ^{238}U is 99.28%, what is the average atomic mass of uranium? Box your answer.

U-234 234 * 0.0001 = 0.0234 amu
U -235 235 * 0.0071 = 1.6685 amu
U-238 238 * 0.9928 = 236.29 amu

0.0234 + 1.6685 + 236.29 = 237.98 amu

7. Naturally occurring chlorine that is put in pools is 75.53 percent ^{35}Cl and 24.47 percent ^{37}Cl. Calculate the average atomic mass. Box your answer.

Cl -35 35 * 0.7553 = 26.4355 amu
Cl-37 37 * 0.2447 = 9.0539 amu

26.4355 + 9.0539 = 35.49 amu

8. Copper used in electric wires comes in two isotopes: ^{63}Cu and ^{65}Cu. What is the average atomic mass if out of every 250 copper atoms 173 are ^{63}Cu and 77 are ^{65}Cu. Box your answer.

Cu-63 173 atoms/250 atoms * 100 = 69.2% 63 * 0.692 = 43.596 amu
Cu-65 77 atoms/250 atoms * 100 = 30.8% 65 * 0.308 = 20.02 amu

43.596 + 20.02 = 63.616 amu

9. What is the atomic mass of hafnium if, out of every 100 atoms, 5 have a mass of 176, 19 have a mass of 177, 27 have a mass of 178, 14 have a mass of 179, and 35 have a mass of 180.0? Box your answer.

Hf-176 5 atoms/100 atoms * 100 = 5% 176 * 0.05 = 8.8 amu
Hf-177 19 atoms/100 atoms * 100 = 19% 177 * 0.19 = 33.63 amu
Hf-178 27 atoms/ 100 atoms * 100 = 27% 178 * 0.27 = 48.06 amu
Hf-179 14 atoms/ 100 atoms * 100 = 14% 179 * 0.14 = 25.06 amu
Hf-180 35 atoms/100 atoms * 100 = 35% 180 * 0.35 = 63.00 amu

8.8 + 33.63 + 48.06 + 25.06 + 63.00 = 178.55 amu

10. Lithium has two naturally occurring isotopes: lithium-6 and lithium-7. If the average atomic mass of lithium is 6.941 amu, which isotope is the most abundant? How do you know?

    Lithium-7 is more abundant because the atomic mass is closer to 7 than it is to 6.

Part III. Fill in the Chart

11. Fill in the chart below. *Do not round the mass of the isotopes.*

Name	Mass of Isotopes	Percent Abundance of Isotopes	Average Atomic Mass & Real Name of Element
Hookfinium	62.930 *	0.6917 = 43.53	63.55 amu = Copper (Cu)
	64.928 *	0.3083 = 20.017	
Mimium	23.985 *	0.7899 = 18.95	24.30 amu = Magnesium (Mg)
	24.986 *	0.1000 = 2.4986	
	25.986 *	0.1101 = 2.86	
Culberstonium	35.968 *	0.003365 = 0.121	39.945 amu = Argon (Ar)
	37.963 *	0.000632 = 0.024	
	39.962 *	0.99600 = 39.80	

Part IV: Challenger: Calculate the Relative Abundance of each Isotope

***Use the atomic masses for the isotopes, not the mass numbers in your calculations.*

Example: The average mass of Copper is 63.546 amu. The atomic masses of the naturally occurring isotopes Cu-63 and Cu-65 are 62.9296 amu and 64.9278 amu, respectively.

Let x be the fraction of Cu-65. Then 1.0 - x = the fraction of Cu-63
Step 1. (64.9278)x + (1.0-x)(62.9296) = 63.546
Step 2. 64.9278x + 62.9296 - 62.9296x = 63.546
Step 3. 1.9982x = 0.6164
Step 4. x = 0.3085; then 1.0 - x = 0.6916
Answer: 30.85% Cu-65 and 69.16% Cu-63

11. The average mass of vanadium is 50.9415 amu. The atomic masses of the naturally occurring isotopes V-50 and V-51 are 49.947161 amu and 50.943962 amu, respectively. Calculate the relative abundance of each isotope and box your answers.

** See Mrs. Culbertson for the answers to these problems

12. Rubidium is a soft, silvery white metal. The two naturally occurring isotopes of rubidium are rubidium-85, with an atomic mass of 84.91179 amu; and rubidium-87, with an atomic mass of 86.90919 amu. What are the percent natural abundances of these isotopes? Box your answers.

13. The two naturally occurring isotopes of nitrogen are nitrogen-14, with an atomic mass of 14.003074 amu; and nitrogen-15 with an atomic mass of 15.000108 amu. What are the percent natural abundances of these isotopes? Box your answers.

14. Complete the table.

Isotope	**Mass (amu)**	**Relative Abundance (%)**
Neon-20	19.992	90.51
Neon-21	20.994	
Neon-22		9.22
Average Atomic Mass =		