Average Atomic Mass

Finding a weighted average

Relative Mass

- The relative mass of an atom is the sum of its protons and neutrons. (Note: Atomic masses are based on ^{12}C = 12 amu.)
- Examples:
  - Carbon 12 has 6 protons and 6 neutrons (6 + 6 = 12)
  - Carbon 14 has 6 protons and 8 neutrons (6 + 8 = 14)
- The relative mass of any isotope is an integer.

Average Atomic Mass

- The masses of the elements listed on the *Periodic Table* are *NOT* integers.
- The masses of the elements listed on the *Periodic Table* are the average masses of the isotopes of each element.
- The average mass of an element is a weighted average.
- Both the mass of the isotopes and the percentage of each effect the average mass.

The Average: The Old Way

Problem: Find the average of the following grades – 100, 100, 100, 100, 100, 100, 90, 90, 90, 50

	Old Way
	100
	100
	100
	100
	100
	100
	90
	90
	90
	50
Total	920
Average	92

The Average: The New Way

Group similar scores

The *Old* Way
100
100
100
100
100
100
90
90
90
50
Total 920
Average 92

The *New* Way
Score (x)
100
90
50

The Average: The New Way

Determine the frequency of each score and the total frequency

The *Old* Way
100
100
100
100
100
100
90
90
90
50
Total: 920
Average: 92

The *New* Way	
Score (x)	Frequency (f)
100	6
90	3
50	1
Total	10

The Average: The New Way

Find the product of the score and the frequency and add them up

The *Old* Way
100
100
100
100
100
100
90
90
90
50
Total 920
Average 92

The *New* Way		
Score (x)	Frequency (f)	Product (fx)
100	6	600
90	3	270
50	1	50
Total	10	920

The Average: The New Way

Find the average by dividing the total product by the total frequency

The *Old* Way
100
100
100
100
100
100
90
90
90
50
Total 920
Average 92

The *New* Way		
Score (x)	Frequency (f)	Product (fx)
100	6	600
90	3	270
50	1	50
Total	10	920
Average		92

The *Weighted* Average

Find the percentage by dividing the frequency by the total frequency

The *Old* Way
100
100
100
100
100
100
90
90
90
50
Total 920
Average 92

The *Weighted* Average			
Score (x)	Frequency (f)	Product (fx)	Percentage (p)
100	6	600	0.6
90	3	270	0.3
50	1	50	0.1
Total	10	920	1.0
Average		92	

The Weighted Average

Find the product by multiplying the score by the percentage. Then, add them up to get the average!

The *Old* Way
100
100
100
100
100
100
90
90
90
50
Total: 920
Average: 92

The *Weighted* Average				
Score (x)	Frequency (f)	Product (fx)	Percentage (p)	Product (px)
100	6	600	0.6	60
90	3	270	0.3	27
50	1	50	0.1	5
Total	10	920	1.0	92
Average		92		**92**

Summary

Find the weighted average as follows:

- Group the data
- Determine the frequency of each score
- Find the percentage of each score by dividing the frequency by the total frequency
- Find the average by multiplying each score by its percentage and adding up the products.

$$x_{AVG} = \sum_{y=1}^{n} p_y x_y = p_1 x_1 + p_2 x_2 + \ldots + p_n x_n$$

Finding Average Mass

Finding average mass is not so complex because the percentages and masses are given.

Problem: What is the average mass of nitrogen if a typical sample contains 99.63 % nitrogen-14 and 0.37 % nitrogen-15?

$$m_{AVG} = \sum_{y=1}^{n} p_y m_y = p_1 m_1 + p_2 m_2 + \ldots + p_n m_n$$

- **Step 1:** Convert the percentages to decimal values
- **Step 2:** Multiply the percentages by the masses
- **Step 3:** Add the products together

Average Mass of Nitrogen

Isotope	*Percentage*	*Mass*	*Product*
Nitrogen-14	0.9963	14	13.95
Nitrogen-15	0.0037	15	0.06
			14.01