

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

**[TP]** The periodic table indicates that “C” has a mass of 12.011. Which of the following statements is true?

14% 1. All carbon atoms have mass 12.011 g  
 14% 2. All carbon atoms have mass 12.011 u  
 14% 3. No carbon atoms have mass 12.011 g  
 14% 4. No carbon atoms have mass 12.011 u  
 14% 5. (1) and (2) are correct  
 14% 6. (3) and (4) are correct  
 14% 7. None of the above

BOSTON UNIVERSITY 1

Lecture 3 CH101 A1 (MWF 9:05 am)  
 Monday, September 11, 2017

For today ...

- Continue: Isotopes → atomic weight
- Chemist's dozen: The mole

Next lecture: Complete isotopes and the mole. Begin ch3: Naming things; molecular mass spectra

To memorize: Tables 3.2 and 3.4; Figures 3.7 and 3.8 (see Handouts tab)

BOSTON UNIVERSITY

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

### Atomic mass unit u

1 u is **defined** to be exactly (1/12) mass of 1 atom of  $^{12}\text{C}$   
 Exactly 12 g of  $^{12}\text{C}$  contains  $N_A = 6.02214 \times 10^{23}$  atoms  
 Therefore, the mass of one  $^{12}\text{C}$  atom is ...  
 $12 \text{ g} / N_A = 1.99265 \times 10^{-23} \text{ g}$   
 And so, **1 u** = ...  
 $(1/12) \times 1.99265 \times 10^{-23} \text{ g} = 1.66054 \times 10^{-24} \text{ g}$

BOSTON UNIVERSITY 3

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

**[Quiz]** Which of the following is the correct mass of a  $^{12}\text{C}$  atom?

13% 1. 12  
 13% 2. 12 g  
 13% 3. 12 u  
 13% 4. 12 g/mol  
 13% 5. 12.011  
 13% 6. 12.011 g  
 13% 7. 12.011 u  
 13% 8. 12.011 g/mol

BOSTON UNIVERSITY 4

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

### Mass spectrometer “weighs” atoms

Strip away an electron, accelerate **positive ions**, and then **deflect** them in a magnetic field.  
**Less deflection, heavier mass**  
 Neon has three “**isotopes**”:  $^{20}\text{Ne}$ ,  $^{21}\text{Ne}$ , and  $^{22}\text{Ne}$   
 Relative peak heights → **isotopic abundance**

BOSTON UNIVERSITY

5

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

### Average mass of CH101 students?

75 students weigh 100 lbs  
 100 students weigh 150 lbs  
 50 students weigh 200 lbs

Sketch the “mass spectrum” of the class, using just counts for the vertical axis

BOSTON UNIVERSITY

6

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

[TP] For our hypothetical class,  
 75 students weigh 100 lbs,  
 100 students weigh 150 lbs,  
 50 students weigh 200 lbs.

Based on your “mass spectrum” sketch, roughly (guesstimate), what will the average be?

0% 1. Less than 100  
 0% 2. Between 100 and 150  
 0% 3. Between 150 and 200  
 0% 4. Greater than 200

BOSTON UNIVERSITY

7

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

### Average mass of CH101 students?

75 students weigh 100 lbs  
 100 students weigh 150 lbs  
 50 students weigh 200 lbs

What is the expression for the **fraction of students** with mass 150 lbs,  $f_{150}$ ?

$$f_{150} = \dots$$

BOSTON UNIVERSITY


8

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

### Average mass of CH101 students?

75 students weigh 100 lbs  
 100 students weigh 150 lbs  
 50 students weigh 200 lbs

In terms of the fractions  $f_{100}$ ,  $f_{150}$ , and  $f_{200}$ , write the expression that evaluates to the **exact average**.


 9

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

### Average mass of CH101 students?

In terms of the fractions  $f_{100}$ ,  $f_{150}$ , and  $f_{200}$ , write the expression that evaluates to the **exact average**.


total mass =  $75 \times 100 \text{ lbs} + 100 \times 150 \text{ lbs} + 50 \times 200 \text{ lbs}$   
 average mass = total mass / students =  $/(75 + 100 + 50)$   
 = total mass / 225  
 =  $(75/225) \times 100 \text{ lbs} + (100/225) \times 150 \text{ lbs} + (50/225) \times 200 \text{ lbs}$   
 =  $f_{100} \times 100 \text{ lbs} + f_{150} \times 150 \text{ lbs} + f_{200} \times 200 \text{ lbs}$

 10

Lecture 3 CH101 A1 (MWF 9:05 am) Fall 2017 Copyright © 2017 Dan Dill dan@bu.edu

**[TP]** For our hypothetical class, average weight of a CH101 student is 144 lbs. Which of the following statements is true for this class?

0% 1. The weight of each student is 144 lbs  
 0% 2. No student weighs 144 lbs  
 0% 3. Neither of the statements is true.

 11