Lecture 2 CH101 A1 (MWF 9:05 am) Fall 2018 Copyright © 2018 Dan Dill dan@bu.edu

[TP] Which of the following is the correct mass of a ^{12}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

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Lecture 2 CH101 A1 (MWF 9:05 am)

Friday, September 7, 2018

- Complete: Liquid volume of gas particles in SCI/109?
- Atoms, elements, and isotopes
- Isotopes → atomic weight

Next lecture: Complete: Isotopes → atomic weight; Chemist's dozen: The mole

On your own: Periodic table 2.12 and 2.13

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Liquid volume of the air in SCI/109

If all of the air in SCI/109 were condensed to liquid, how many 5-gallon containers would be required to hold the liquid air?

Volume of room & density of air → mass of air

Mass of air & density of liquid air → volume of liquid air

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Liquid volume of the air in SCI/109

If all of the air in SCI/109 were condensed to liquid, how many 5 gallon containers would be required to hold the liquid air?

Volume of room & density of air → mass of air

Density of air at 20 °C is 1.2041 kg/m^3 (Google)

Mass of air …

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Liquid volume of the air in SCI/109

If all of the air in SCI/109 were condensed to liquid, how many 5 gallon containers would be required to hold the liquid air?

Volume of room & density of air → mass of air

Density of air at 20 °C is 1.2041 kg/m^3 (Google)

Mass of air ≈ 2400 kg

Liquid volume of the air in SCI/109

If all of the air in SCI/109 were condensed to liquid, how many 5 gallon containers would be required to hold the liquid air?

Mass of air & density of liquid air → volume of liquid air

Air composition by mass is
75.5% N_2, 23.2% O_2, and 1.3% Ar (Google)

Liquid densities are
0.808 g/cm^3 N_2, 1.141 g/cm^3 O_2, 1.3954 g/cm^3 Ar (Google)

To keep the calculation simple, let's assume density of liquid air is about 1.0 g/cm^3

Liquid volume of the air in SCI/109

If all of the air in SCI/109 were condensed to liquid, how many 5-gallon containers would be required to hold the liquid air?

Mass of air ≈ 2400 kg

Liquid air density ≈ 1.0 g/cm^3

1 gal = 3785 cm^3

[Group quiz] If all of the air in SCI/109 were condensed to liquid, how many 5-gallon containers would be required to hold the liquid air?

0% 1. Much less than 1
0% 2. About 1
0% 3. About 5
0% 4. About 10
0% 5. Much more than 10

Liquid volume of the air in SCI/109

If all of the air in SCI/109 were condensed to liquid, how many 5 gallon containers would be required to hold the liquid air?

Mass of air ≈ 2400 kg

Liquid air density ≈ 1.0 g/cm^3

1 gal = 3785 cm^3

Volume of liquid air is about 600 gal ≈ 130 5-gallon containers!!!

So, while atoms are small, they take up space

Atoms, elements, isotopes

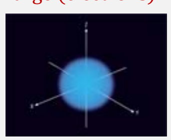
The world is made of atoms.

Atoms come in different kinds (elements)

Atoms of each kind come in different flavors (isotopes)

Atoms

Mostly wispy, nearly empty,
cloud of negative charge (electrons) ≈ 10^{-8} cm diameter

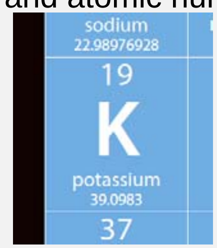


Nucleus: ≈ 10^{-12} cm diameter extraordinarily dense
sphere of positive charge

Positive charge due to protons

Mass ≈ protons + neutral neutrons

Element identity and atomic number Z



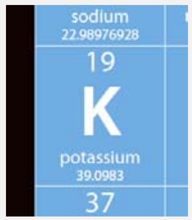
Number of protons = atomic number $Z = 19$
Relative atomic weight = 39.0983
Where does the number 39.0983 come from?

Atoms of an element come in different "flavors"

Atoms with the same number of protons …
but with different numbers of neutrons …
are chemically the same …
but have different masses

We call such different flavors of atoms of an element isotopes

39.0983 u is the average mass of the different kinds of atoms (isotopes) of K that are in a sample of K.



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Atomic mass unit u

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Atomic mass unit u

1 u defined to be exactly $\frac{1}{12}$ of the mass of 1 atom of ^{12}C

Exactly 12 g of ^{12}C contains $N_A = 6.02214 \times 10^{23}$ atoms

Therefore, the mass of one ^{12}C atom is …

$12\text{ g}/N_A = 1.99265 \times 10^{-23}\text{ g}$

And so, 1 u = …

$\frac{1}{12} \times 1.99265 \times 10^{-23}\text{ g} = 1.66054 \times 10^{-24}\text{ g}$

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[Quiz] Which of the following is the correct mass of a ^{12}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

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