SI Chemistry - Full Discipline Demo

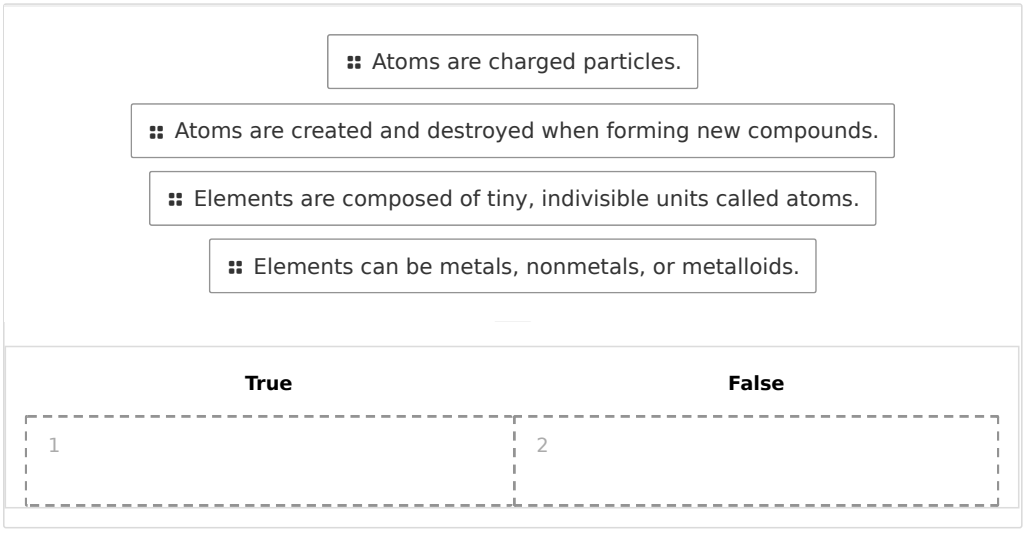
Atoms, Isotopes, and Atomic Mass

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Chemistry - Full Discipline Demo
Course	SI Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Categorize each statement as true or false.



Correct answers:

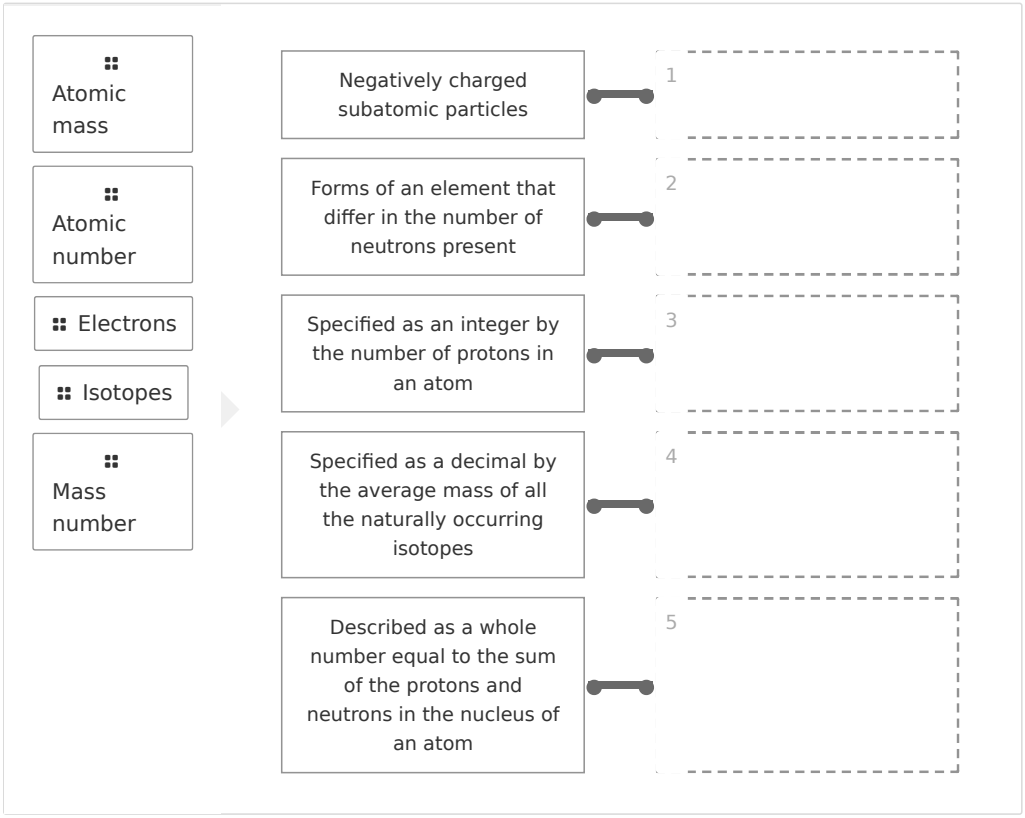
1 Elements are composed of tiny, indivisible units called atoms.

Elements can be metals, nonmetals, or metalloids.

2 Atoms are created and destroyed when forming new compounds.

Atoms are charged particles.

Match each term with the best description.



Correct answers:

1 Electrons 2 Isotopes 3 Atomic number 4 Atomic mass

5 Mass number

Exploration

Elements in each group of the periodic table have similar ____.

- atomic masses
- properties ✔
- symbols
- All of the above

Dalton's theory states that elements are made up of tiny units called _____.

- atoms ✔
- compounds
- isotopes
- molecules

Atoms consist of negatively charged _____ and positively charged _____.

- electrons, neutrons
- electrons, protons ✔
- protons, electrons
- protons, neutrons

Atoms of an element may differ in mass, but they always have the same number of _____.

- electrons
- isotopes
- neutrons
- protons ✔

Exercise 1

What are isotopes? How do isotopes of a given element differ? How are isotopes of a given element similar?

Isotopes are forms of an element that contain the same number or protons, but contain different numbers of neutrons, and thus have different atomic masses. Isotopes have the same atomic number (# of protons) and many of the same chemical properties.

Explain the difference between mass number and atomic mass.

The mass number is the number of protons and neutrons that make up an atom. The atomic mass is the average mass of all the isotopes of an element. The atomic mass is weighted by the natural abundance of each isotope.

How many protons are in the nucleus of a nitrogen-15 isotope? How many neutrons?

7 protons; 8 neutrons

How do your calculated atomic masses of oxygen and sulfur compare to the atomic masses listed in the period table: oxygen = 15.999 amu, sulfur = 32.065 amu? If your answers differed, explain where the error may have been incurred.

Student answers will vary. Both calculated atomic masses are within 0.001 of published values which vary by this degree in different versions of the periodic table. Otherwise, differences could be due to rounding or calculation errors.

Copper has only two naturally occurring isotopes, copper-63 and copper-65. Use the atomic mass of copper from the periodic table to determine which must be the most abundant.

The atomic mass of copper is given as 63.546, which is closer to 63 than 65. This tells us that copper-63 is the more abundant isotope of copper.

Data Table 1: Isotope Information

(SAMPLE ANSWER BELOW)

	Isotope A	Isotope B	Isotope C
Number of Protons	6	6	6
Number of Neutrons	6	7	8
Atomic Number	6	6	6
Mass Number	12	13	14
Isotope Name	Carbon-12	Carbon-13	Carbon-14

Photo 1: Isotope B Drawing

(SAMPLE ANSWER BELOW)

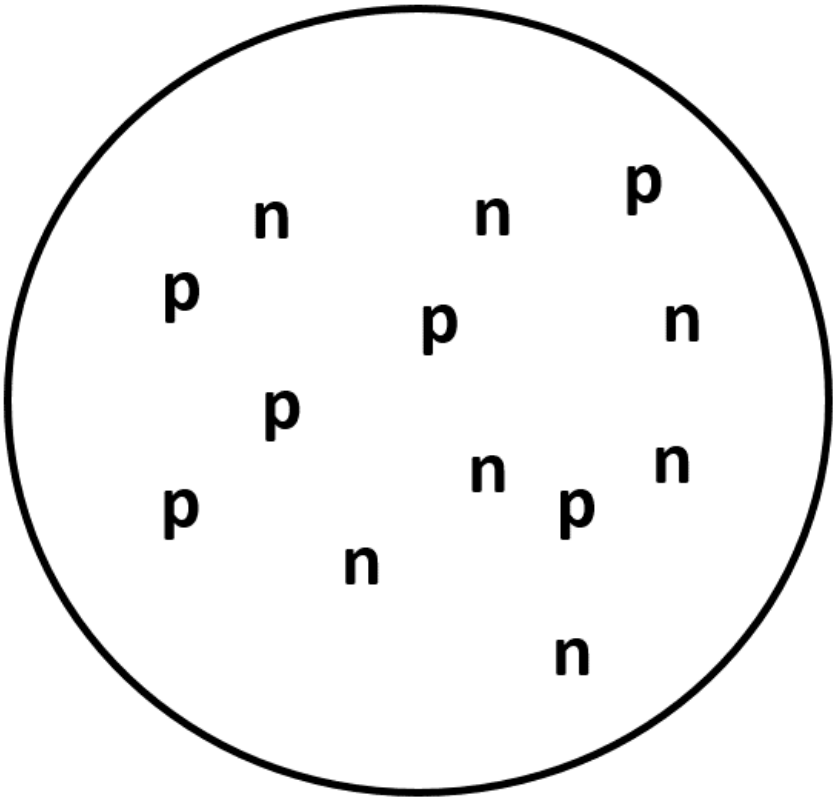
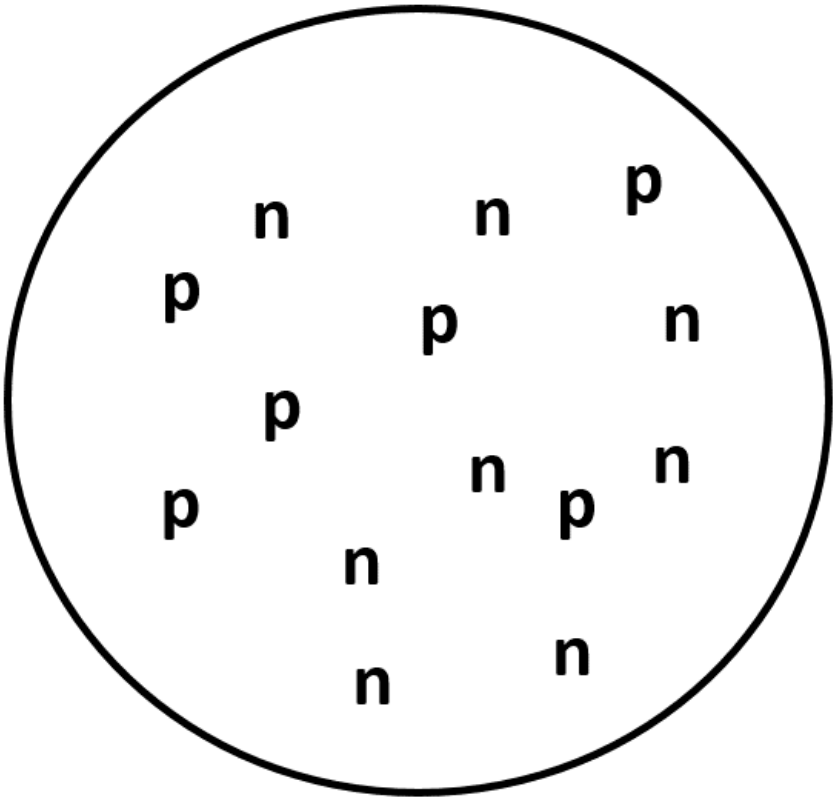


Photo 2: Isotope C Drawing
(SAMPLE ANSWER BELOW)



Data Table 2: Isotope and Atomic Masses for Oxygen and Sulfur
(SAMPLE ANSWER BELOW)

Element	Naturally Occurring Isotope	Natural Abundance of Isotope (%)	Mass of Isotope (amu)	Calculated Mass of Element (amu)
Oxygen	Oxygen-16	99.757	15.994915	15.999
	Oxygen-17	0.038	16.999132	
	Oxygen-18	0.205	17.999160	
Sulfur	Sulfur-32	94.99	31.972071	32.065
	Sulfur-33	0.75	32.971459	
	Sulfur-34	4.25	33.967867	
	Sulfur-36	0.01	35.967081	

Photo 3: Atomic Mass Calculations
(SAMPLE ANSWER BELOW)

$$\text{O} = 15.999 \text{ amu} = \frac{[(15.994915 \text{ amu} \times 99.757\ \%) + (16.999132 \text{ amu} \times 0.038\ \%) + (17.999160 \text{ amu} \times 0.205\ \%)]}{100\%}$$

$$\text{S} = 32.065 \text{ amu} = \frac{[(31.972071 \text{ amu} \times 94.99\ \%) + (32.971459 \text{ amu} \times 0.75\ \%) + (33.967867 \text{ amu} \times 4.25\ \%) + (35.967081 \text{ amu} \times 0.01\ \%)]}{100\%}$$

Competency Review

Elements are substances consisting of atoms that have the same number of protons.

- [x] True ✔
- [ ] False

Electrons are _____ protons and neutrons.

- [ ] larger than
- [x] smaller than ✔
- [ ] the same size as
- [ ] All of the above

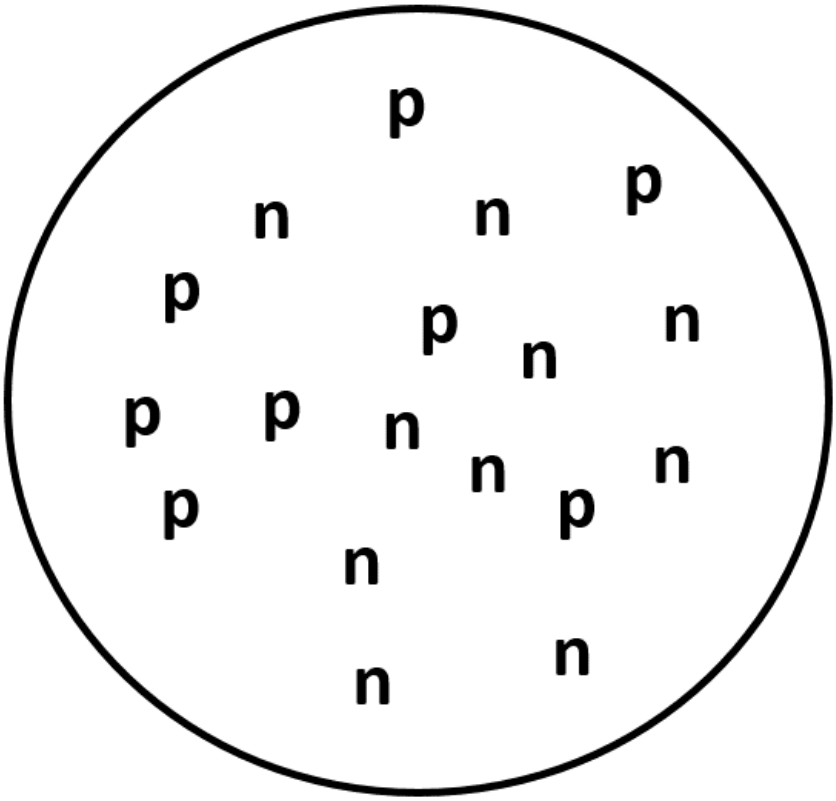
Isotopes of an element contain different numbers of _____.

- [ ] atoms
- [ ] electrons
- [x] neutrons ✔
- [ ] All of the above

The atomic mass of an element is the average mass of all the naturally occurring isotopes.

- [x] True
- [ ] False

The isotope diagram illustrates an atomic number of _____.



- [ ] 2
- [x] 8
- [ ] 10
- [ ] 18

The helium-3 isotope has an abundance of 0.01%, compared to the helium-4 isotope which has an abundance of 99.99%. The estimated atomic mass of helium is closest to the whole number _____.

- 1 amu
- 3 amu
- 4 amu ✔
- 7 amu

Chlorine has an atomic mass of 35.453 amu and 2 naturally occurring isotopes, Cl-35 and Cl-37. Based on atomic mass Cl-35 _____ compared to Cl-37.

- is less abundant
- is more abundant ✔
- has similar abundance
- All of the above

Extension Questions

Lithium exists as 2 isotopes. Research each isotope and include the relative abundance, mass number, atomic mass, and noteworthy uses of each. Cite your reference in the answer. (SAMPLE ANSWER BELOW)

Li-6 has a mass number of 6, atomic mass of 6.015 amu and natural abundance of 7.59%. It is used in thermonuclear weapons and biochemical research. Li-7 has a mass number of 7, atomic mass of 7.016, and relative abundance of 92.41%. It is used to control the pH level of coolant in pressurized water reactors and for the production of medical research radioisotope Be-7.