

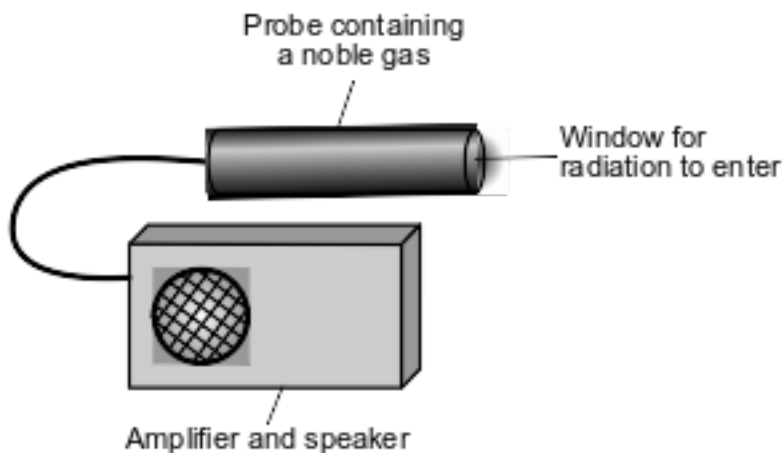
Characteristic Trends

- Which element requires the least amount of energy to remove the most loosely held electron from a gaseous atom in the ground state?
(1) Na (2) Ar (3) P (4) Cl
- As the elements in Period 2 are considered in order from lithium to fluorine, there is an increase in the
(1) atomic radius
(2) electronegativity
(3) number of electron shells
(4) number of electrons in the first shell
- As the first five elements in Group 14 are considered in order from top to bottom, there are changes in both the
(1) number of valence shell electrons and number of first shell electrons
(2) electronegativity values and number of first shell electrons
(3) number of valence shell electrons and atomic radii
(4) electronegativity values and atomic radii
- As the elements in Period 2 of the Periodic Table are considered in order from left to right, which property generally decreases?
(1) atomic radius (2) electronegativity (3) ionization energy (4) nuclear charge
- Which ion has the largest radius?
(1) Br^- (2) Cl^- (3) F^- (4) I^-
- Based on Table S, which group on the Periodic Table has the element with the highest electronegativity?
(1) Group 1 (2) Group 2 (3) Group 17 (4) Group 18
- Which trend is observed as the first four elements in Group 17 on the Periodic Table are considered in order of increasing atomic number?
(1) Electronegativity increases.
(2) First ionization energy decreases.
(3) The number of valence electrons increases.
(4) The number of electron shells decreases.
- Which group on the Periodic Table has two elements that exist as gases at STP?
(1) Group 1 (2) Group 2 (3) Group 16 (4) Group 17
- Which general trends in atomic radius and electronegativity are observed as the elements in Period 3 are considered in order of increasing atomic number?
(1) Atomic radius decreases and electronegativity increases.
(2) Atomic radius increases and electronegativity decreases.
(3) Both atomic radius and electronegativity increase.
(4) Both atomic radius and electronegativity decrease.

Base your answers to questions 10 on the information below and on your knowledge of chemistry.

Radioactive emissions can be detected by a Geiger counter. When radioactive emissions enter the Geiger counter probe, which contains a noble gas such as argon or helium, some of the atoms are ionized. The ionized gas allows for a brief electric current. The current causes the speaker to make a clicking sound. To make sure that the Geiger counter is measuring radiation properly, the device is tested using the radioisotope Cs-137.

To detect gamma radiation, an aluminum shield can be placed over the probe window, to keep alpha and beta radiation from entering the probe. A diagram that represents the Geiger counter is shown below.



10 Compare the first ionization energy of argon to the first ionization energy of helium.

Base your answers to questions 11 on the information below and on your knowledge of chemistry.

Periodic trends are observed in the properties of the elements in Period 3 on the Periodic Table. These elements vary in physical properties, such as phase, and in chemical properties, such as their ability to lose or gain electrons during a chemical reaction.

11 State the general trend in atomic radius as the elements in Period 3 are considered in order of increasing atomic number.

Base your answers to questions 12 on the information below and on your knowledge of chemistry.

The elements in Group 2 on the Periodic Table can be compared in terms of first ionization energy, electronegativity, and other general properties.

12 Explain, in terms of atomic structure, why barium has a lower first ionization energy than magnesium.

13 State the general trend in first ionization energy as the elements in Period 3 are considered from left to right.

Base your answers to questions 14 on the information below and on your knowledge of chemistry.

Rubidium and iodine have different chemical and physical properties. Some of these properties are shown in the table below.

Some Physical and Chemical Properties of Rubidium and Iodine

Rubidium	Iodine
silvery-white solid	bluish-black lustrous solid
forms ionic compounds with nonmetals	forms ionic bonds with active metals
reacts with oxygen in the air	sublimes at room temperature
specific heat = 0.363 J/g•K	specific heat = 0.214 J/g•K

- 14 Compare the atomic radius of an atom of iodine to the atomic radius of an atom of rubidium when both atoms are in the ground state.

Base your answers to questions 15 on the information below and on your knowledge of chemistry.

Many scientists made observations of the elements that led to the modern Periodic Table. In 1829, Dobereiner found groups of three elements that have similar properties and called each of these groups a triad. Dobereiner noticed a relationship between the atomic masses of the elements in each triad. Triad 1, shown in the table below, consists of sulfur, selenium, and tellurium. The middle element, selenium, has an atomic mass that is close to the sum of the atomic masses of sulfur and tellurium, divided by 2.

For example: $\frac{32 \text{ u} + 128 \text{ u}}{2} = 80. \text{ u}$, which is close to the 79 u value in the table.

The other triads shown in the table below demonstrate the same mathematical relationship.

Dobereiner's Triads

Triad	Triad	Dobereiner's Atomic Masses (u)
1	sulfur selenium tellurium	32 79 128
2	calcium strontium barium	40. 88 137
3	chlorine bromine iodine	35.5 80. 127
4	lithium sodium potassium	7 23 39

- 15 State the trend in first ionization energy as the elements in triad 3 are considered in order of increasing atomic number.

Answer Keys

- 1 1
- 2 2
- 3 4
- 4 1
- 5 4
- 6 3
- 7 2
- 8 4
- 9 1

10 Allow 1 credit. Acceptable responses include, but are not limited to:

- Argon has a lower ionization energy than helium.
- The Ar has a first ionization energy of 1521 kJ/mol and the He has a first ionization energy of 2372 kJ/mol.
- Helium has a higher first ionization energy than argon.

11 Allow 1 credit. Acceptable responses include, but are not limited to:

- As the atomic number of the elements in Period 3 increases, the atomic radius generally decreases.
- The radius gets smaller.

12 Allow 1 credit. Acceptable responses include, but are not limited to:

- An atom of Ba has three more electron shells than an atom of Mg, so less energy is required to remove one of the outermost electrons from an atom of Ba.
- Barium atoms have more inner shell electrons, resulting in a greater shielding effect.
- Magnesium's valence electrons are closer to the nucleus.
- Barium has a larger atomic radius.

13 Allow 1 credit. Acceptable responses include, but are not limited to:

- The first ionization energies of the elements in Period 3 generally increase from left to right.
- Ionization energy increases.

14 Allow 1 credit. Acceptable responses include, but are not limited to:

- In the ground state, the atomic radius of an iodine atom is smaller than the atomic radius of a rubidium atom.
- The Rb atom is larger than the I atom.
- The Rb atomic radius is 215 pm, but the I atomic radius is only 136 pm.

15 Allow 1 credit. Acceptable responses include, but are not limited to:

- As the atomic number increases, the first ionization energy decreases.
- The first ionization energy decreases.