



Base your answers to questions 8 on the information below.

The atomic radius and the ionic radius for some Group 1 and some Group 17 elements are given in the tables below.

Atomic and Ionic Radii of Some Elements

Group 1		Group 17	
Particle	Radius (pm)	Particle	Radius (pm)
Li atom	130.	F atom	60.
Li <sup>+</sup> ion	78	F <sup>-</sup> ion	133
Na atom	160.	Cl atom	100.
Na <sup>+</sup> ion	98	Cl <sup>-</sup> ion	181
K atom	200.	Br atom	117
K <sup>+</sup> ion	133	Br <sup>-</sup> ion	?
Rb atom	215	I atom	136
Rb <sup>+</sup> ion	148	I <sup>-</sup> ion	220.

8 Estimate the radius of a Br ion.

Base your answers to questions 9 on the information below.

The atomic number and corresponding atomic radius of the Period 3 elements are shown in the data table below.

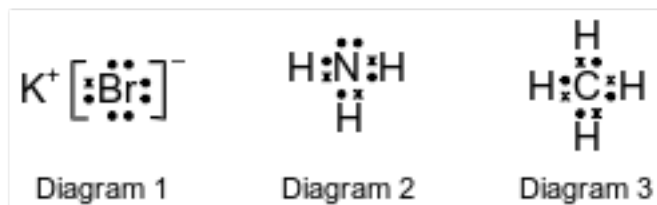
Data Table

Atomic Number	Atomic Radius (pm)
11	160.
12	140.
13	124
14	114
15	109
16	104
17	100.
18	101

9 Explain, in terms of electrons, the change in radius when a sodium atom becomes a sodium ion.

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

The Lewis electron-dot diagrams for three substances are shown below.



- 10 Identify the noble gas that has atoms with the same electron configuration as the positive ion represented in diagram 1, when both the atoms and the ion are in the ground state.

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

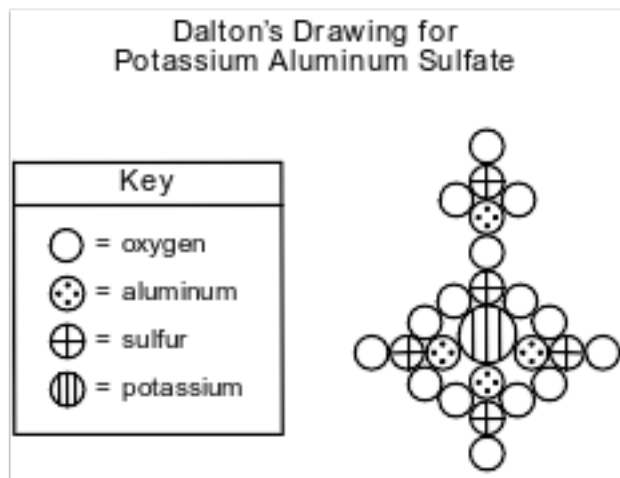
The formulas and names of four chloride compounds are shown in the table below.

Formula	Name
$\text{CCl}_4$	carbon tetrachloride
$\text{RbCl}$	rubidium chloride
$\text{CsCl}$	cesium chloride
$\text{HCl}$	hydrogen chloride

- 11 Explain, in terms of atomic structure, why the radius of a cesium ion in cesium chloride is smaller than the radius of a cesium atom when both are in the ground state.

Base your answers to questions 12 on the information below.

John Dalton, an early scientist, sketched the structure of compounds using his own symbols for the elements known at the time. Dalton's symbols for four elements and his drawing of potassium aluminum sulfate are represented by the diagram below.

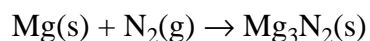


Today, it is known that the chemical formula for potassium aluminum sulfate is  $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ . It is a hydrated compound because water molecules are included within its crystal structure. There are 12 moles of  $\text{H}_2\text{O}$  for every 1 mole of  $\text{KAl}(\text{SO}_4)_2$ . The compound contains two different positive ions. The gram-formula mass of  $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  is 474 grams per mole.

- 12 Identify one positive ion in the hydrated compound. Your response must include both the chemical symbol and charge of the ion.

Base your answers to questions 13 on the information below and on your knowledge of chemistry.

When magnesium is ignited in air, the magnesium reacts with oxygen and nitrogen. The reaction between magnesium and nitrogen is represented by the unbalanced equation below.



- 13 Explain, in terms of electrons, why an atom of the metal in this reaction forms an ion that has a smaller radius than its atom.
- 14 Explain, in terms of electrons, why the radius of a potassium atom is larger than the radius of a potassium ion in the ground state.

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

A sample of seawater is analyzed. The table below gives the concentration of some ions in the sample.

**Concentration of Some Ions  
in a Seawater Sample**

Ion	Concentration (M)
$\text{Cl}^-$	0.545
$\text{Na}^+$	0.468
$\text{Mg}^{2+}$	0.054
$\text{SO}_4^{2-}$	0.028
$\text{Ca}^{2+}$	0.010
$\text{K}^+$	0.010

15 Compare the radius of an  $\text{Mg}^{2+}$  ion in the seawater to the radius of an Mg atom.

## Answer Keys

1 1

2 3

3 3

4 2

5 3

6 1

7 1

8 Allow 1 credit for an ionic radius value greater than 181 pm and less than 220. pm.

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

- The radius of a sodium ion is smaller because the sodium atom lost one electron.
- An  $\text{Na}^+$  ion is smaller because it has one fewer electron shell.

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

- argon
- Ar

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

- A cesium atom loses its valence electron, making the cesium ion smaller.
- The cesium atom has one more electron shell than the cesium ion.
- A  $\text{Cs}^+$  ion has only 5 shells of electrons in the ground state and the Cs atom has 6 shells.

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

- $\text{K}^+$
- $\text{Al}^{3+}$

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

- An atom of magnesium loses its outer shell electrons to form the  $\text{Mg}^{2+}$  ion.
- The electron configuration of a magnesium atom is 2-8-2, and the electron configuration of the magnesium ion is 2-8.
- An atom of the metal loses electrons to form the ion.

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

- A potassium atom has four electron shells and a potassium ion has three electron shells.
- A potassium atom has one more electron shell than a potassium ion.
- A  $\text{K}^+$  ion has one fewer electron than a K atom.

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

- The radius of an  $\text{Mg}^{2+}$  ion is smaller than the radius of an Mg atom.
- The atom has a larger radius than the ion.