

- Become familiar with the charge of some common ions.
- Use the periodic table to predict ion charge.

Some elements, especially transition metals, can form ions with variable charges. Figure 3.3.1 shows the characteristic charges for some of these ions. Notice that there is no simple pattern for transition metal ions (or for the larger main group elements) as there is with the main group ions. This is because the transition metals have electrons in *d* subshell and do not follow the octet rule. In order for an element such as iron (Fe) to achieve the same noble gas configuration of argon (Ar), it would need to lose 6 electrons in the *3d* subshell and 2 electrons in the *4s* subshell. An iron ion with a charge of +8 is not very likely, therefore, the octet rule is not applicable to transition elements.

For a multiply-charged ion, the correct convention is to write the charge number first followed by the sign. For example, the barium cation is written  $\text{Ba}^{2+}$ , not  $\text{Ba}^{+2}$ .

1A																	8A
H <sup>+</sup>	2A																
Li <sup>+</sup>																	
Na <sup>+</sup>	Mg <sup>2+</sup>	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	
							Fe <sup>2+</sup>	Co <sup>2+</sup>	Ni <sup>+</sup>	Cu <sup>+</sup>	Zn <sup>2+</sup>	Al <sup>3+</sup>		P <sup>3-</sup>	O <sup>2-</sup>	F <sup>-</sup>	
K <sup>+</sup>	Ca <sup>2+</sup>	Sc <sup>3+</sup>	Ti <sup>2+</sup>	V <sup>2+</sup>	Cr <sup>2+</sup>	Mn <sup>2+</sup>	Fe <sup>3+</sup>	Co <sup>3+</sup>		Cu <sup>2+</sup>					Se <sup>2-</sup>	Br <sup>-</sup>	
Rb <sup>+</sup>	Sr <sup>2+</sup>									Ag <sup>+</sup>	Cd <sup>2+</sup>					I <sup>-</sup>	
Cs <sup>+</sup>	Ba <sup>2+</sup>									Au <sup>+</sup>							
										Au <sup>3+</sup>			Pb <sup>2+</sup>				

Figure 3.3.1: Common ions formed by specific elements on the periodic table. The charge that a representative (main group element) acquires when it becomes an ion is related to the location on the periodic table. Note that some metal atoms, specifically the transition elements, commonly form ions with variable charges.

Which of these ions is *not likely* to form?

- a.  $\text{Mg}^+$   
b.  $\text{K}^+$

(a) Mg is in Group 2A and has two valence electrons. It achieves octet by losing two electrons to form  $\text{Mg}^{2+}$  cation. Losing only one electron to form  $\text{Mg}^+$  does not make an octet, hence,  $\text{Mg}^+$  is not likely to form.

Which of these ions is *not likely* to form?

- a.  $S^{3-}$
- b.  $N^{3-}$

**Answer**

(a) S is in Group 6A and has six valence electrons. It achieves octet by gaining two electrons to form  $S^{2-}$  anion. Gaining three electrons to form  $S^{3-}$  does not make it octet, hence,  $S^{3-}$  is not likely to form.

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