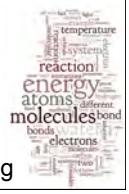
Periodic Trends



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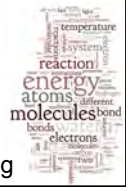
Periodic Table

- Originally developed by Mendeleev
- On basis of experimental behavior and repeating (periodic) patterns)
- He left spaces for undiscovered elements
- Originally on basis of increasing atomic mass - then on atomic number
- Really electron organization explains repeating patterns



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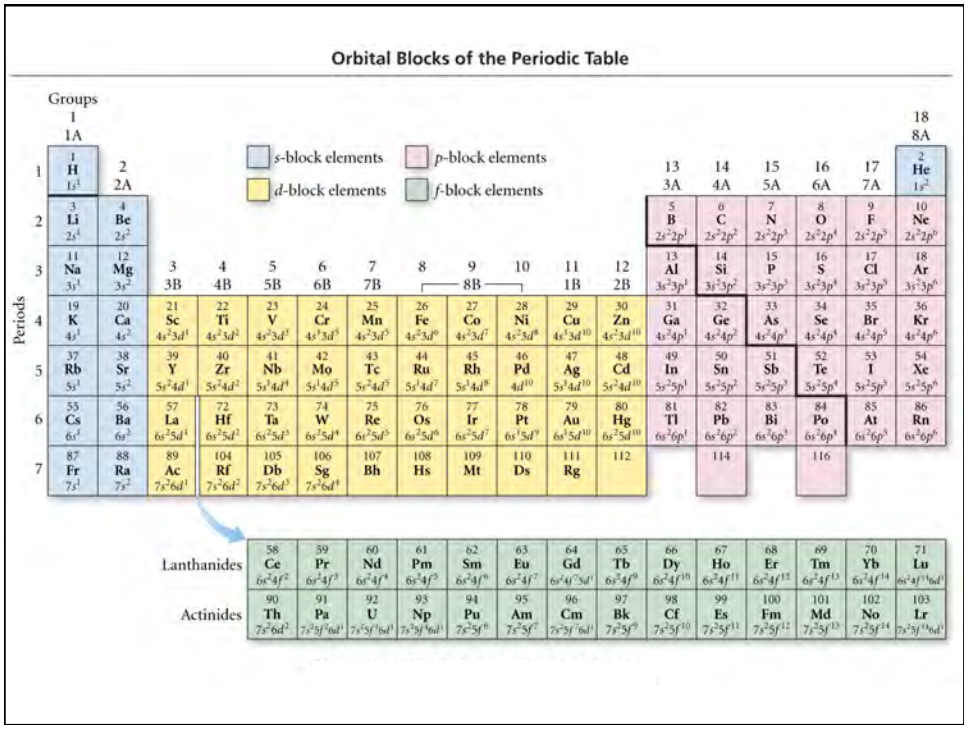


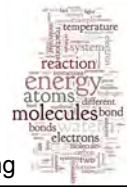
What is the electron configuration of O?

A. $1s^2$

B. $2s^2\ 2p^4$

C. $1s^2\ 2s^2\ 2p^4$

D. $1s^2\ 2p^4$



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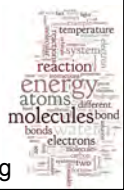
What is the core/valence electron configuration of S?

- [Ne] 3s2 3p4
- [Ar] 3s2 3p4
- [Ne] 3s2 3p2
- [Ar] 3s2 3p2



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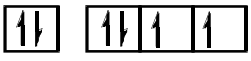
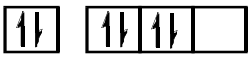
Which of the following correctly illustrates the valence electron configuration of sulfur?

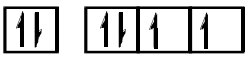
a)



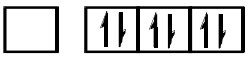
b)

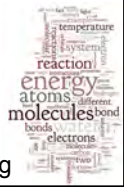


c)



d)





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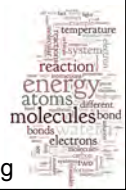
Periodic Trends

- Depend on
  - # Valence electrons
  - Effective nuclear charge



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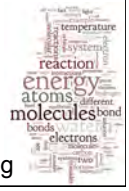
Core and Valence Electrons

- Core electrons are those in filled shells – strongly attracted to the nucleus, take no part in reactions
- Valence electrons in outer (unfilled shells)
- How many core/valence electrons do
- Na, Mg, Al, Si, P, Cl, Ar have?



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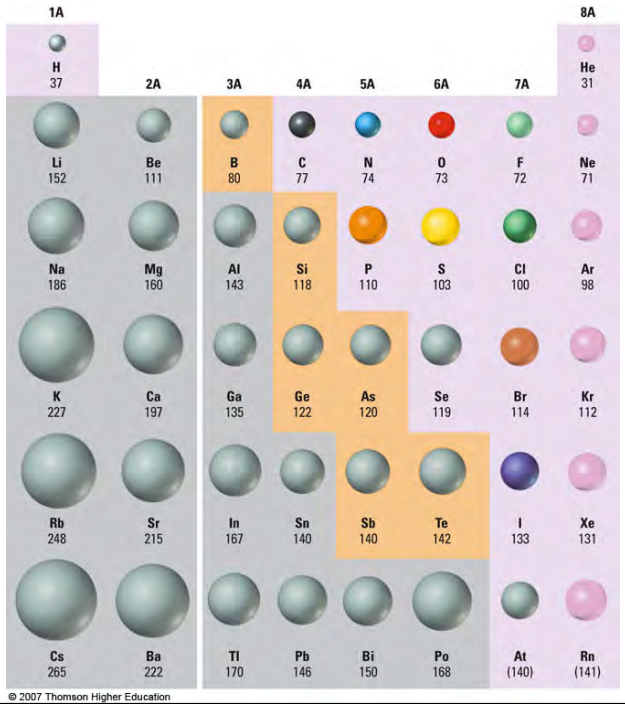
Atomic Radius (pm)



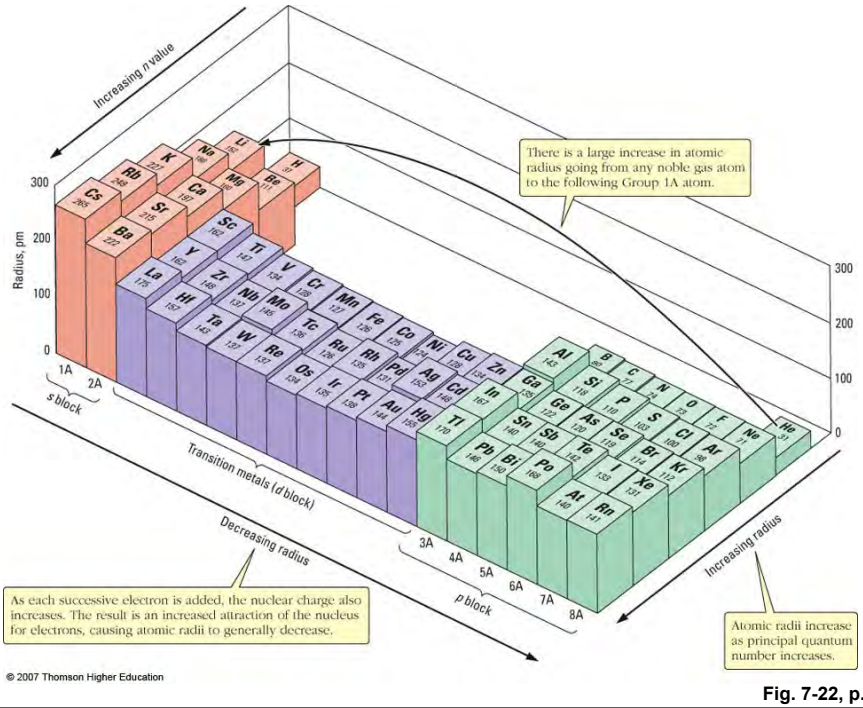
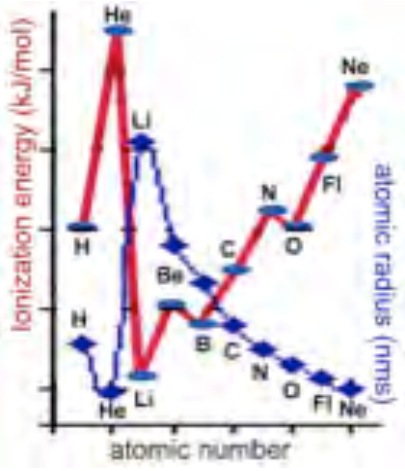


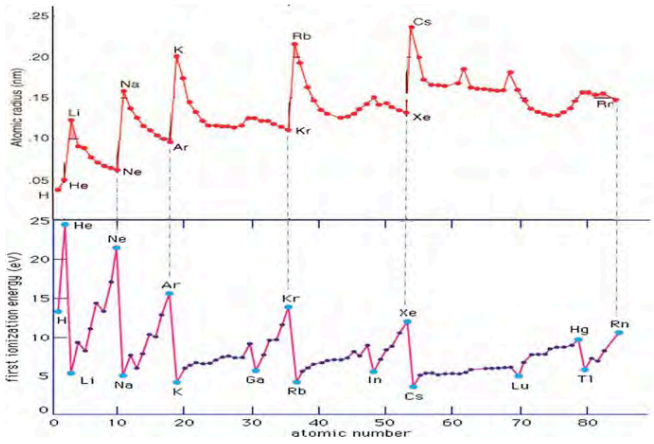
Fig. 7-22, p. 312

Periodic trends in atomic radius and ionization energy



- Small atoms have higher ionization energies

Periodic trends in atomic radius and ionization energy



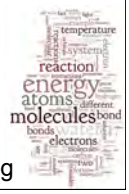
Effective Nuclear Charge

Charge screened by core electrons

$$Z_{eff} = Z - S$$

Effective Nuclear Charge

Actual Nuclear Charge



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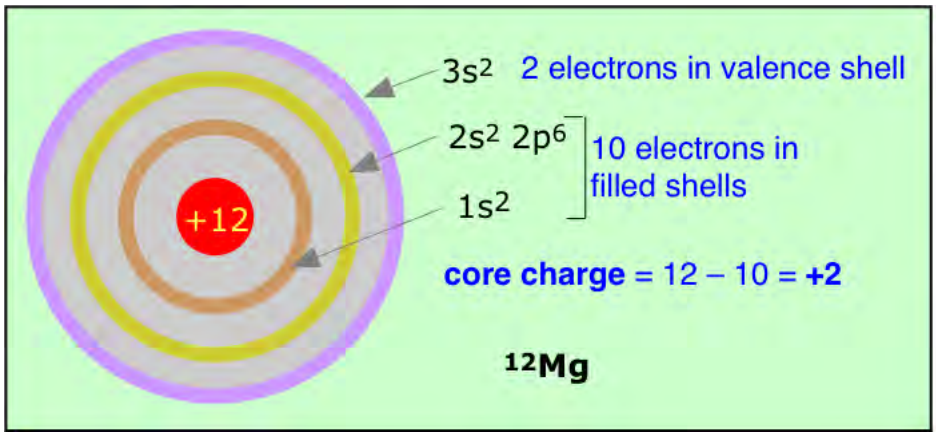
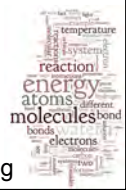


Ionization Energies

- $M(g) \rightarrow M^{+}(g) + e^{-}$
- Energy required to remove outermost valence electron (in the gas phase)



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Ionization Energy

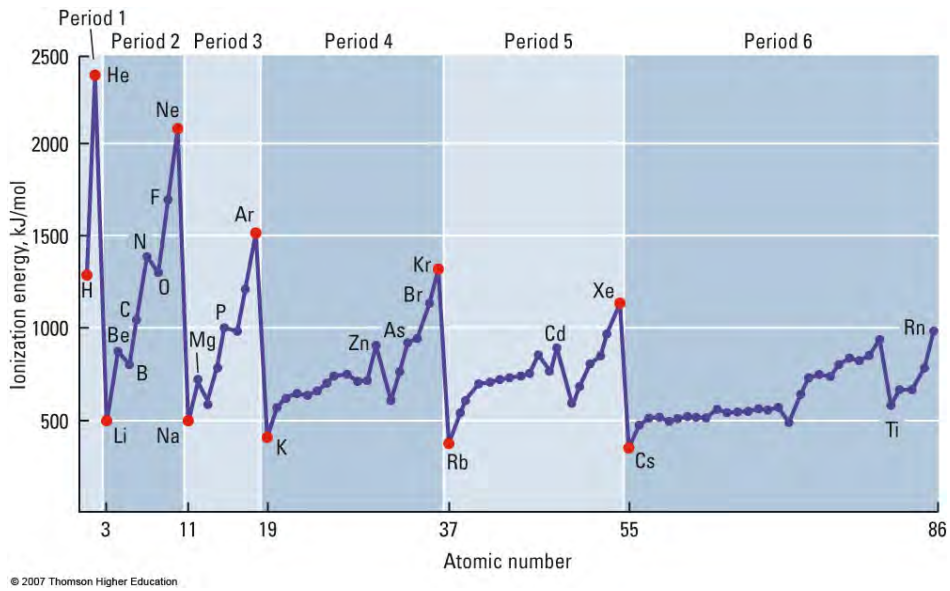
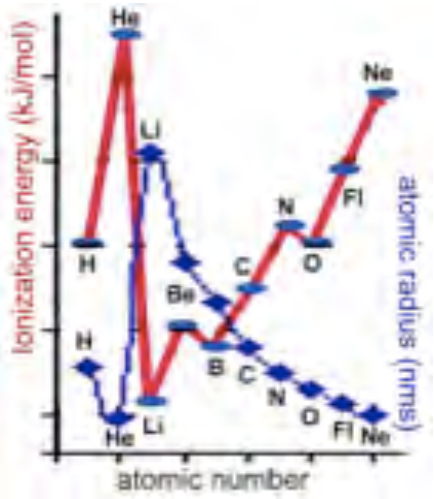
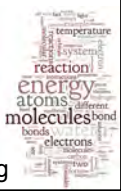


Fig. 7-25, p. 316



2nd Ionization Energy

- $M^{+}(g) \rightarrow M^{2+}(g) + e–$
- Third IE
- $M^{2+}(g) \rightarrow M^{3+}(g) + e–$



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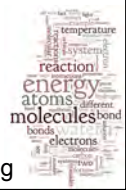
Which ionization energy is larger?

A. First IE: $Mg_{(g)} \rightarrow Mg_{(g)}^{+} + e^{-}$

B. Second IE: $Mg_{(g)}^{+} \rightarrow Mg_{(g)}^{2+} + e^{-}$

C. Third IE: $Mg_{(g)}^{2+} \rightarrow Mg_{(g)}^{3+} + e^{-}$



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Which ionization energy is larger?

A. First IE: $Mg_{(g)} \rightarrow Mg_{(g)}^{+} + e^{-}$

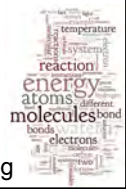
- 738 kJ/mol

B. Second IE: $Mg_{(g)}^{+} \rightarrow Mg_{(g)}^{2+} + e^{-}$

- 1450 kJ/mol

C. Third IE: $Mg_{(g)}^{2+} \rightarrow Mg_{(g)}^{3+} + e^{-}$

- 7730 kJ/mol



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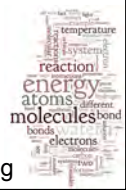
Why?

- What factors affect removing the electron?
- Charge (q1, q2)
- r
- What happens to the radius of the atom (ion) when an electron is removed?



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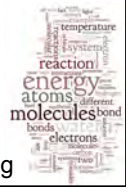
Formation of cations

- Which has a larger radius? (why)

A.Li

B.Li^+

C.same



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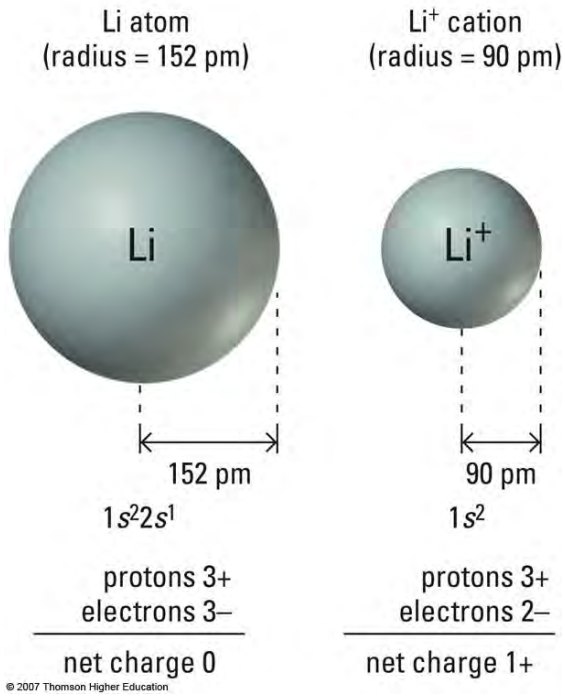


p. 313

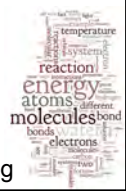
Formation of anions

- Which has the largest radius? Why?

A.F

B.F^-

C.same



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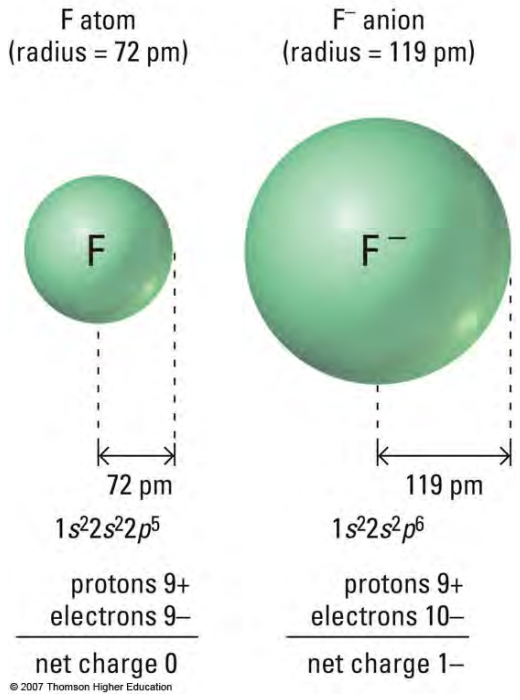
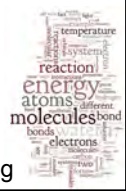


p. 314

Ionization energies are affected by

- Size of atom/ion (smaller size – higher IE)
- Size of charges (larger charge larger IE)
- The shell that the electron is removed from



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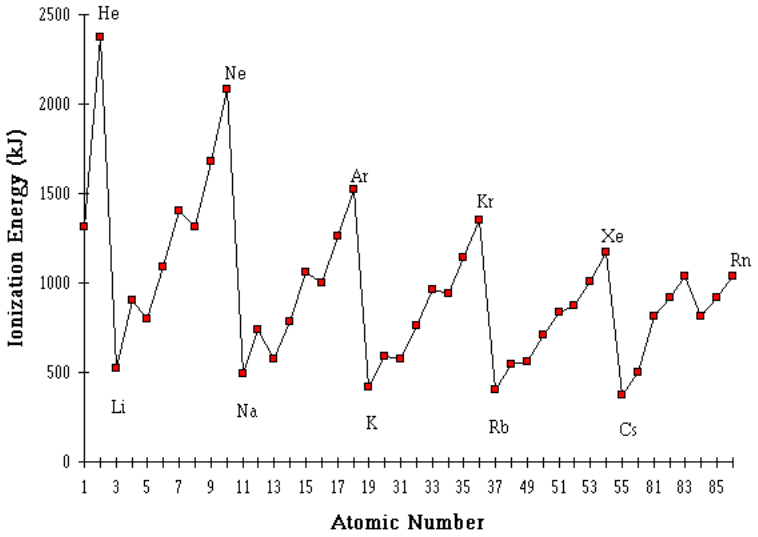
More evidence for electron shells



Consider the following successive ionization energies (kJ/mol):

IE_1	IE_2	IE_3	IE_4	IE_5	IE_6	IE_7
1012	1900	2910	4960	6270	22,200	26,345

Which element in period three would most likely show this trend in ionization energies?

A. Mg
B. Al
C. Si
D. P
E. S