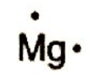
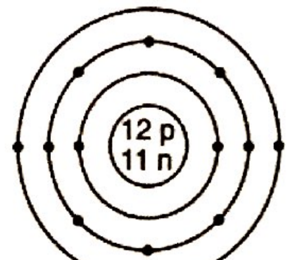
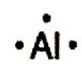
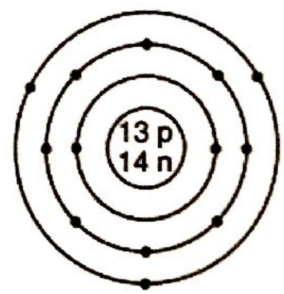
Free Response Practice #2 (10 points)

2. Answer the following questions related to the properties of magnesium and aluminum.

Atomic Diagrams of Magnesium and Aluminum

Key
• = electron

Element	Lewis Electron-Dot Diagram	Electron-Shell Diagram
magnesium		
aluminum		

a. Write the complete electron configuration for a neutral atom of magnesium in the ground state. (1 point)

b. Write the complete orbital diagram for a neutral atom of aluminum in the ground state. (1 point)

c. The table below represents the first ionization energy for the elements in Period 3. The missing first ionization energy values are 496 kJ/mol, 578 kJ/mol, 738 kJ/mol, and 789 kJ/mol. Use these values and your understanding of the trend of first ionization energy to complete the table below. (2 points)

Element	Atomic Number	Symbol	First Ionization Energy (kJ/mol)
Sodium	11	Na	496
Magnesium	12	Mg	738
Aluminum	13	Al	578
Silicon	14	Si	789
Phosphorus	15	P	1012
Sulfur	16	S	1000
Chlorine	17	Cl	1251
Argon	18	Ar	1521

] Group 2/3 exception! "s^2p^1 glitch"

d. Why is the first ionization energy of sulfur lower than that of phosphorus? Explain using Coulomb's Law. (2 points)

e. Which element from Period 3 does the table of successive ionization energies below represent? Explain. (2 points)

Ionization Energies (kJ/mol)							
1st IE	2nd IE	3rd IE	4th IE	5th IE	6th IE	7th IE	8th IE
578	1,820	2,750	11,600	14,800	18,400	23,300	27,500

f. Write the electron configuration for the most commonly formed ion of the element chosen in part (e). (1 point)

i. Identify one other neutral atom or ion that is isoelectronic with the most commonly formed ion of this element. (1 point)

(a) $1s^2 2s^2 2p^6 3s^2$ (note: noble gas notation NOT accepted for "complete" e^- config)

(b) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ ↑
1s 2s 2p 3s 3p

(d) Coulomb's law states that energy of repulsion is directly proportional to the magnitude of the charges. Although S has more p^+ than P, the repulsion of the paired 3p e^- in S reduces the force of their attraction to the nucleus, so less energy is needed to remove one of these paired e^- from S than to remove an unpaired e^- from P.

(e) Al, b/c its 4 e^- requires significantly more energy to remove than the first 3, so it must have 3 valence e^- + the 4th + higher e^- must be closer to the nucleus (core e^-).

(f) $1s^2 2s^2 2p^6$ or $[He] 2s^2 2p^6$

(i) N^{3-}, O^{2-}, F^-, Ne, Na^+, Mg^{2+}