

Complete in pencil. Erase mistakes completely. If you need more space, use the back of the sheets as are necessary. Use significant figures for atomic masses as recorded on the Periodic Table and for the constants as given to you.

$$\Delta E = h\nu \quad c = \lambda\nu \quad E_n = \frac{-2.178 \times 10^{-18} \text{ joule}}{n^2} \quad q = mc\Delta T$$
$$h = 6.63 \times 10^{-34} \text{ J s} \quad c = 3.0 \times 10^8 \text{ m s}^{-1}$$

Multiple Choice (3 pts each): Choose the option that is the best answer or completes each question or statement. Write the letter of your answer in the space to the right.

- Which of the following shows the standard state formation of potassium chloride?
 - $\text{K (s)} + \text{Cl}_2 \rightarrow \text{KCl (s)}$
 - $\text{K (s)} + \frac{1}{2} \text{Cl}_2 \rightarrow \text{KCl (s)}$
 - $2 \text{K (s)} + \text{Cl}_2 \rightarrow 2 \text{KCl (s)}$
 - $\text{K (s)} + \frac{1}{2} \text{Cl}_2 \rightarrow \text{KCl (g)}$Answer: _____
- When an endothermic reaction takes place, q_{reaction} is:
 - Equal to zero.
 - Negative.
 - Positive.
 - None of the above.Answer: _____
- How much heat is required to raise the temperature of 100.0 g water from 10.0°C to 60.0°C? (specific heat of water is 4.18 J/g°C.)
 - $2.090 \times 10^4 \text{ J}$
 - $-2.09 \times 10^4 \text{ J}$
 - $2.09 \times 10^4 \text{ J}$
 - $2.09 \times 10^4 \text{ kJ}$Answer: _____
- Energy transitions in which an excited electron “relaxes” to $n = 2$ are associated with:
 - The Lyman series.
 - Visible light.
 - The Paschen series.
 - Ultraviolet light.
 - The World Series.Answer: _____
- What is a permissible set of quantum numbers for the highest energy electron of yttrium, ${}_{39}\text{Y}$?
 - 4, 1, 0, $\frac{1}{2}$
 - 4, 2, -1, $\frac{1}{2}$
 - 4, 0, 0, $-\frac{1}{2}$
 - 3, 2, -2, $\frac{1}{2}$Answer: _____
- Which series is ranked in order of increasing electronegativity?
 - N, P, As, Sb
 - F, O, N, C
 - I, Br, Cl, F
 - Ga, Si, P, SeAnswer: _____

7. In any one period of the periodic table, the element in Group IA, as compared to the element in Group VIIA, has a
- Larger number of valence electrons.
 - Lower electron affinity.
 - Smaller radius.
 - Higher ionization energy.
 - None of the above.
- Answer:** _____
8. Which of the following would have the largest second ionization energy?
- K
 - Ne
 - Cl
 - Na
- Answer:** _____
9. Which of the following would have the greatest shielding effect?
- Ba
 - Ca
 - Xe
 - Rb
- Answer:** _____
10. Which of the following sets of quantum numbers represents the highest energy state?
- 5, 1, 1, -1/2
 - 5, 2, 0, +1/2
 - 4, 2, -1, +1/2
 - 6, 0, 0, -1/2
 - 5, 2, 1, -1/2
- Answer:** _____
11. Which of the following atoms is largest in size?
- O
 - Al
 - Na
 - F
 - Mg
- Answer:** _____
12. Which of the following is least metallic?
- I
 - O
 - Cs
 - K
 - Te
- Answer:** _____
13. Which series is ranked in order of increasing electronegativity?
- O, S, Se, Te
 - Cl, S, P, Si
 - In, Sn, N, O
 - C, Si, P, Se
- Answer:** _____

Free Response

14. (4 pts) Make a sketch of the d_{xy} electron density (or 95% probability) plot. Be sure to label your axes.

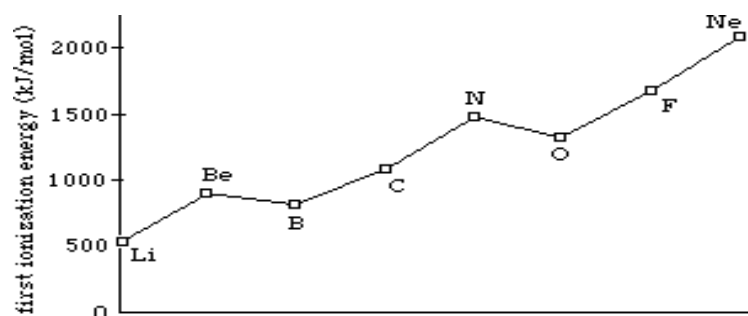
15. Modified from 1980 D (10 pts)

a. (4 pts) Write the complete ground state electron configuration for an arsenic atom, showing the number of electrons in each subshell.

b. (6 pts) Briefly explain how the electron configuration of the arsenic atom in the ground state is consistent with the existence of the following known compounds: Na_3As , AsCl_3 , and AsF_5 .

16. Modified from 1990 D (19 pts)

The diagram shows the first ionization energies for the elements from Li to Ne.



a. (2 pts) Define the term “ionization energy” of an atom.

Briefly (in one to two sentences) explain each of the following in terms of atomic structure.

b. (4 pts) In general, there is an increase in the first ionization energy from Li to Ne.

c. (4 pts) The first ionization energy of B is lower than that of Be.

d. (4 pts) The first ionization energy of O is lower than that of N.

e. (5 pts) Predict how the first ionization energy of Na compares to those of Li and of Ne. Explain.