

Name: _____

This exam is subject to the terms and conditions of the NKU Honor Code. You are not to give or receive assistance during this exam. No programmable or graphing calculators are permitted during this exam. Remember to report all answers to the correct number of significant digits and show all work as appropriate to receive partial credit!

By signing below, I signify that I have adhered to the NKU Honor Code and did not give or receive assistance during this exam. I recognize that failure to adhere to the Honor Code will result in a zero grade for this exam.

Constants

$$R_H = 2.18 \times 10^{-18} \text{ J}$$

$$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$c = 3.00 \times 10^8 \text{ m}\cdot\text{s}^{-1}$$

Exam Grade (Completed by Instructor):

P2 / **25**

P3 / **33**

P4 / **58**

P5 / **66**

P6 / **18**

Total / **200**

True/False (2 pts each):

- 1 ___ A neon atom in its ground state will be diamagnetic.
- 2 ___ The radii of ions are always smaller than the radii of the corresponding atoms of the same element.
- 3 ___ The bond in F₂ is described as polar covalent.
- 4 ___ Each shell (principal energy level) of quantum number n contains n subshells.

Fill in the Blank (2 pts each question):

- 5 The _____ principle states that as protons are added to an atom, electrons are added from lowest to highest energy atomic orbitals.
- 6 _____ is the minimum energy required to remove a mole of electrons from a mole of gaseous ground state atoms.
- 7 The _____ states that atoms tend to form bonds until they have eight valence electrons (two for hydrogen).
- 8 The _____ states that you can't simultaneously know both the momentum and position of an electron.

Multiple Choice (3 points each):

- 9 ___ Complete this sentence: Atoms emit visible and ultraviolet light
- a. as electrons jump from lower energy levels to higher levels.
 - b. as the atoms condense from a gas to a liquid.
 - c. as electrons jump from higher energy levels to lower levels.
 - d. as they are heated and the solid melts to form a liquid.
 - e. as the electrons move about the atom within an orbit.
- 10 ___ Which one of the following sets of quantum numbers is not possible?
- | | n | l | m _l | m _s |
|----|---|---|----------------|----------------|
| a. | 4 | 3 | -2 | +1/2 |
| b. | 3 | 0 | 1 | -1/2 |
| c. | 3 | 0 | 0 | +1/2 |
| d. | 2 | 1 | 1 | -1/2 |
| e. | 2 | 0 | 0 | +1/2 |
- 11 ___ Mendeleev proposed the existence of an unknown element that he called "eka-aluminum." This element is now called
- a. magnesium
 - b. silicon
 - c. gallium
 - d. boron
 - e. germanium

- 12 _____ The general electron configuration for atoms of the halogen group is
- ns^2np^5
 - ns^2np^6
 - $ns^2np^6(n-1)d^7$
 - ns^1
 - ns^2np^7
- 13 _____ Which of these atoms will have the largest radius?
- B
 - Cl
 - Br
 - Si
 - Ga
- 14 _____ Which of the following elements has the greatest metallic character?
- Br
 - F
 - Ge
 - Rb
 - O
- 15 _____ Which atom will have the most similarities with boron ($Z = 5$)?
- Si
 - Al
 - In
 - Zn
 - O
- 16 _____ Which of the bonds below would have the greatest polarity (highest percent ionic character)?
- Si-P
 - Si-S
 - Si-Se
 - Si-Cl
 - Si-I
- 17 _____ Which element will display an unusually large energy increase between its third and fourth ionization energies?
- Si
 - Na
 - Mg
 - P
 - Al

Short Answer (points listed by problem, show all work **on the exam** to obtain partial credit):

18(15) Write all three Lewis dot resonance structures for CS_3^{2-} . Indicate the formal charges of all atoms.

19(14) Calculate the wavelength of the light (in nm) emitted by a hydrogen atom during a transition of its electron from the $n = 4$ to the $n = 1$ principal energy level.

20(14) Use the Born-Haber cycle to calculate the lattice energy of LiCl(s) given the following data:

ΔH° of sublimation of $\text{Li} = +155.2 \text{ kJ/mol}$

$\text{IE (Li)} = +520 \text{ kJ/mol}$

$\text{EA (Cl)} = +348 \text{ kJ/mol}$

$\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$

$\Delta H^\circ = +121.4 \text{ kJ/mol}$

$\text{Li(s)} + 1/2\text{Cl}_2(\text{g}) \rightarrow \text{LiCl(s)}$

$\Delta H^\circ = -469.1 \text{ kJ/mol}$

21(30) Write the full electron configurations for the following atoms. Do *not* use noble gas core abbreviations!

(a) C ($Z = 6$)

(b) F ($Z = 9$)

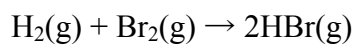
(c) Ar ($Z = 18$)

(d) Cu ($Z = 29$)

(e) Cs ($Z = 55$)

(f) Po ($Z = 84$)

22(11) Use bond energies (BE) to estimate the enthalpy of formation of HBr(g).

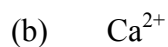
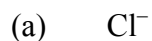


$$\text{BE (H-H)} = 436 \text{ kJ/mol}$$

$$\text{BE (Br-Br)} = 192 \text{ kJ/mol}$$

$$\text{BE (H-Br)} = 366 \text{ kJ/mol}$$

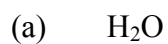
23(25) Write the electron configurations for the following ions, using noble gas core abbreviations. Do *not* write out the full electron configuration!



24(15) Write the Lewis dot symbols for the following elements.



25(15) Write the Lewis dot structures for the following elements.



26(9) Imagine that (once again) you're teaching CHE 120 in the spring. Today's topic is ionization energy, so clearly (but briefly) teach me everything I need to know about this topic in the space below, using pictures, graphs, equations, whatever in your lesson. Make sure you include the appropriate trends found in the periodic table!

27(9) Write a brief paragraph describing the contributions of Niels Bohr to atomic theory.