

General Chemistry 1 (CHEM 1141)

Shawnee State University – Fall 2024

December 5, 2024

Exam # 3 A

Name _____

*Please print your full name, and the exam version (3 A) that you have on the scantron sheet!
(Bubble in the best answer choice for each question on the scantron sheet in pencil!)*

Please ☒ check the box next to your correct section number.

| | | |
|-------------------|---|------------------|
| Section #: | <input type="checkbox"/> 1. (Mon Lab, 11:10 AM – 1:55 PM) | } Fleeman |
| | <input type="checkbox"/> 2. (Wed Lab, 11:10 AM – 1:55 PM) | |
| | <input type="checkbox"/> 3. (Tue Lab, 11:00 AM – 1:50 PM) | } Napper |
| | <input type="checkbox"/> 4. (Thu Lab, 11:00 AM – 1:50 PM) | |

Multiple Choice: _____ / 50

Q21: _____ / 10

Q22: _____ / 10

Q23: _____ / 10

Q24: _____ / 10

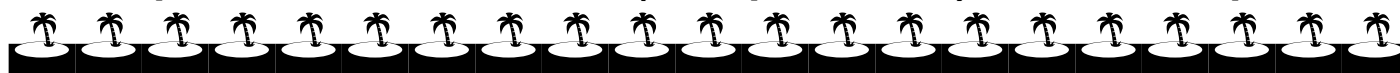
Q25: _____ / 10

BONUS: _____ / 3

TOTAL: _____ / 100



Each problem in this section (multiple choice) is worth 2.5 points!



- Q1. Which is an **impossible** set of quantum numbers (n, l, m_l, m_s) for an electron in an atom?
- A) (1, 1, 0, $+1/2$)
B) (2, 0, 0, $-1/2$)
C) (4, 2, -1, $+1/2$)
D) (3, 2, -2, $-1/2$)
- Q2. The region of the electromagnetic spectrum with a **longer** wavelength than microwave is referred to as:
- A) ultraviolet
B) infrared
C) gamma
D) radio
- Q3. Which gas phase atom or ion has the following orbital diagram?
- [Ar]

| | | | | |
|----------------------|----------------------|----------------------|------------|------------|
| $\uparrow\downarrow$ | $\uparrow\downarrow$ | $\uparrow\downarrow$ | \uparrow | \uparrow |
|----------------------|----------------------|----------------------|------------|------------|

| |
|----------------------|
| $\uparrow\downarrow$ |
|----------------------|
- 3d 4s
- A) Fe^{3+}
B) Ni
C) Zn^{2+}
D) Fe
- Q4. Which of the terms below accurately describe the energy associated with the following process:



- A) electron affinity
B) ionization energy
C) electronegativity
D) binding energy

- Q5. The **energy** of a photon of light with a frequency of 1.2×10^{12} Hz is:
- A) 2.5×10^{-4} J
 - B) 5.2×10^{-23} J
 - C) 7.1×10^{-18} J
 - D) 8.0×10^{-22} J
- Q6. Which electron transition in a hydrogen atom would result in the **emission** of the **highest frequency** light?
- A) $n = 1 \rightarrow n = 3$
 - B) $n = 1 \rightarrow n = 4$
 - C) $n = 4 \rightarrow n = 1$
 - D) $n = 3 \rightarrow n = 1$
- Q7. The principle that states that it is impossible to know with complete certainty both the position and momentum of a particle is named after which scientist?
- A) Schrödinger
 - B) Heisenberg
 - C) Einstein
 - D) Bohr
- Q8. Which substance requires an element with an **expanded** octet when writing its Lewis structure?
- A) BeCl_2
 - B) C_2H_2
 - C) SF_2
 - D) IF_3
- Q9. Which set of atoms is arranged correctly from **smallest to largest** radius?
- A) $\text{Na} < \text{K} < \text{Al}$
 - B) $\text{K} < \text{Na} < \text{Al}$
 - C) $\text{Na} < \text{Al} < \text{K}$
 - D) $\text{Al} < \text{Na} < \text{K}$

- Q10. The name of the **molecular geometry** around an atom with three bonds and two lone pairs is:
- A) trigonal bipyramidal
 - B) trigonal planar
 - C) t-shaped
 - D) see-saw
- Q11. Theobromine, $\text{C}_7\text{H}_8\text{N}_4\text{O}_2$, is a component of dark chocolate. Determine the number of **valence electrons** for theobromine.
- A) 72
 - B) 54
 - C) 68
 - D) 36
- Q12. Which of the following set of quantum numbers describes a **4d orbital**?
- A) $n = 4, \quad l = 2, \quad m_l = -2, \quad m_s = +1/2$
 - B) $n = 4, \quad l = 2, \quad m_l = -3, \quad m_s = +1/2$
 - C) $n = 4, \quad l = 1, \quad m_l = +1, \quad m_s = +1/2$
 - D) $n = 4, \quad l = 3, \quad m_l = -2, \quad m_s = +1/2$
- Q13. Which of the following atoms has **one** unpaired electron in its ground-state configuration?
- A) Mg
 - B) Al
 - C) Mn
 - D) P
- Q14. Which of the following species is **polar**?
- A) CO_2
 - B) BF_3
 - C) SO_2
 - D) SiF_4

- Q15. How many **lone pairs** of electrons are around the central atom in PCl_3 ?
- A) 0
 - B) 1
 - C) 2
 - D) 3
- Q16. Which of the following molecules contain a **triple bond**?
- A) NH_3
 - B) O_3
 - C) N_2H_4
 - D) CO
- Q17. Which of the following bonds would be expected to have the **shortest** length?
- A) $\text{C}\equiv\text{C}$
 - B) $\text{C}=\text{C}$
 - C) $\text{C}-\text{C}$
 - D) $\text{C}-\text{H}$
- Q18. The molecular geometry with the **smallest** bond angle is:
- A) linear
 - B) trigonal planar
 - C) tetrahedral
 - D) octahedral
- Q19. Which of the following is **isoelectronic** with Ba^{2+} ?
- A) Sr^{2+}
 - B) La^+
 - C) I^-
 - D) Rn
- Q20. The number of **oscillations** a wave makes per second (unit time) is its:
- A) frequency
 - B) wavelength
 - C) amplitude
 - D) speed



Each problem in this section (short answer) is worth 10 points!

All work must be shown to receive credit!

You must use the factor-label (conversion-factor) method for all conversions!

Be sure to include units where applicable!

All numeric answers must be rounded to the correct number of significant figures!



Q21. An electron in a rubidium (Rb) atom undergoes a transition that results in the **absorption** of light with a wavelength of 781 nm.

(This is a ruby-red color and it explains how the element got its name!)

(A) Calculate the energy in Joules that this corresponds to.

(B) Did the electron transition to a higher-energy level or a lower-energy level?
Explain!

(C) Write out the full electron configuration for a ground-state atom of rubidium.

(D) Write out the orbital diagram for rubidium using an appropriate noble gas core.

(E) Are rubidium atoms diamagnetic or paramagnetic? Explain!

Q22. (A) Explain why elements in the **same group** have similar chemical properties?

(B) What happens to the atomic radius for atoms as you go from left to right on the periodic table?

(C) Explain WHY you see this trend in part (B) above. **Write complete, grammatically correct, sentences for your explanation!**

(D) Using an appropriate noble gas core, write out the electron configuration for the Co^{2+} ion.

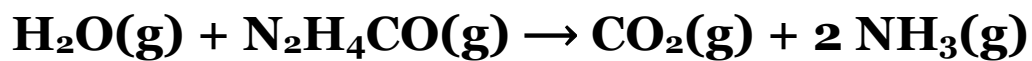
(E) What is the name of the law/principle that states that all electrons in an atom must have different sets of quantum numbers?

Q23. Predict the molecular geometry and polarity of BrF_5 .

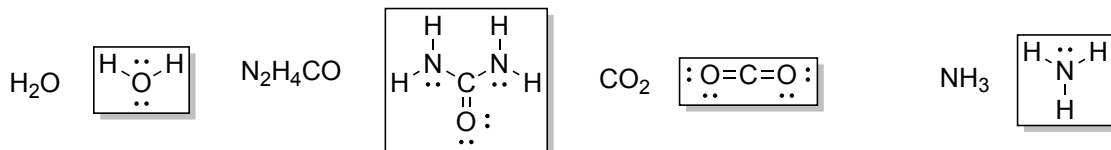
Include the following information in your answer:

- ☐ A count of the total number of valence electrons
- ☐ A valid Lewis structure
- ☐ A sketch of the geometry of the molecule using line/dash/wedge notation
- ☐ The value of the bond angle(s) written out
- ☐ The name of the **molecular** geometry
- ☐ A clear **explanation** of why the molecule BrF_5 is polar or nonpolar

Q24. Use bond energies to estimate ΔH for the reaction:

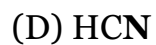
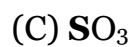


given the valid Lewis structures:



| Bond | Energy (kJ/mol) | Bond | Energy (kJ/mol) |
|------|-----------------|-------------------------|-----------------|
| O—H | 467 | C—N | 305 |
| N—H | 391 | C=O | 745 |
| C—H | 413 | C=O (in CO_2) | 799 |

Q25. Draw Lewis structures for the following compounds and determine the formal charge of the **highlighted atoms in each compound**. Show your work for determining the formal charges.





3 Point Bonus Question



Sketch out the shape for an “s” and a “p” orbital.

s

p

Exam checklist:

(Check the boxes to certify the following:)

- ☐ My full name is written legibly on the front page
- ☐ My correct lab section has been indicated on the front page
- ☐ My full name is written legibly on the scantron sheet
- ☐ My exam version (A, B, C, or D) is written on the scantron sheet
- ☐ I have shown work for all problems (where appropriate), paying attention to
 - Significant figures / decimal places
 - Units
- ☐ I have used the conversion-factor method for all conversions
- ☐ If I have torn off the back page (periodic table), I will not turn it in with my exam!



Thank you from the Chemistry Professors and Good Luck!

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Useful information:

$$c = v\lambda$$

$$E = h \nu$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$E_n = -R_H \left(\frac{1}{n^2} \right)$$

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

$$\lambda = \frac{h}{mu}$$

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

Periodic Table of the Elements

| Periodic Table of the Elements | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------|-------|-------|-------|-----|-------|-------|-------|-------|--------|-------|-------|-------|-------|--|------|-----|----|-------|-------|-------|-------|--------|-------|
| IA | IIA | | | | | | | | | | | | | | IIIA | IVA | VA | VIA | VIIA | VIIIA | | | |
| 1 | 2 | | | | | | | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
| 1 | 2 | | | | | | | | | | | | | | | | | 5 | 6 | 7 | 8 | 9 | 10 |
| H | He | | | | | | | | | | | | | | | | | B | C | N | O | F | Ne |
| 1.008 | | | | | | | | | | | | | | | | | | 10.81 | 12.01 | 14.01 | 16.00 | 19.00 | 20.18 |
| 3 | 4 | | | | | | | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
| Li | Be | | | | | | | | | | | | | | | | | Al | Si | P | S | Cl | Ar |
| 6.941 | 9.012 | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 12 | | | | | | | | | | | | | | | | | | | | | | |
| Na | Mg | | | | | | | | | | | | | | | | | | | | | | |
| 22.99 | 24.31 | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 4 | | | | | | | | | | | | | | | | | 12 | 13 | 14 | 15 | 16 | 17 |
| K | Ca | | | | | | | | | | | | | | | | | Zn | Ga | Ge | As | Se | Br |
| 39.10 | 40.08 | | | | | | | | | | | | | | | | | 65.39 | 69.72 | 72.61 | 74.92 | 78.96 | 79.90 |
| 37 | 38 | | | | | | | | | | | | | | | | | 47 | 48 | 49 | 50 | 51 | 52 |
| Rb | Sr | | | | | | | | | | | | | | | | | Cd | In | Sn | Sb | Te | I |
| 85.47 | 87.62 | | | | | | | | | | | | | | | | | 112.4 | 114.8 | 118.7 | 121.8 | 127.60 | 126.9 |
| 55 | 56 | | | | | | | | | | | | | | | | | 79 | 80 | 81 | 82 | 83 | 84 |
| Cs | Ba* | | | | | | | | | | | | | | | | | Hg | Tl | Pb | Bi | Po | At |
| 132.9 | 137.3 | | | | | | | | | | | | | | | | | 200.6 | 204.4 | 207.2 | 209.0 | 210 | 222 |
| 87 | 88 | | | | | | | | | | | | | | | | | 111 | 112 | 113 | 114 | 115 | 116 |
| Rf | Ra** | | | | | | | | | | | | | | | | | | | | | | |
| Fr | | | | | | | | | | | | | | | | | | | | | | | |
| 223 | 226 | | | | | | | | | | | | | | | | | | | | | | 238 |
| 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | | | | | | | | | | |
| La | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | | | | | | | | | | |
| 138.9 | 140.1 | 140.9 | 144.2 | 146 | 150.4 | 152.0 | 157.3 | 158.9 | 162.50 | 164.9 | 167.3 | 168.9 | 173.0 | | | | | | | | | | |
| 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | | | | | | | | | | |
| Ac | Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | | | | | | | | | | |
| 227 | 232.0 | 231.0 | 238.0 | 237 | 244 | 243 | 247 | 247 | 251 | 252 | 257 | 258 | 259 | | | | | | | | | | |