

General Chemistry 1 (CHEM 1141)

Shawnee State University – Fall 2018

December 6, 2018

Exam # 4A

Name _____

*Please write your full name, and the exam version (4A) that you have on the scantron sheet !
(Bubble in the best answer choice for each question on the green & white scantron sheet in pencil !)*

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

- Section #:**
- ☐ 1. (Monday Lab, 10:00 AM – 12:53 PM) – Dr. Wendi Fleeman
 - ☐ 2. (Wednesday Lab, 10:00 AM – 12:53 PM)
 - ☐ 3. (Monday Lab, 2:00 PM – 4:53 PM) – Dr. Andy Napper
 - ☐ 4. (Wednesday Lab, 2:00 PM – 4:53 PM)
 - ☐ 6. (Tuesday Lab, 12:30 PM – 3:23 PM) – Dr. Daniel Finnen

Multiple Choice: _____ / **50**

Q21: _____ / **10**

Q22: _____ / **10**

Q23: _____ / **10**

Q24: _____ / **10**

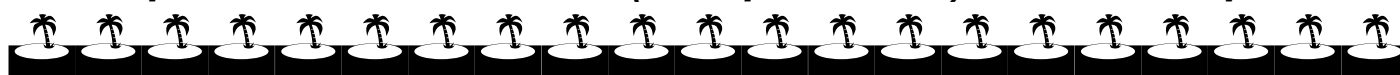
Q25: _____ / **10**

BONUS: _____

TOTAL: _____ / **100**



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



Q1. What type of **orbital** is shown below?



- A) s
 - B) p
 - C) d
 - D) f
- Q2. Which of the following atoms will be **paramagnetic**?
- A) He
 - B) Mg
 - C) O
 - D) Zn
- Q3. What period three element has the following ionization energies (all in kJ/mol)?
 $IE_1 = 1012, IE_2 = 1900, IE_3 = 2910, IE_4 = 4960, IE_5 = 6270, IE_6 = 22,200$
- A) Cl
 - B) P
 - C) S
 - D) Si
- Q4. The chemical equation corresponding to the electron affinity for nitrogen is:
- A) $N_2(g) + 6e^- \rightarrow 2N^{3-}(g)$
 - B) $N(g) \rightarrow N^+(g) + e^-$
 - C) $N(g) \rightarrow N^-(g) + e^-$
 - D) $e^- + N(g) \rightarrow N^-(g)$

Q5. What type of bond is best shown by the overlap below?



- A) sp^3
- B) sigma
- C) pi
- D) delta

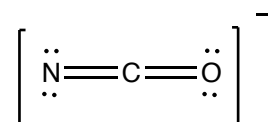
Q6. The reason that all the nitrogen-oxygen bonds in the nitrate ion are the same length is best explained in terms of nitrate having:

- A) more than one resonance structure
- B) the lowest set of formal charges possible
- C) the most electronegative element on the outside of the ion
- D) an expanded octet

Q7. Arrange the following atoms in terms of **increasing** Z_{eff} (effective nuclear charge, lowest < highest) for their valence electrons:

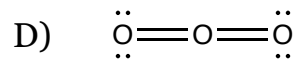
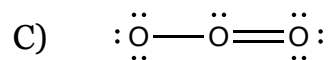
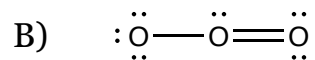
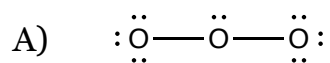
- A) $\text{Na} < \text{Si} < \text{Cl}$
- B) $\text{Kr} < \text{Pb} < \text{K}$
- C) $\text{F} < \text{N} < \text{Al}$
- D) $\text{C} < \text{Si} < \text{Al}$

Q8. What is the formal charge on the **nitrogen atom** in the cyanate ion shown below?

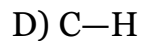
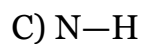
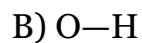
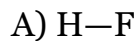


- A) -2
- B) -1
- C) 0
- D) +1

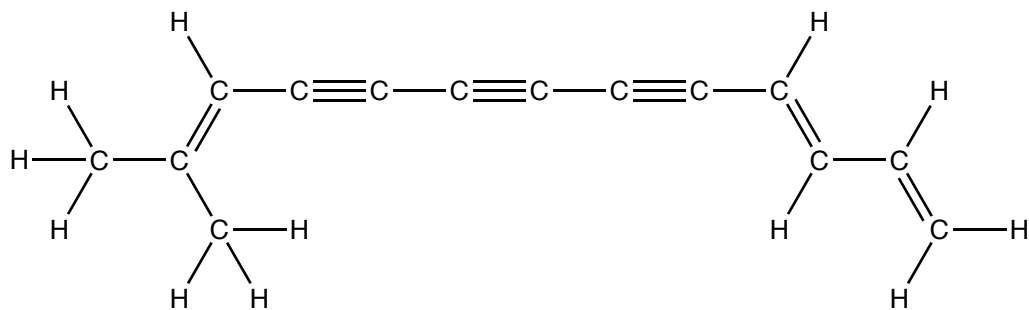
Q9. The most correct Lewis structure for the ozone (O_3) molecule is:



Q10. Which of the following bonds would be the **least polar**?



Q11. The compound shown below is found in safflowers and serves as the chemical defense against nematodes (roundworms).



The total number of pi (π) bonds in this compound is:



Q12. Each of the following sets of quantum numbers is supposed to specify an orbital.

Choose the one set of quantum numbers that **does NOT contain an error**.

A) $n = 2, l = 2, m_l = -1$

B) $n = 2, l = 2, m_l = -3$

C) $n = 3, l = 2, m_l = -3$

D) $n = 4, l = 3, m_l = +2$

Q13. Give the complete electron configuration for Mn:

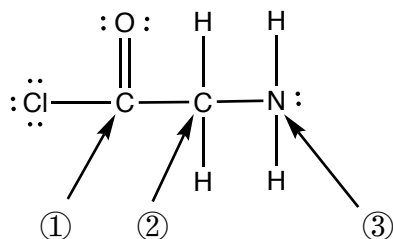
A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^5$

B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^6$

C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^5$

D) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$

Q14. Consider the molecule below. Determine the **molecular geometry** at each of the three labelled atoms.



A) 1 = trigonal planar, 2 = tetrahedral, 3 = trigonal pyramidal

B) 1 = tetrahedral, 2 = tetrahedral, 3 = tetrahedral

C) 1 = trigonal planar, 2 = tetrahedral, 3 = tetrahedral

D) 1 = tetrahedral, 2 = tetrahedral, 3 = trigonal planar

Q15. Of the following, which atom has the **largest** atomic radius?

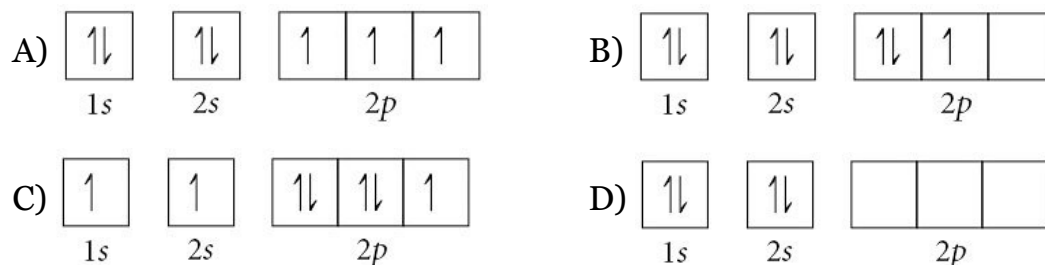
A) Li

B) F

C) Na

D) Cl

Q16. Choose the orbital diagram that represents the ground state of N.



Q17. Place the following in order of **increasing radius** (smallest < largest).

- A) $\text{Sr}^{2+} < \text{Br}^- < \text{Se}^{2-}$
B) $\text{Br}^- < \text{Sr}^{2+} < \text{Se}^{2-}$
C) $\text{Se}^{2-} < \text{Br}^- < \text{Sr}^{2+}$
D) $\text{Sr}^{2+} < \text{Se}^{2-} < \text{Br}^-$

Q18. Place the following elements in order of **decreasing electronegativity** (largest > smallest): **Sr, C, F, Sn**

- A) $\text{Sn} > \text{Sr} > \text{F} > \text{C}$
B) $\text{F} > \text{Sn} > \text{C} > \text{Sr}$
C) $\text{Sn} > \text{F} > \text{Sr} > \text{C}$
D) $\text{F} > \text{C} > \text{Sn} > \text{Sr}$

Q19. Identify the **least polar** (*most non-polar*) compound:

- A) NH_3
B) BF_3
C) CHCl_3
D) H_2O

Q20. Identify the compound with an atom that has an **incomplete octet**:

- A) ICl_5
B) CO_2
C) CCl_4
D) BeCl_2



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

All work must be show in order 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. Write **full** electron-configurations for the following species:

A) F

B) V

C) The zinc ion, Zn^{2+}

Write the **orbital diagram** for oxygen, O

Q22. Write valid Lewis structures for the following species. Be sure to include the total number of valence electrons as part of your answer.

A) NO_2^- **total #valence e⁻s:** _____

(also, show all resonance structures)

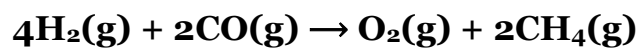
B) SO_4^{2-} **total #valence e⁻s:** _____

(also, show formal charges for each atom, and **explain** how you calculated them)

C) BF_3 **total #valence e⁻s:** _____

D) CN^- **total #valence e⁻s:** _____

Q23. Use bond energies to calculate $\Delta H^\circ_{\text{rxn}}$ for the chemical equation given below. Be sure to draw valid Lewis structures of all reactants and products as part of your answer. Clearly explain your calculation!



Q24. Fill in the blanks:

(A) Four valid quantum numbers for an electron in a 3-p orbital are:

$$n = \underline{\hspace{1cm}}, l = \underline{\hspace{1cm}}, m_l = \underline{\hspace{1cm}}, \text{ and } m_s = \underline{\hspace{1cm}}.$$

(B) Give the proper name for the following **rules/principles**:

- Electrons occupy lower-energy orbitals before filling up

higher-energy ones: _____.

- Electrons occupy different orbitals within a subshell with parallel spins,

before pairing up in the same orbital: _____.

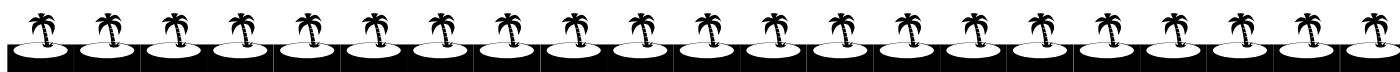
- Every electron in an atom must have a unique set of quantum

numbers: _____.

(C) A fourth period element that is an exception to the usual rules of forming electron configurations is: _____ and has an abbreviated (noble-gas core) electron configuration of: _____.

Q25. Predict the molecular geometry and polarity of SCl_4 . Your answer should include:

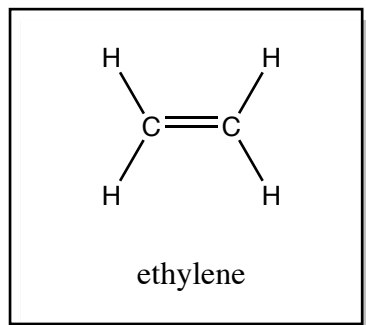
- ☐ A valid Lewis structure
- ☐ The total number of valence electrons
- ☐ A sketch of the geometry using line/dash/wedge notation
- ☐ The value of the bond angle(s) written out
- ☐ The name of the molecular geometry
- ☐ A clear explanation of why SCl_4 is polar or non-polar



Bonus Question



What type of hybrid orbitals are used on the carbon atoms in ethylene, C_2H_4 ?



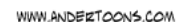
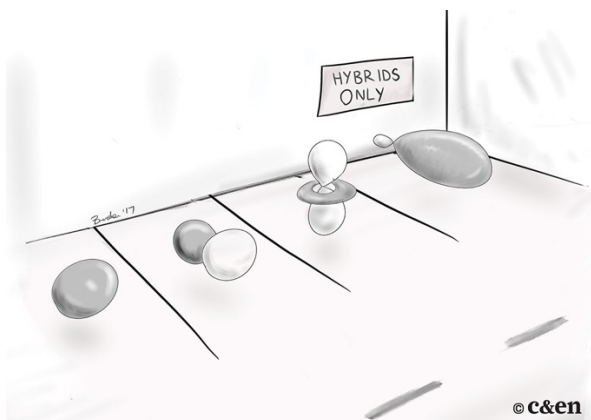
Type of hybrid orbital: _____

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Useful Information:

Bond	Bond Enthalpy (kJ/mol)	Bond	Bond Enthalpy (kJ/mol)
H—H	436.4	C—H	414
H—O	460	C—C	347
C—O	351	C=C	620
C=O	745 (average)	C≡C	812
C=O	799 (in CO ₂)	O—O	142
C≡O	1077	O=O	498.7

Periodic Table of the Elements										IIIA	IVA	VA	VIA	VIIA	VIIIA		
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.60	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba* 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [210]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra** [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [265]	109 Mt [268]	110 [269]	111 [272]	112 [277]	113 [285]	114 [285]	115 [289]	116 [289]	117 [293]	118 [293]
*	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.50	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0			
**	89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]			



"Rats! I thought lanthanoids and actanoids were gonna be giant robots or something."