

Chem 1141

Fall 2014

Exam 4A

Name: _____

Please write your full name, and which exam version (4A) you have on the scantron sheet.

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

Section #:

☐ 1. (Tuesday Lab, 4 – 6:50 pm)

☐ 2. (Thursday Lab, 4 – 6:50 pm)

☐ 3. (Monday Lab, 11 – 1:50 pm)

☐ 4. (Wednesday Lab, 11 – 1:50 pm)

☐ 5. (Wednesday Lab, 2 – 4:50 pm)

Multiple Choice: _____ /30

Q11: _____ /10

Q12: _____ /10

Q13: _____ /10

Q14: _____ /10

Q15: _____ /10

Q16: _____ /10

Q17: _____ /10

BONUS: _____ /3

TOTAL: _____ /100

Multiple Choice. [3 points each.] Record your answers to the multiple choice questions on the scantron sheet. Choose the *best* response.

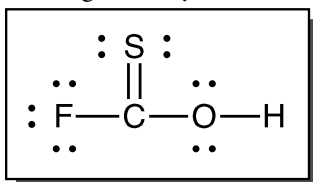
Q1. Who is generally credited with creating the first periodic table?

- a) Pauli b) Schrödinger c) Mendeleev d) Auf Bau e) Lewis

Q2. The chemical equation corresponding to the electron affinity of sodium is:

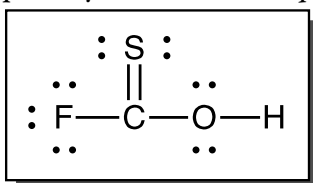
- a) $\text{Na(s)} \longrightarrow \text{Na(s)} + \text{e}^-$ b) $\text{Na(g)} \longrightarrow \text{Na}^+(\text{g}) + \text{e}^-$
 c) $\text{Na(l)} \longrightarrow \text{Na}^-(\text{g}) + \text{e}^-$ d) $\text{Na(g)} + \text{e}^- \longrightarrow \text{Na}^-(\text{g})$
 e) $\text{Na}^-(\text{g}) \longrightarrow \text{Na(g)} + \text{e}^-$

Q3. The molecular geometry about the oxygen atom in the following Lewis structure is predicted by VSEPR to be:



- a) linear b) trigonal planar c) bent d) see-saw e) tetrahedral

Q4. What type of hybrid orbital is required for the carbon atom in the following Lewis structure?



- a) sp b) sp² c) sp³ d) sp³d e) sp³d²

Q5. Which of the following bonds is non-polar covalent?

- a) F—F b) H—Cl c) Li—Br d) Se—Br e) Na—Cl

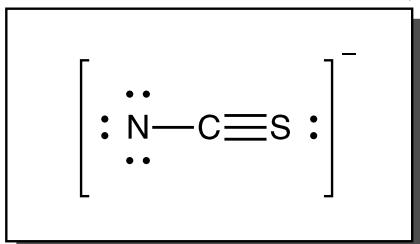
Q6. Which of these compounds does not follow the octet rule?

- a) NF₃ b) CF₄ c) AsBr₃ d) PF₅ e) Cl₂

Q7. The H—N—H bond angle in NH₃ is:

- a) 180° b) 120° c) slightly more than 120°
 d) 109.5° e) slightly less than 109.5°

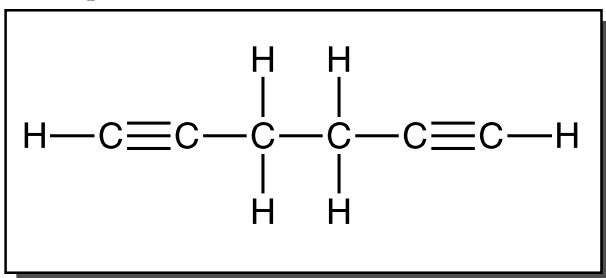
Q8. One possible Lewis structure for the thiocyanate ion, SCN⁻ is:



The formal charge on the **nitrogen** atom is:

- a) 2- b) 1- c) 0 d) 1+ e) 2+

Q9. The number of pi bonds in the molecule below is:



a) 2

b) 4

c) 6

d) 10

e) 15

Q10. Which of the following has the largest atomic radius?

a) F

b) N

c) O

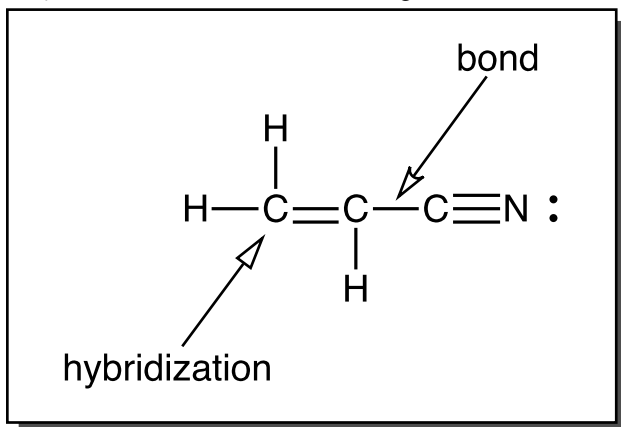
d) S

e) P

Short Response.

Show all work to receive credit. Be sure to write complete sentences in your explanations!

Q11. [10 pts.] Acrylonitrile is used as the starting material for manufacturing acrylic fibers. Its Lewis structure is:



a) How many sigma and pi bonds are there in this molecule? _____ σ , _____ π

b) For the **bond** indicated above, list the types of atomic or hybrid orbitals that are overlapping to form the bond: _____ (left carbon atom) and _____ (right carbon atom).

c) The **bond** indicated in part (b) is an example of a sigma or a pi bond? _____ (state which)

d) What is the orbital **hybridization** of the **far left** carbon atom? _____

e) Draw the orbital diagram for the carbon atom in part (d).

Q12. [10 pts.] a) Rank the following bonds in order of **increasing** bond length:

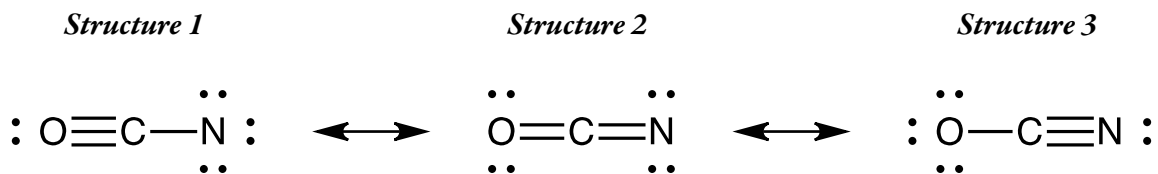


b) Draw the Lewis dot structure for a nitrogen atom:

c) What angle do **sp** hybrid orbitals make with one another? _____

d) What is the tetrahedral bond angle? _____

Q13. [10 pts.] Determine the formal charge for each atom in the following three resonance structures for the $[\text{OCN}]^-$ anion. Explain which one of these resonance structures is the most favored.



Formal Charges:

O_____

C _____

N_____

Formal Charges:

O_____

C_____

N_____

Formal Charges:

O _____

C_____

N_____

Most favored structure: _____

Explanation:

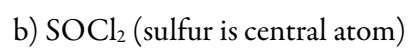
Q14. [10 pts.] Predict the molecular geometry and polarity of SF₄. Your answer should include:

- ☐ A valid Lewis structure
- ☐ A sketch of the geometry using line/dash/wedge notation
- ☐ The value of the bond angle(s) written out
- ☐ A clear explanation of why SF₄ is polar or non-polar

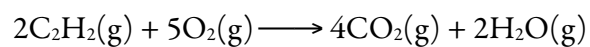
Q15. [10 pts.] Answer **two** of the following. Clearly indicate which two you want graded!

- a) What is meant by the term: effective nuclear charge, Z_{eff} ?
Explain the trend in Z_{eff} moving across the rows of the periodic table.
- b) What is ionization energy?
Explain the trend in ionization energy moving across the rows of the periodic table.
- c) How does the size of an ion (cation/anion) compare to the size of the neutral atom from which it is formed? Explain your answer.
- d) Write out the ground-state electron configuration for a copper(I) **ion**.

Q16. [10 pts.] Draw Lewis structures for the following compounds:



Q17. [10 pts.] Use bond energies to estimate $\Delta H^\circ_{\text{rxn}}$ for the combustion of two moles of acetylene:



Hint: Drawing the Lewis structures for each will help determine what types of bond are formed/broken.

BONUS: Is FBH_2 (boron is the central atom) polar or non-polar? Explain.

Periodic Table

1 IA																	18 VIIIA
1 H 1.01	2 He 4.00																
3 Li 6.94	4 Be 9.01																
11 Na 22.99	12 Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	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 39.1	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	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 74.92	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 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.9	54 Xe 131.29
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	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	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac^ (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (271)	111 Rg (272)							

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 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa (231)	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)	103 Lr (260)

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

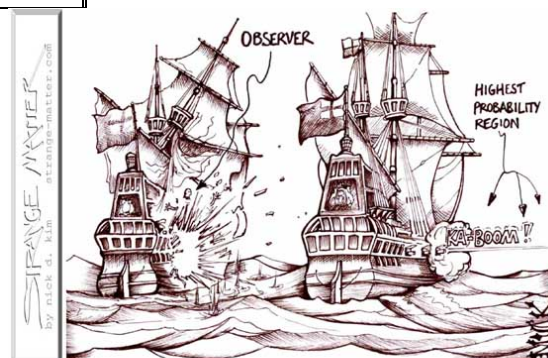


ILLUSTRATION FROM THE TEXTBOOK
"CANNON-BALLS: A QUANTUM MECHANICAL TREATMENT."