

Name: Answer Key

Last

First

MI

Chemistry 233-002 Exam 1

Fall 2017

Dr. J. Osbourn

Instructions: The first 16 questions of this exam should be answered on the provided Scantron. You must use a pencil for filling in the Scantron sheet. Ensure all erasures are complete. Any questions left blank will be marked incorrect. Any question with multiple answers selected will be marked incorrect. Answer the remaining questions on the exam itself. Show all work and provide complete explanations.

Please write your name on:

- The first page (Exam Cover Page)
- The second page (Grading Page)
- The Scantron Sheet – Circle your Last Name

Please bubble in your WVU Student ID Number on your Scantron sheet.

The Periodic Table

1 IA																				18 VIIIA		
1 H 1.01	2 He 4.00											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18					
3 Li 6.94	4 Be 9.01											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95					
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 39.1	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)

Exams will be returned by placing them alphabetically on the table at the front of Clark 101. Your grade will not be visible as it is on the second page. If, however, you have a privacy concern, check the box below and all of your exams will be held back so that you can pick them up privately.

Hold Back My Exams

Please do not rip off this cover sheet

Name: _____
Last First MI

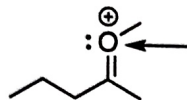
Grading Page (Exam 1):

Page	Points Possible	Points Earned
Multiple Choice (3-6)	32	
7	17	
8	25	
9	26	
TOTAL	100	

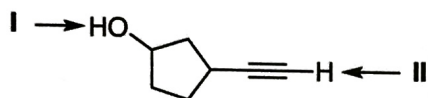
Multiple Choice

Choose the one best answer for each of the following questions. Using a pencil, record this answer on the provided Scantron sheet. (2 points each)

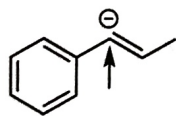
1. What is the hybridization of the indicated atom in the structure below?



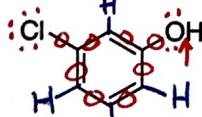
- a. sp
 - b. s
 - c. sp²
 - d. p
 - e. sp³
2. The approximate pKa values of protons I and II are 16 and 25, respectively.



- a. 16, 35
 - b. 11, 35
 - c. 16, 25
 - d. 11, 45
 - e. 12, 25
3. How many hydrogen atoms are present on the indicated carbon atom?



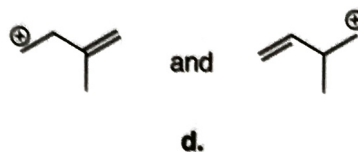
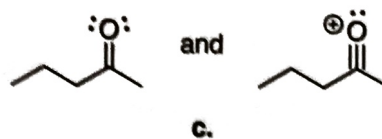
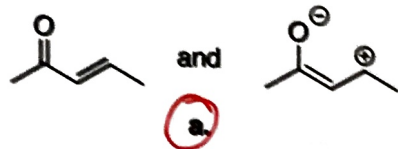
- a. Zero
 - b. One
 - c. Two
 - d. Three
4. The molecule shown below has 13 σ-bonds and 5 lone electron pairs.



- a. 5, 5
- b. 8, 2
- c. 8, 5
- d. 5, 5
- e. 2, 2

} non of the choices contain the correct answer.

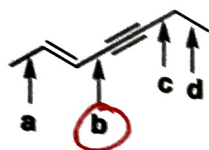
5. Which of the following pairs of structures represent resonance structures?



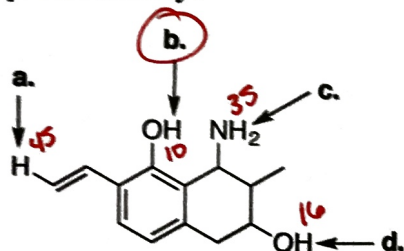
more than one of the pairs represent resonance structures

e.

6. Which one of the indicated C-C single bonds is the shortest?

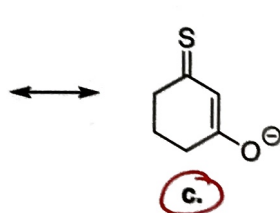
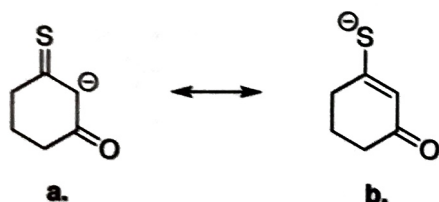


7. If the molecule below were reacted with a strong base, which proton would the base react with preferentially?



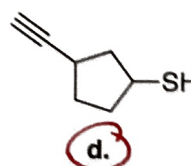
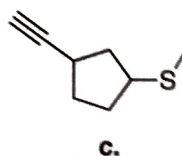
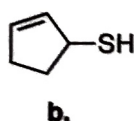
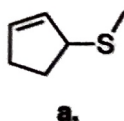
Base will react with the most acidic H

8. Consider the three resonance structures shown below. Which would be the major contributor to the resonance hybrid?

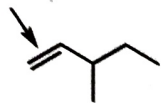


\ominus on most e⁻ neg atom

9. Which molecule below contains both a thiol and an alkyne functional group?

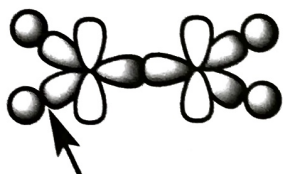


10. What type of orbital overlap is present in the indicated bond?



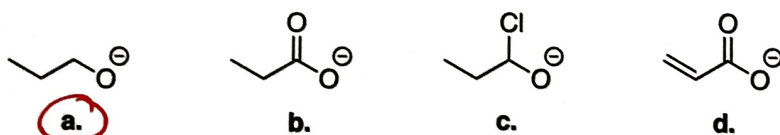
- a. Csp^3-Csp^3
- b. Csp^2-Csp^2
- c. Csp^2-Csp^2 and $Cp-Cp$**
- d. Csp^2-Csp^3
- e. Csp^2-Csp^3 and $Cp-Cp$

11. Using the orbital picture shown below, determine the type of orbital overlap that is present in the indicated σ -bond.

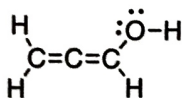


- a. $p-sp^3$
- b. $s-sp^2$**
- c. $s-sp^3$
- d. $p-sp^2$
- e. sp^3-sp^2

12. Which compound below would you expect to be the strongest base?

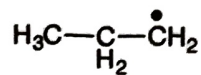


13. Evaluate the legitimacy of the Lewis structure shown below.



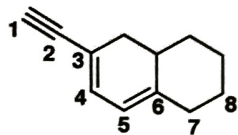
- a. The structure is legitimate.**
- b. The structure is not legitimate because the oxygen does not have an octet.
- c. The structure is not legitimate because the formal charges are not shown.
- d. The structure is not legitimate because the middle carbon lacks an octet.
- e. The structure is not legitimate because the leftmost carbon is missing a lone pair.

14. Consider the structure shown below, which is called a free radical and contains an unpaired electron on the carbon. What is the formal charge on the carbon atom?



- a. 0
- b. +1
- c. -1
- d. +2

15. Which two carbon atoms participate in the longest C-C σ -bond?

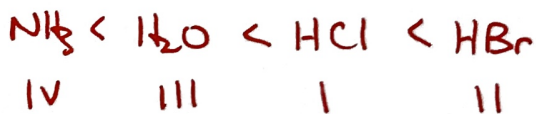


- a. C1-C2
- b. C2-C3
- c. C3-C4
- d. C6-C7
- e. C7-C8

16. Rank the compounds below in order of increasing acidity.



- a. IV < III < I < II
- b. III < IV < I < II
- c. III < IV < II < I
- d. ~~IV < III < I < II~~
- e. I < II < IV < III



Completion Section

Answer the remaining questions in the spaces provided. Show all work and provide complete explanations.

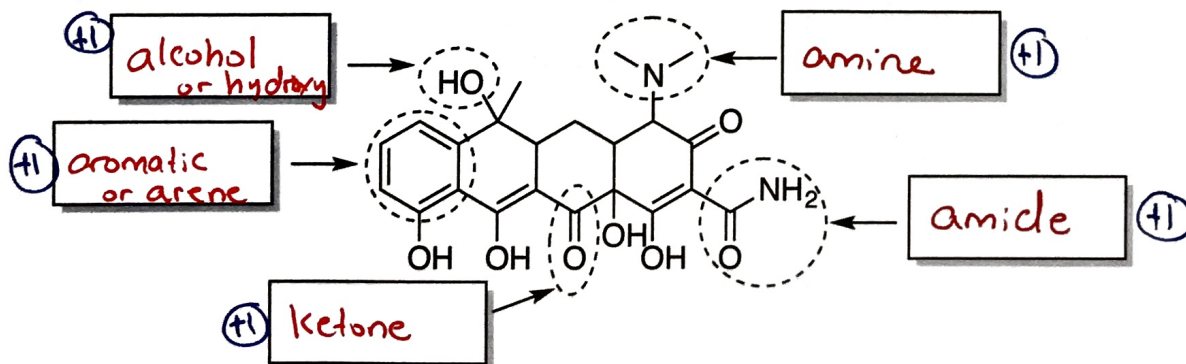
- (6) 17. Provide the formula (C_xH_y), name, and skeletal (bond-line) structure for the straight chain alkanes containing 4 carbon atoms and 6 carbon atoms. (3 points each)

#C	Formula	Name	Skeletal Structure
4	C_4H_{10} (+1)	Butane (+1)	(+1)
6	C_6H_{14} (+1)	Hexane (+1)	(+1)

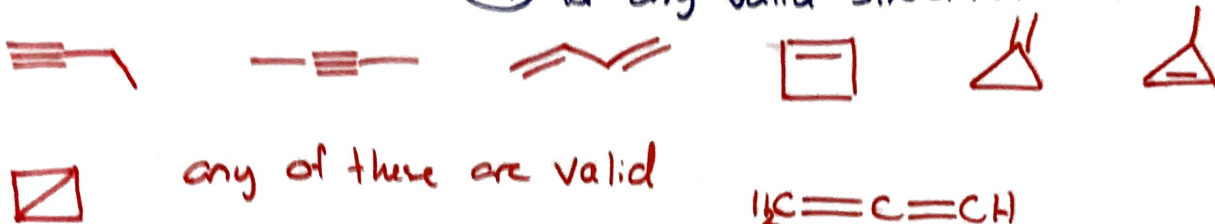
- (6) 18. For each compound shown below, complete the table by drawing the missing skeletal or condensed structure. (2 points each)

	Condensed Structure	Skeletal Structure
a	$(CH_3)_2CH(CH_2)_4OH$ (+2)	
b	$CH_3CH_2CHCl(CH_2)_2CO_2H$	
c	$CH_3CH=CHCH_2CH(CH_3)CH_2Br$ (+2) or $CH_3CH=CHCH_2CH(CH_3)CH_2Br$	

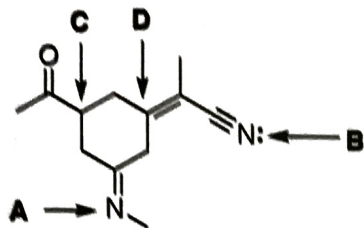
- (5) 19. Below is the structure of tetracycline, an antibiotic used to treat a number of infections with skin infections being the most common. Identify the five indicated functional groups in the molecule. (5 points)



(-1) 20. Draw a valid uncharged Lewis structure or skeletal structure for a compound with the molecular formula C_4H_6 . (4 points) (+4) for any valid structure. No partial credit.

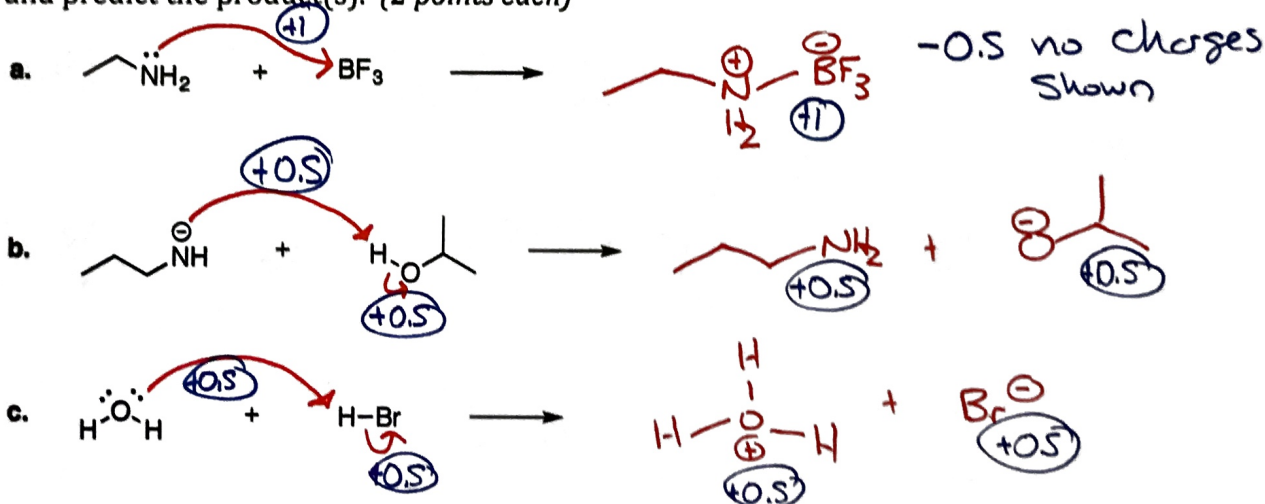


(12) 21. Use the molecule shown below to answer the following questions. (2 points each)

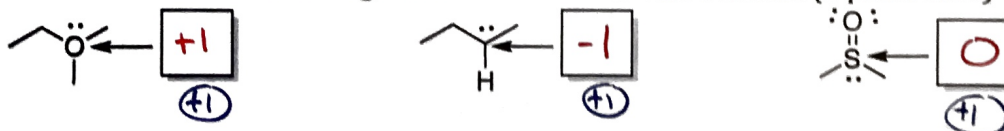


- What is the hybridization of nitrogen A?
 sp^2 (+2) \rightarrow has a lone pair
- In what orbital does the lone pair on nitrogen B reside?
 sp (+2)
- What is the geometry at carbon C?
tetrahedral (+2)
- What is the approximate bond angle at carbon D?
 120° (+2)
- How many total π -bonds are present in the molecule?
5 (+2)
- What is the molecular formula of the molecule?
 $C_{12}H_{16}N_2O$ (+2)

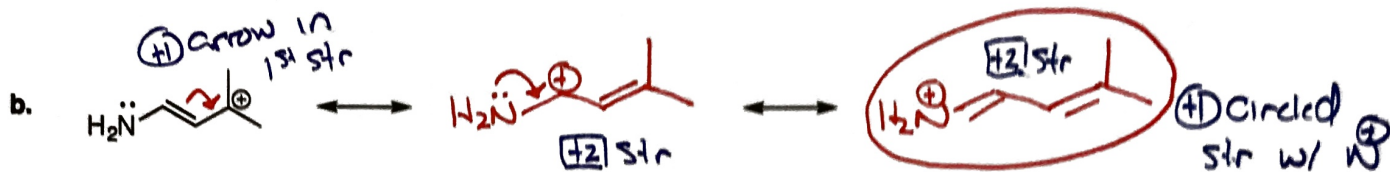
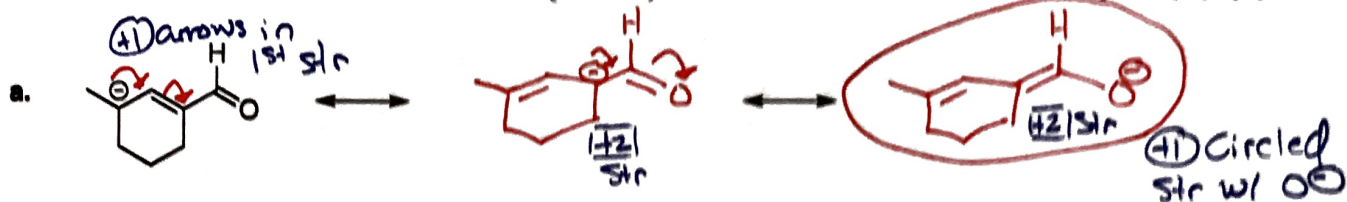
(6) 22. For each reaction shown below, draw in curved arrows in the reactants to show electron flow and predict the product(s). (2 points each)



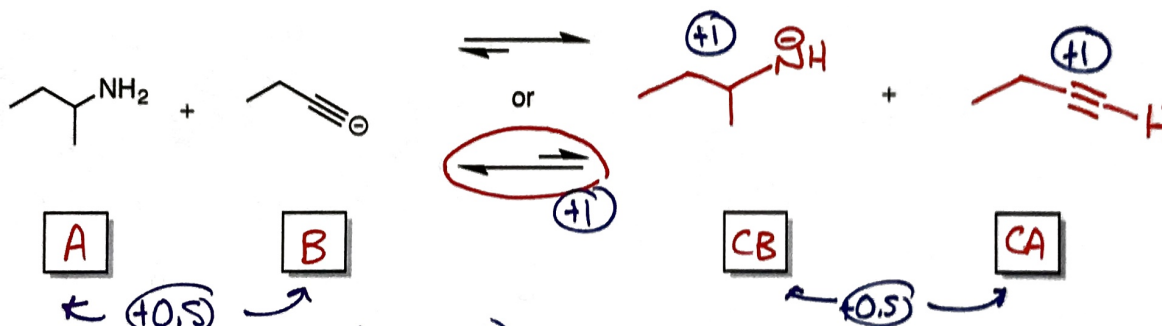
(3) 23. Determine the formal charge on each of the indicated atoms. (1 point each)



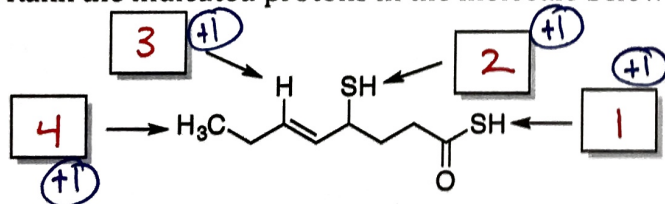
- (12) 24. For each structure shown below, complete the following: (12 points)
- Draw all relevant resonance structures. (2 pts each structure)
 - Use curved arrows to show electron flow. (1 pt)
 - Circle the "best" resonance structure (the major contributor to the resonance hybrid). (1 pt)



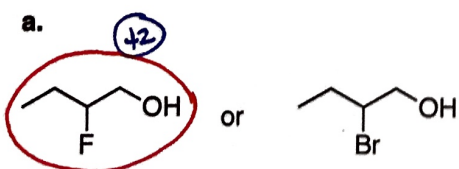
- (4) 25. For the acid/base reaction below: 1. Draw the correct products; 2. Label the acid (A), base (B), conjugate acid (CA), and conjugate base (CB); 3. Circle the set of equilibrium arrows that best represents the direction in which the reaction lies. (4 points)



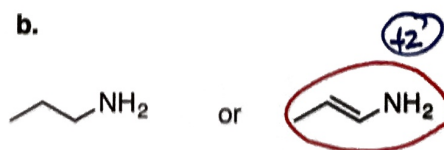
- (4) 26. Rank the indicated protons in the molecule below from most acidic (1) to least acidic (4). (2 pts)




- (6) 27. For each pair, circle the molecule that is more acidic and provide a very brief explanation for your choice. (3 points each)



F is more e- neg +
is more inductively (+) explanation
withdrawing



The Conjugate base 
is resonance stabilized
(+) explanation