

Answer Key

Chemistry 233-001/002 Exam 1 – Version A

Fall 2019

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Instructions: Answer the first 14 questions of this exam using the bubble sheet attached to the end of this exam booklet. You may detach this sheet if you wish. Answer the remaining questions directly on this exam. Show all work and provide complete explanations.

The Periodic Table

IA	1	2											13	14	15	16	17	VIII A
	H																	He
	1.01	IIA																4.00
	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
	6.94	9.01											10.81	12.01	14.01	16.00	19.00	20.18
	11	12	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Na	Mg											Al	Si	P	S	Cl	Ar
	22.99	24.31	III B	IV B	V B	VIB	VII B	VIII B			IB	II B	26.98	28.09	30.97	32.07	35.45	39.95
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
	39.1	40.08	44.96	47.88	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.39	69.72	72.61	74.92	78.96	79.90	83.80
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
	85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.6	126.9	131.29
	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
	132.9	137.3	138.9	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209	(209)	(210)	(222)
	87	88	89	104	105	106	107	108	109	110	111							
	Fr	Ra	Ac^	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							
	(223)	(226)	(227)	(261)	(262)	(263)	(264)	(265)	(268)	(271)	(272)							

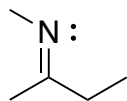
	58	59	60	61	62	63	64	65	66	67	68	69	70	71
*	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	140.1	140.9	144.2	(145)	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
^	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	232.0	(231)	238.0	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

Multiple-Choice

Choose the best answer for each of the following questions. Record each answer on the attached bubble sheet. **Ensure you completely bubble in your answers.** (2 points each)

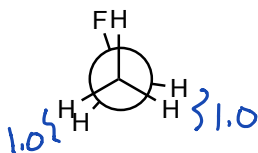
1. In what orbital does the nitrogen lone pair reside in the following molecule?

- a. sp^2
- b. sp
- c. sp^3
- d. p
- e. none of the above



2. What is the energy cost associated with the H/F eclipse in the following conformation? The relative energy (E_{rel}) of the conformation is 3.3 kcal/mol.

- a. 0.3 kcal/mol
- b. 1.0 kcal/mol
- c. 1.3 kcal/mol
- d. 1.5 kcal/mol

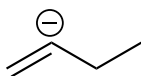


$$1.0 + 1.0 + x = 3.3$$

$$x = 1.3$$

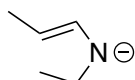
3. How many hydrogen are bonded to the carbon bearing the negative charge in the following structure?

- a. zero
- b. one
- c. two
- d. three
- e. four

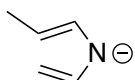


4. In the following group of compounds, III is the strongest base while II is the weakest base.

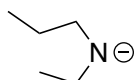
- a. I, III
- b. II, I
- c. III, II
- d. III, I
- e. II, III



I



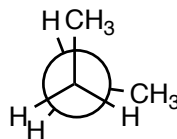
II



III

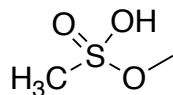
5. What is the CH_3/CH_3 dihedral angle in the following Newman projection?

- a. 90°
- b. 120°
- c. 60°
- d. 45°
- e. 180°



6. What is the formal charge on sulfur in the following molecule?

- a. zero
- b. +1**
- c. +2
- d. -1
- e. -2

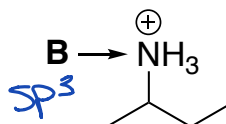
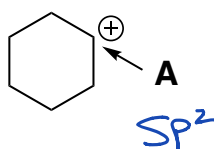


$$6 - 5 - 0 = +1$$

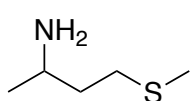
bonds lone pair e⁻

7. What is the hybridization of atoms **A** and **B**?

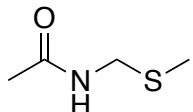
- a. A = sp²; B = sp³**
- b. A = sp³; B = sp²
- c. A = sp²; B = sp²
- d. A = sp³; B = sp³
- e. None of the above



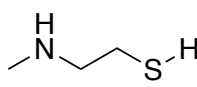
8. Which of the following contains an **amide** and a **thiol** functional group?



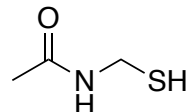
a



b

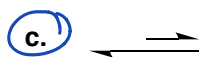
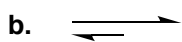
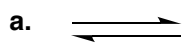
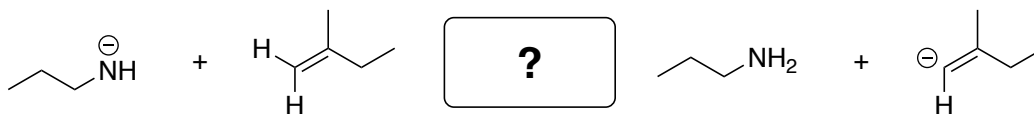


c



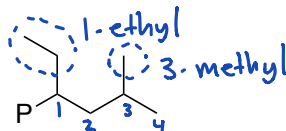
d

9. Which arrow best describes the following acid/base reaction?

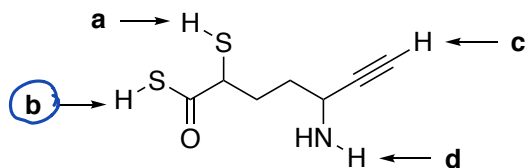


10. How would the following complex substituent be named when attached to a parent (P) chain?

- a. 5-methylhexyl
- b. 1-ethyl-3-methylbutyl**
- c. 3-(5-methylethyl)
- d. 1-ethyl-2-isopropylethyl

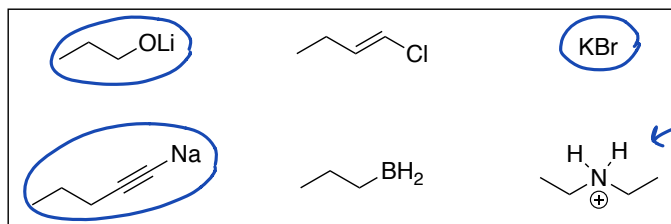


11. What is the most acidic proton in the following molecule?



12. How many ionic compounds are present in the box shown below?

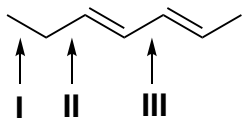
- a. zero
- b. one
- c. two
- d. three**
- e. four



can also be selected

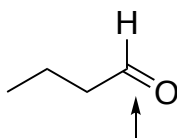
13. In the following molecule, III is the strongest C-C single bond and I is the weakest C-C single bond.

- a. I, II
- b. II, I
- c. I, III
- d. III, I**
- e. III, II



14. What is the orbital overlap involved in the following bond?

- a. Cp-Op
- b. Csp²-Osp²
- c. Csp²-Osp² & Cp-Op**
- d. Csp²-Osp & Cp-Op
- e. None of the above

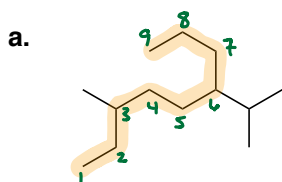


*either answer
Correct*

Completion Section

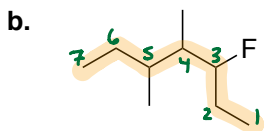
Answer the remaining questions directly on the exam itself. Please write neatly and darkly as your answers will be scanned.

(4) 15. Write the IUPAC name for each molecule shown below. (3 points each)

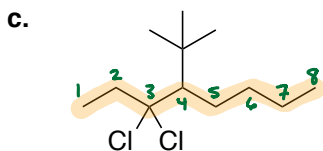


6-isopropyl-3-methylnonane
 (+1) (+1) (+1)

-1 wrong #
 -1 wrong abc order of substituents
 -1 wrong parent chain

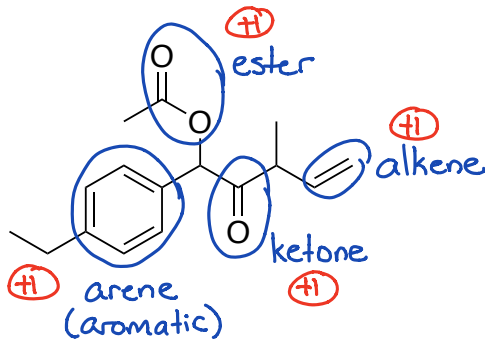


3-fluoro-4,5-dimethylheptane
 (+1) (+0.5) (+0.5) (+1)



+tert-butyl or butyl
 must have 3,3
 4-tert-butyl-3,3-dichlorooctane
 (+1) (+0.5) (+0.5) (+1)

(4) 16. Circle and identify the functional groups in the following molecule. (4 points)



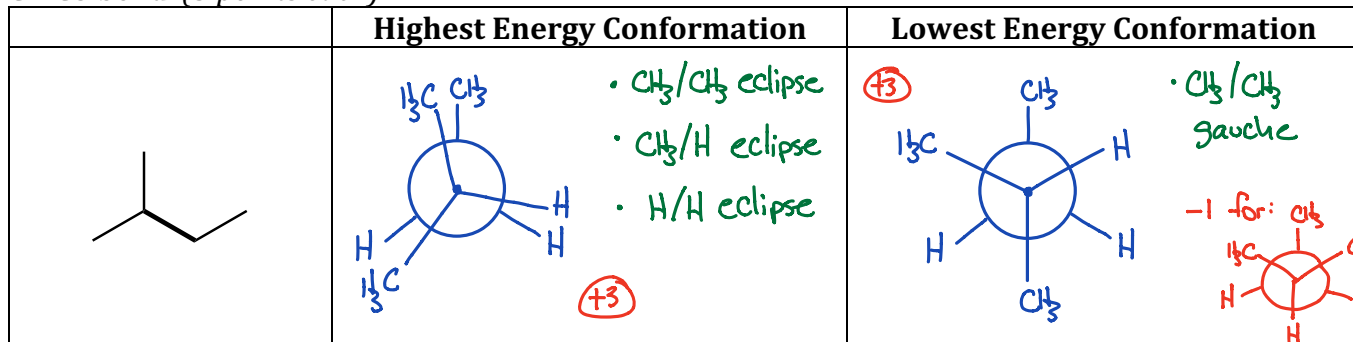
(-0.5) for spelling mistake

(4) 17. For each of the following, use the provide template to complete the Newman projection or 3D structure. (2 points each)

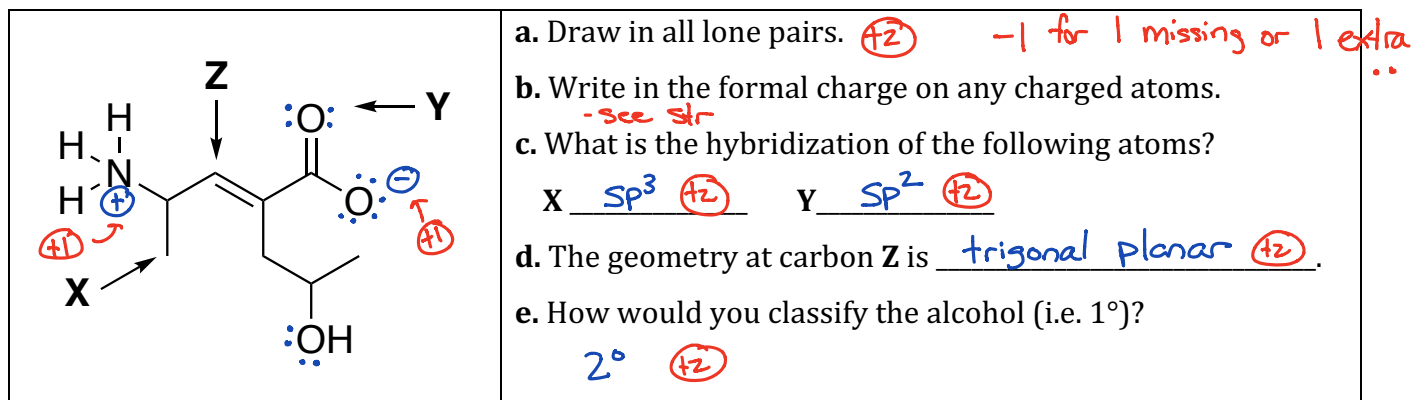
Newman Projection	3D Structure	Newman Projection	3D Structure
<p>a.</p> <p>template (+2)</p>			<p>b.</p> <p>template (+2)</p>

← No partial credit →

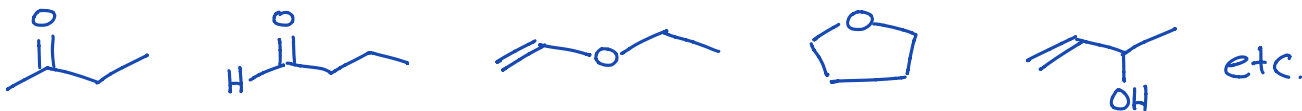
- (6) 18. Draw the highest energy and lowest energy conformations of 2-methylbutane viewing along the C2-C3 bond. (3 points each)



- (12) 19. Use the molecule shown below to answer the following questions. Note: All appropriate hydrogen are drawn in on non-carbon atoms! (2 points each)



- (4) 20. Draw a valid Lewis or skeletal structure for C₄H₈O. (4 points)

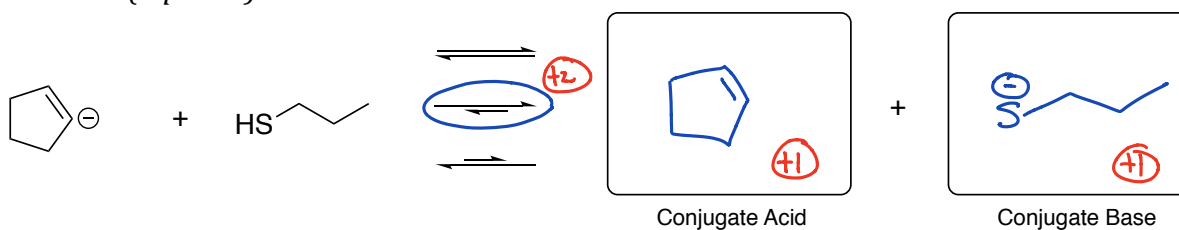


A valid structure will contain 4C, 1Oxygen, + a π-bond or a ring.

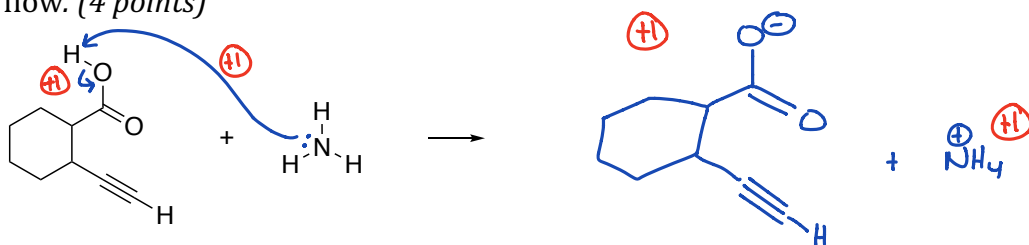
(+4) valid neutral structure

(-2) if structure is valid but it doesn't represent the correct formula (C₄H₈O)

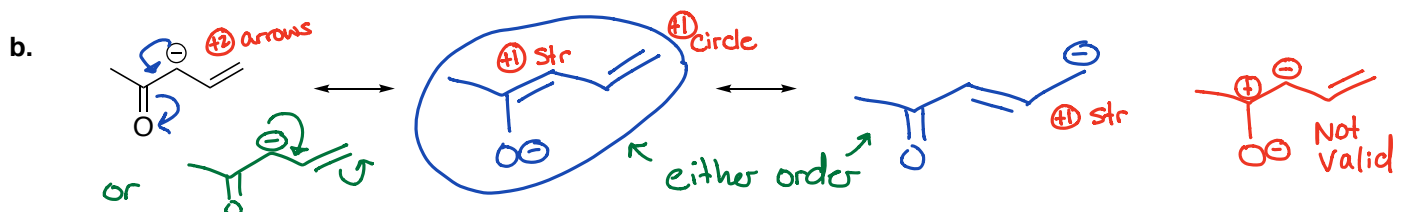
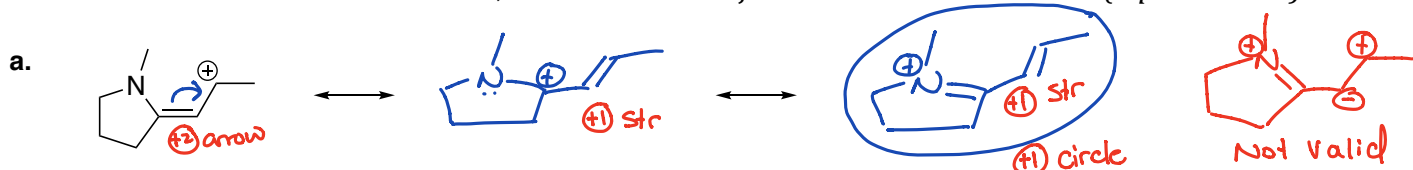
- (4) 21. Complete the acid/base reaction shown below by drawing the conjugate acid and conjugate base in the appropriate spaces. Then circle the equilibrium arrow that best represents the direction of the reaction. (4 points)



(4) 22. Draw the products of the following acid/base reaction and include curved arrows to show electron flow. (4 points)



(10) 23. For each of the following: I. Draw the additional resonance structures; II. Add curved arrows on the first structure to show electron flow; III. Circle the major resonance contributor. (5 points each)



(6) 24. Circle the stronger acid in each pair and provide a very brief explanation. (3 pts each)

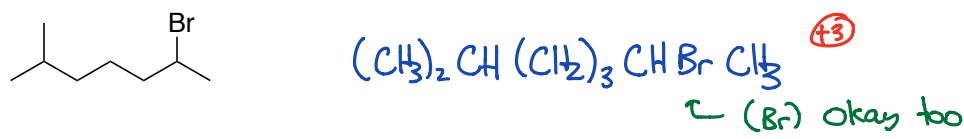


F is more e⁻ neg + better stabilizes conjugate base by the inductive effect

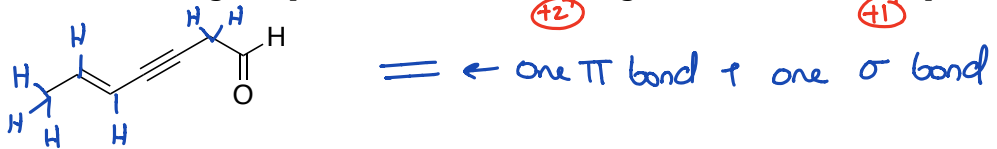


Conjugate base is resonance stabilized

(3) 25. Convert the following skeletal structure to a condensed structure. (3 points)



(3) 26. The following compound contains 15 sigma bonds and 4 pi bonds. (3 points)



(3) 27. Draw three valid isomers of heptane. (3 points)

