

Seat No. \_\_\_\_\_

LAST NAME WST

FIRST NAME \_\_\_\_\_

There are 8 pages to this exam. Check to make sure you have a complete exam.

PLEASE ALSO PRINT YOUR NAME ON THE TOP OF  
THE BACK OF THE LAST PAGE OF THE EXAM

**CHEMISTRY 331**

**EXAM I**

Spring 2009 (1/30/09)

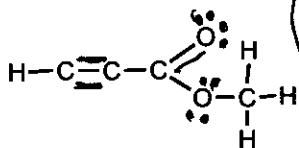
- |                    |       |
|--------------------|-------|
| I. (18 points)     | _____ |
| II. (17 points)    | _____ |
| III. (6 points)    | _____ |
| IV. (9 points)     | _____ |
| V. (10 points)     | _____ |
| VI. (14 points)    | _____ |
| VII. (14 points)   | _____ |
| VIII. (12 points)  | ===== |
| TOTAL (100 points) | _____ |



## II. (17 points)

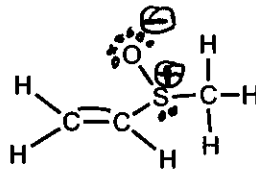
A. (8 points) Partial Lewis (e-dot) structures showing all  $\sigma$ -bonds are given below (both molecules are overall neutral). Complete the structures with lines for bonds and dots for nonbonding electrons. Show formal charges if appropriate. All structures follow the octet rule.

1.



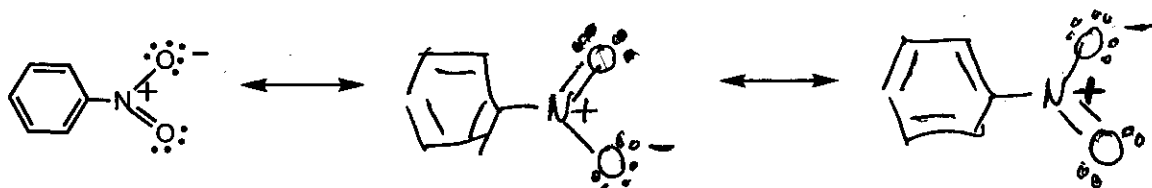
0 errors = 4 pts  
1 error = 2 pts  
2 errors = 0 pts

2.

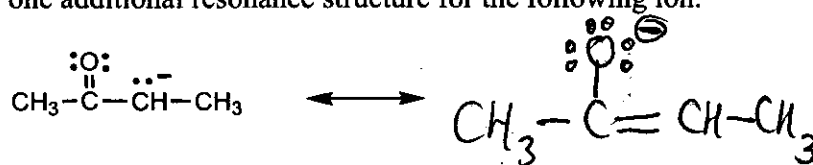


3 pts for correct  
10 e<sup>-</sup>  
1 pt for correct charges

B. (6 points) Draw two additional resonance structures for the following molecule.

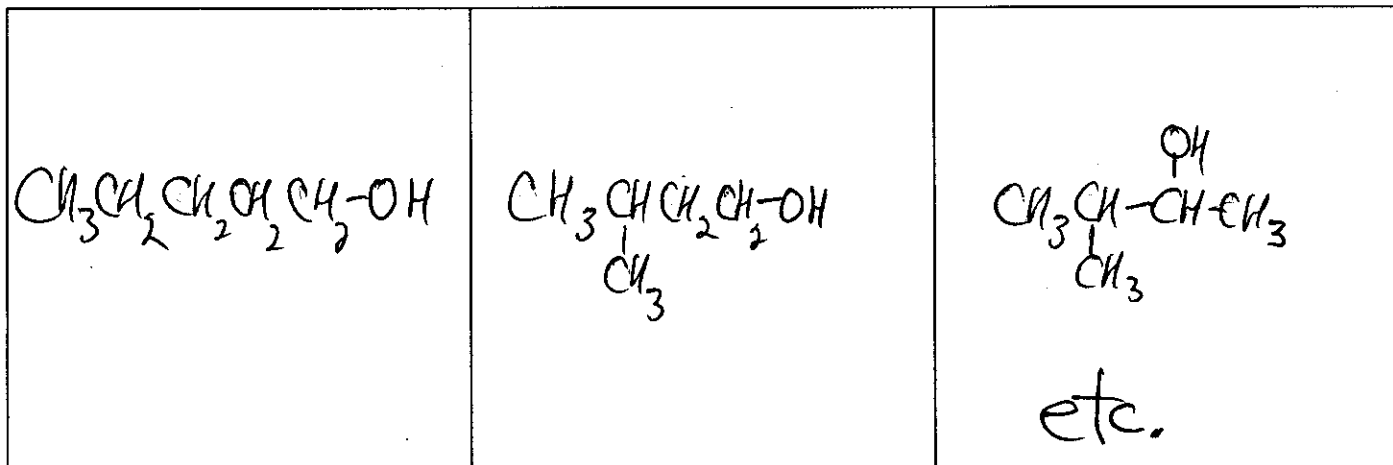


C. (3 points) Draw one additional resonance structure for the following ion.



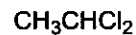
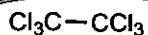
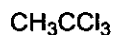
1A																	8A
1	2A															2	
H	He															He	
1.01																4.00	
3	4	8B										5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
6.94	9.01											10.8	12.0	14.0	16.0	19.0	20.2
11	12	3B	4B	5B	6B	7B	8	9	10	11B	12B	13	14	15	16	17	18
Na	Mg	3	4	5	6	7	8	9	10	11	12	Al	Si	P	S	Cl	Ar
23.0	24.3											27.0	28.1	31.0	32.1	35.4	39.9
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	40.1	45.0	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	69.7	72.6	74.9	79.0	79.9	83.8
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
85.5	87.6	88.9	91.2	92.9	95.9	(98)	101	103	106	108	112	115	119	122	128	127	131
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
133	137	139	178	181	184	186	190	192	195	197	201	204	207	209	(209)	(210)	(222)
87	88	89	104	105	106	107	108	109									
Fr	Ra	Ac	Rf	Ha	Unh	Uns	Uno	Une									
(223)	226	227	(261)	(262)	(263)	(262)	(265)	(266)									

III. (6 points) In the boxes below draw three different isomeric alcohols that have the molecular formula  $C_5H_{12}O$  (there are more than six of these). Draw these alcohols using condensed structures or any other standard symbolism used for writing structures.

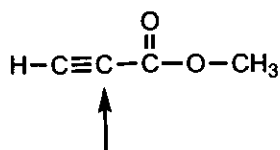


IV. (9 points)

A. (3 points) Circle the compound with the smallest dipole moment.



B. (6 points) Give the hybridization and approximate C-Z-C bond angle for the atoms marked with an arrow.



hybridization

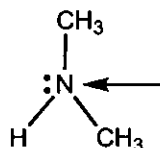
$sp$

hybridization

approximate C-C-C bond angle

$180^\circ$

approximate C-N-C bond angle

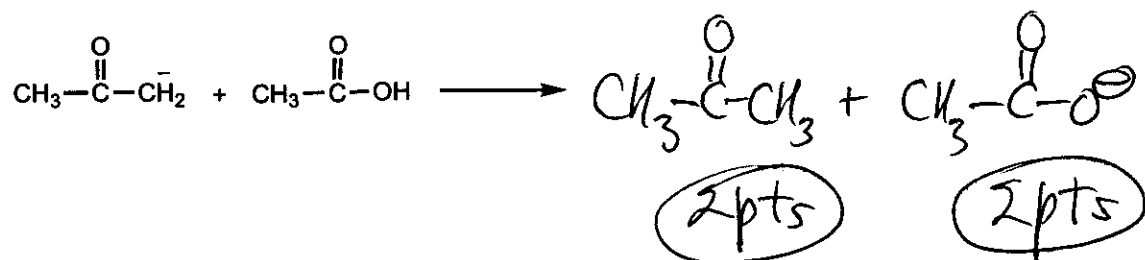


$sp^3$

$109^\circ$

V. (10 points)

A. (6 points) Draw the products of the following reaction.

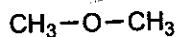
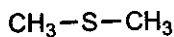


Acetic acid ( $\text{CH}_3\text{COOH}$ ) has a  $\text{pK}_a$  of 4.76 and acetone ( $\text{CH}_3\text{COCH}_3$ ) has a  $\text{pK}_a$  of 19.3. Will the reaction shown proceed in the direction indicated?

(circle one) Yes    No

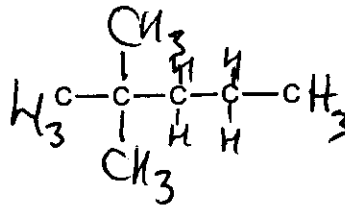
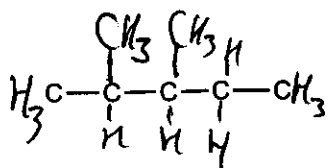
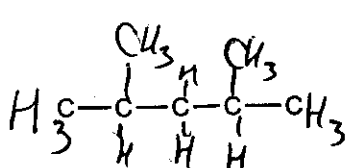
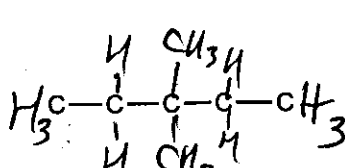
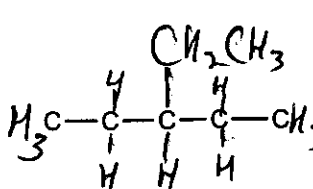
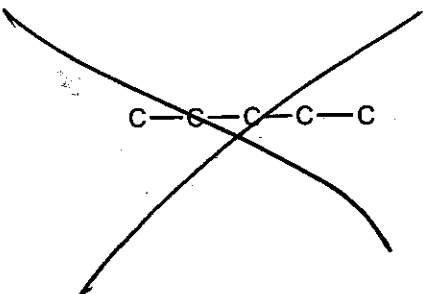
2pts

B. (4points) Circle the following reagents which are likely to act as Lewis bases (4 points for no errors; 2 points for one error; 0 points for 2 or more errors)



## VI. (14 points)

A. Complete the structures below to show ALL constitutional isomers (note: constitutional isomers only, no stereoisomers) of  $C_7H_{16}$  whose longest chain of atoms has *five* carbon atoms. **Be sure to show all hydrogens.** There are no more than 6 correct constitutional isomers and there may be fewer. **Cross out any boxes that are not used.** Points will be deducted for duplicate or incorrect structures.

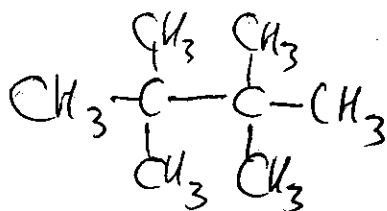
	
	
	

+2 pts for one correct structure  
 +3 pts for other correct structures  
 -2 pts for duplicate or incorrect structure  
 -2 pts if Hs are not shown  
 from total points

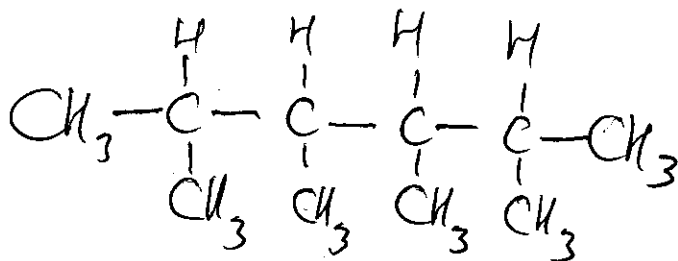


## VIII. (12 points)

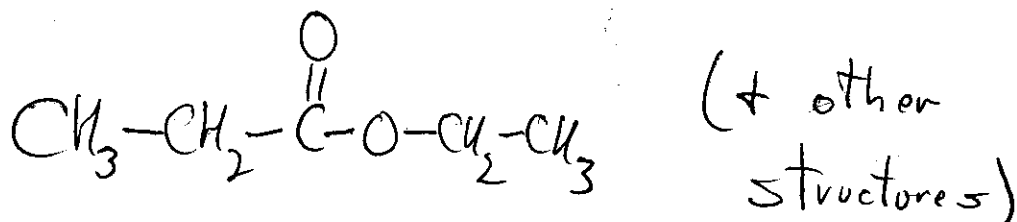
A. (3 points) Draw the structure of an isomer with the molecular formula  $C_8H_{18}$  that has only  $1^\circ$  hydrogens.



B. (3 points) Draw the structure of an isomer with the molecular formula  $C_{10}H_{22}$  that has only  $1^\circ$  and  $3^\circ$  hydrogens



C. (3 points) Draw the structure of an ester that has the molecular formula  $C_5H_{10}O_2$ .



D. (3 points) Circle the alkane that should have the highest boiling point.

