NAME:_____ Section:_____ Student Number:_____

Spring 2020 **Chemistry 2500 Midterm #1A** ____/ 70 marks

INSTRUCTIONS:

1) Please read over the test carefully before beginning. You should have 7 pages of questions and a data/periodic table sheet.
2) Unless otherwise stated in the question, explain all of your answers fully. Use diagrams where appropriate. When invoking any argument based on resonance, you must draw all relevant resonance structures.
3) ALL structures must be drawn showing lone pairs, non-zero formal charges and reasonable bond angles – regardless of whether they are expanded, condensed or line-bond. Marks will be deducted for poorly drawn structures.
4) Marks will be deducted for incorrect information added to an otherwise correct answer.
5) If your work is not legible, it will be given a mark of zero.
6) Calculators are not allowed. You are not permitted to have any electronic devices with you during the exam unless authorized by the instructor.
7) You may use a molecular model kit.
8) You have 2 hours to complete this test.

Confidentiality Agreement:

I agree not to discuss (or in any other way divulge) the contents of this exam until after 8:00 pm Mountain Time on Thursday, February 13th, 2020. I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/70 on this exam and removal of the "overwrite midterm mark with final exam mark" option for my grade in this course; the maximum punishment would include expulsion from this university.

Signature: _____ Date: _____

Course: CHEM 2500 (Organic Chemistry I)
Semester: Spring 2020
The University of Lethbridge

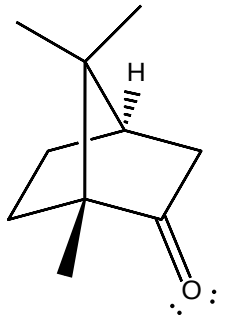
Question Breakdown

Q1	/ 7
Q2	/ 5
Q3	/ 8
Q4	/ 10
Q5	/ 12
Q6	/ 10
Q7	/ 10
Q8	/ 8

Total	/ 70

NAME:_____ Section:_____ Student Number:_____

1. The molecule below is camphor, one of the main ingredients in Buckley's original cough syrup and Vick's Vaporub: **[7 marks]**



(a) What is the molecular formula for camphor? *[1 mark]*

(b) Circle and name the functional group in camphor. *[2 marks]*

(c) Draw a * at each chirality center in camphor. *[2 marks]*
*Marks will be deducted for extra * on atoms that aren't chirality centers.*

(d) What is the definition of a chiral molecule? According to this definition, is camphor chiral or achiral? *[2 marks]*

2. Draw both chair conformers of *trans*-1-isopropyl-3-methylcyclohexane. Write "more stable" under the more stable of the two conformers. **[5 marks]**

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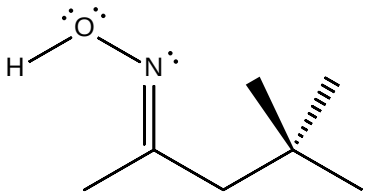
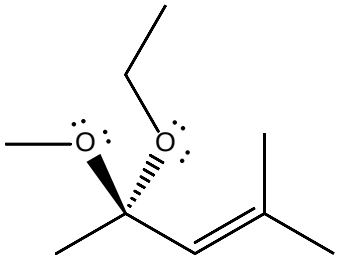
3. For each of the molecules below, assign the stereochemical configuration(s) as *E, Z, R* or *S*. *For full marks, you must show the priority numbers you used to assign each configuration and it must be clear what part of the molecule is being described as E, Z, R or S.* **[8 marks]**

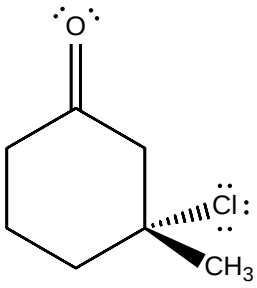
(a)



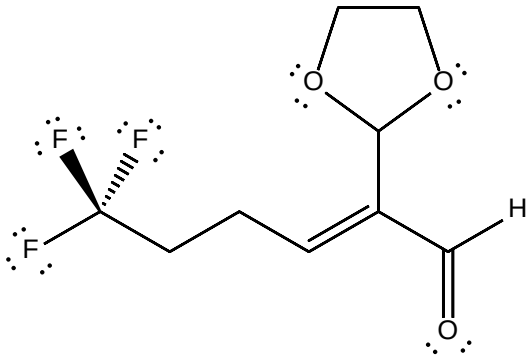
(b)



(c)



(d)



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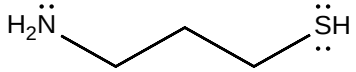
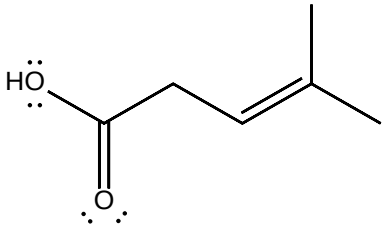
4. Name each of the following molecules according to IUPAC rules. **[10 marks]**
You do not need to explain your names.

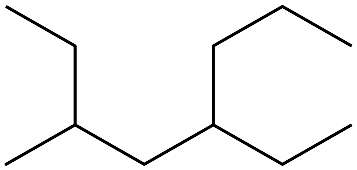
(a)



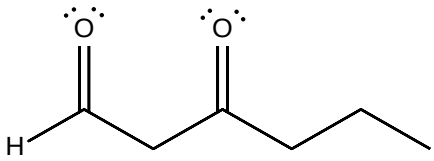
(b)



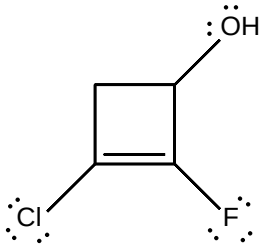
(c)



(d)



(e)



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5. For each of the following pairs of molecules: **[12 marks]**

- circle the most acidic hydrogen atom(s) on each molecule,
- identify the stronger acid, and
- explain why it is the stronger acid (in terms of chemical structure(s); I am looking for more than numbers from a table)

(a)

(b)

(c)

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6. Carbonate ions (CO_3^{2-}) are strong enough bases to deprotonate phenols but not aliphatic alcohols like methanol, ethanol or propanol. **[10 marks]**

(a) Draw resonance structures that demonstrate why phenol is a stronger acid than ethanol. *[4 marks]*

(b) Use pKa values to explain why a carbonate ion can deprotonate a significant fraction of molecules in a sample of phenol. Your answer should include a balanced reaction equation. *[3 marks]*

(c) Use pKa values to explain why a carbonate ion will **NOT** deprotonate a significant fraction of molecules in a sample of methanol. Your answer should include a balanced reaction equation. *[3 marks]*

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7. Draw all **<u>structural</u>** isomers with the molecular formula C_3H_4BrCl. **[10 marks]**
Marks may be deducted if the same isomer is drawn multiple times.

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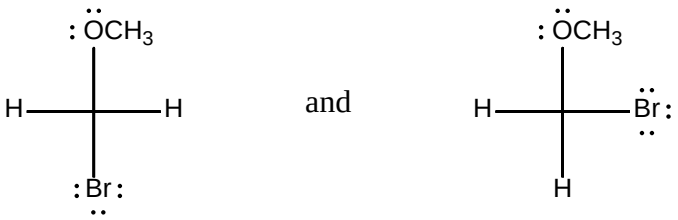
8. What is the relationship between each of the following pairs of molecules? **[8 marks]**
For each pair, indicate whether they are:

- C – conformers,
- D – diastereomers,
- E – enantiomers,
- SI – structural isomers, or
- I – identical molecules

(a)



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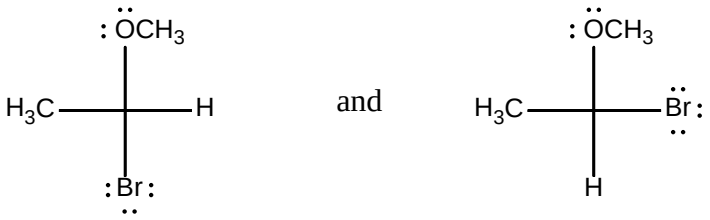

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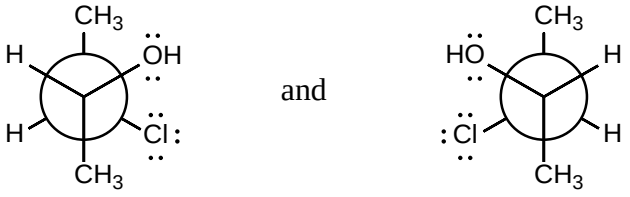

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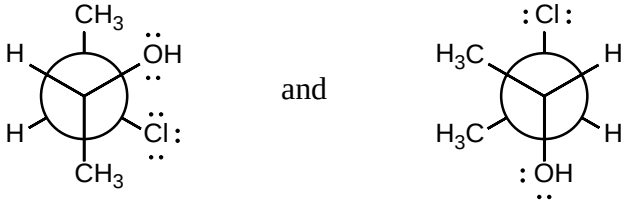

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Some Useful Data

Principal Functional Group Priority List

Carboxylic acid
Sulfonic acid
Ester
Acid chloride
Amide
Nitrile
Aldehyde
Ketone
Alcohol
Thiol
Amine

Chem 1000 Standard Periodic Table

1												13	14	15	16	17	18
1.0079 **H** 1	2																4.0026 **He** 2
6.941 **Li** 3	9.0122 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.0067 **N** 7	15.9994 **O** 8	18.9984 **F** 9	20.1797 **Ne** 10
22.9898 **Na** 11	24.3050 **Mg** 12	3	4	5	6	7	8	9	10	11	12	26.9815 **Al** 13	28.0855 **Si** 14	30.9738 **P** 15	32.066 **S** 16	35.4527 **Cl** 17	39.948 **Ar** 18
39.0983 **K** 19	40.078 **Ca** 20	44.9559 **Sc** 21	47.88 **Ti** 22	50.9415 **V** 23	51.9961 **Cr** 24	54.9380 **Mn** 25	55.847 **Fe** 26	58.9332 **Co** 27	58.693 **Ni** 28	63.546 **Cu** 29	65.39 **Zn** 30	69.723 **Ga** 31	72.61 **Ge** 32	74.9216 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
85.4678 **Rb** 37	87.62 **Sr** 38	88.9059 **Y** 39	91.224 **Zr** 40	92.9064 **Nb** 41	95.94 **Mo** 42	(98) **Tc** 43	101.07 **Ru** 44	102.906 **Rh** 45	106.42 **Pd** 46	107.868 **Ag** 47	112.411 **Cd** 48	114.82 **In** 49	118.710 **Sn** 50	121.757 **Sb** 51	127.60 **Te** 52	126.905 **I** 53	131.29 **Xe** 54
132.905 **Cs** 55	137.327 **Ba** 56	**La-Lu**	178.49 **Hf** 72	180.948 **Ta** 73	183.85 **W** 74	186.207 **Re** 75	190.2 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.967 **Au** 79	200.59 **Hg** 80	204.383 **Tl** 81	207.19 **Pb** 82	208.980 **Bi** 83	(210) **Po** 84	(210) **At** 85	(222) **Rn** 86
(223) **Fr** 87	226.025 **Ra** 88	**Ac-Lr**	(265) **Rf** 104	(268) **Db** 105	(271) **Sg** 106	(270) **Bh** 107	(277) **Hs** 108	(276) **Mt** 109	(281) **Ds** 110	(280) **Rg** 111	(285) **Cn** 112	(284) **Nh** 113	(289) **Fl** 114	(288) **Mc** 115	(293) **Lv** 116	(294) **Ts** 117	(294) **Og** 118

138.906 **La** 57	140.115 **Ce** 58	140.908 **Pr** 59	144.24 **Nd** 60	(145) **Pm** 61	150.36 **Sm** 62	151.965 **Eu** 63	157.25 **Gd** 64	158.925 **Tb** 65	162.50 **Dy** 66	164.930 **Ho** 67	167.26 **Er** 68	168.934 **Tm** 69	173.04 **Yb** 70	174.967 **Lu** 71
227.028 **Ac** 89	232.038 **Th** 90	231.036 **Pa** 91	238.029 **U** 92	237.048 **Np** 93	(240) **Pu** 94	(243) **Am** 95	(247) **Cm** 96	(247) **Bk** 97	(251) **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(262) **Lr** 103

Developed by Prof. R. T. Boeré (updated 2016)