CHEMISTRY 2500: Organic Chemistry I
MIDTERM-1
Friday, October 19, 2018

Instructions:

- This exam paper consists of 11 questions.
- The exam is worth a total of 64 marks. Most of these marks are for explanation/showing your work rather than for reaching the correct answer. Explain all of your answers fully using diagrams where appropriate (a picture really is worth a thousand words!).
- Marks will be deducted for poorly drawn structures.
- No calculators allowed. No other electronic devices can be present with you during the exam unless authorized by the instructor.
- You may use a molecular model kit.
- There is a 2-hour time limit.
- If your work is not legible, it will be given a mark of zero.
- **Read the questions carefully**. Good luck.

Confidentiality Agreement:

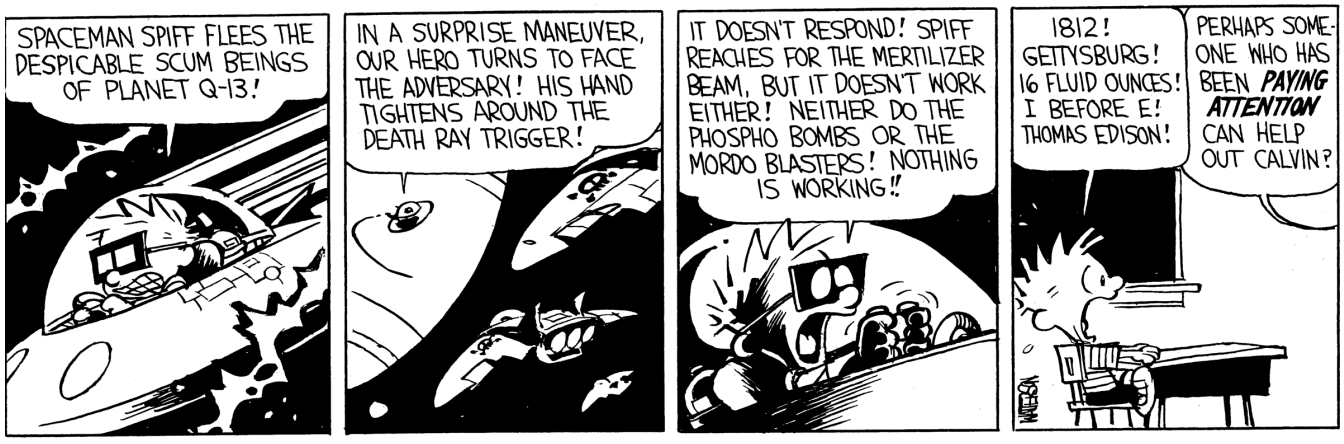
I agree not to discuss (or in any other way divulge) the contents of this exam until they have all been marked and returned. I understand that, if I were to break this agreement, I would be choosing to commit academic misconduct, a serious offense that will be punished. The minimum punishment would be a mark of 0 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: _____

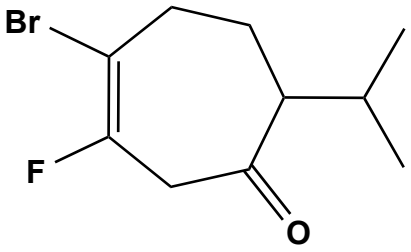
Course: CHEM 2500 (Organic Chemistry I)
Semester: Fall 2018
The University of Lethbridge

Question Breakdown

Q1	**/2**
Q2	**/6**
Q3	**/10**
Q4	**/8**
Q5	**/5**
Q6	**/5**
Q7	**/4**
Q8	**/6**
Q9	**/4**
Q10	**/4**
Q11	**/10**
Total	**/64**



1. Name the following molecule according to IUPAC rules. **[2 marks]**



2. **[6 marks]**

(a) Using line structures, draw the structure of **(2*R*,3*S*)-3-bromobutane-2-ol**

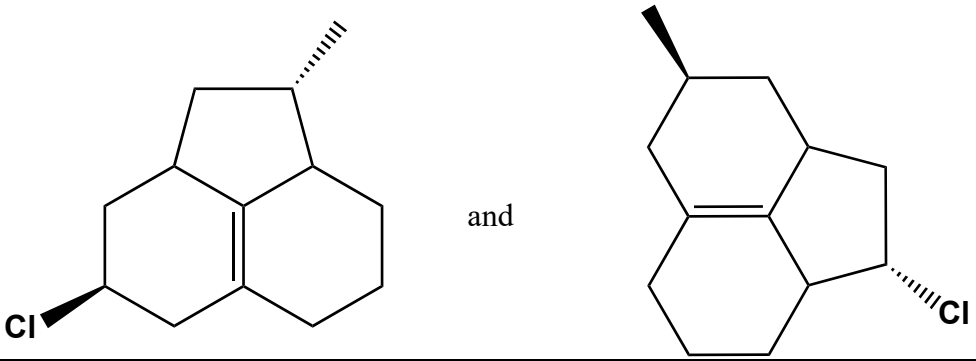
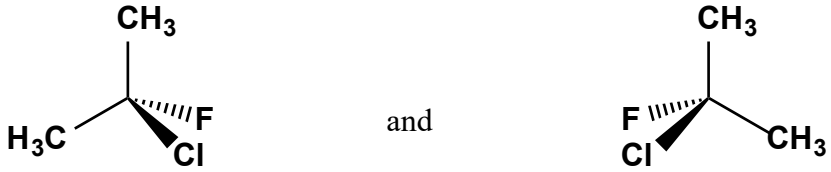
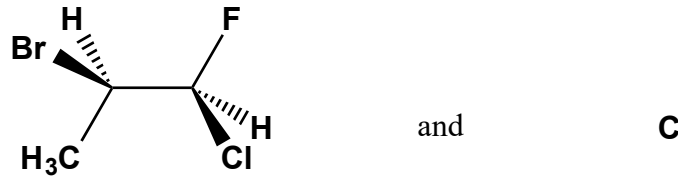
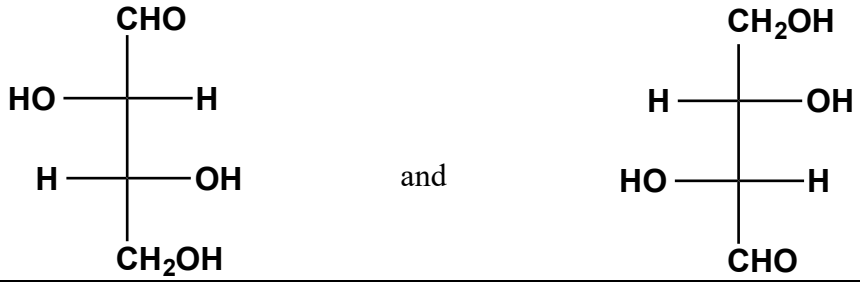
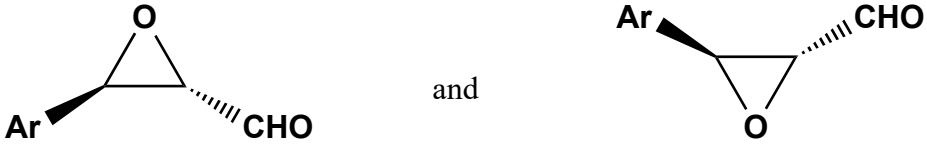
(b) Using line structures, draw the **enantiomer** of (2*R*,3*S*)-3-bromobutane-2-ol.

(c) Looking down the C2-C3 bond of (2*R*,3*S*)-3-bromobutane-2-ol**,** draw the **staggered** Newman projection in which the two methyl groups are antiperiplanar (180º apart).

3. Using the appropriate letter or letters, indicate the relationship(s) between the following pairs of molecules. If there is more than one relationship, provide all the letters that apply. *No explanation is necessary.*

[10 marks]

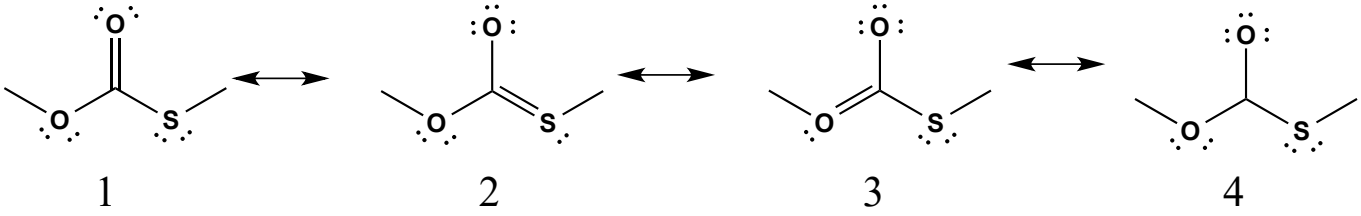
A = stereoisomers
B = constitutional isomers
C = conformers
D = diastereomers
E = enantiomers
F = identical molecules
G = none of the above

	relationship(s)
 and	
 and	
 and	
 and	
 and	

4. **[8 marks]**

(a) For the following resonance structures, add formal charges where appropriate.

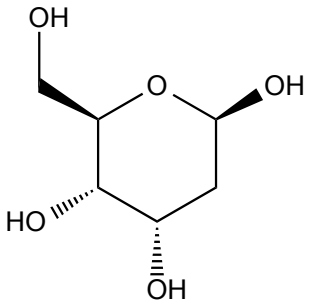
(b) Use curved arrows to show the electron movement necessary to covert structure 1 into 2, 2 into 3, 3 into 4 **AND** 4 into 1.



1 2 3 4

(c) Rank these resonance structures in terms of their contribution to the character of this species and indicate degenerate structures (structures of equal energy), if any. Explain your reasoning.

5. Draw the two chair conformers for the following molecule and identify the most stable conformer. **All** axial and equatorial bonds must be drawn and they will be graded for proper placement. **[5 marks]**



6. Using only the formula $C_4H_8O_2$, draw a molecule that exemplifies each of the following. Use only line structures (no condensed or expanded structures) and avoid any O-O bonds. Note, your answers may contain more than one functional group. **[5 marks]**

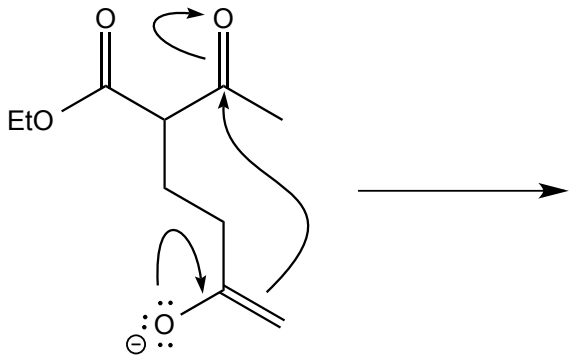
(a) a carboxylic acid

(b) an alkene that is neither *E*/*Z* nor *cis/trans*

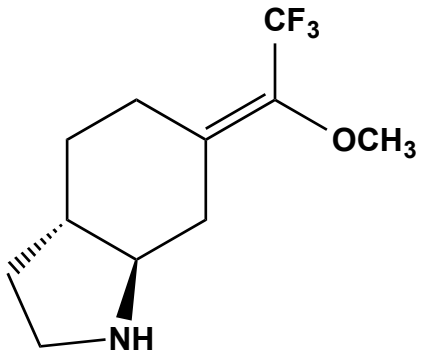
(c) a pair of diastereomers

(d) a cyclic alcohol

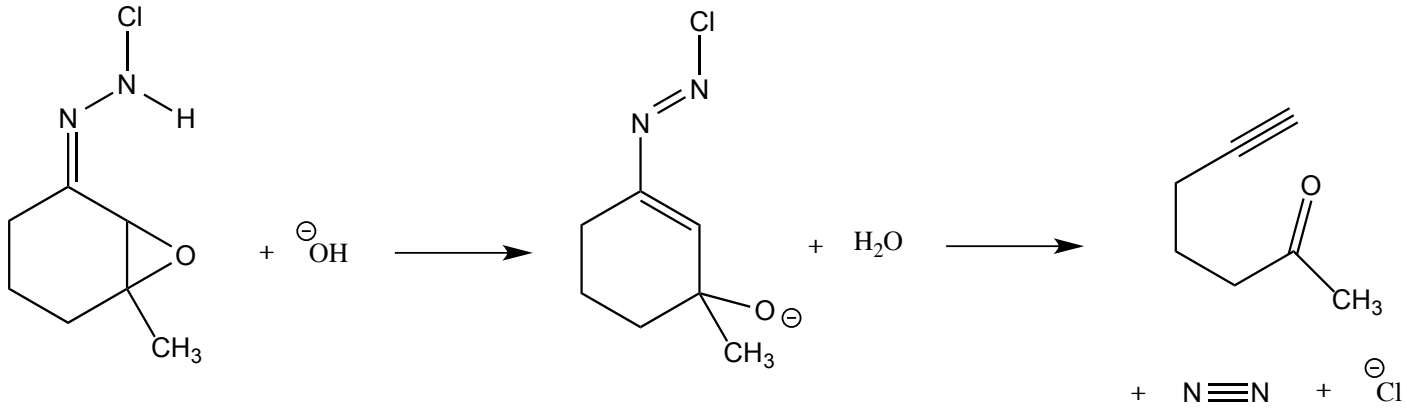
7. Draw the product(s) of the following reaction. Where appropriate, include lone pairs and formal charges. [**4 marks**]



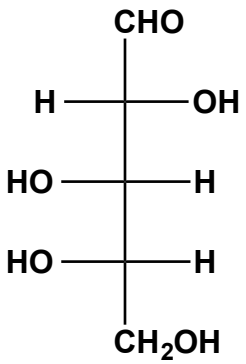
8. For the molecule below, where appropriate, assign the stereochemical configuration(s) as *E*, *Z*, *R* or *S*. *For full marks, you must show the priority numbers you used to assign each configuration and it must be clear what part of the molecule is being described as E, Z, R or S.* **[6 marks]**



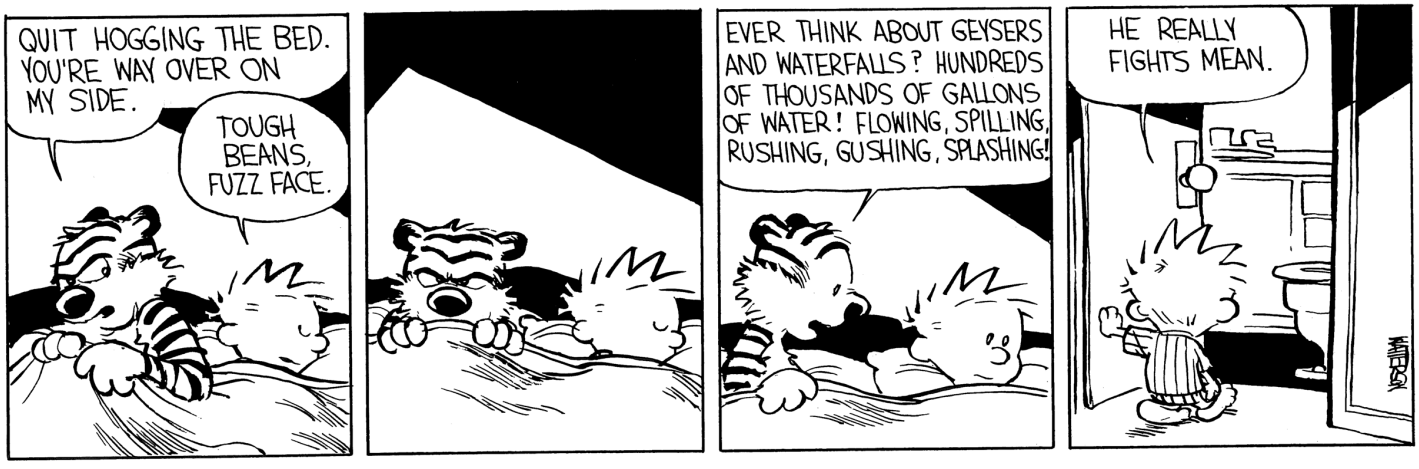
9. Draw the curved arrows that accomplish the following transformation. Include all lone pairs. **[4 marks]**



10. For the following Fischer projection, draw the corresponding zig-zag line drawing. **[4 marks]**



11. Draw *all* isomers (constitutional and stereo) for $C_2H_2Cl_2O$. There are more than 1 and less than 10. All molecules are neutral, and every atom has a formal charge of zero. Avoid any O-Cl bonds. **Only line structures will be graded (NO expanded or condensed structures)**. **[10 marks]**



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																	18
1.0079 **H** 1	2											13	14	15	16	17	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**	(261) **Rf** 104	(262) **Db** 105	(263) **Sg** 106	(262) **Bh** 107	(265) **Hs** 108	(266) **Mt** 109	(281) **Dt** 110	(283) **Rg** 111							

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	(260) **Lr** 103

Developed by Prof. R. T. Boeré