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.

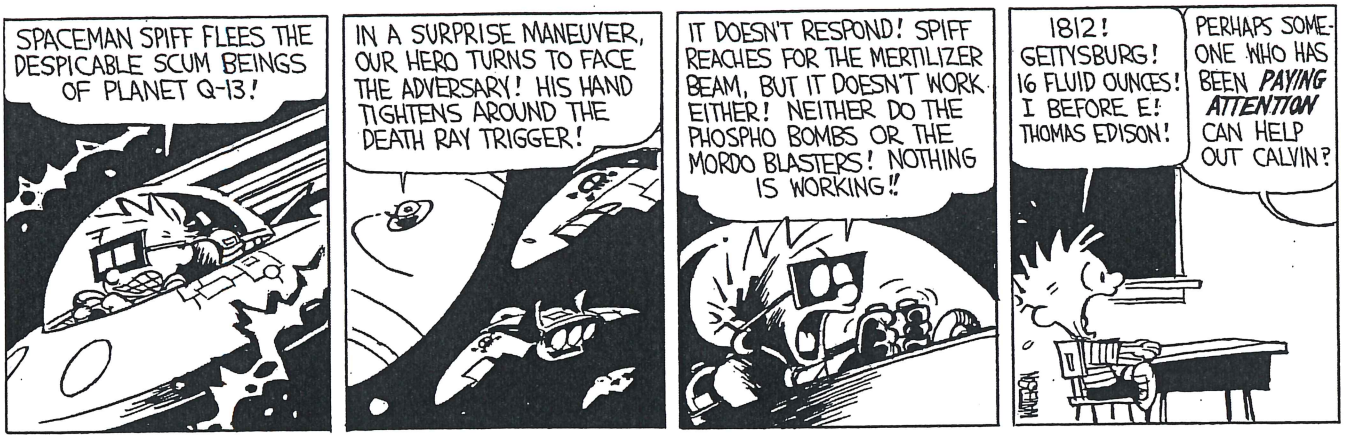
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Course: CHEM 2500 (Organic Chemistry I)
Semester: Fall 2018
The University of Lethbridge

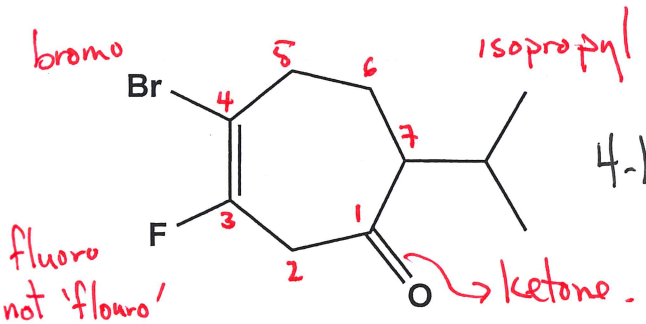
KEY

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**



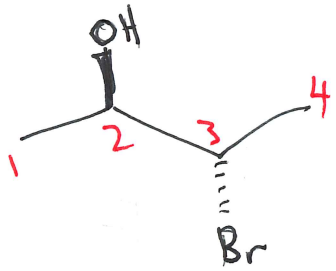
1. Name the following molecule according to IUPAC rules. **[2 marks]**



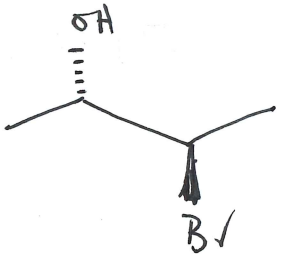
4-bromo-3-fluoro-7-isopropylcyclohept-3-enone.

2. **[6 marks]**

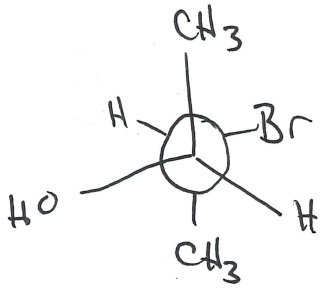
(a) Using line structures, draw the structure of **(2*R*,3*S*)-3-bromobutane-2-ol**



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



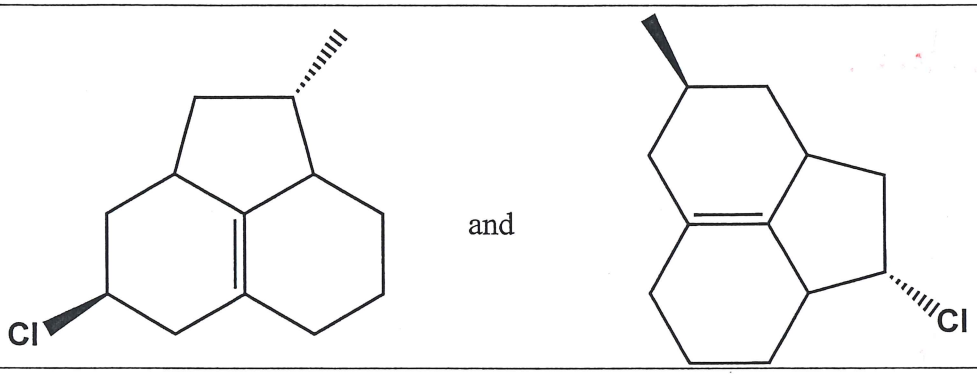
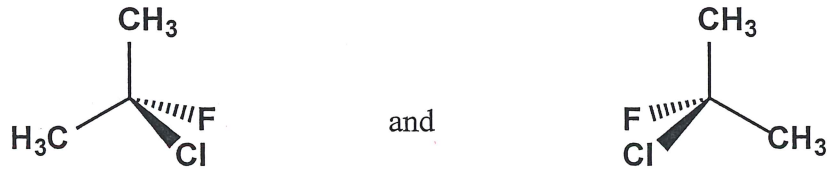
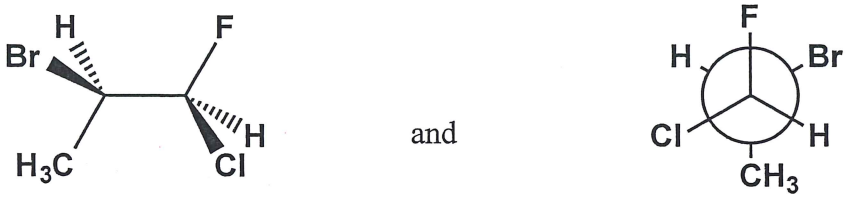
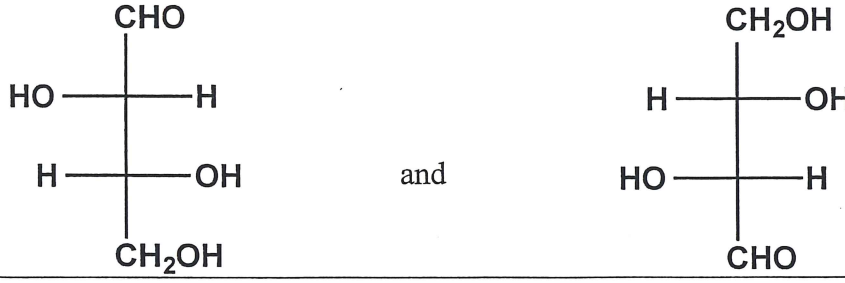
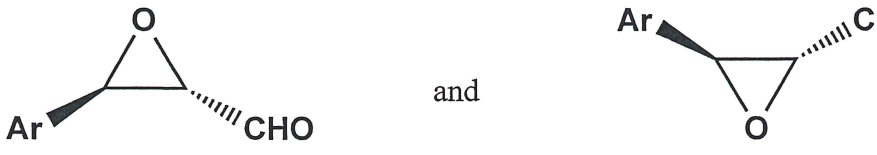
(c) Looking down the C2-C3 bond of (2*R*,3*S*)-3-bromobutane-2-ol, draw the **staggered** Newman projection in which the two methyl groups are antiperiplanar (180° apart).



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]

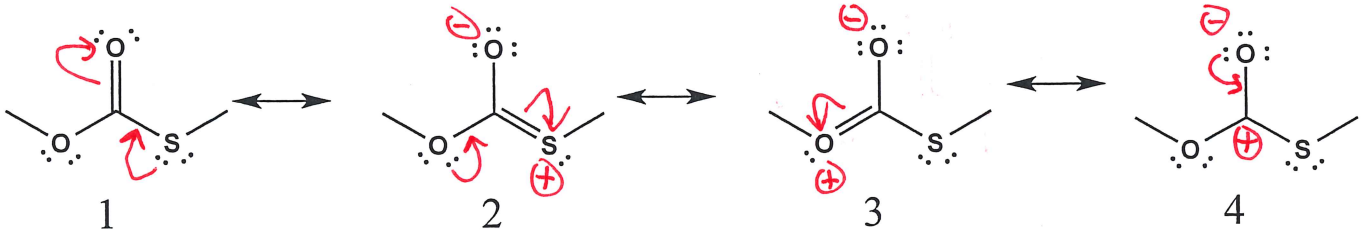
A = stereoisomers
B = constitutional isomers
C = conformers
D = diastereomers
E = enantiomers
F = identical molecules
G = none of the above

	relationship(s)
	B
	F
	A, D
	A, E
	A, E

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.

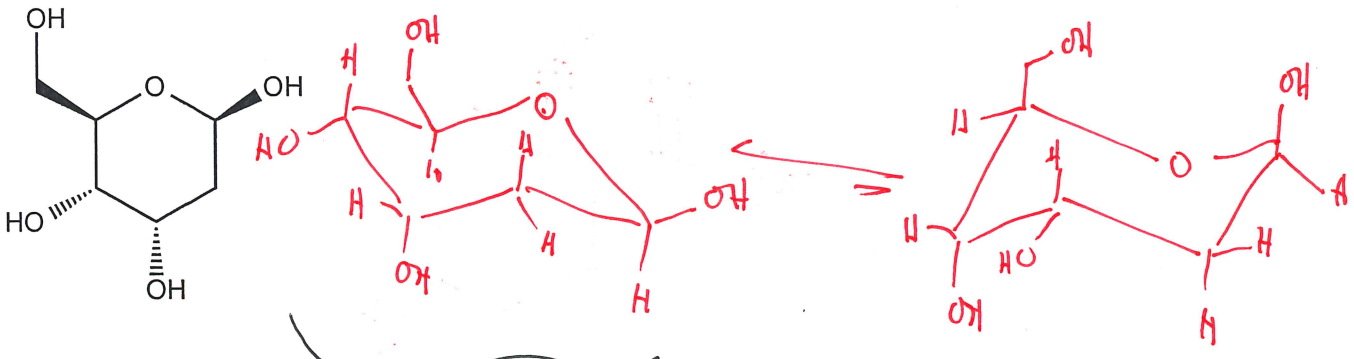
① > ② > ③ > ④

① no formal charges and all atoms have full octets.

② > ③ both have full octets and 2 formal charges (⊖ & ⊕). ② is better than ③ because the formal ⊕ charge is on the more electropositive sulfur atom.

④ is the least contributing resonance structure because carbon is lacking an octet.

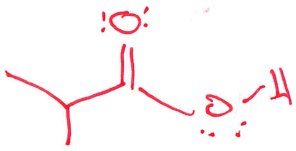
5. Draw the two chair conformers for the following molecule and identify the most stable conformer. **All** axial and equatorial bonds must be drawn and they will be graded for proper placement. **[5 marks]**



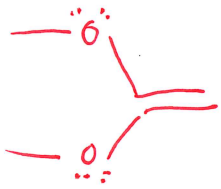
more stable as more groups are equatorial.

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]**

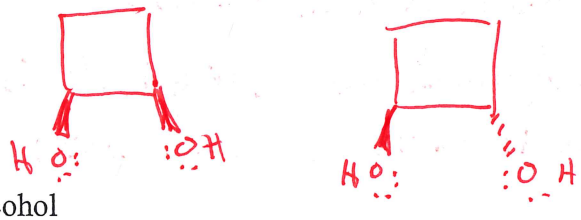
(a) a carboxylic acid The following represent 1 possible correct answer:



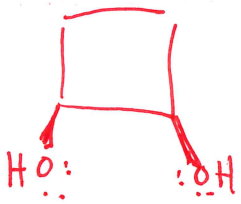
(b) an alkene that is neither *E*/*Z* nor *cis*/*trans*



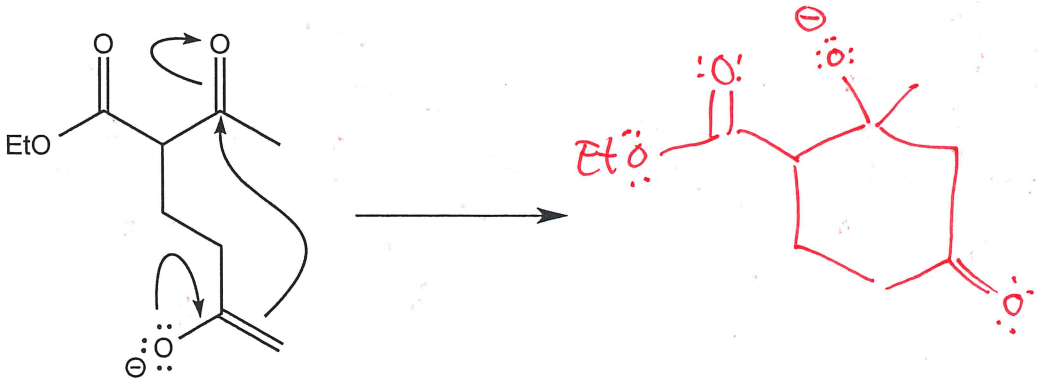
(c) a pair of diastereomers



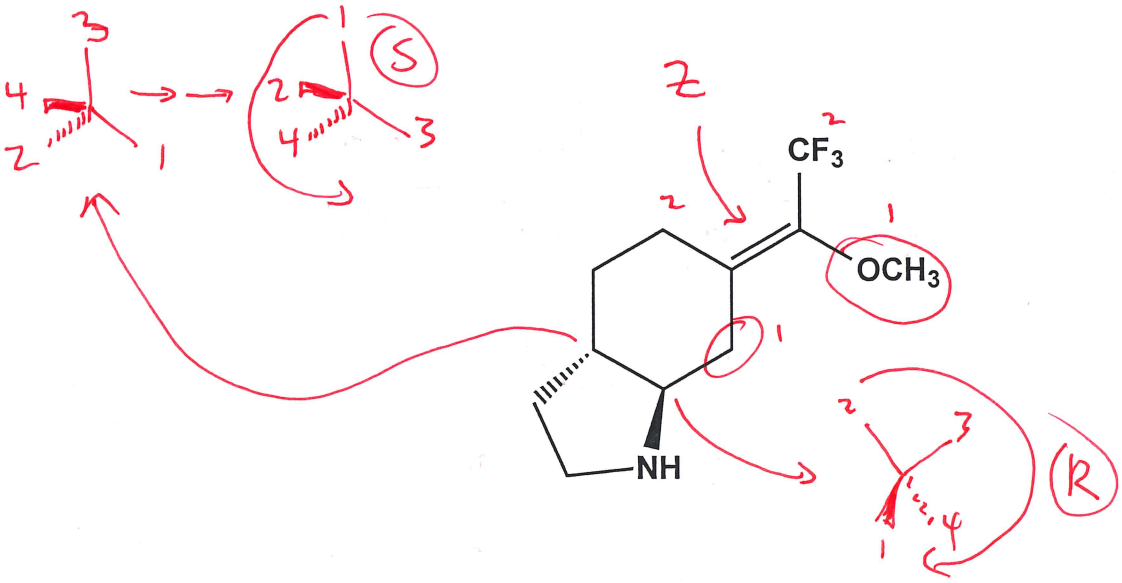
(d) a cyclic alcohol



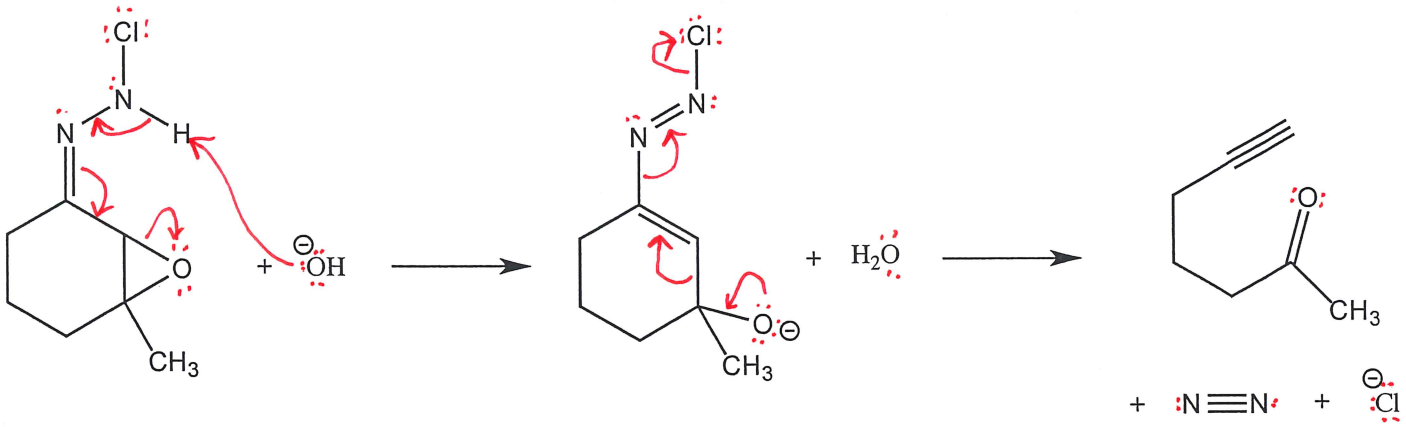
7. Draw the product(s) of the following reaction. Where appropriate, include lone pairs and formal charges. **[4 marks]**



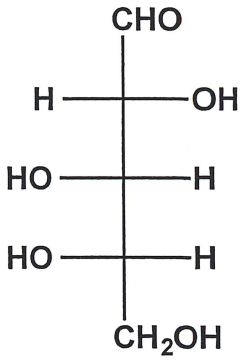
8. For the molecule below, where appropriate, assign the stereochemical configuration(s) as *E*, *Z*, *R* or *S*. *For full marks, you must show the priority numbers you used to assign each configuration and it must be clear what part of the molecule is being described as E, Z, R or S.* **[6 marks]**

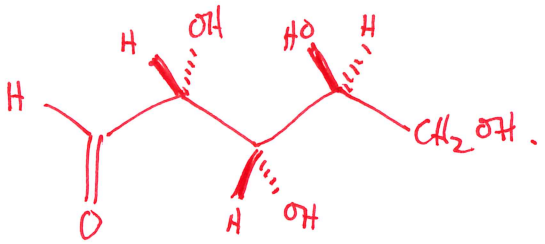


9. Draw the curved arrows that accomplish the following transformation. Include all lone pairs. **[4 marks]**

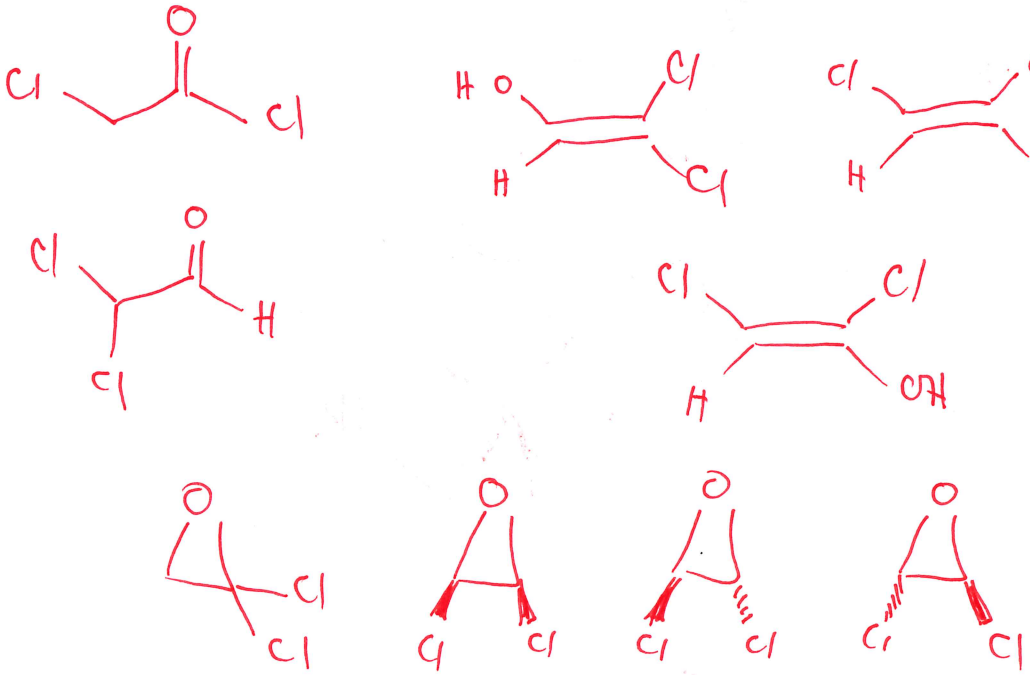


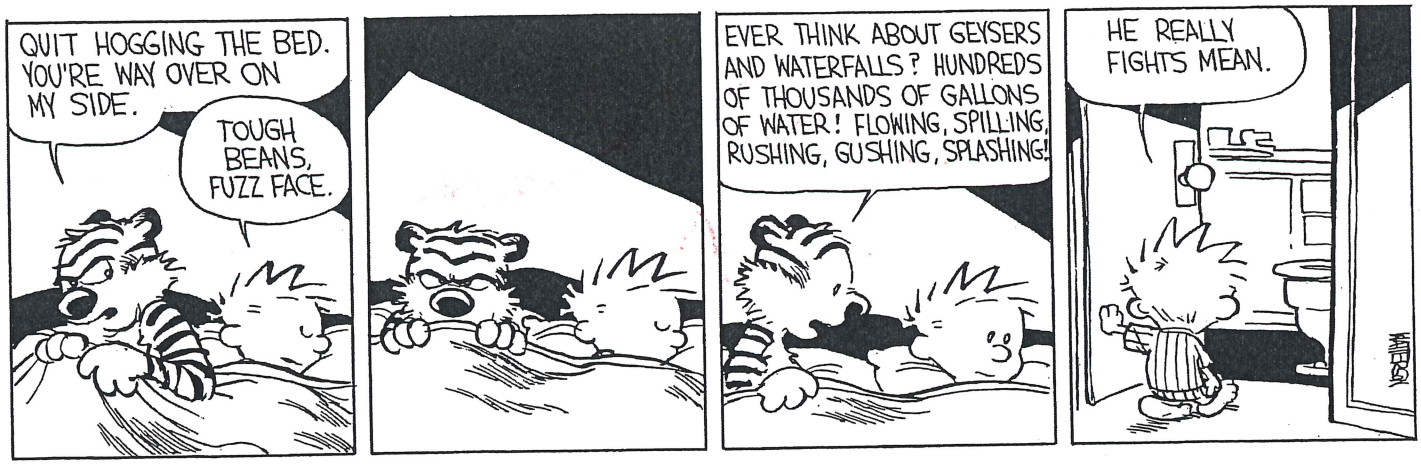
10. For the following Fischer projection, draw the corresponding zig-zag line drawing. **[4 marks]**





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																	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