NAME:_____ Section:_____ Student Number:_____

Fall 2019 **Chemistry 2600 Midterm 2** ____/ 50 marks

INSTRUCTIONS:

1) Please read over the test carefully before beginning. You should have 6 pages of questions in addition to this cover page and a periodic table.
2) You have also been given a 6 page Spectroscopy Data Package. **PLEASE DO NOT WRITE ON THE SPECTROSCOPY DATA PACKAGE!** If you need scrap paper, use the back of any page of the test. On questions with spectra, you may also do rough work directly on the spectra.
3) You may use a molecular model kit and ruler. You may not have any papers or other written materials in your model kit.
4) Electronic devices (including calculators) are **not** allowed for this test.
5) If your work is not legible, it will be given a mark of zero.
6) For full credit, explanations must be complete. In many cases, complete explanations include drawing relevant structures. If delocalization of electrons is invoked, the relevant resonance structures must be drawn.
7) Marks will be deducted for incorrect information added to an otherwise correct answer.
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 5:00pm Mountain Time on Wednesday, November 6th, 2019 (the day after the test). I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/50 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 2600 (Organic Chemistry II)
Semester: Fall 2019
The University of Lethbridge

Question Breakdown

Q1	/ 8
Q2	/ 4
Q3	/ 4
Q4	/ 8
Q5	/ 7
Q6	/ 11
Q7	/ 8

Total	/ 50

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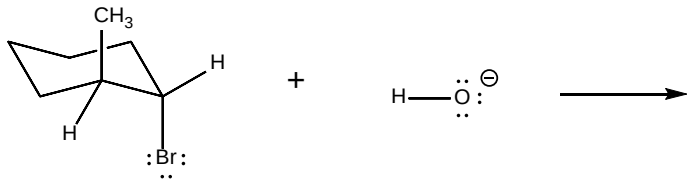
1. Consider the following reaction mixture: **[8 marks]**



(a) Draw the major organic product obtained if the reaction proceeds according to an S_N2 mechanism. Briefly explain why this isomer is obtained. *[4 marks]*

(b) Draw the major organic product obtained if the reaction proceeds according to an E2 mechanism at high temperature. Briefly explain why this isomer is obtained. *[4 marks]*

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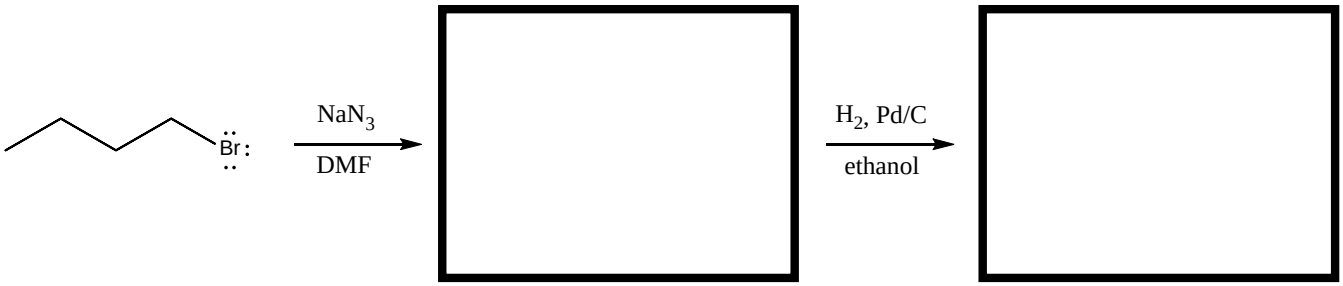
2. 5-Bromo-1,3-cyclopentadiene is a bad substrate for S_N1 or E1 reactions. Why? **[4 marks]**

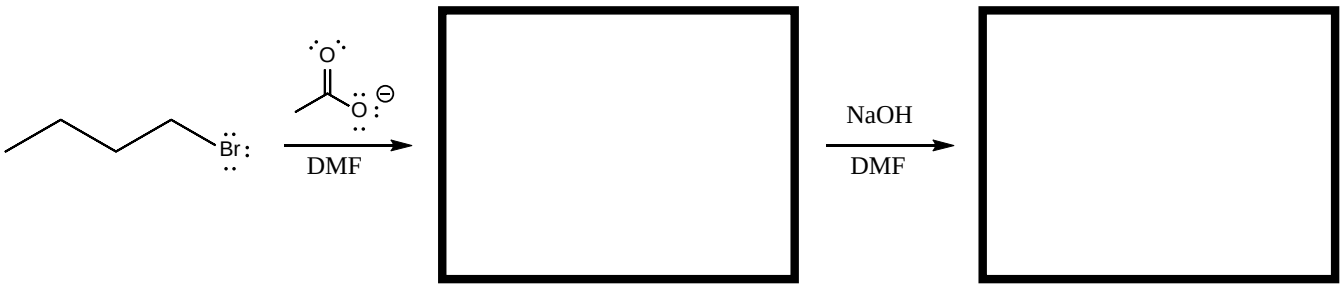
For full credit, your answer must include the structure of 5-bromo-1,3-cyclopentadiene and any other relevant structures. If you need a hint, start drawing the mechanism for an S_N1 or E1 reaction involving 5-bromo-1,3-cyclopentadiene.

3. For each of the following multi-step processes, draw the major organic product of each step in the appropriate box. **[4 marks]**

(a)



(b)



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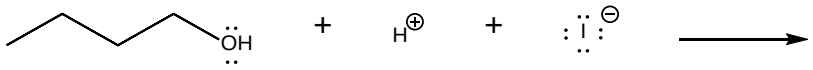
4. Indicate whether or not you would expect to see a significant amount of reaction according to each mechanism type by circling 'yes' or 'no'. In the bottom row of each table, justify your answer by: **[8 marks]**

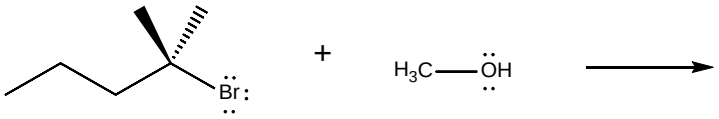
- For each 'yes', drawing the organic product(s) that will be observed.
- For each 'no', briefly explaining why you expect little-to-no reaction.

(a)



S_N1? yes / no	**S_N2?** yes / no	**E1?** yes / no	**E2?** yes / no

(b)



S_N1? yes / no	**S_N2?** yes / no	**E1?** yes / no	**E2?** yes / no

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5. A kinetic study of the reaction between an alkyl chloride (RCl) and a non-nucleophilic base ($base$) provided the following data: **[7 marks]**

$[RCl]$ $\left(\frac{mol}{L}\right)$	$[base]$ $\left(\frac{mol}{L}\right)$	Rate of reaction $\left(\frac{mol}{L \cdot s}\right)$
1	1	10
1	2	20
2	4	80
4	4	160

(a) Write the rate law for this reaction. Include a numerical value and units for k. *[4 marks]*
Clearly identify the order of each reactant.

(b) Did this reaction proceed via an S_N1, S_N2, E1 or E2 mechanism? Explain your choice. It must be clear why all three alternative options were rejected. *[3 marks]*

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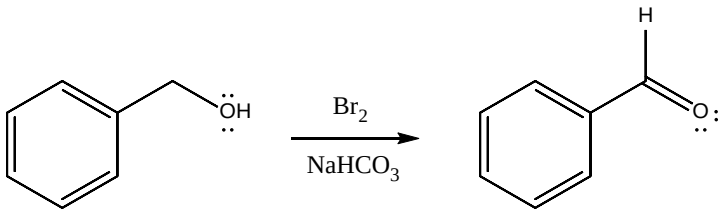
6. **[11 marks]**

(a) Draw a reasonable mechanism for the following reaction. *[5 marks]*



(b) Briefly explain how you would use each of the following spectroscopic methods to determine whether or not this reaction had gone to completion. *[6 marks]*
Your answers should address how you would monitor for both reactant and product.

i. ^{1}H NMR

ii. ^{13}C NMR

iii. IR

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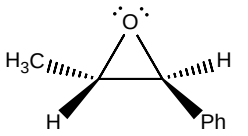
7. Draw a reasonable mechanism for the following reaction and draw the final product in the box provided. *Clearly show any relevant stereochemistry of the final product.* **[8 marks]**



$\xrightarrow[CH_3OH]{H^+}$

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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)