Course Number	CHEMISTRY 264
Course Title	INTRODUCTORY ORGANIC CHEMISTRY "Practice Exam"
Instructor	J. M. Chong

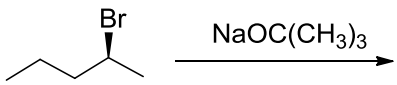
Date of Exam	December 7, 2012
Time of Exam	9:00 – 11:30 am
Duration of Exam	2.5 HOURS
Number of Exam Pages (including this cover sheet)	8
Exam Type	CLOSED BOOK
Additional Materials Allowed	CALCULATORS, MOLECULAR MODELS

INSTRUCTIONS

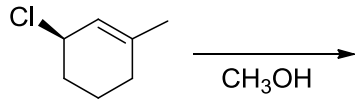
1. Answer all of the questions on directly on the exam in the space provided or on an examination booklet.
2. Remember to put your name and ID number on both your exam and your examination booklet.
3. The following abbreviations may appear:
   - Ac = acetyl = $CH_3C(O)$
   - cat. = catalytic amount of
   - D = deuterium, ^2H
   - DMSO = dimethylsulfoxide
   - Et = ethyl, C_2H_5
   - equiv = (molar) equivalents
   - m-CPBA = meta-chloroperoxybenzoic acid
   - Me = methyl, CH_3
   - Ph = phenyl, C_6H_5
4. Total Marks possible: 100
5. No extra time will be allowed so budget your time accordingly.
6. A Periodic Table of the Elements appears on the last page of this examination.

1. What will be the major product(s) of the following reactions? In each case, show stereochemistry and note whether the reaction has proceeded with retention, inversion, racemization, syn- addition, or anti-addition as appropriate. [2 marks each; 30 marks total]

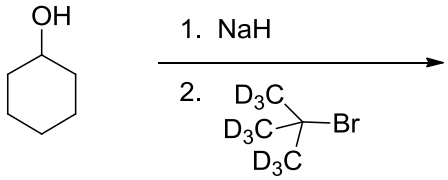
(a)



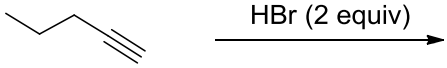
(b)



(c)



(d)



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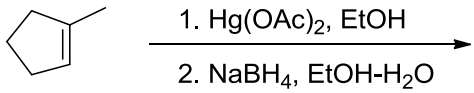
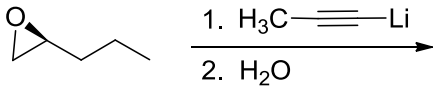
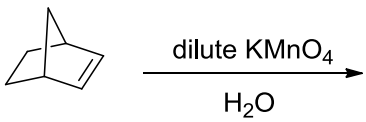


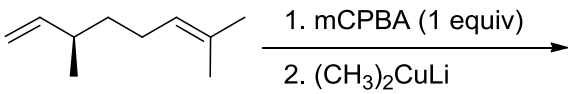
(f)



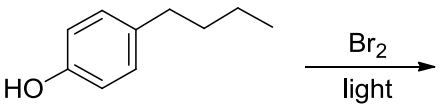
(g)



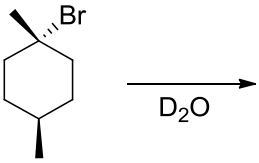
(h)


1. mCPBA (1 equiv)
2. (CH3)2CuLi

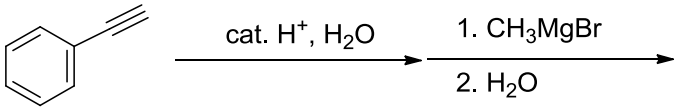
(i)


HO
Br2
light

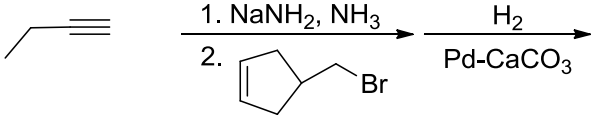
(j)


Br
D2O

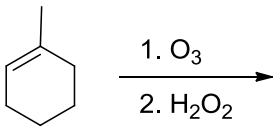
(k)


cat. H+, H2O
1. CH3MgBr
2. H2O

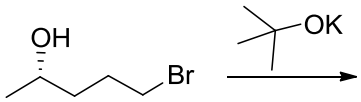
(l)


1. NaNH2, NH3
2.
Br
H2
Pd-CaCO3

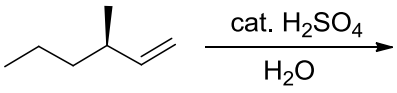
(m)


1. O3
2. H2O2

(n)

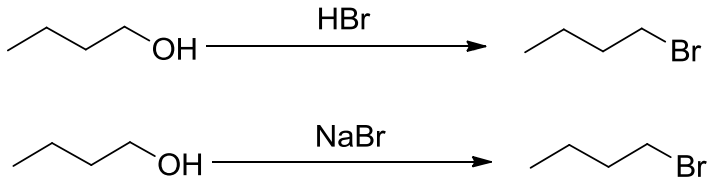

OH
Br
OK

(o)

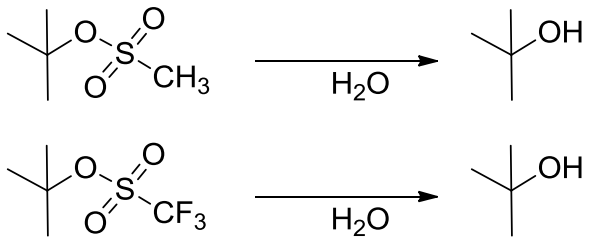

cat. H2SO4
H2O

2. For each of the following pairs of reactions, indicate which will be faster and EXPLAIN WHY. [2 marks each; 10 marks total]

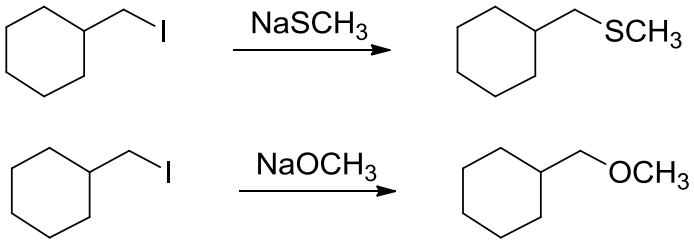
(a)



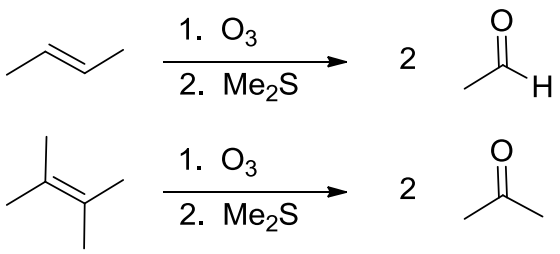
(b)



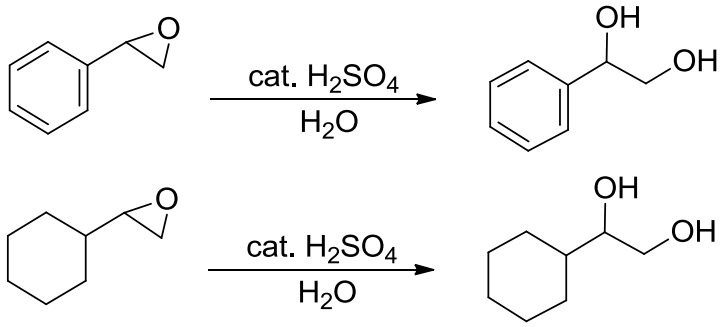
(c)



(d)



(e)



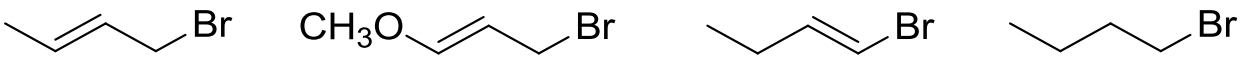
3. Show how bond dissociation energies can or cannot be used to explain the following:
[2 marks each; 6 marks total]

(a) The relative reactivities of alkyl fluorides and chlorides in substitution reactions.

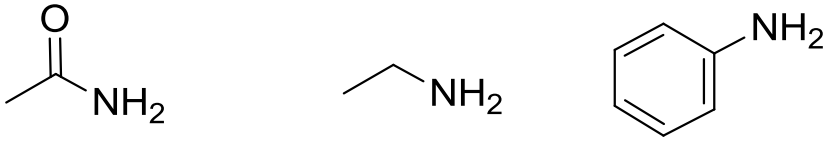
(b) The relative reactivities of HI and HBr with alkenes.

(c) The relative acidities of alcohols and primary amines.

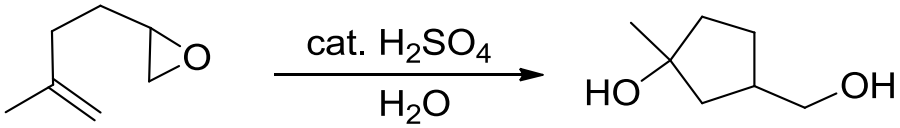
4. Rank the following compounds in order of increasing rate of reaction in S_N2 substitutions. Draw structures of and note the relative stabilities of key intermediates and/or transition states to explain your ranking.
[5 marks]



5. Rank the following compounds in order of decreasing acidity. Explain your rankings using resonance structures and stability arguments. [5 marks]

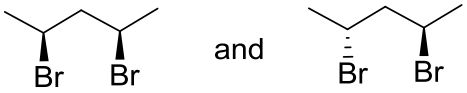


6. Draw a reasonable mechanism for the following transformation. Be sure to use the correct arrows to show movements of electron pairs, equilibria, irreversible steps, and resonance as appropriate. [4 marks]

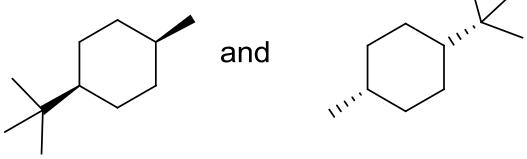


7. For the following pairs of compounds, note the relationship between them. Specifically, label them as constitutional isomers, same, diastereomers, enantiomers or not isomers. [1 mark each; 4 marks total]

(a)



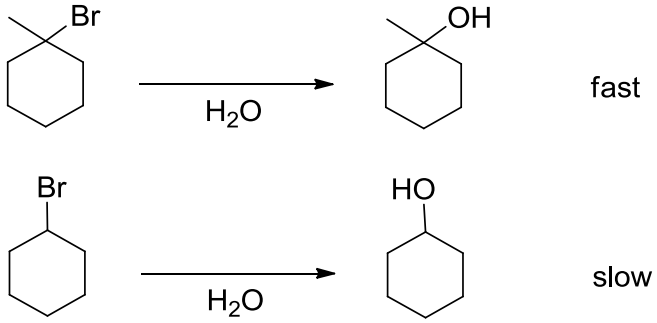
(b)



(c)

(d)

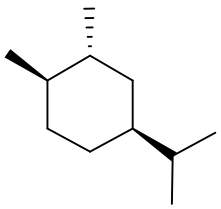
8. Draw reaction coordinate diagrams to illustrate why the following reactions proceed at very different rates. Draw mechanisms and carefully label transition states and intermediates in your reaction coordinate diagrams. [5 marks]



9. Explain the following: [4 marks each; 12 marks total]

(a) Explain the stereochemical outcomes of the following reactions based on mechanistic arguments. Draw any important intermediates and/or transition states.

(b) Explain which chair conformation of the following compound will be more stable. You will need to draw all the possible chair conformations.

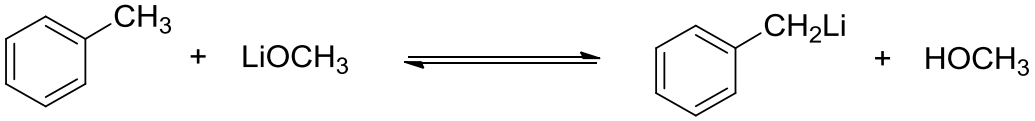


(c) Explain why only trans-2-butene (and no cis-2-butene) is formed when 2-butyne is treated with Li in liquid ammonia. You will need to show key intermediates.

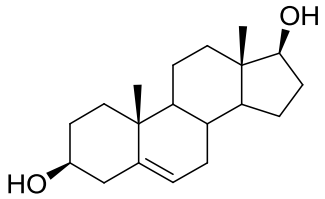
10. Write your answers to the following questions in the boxes provided. [1 mark each; 9 marks total]

(a) Draw a compound that is both a hydrogen bond donor and a hydrogen bond acceptor.

(b) For the following possible acid-base reaction, will the position of the equilibrium lie to the right or the left?



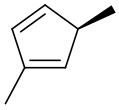
(c) How many stereoisomers are possible for a compound with the following general structure?



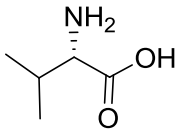
(d) and (e) Assign the absolute stereochemistry of the stereocentres in the following molecules according to the Cahn-Ingold-Prelog rules.

d e

(d)



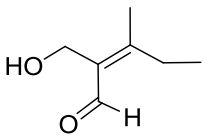
(e)



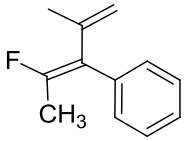
(f) and (g) Assign the stereochemistry of the double bond in the following molecules according to the Cahn-Ingold-Prelog rules.

f g

(f)



(g)

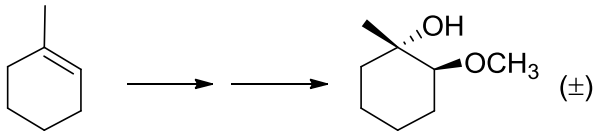


(g) Draw a compound that contains both a ketone and a carboxylic acid functional group.

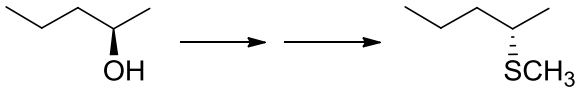
(h) What is the shape of the ozone molecule, O_3 ?

11. Provide reagents and/or reaction conditions that could be used to carry out the following transformations such that the major product is the one shown. More than one step may be required. You may use any other stable organic or inorganic reagents but the starting material given must form part of the final product. Pay attention to stereochemistry. [2 marks each; 10 marks total]

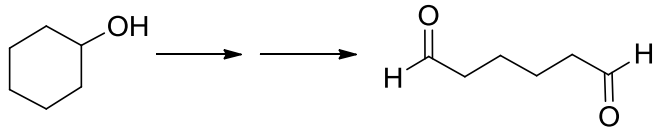
(a)



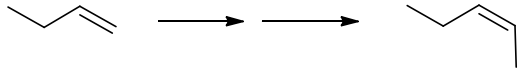
(b)



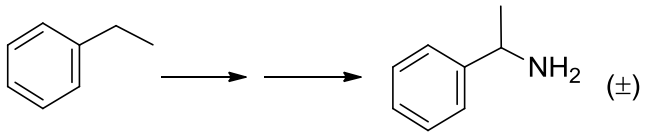
(c)



(d)



(e)



End of Questions

(1) IA				KEY								(13) IIIA	(14) IVA	(15) VA	(16) VIA	(17) VIIA	(18) Noble Gases
1 **H** 1.008 Hydrogen	(2) IIA																2 **He** 4.003 Helium
3 **Li** 6.941 Lithium	4 **Be** 9.012 Beryllium			47 **Ag** 107.9 Silver	Atomic Number **SYMBOL** Atomic Weight Name							5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 22.99 Sodium	12 **Mg** 24.31 Magnesium	(3) IIIB	(4) IVB	(5) VB	(6) VIB	(7) VIIB	(8) VIIIB	(9) VIIIB	(10) VIIIB	(11) IB	(12) IIB	13 **Al** 26.98 Aluminum	14 **Si** 28.09 Silicon	15 **P** 30.97 Phosphorus	16 **S** 32.06 Sulfur	17 **Cl** 35.45 Chlorine	**Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.90 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.71 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.37 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 72.59 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 98.91 Technetium	44 **Ru** 101.1 Ruthenium	45 **Rh** 102.9 Rhodium	46 **Pd** 106.4 Palladium	47 **Ag** 107.9 Silver	48 **Cd** 112.4 Cadmium	49 **In** 114.8 Indium	50 **Sn** 118.7 Tin	51 **Sb** 121.8 Antimony	52 **Te** 127.6 Tellurium	53 **I** 126.9 Iodine	54 **Xe** 131.3 Xenon
55 **Cs** 132.9 Cesium	56 **Ba** 137.3 Barium	57 **La** 138.9 Lanthanum	72 **Hf** 178.5 Hafnium	73 **Ta** 180.9 Tantalum	74 **W** 183.9 Tungsten	75 **Re** 186.2 Rhenium	76 **Os** 190.2 Osmium	77 **Ir** 192.2 Iridium	78 **Pt** 195.1 Platinum	79 **Au** 197.0 Gold	80 **Hg** 200.6 Mercury	81 **Tl** 204.4 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 209.0 Bismuth	84 **Po** (210) Polonium	85 **At** (210) Astatine	86 **Rn** (222) Radon