CHM 1321B
SAMPLE Final Exam
IMPORTANT: this is a *sample* final only, to be used as a practice *as part of your studying*

April 2012 Professor: Alison Flynn

Time: 3 hours

Last Name: _____ **First Name:** _____

Student Number: _____ **Seat number:** _____

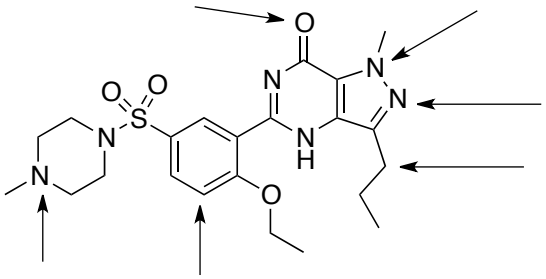
Notes:

- The marks are given as a guide and are subject to minor changes
- A faculty-approved calculator and molecular models are permitted
- Show stereochemistry where applicable
- The final page of the exam has a pK_a table and a periodic table
- Total number of pages: 15
- Approximate number of points: 148

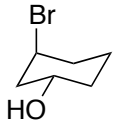
1. Draw 2-methyl-4-(1-methylethyl)octane

2. Draw para-nitrotoluene

3. Identify the hybridization of each of the indicated atoms in viagra, an erectile dysfunciton drug, shown below.

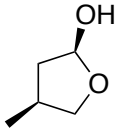


4.
   a. Draw the following compound in two dimensions.
   b. Name the compound

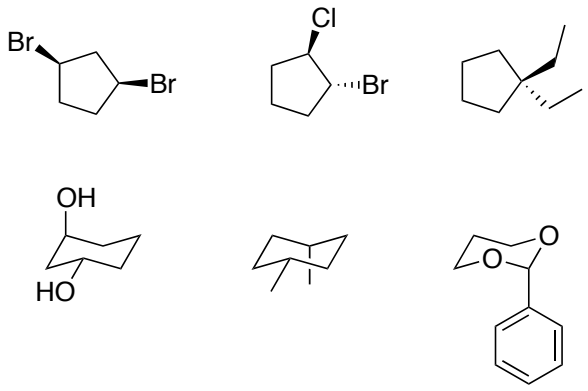


5. Draw (2S,3R)-2-bromo-3-chloropentane in a Newman projection (staggered conformation) looking down the C2-C3 bond.

6. Draw a diastereomer of the structure shown.

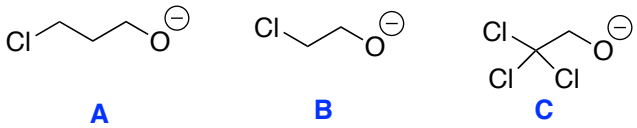


7. Circle the chiral molecule(s) and underline the meso compound(s):



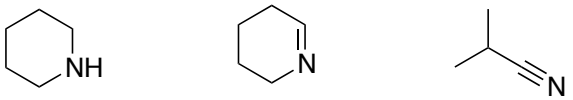
8. Rank the bases in each group in increasing order of basicity (base strength):

a.



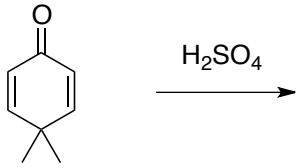
A B C

b.



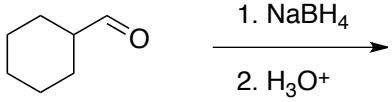
A B C

9. Propose a mechanism for the following transformation, which gives a more stable constitutional isomer of the starting material.

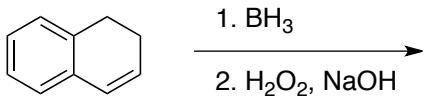


10. Give the major organic product of each of the following transformations:

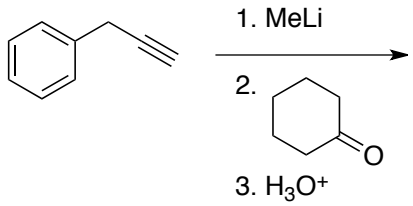
a.



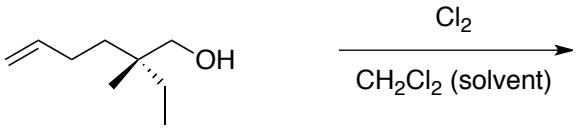
b.



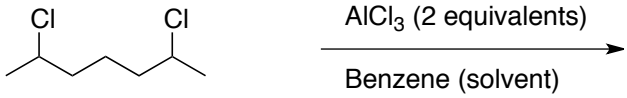
c.



d.

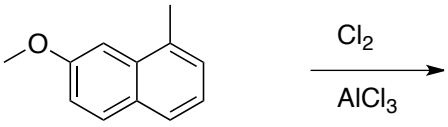


e.

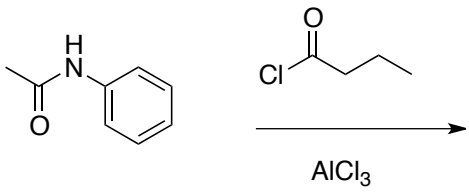


f.

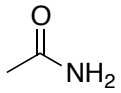
g.

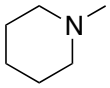


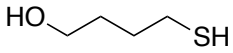
h.

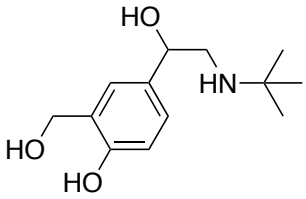


11. Draw the conjugate acid of each of the following compounds:

a. 

b. 

c. 

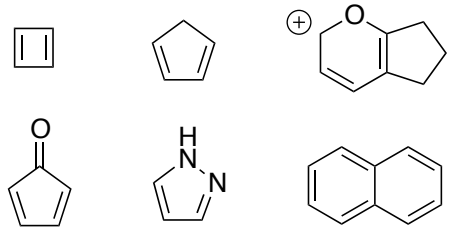
d. 

Ventolin (Salbutamol) - asthma drug

12. Circle the form of ventolin (above) that would be found in the body at physiological pH (7.4).

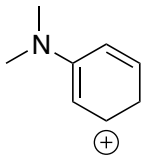
13. Draw the orbitals that show the location of lone pair(s) and π electrons for the following compound.

14. Circle the aromatic ring(s), underline the anti-aromatic ring(s), and do nothing with the non-aromatic ring(s).



15.

a. Draw the important resonance structures of the following ion.



b. Label the major resonance structure.
c. Explain your choice in part b.

16. For the following reaction:

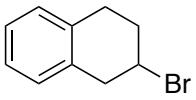
a. Draw the mechanism and products.

b. Predict the direction of the equilibrium.

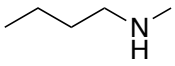
c. Explain your choice in part b.

17. Draw the starting materials that should be used to form each of the compounds below. One of the starting materials in each set should contain a π bond.

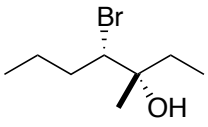
a.



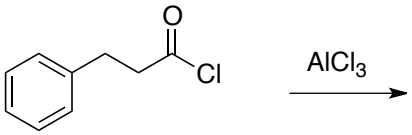
b.



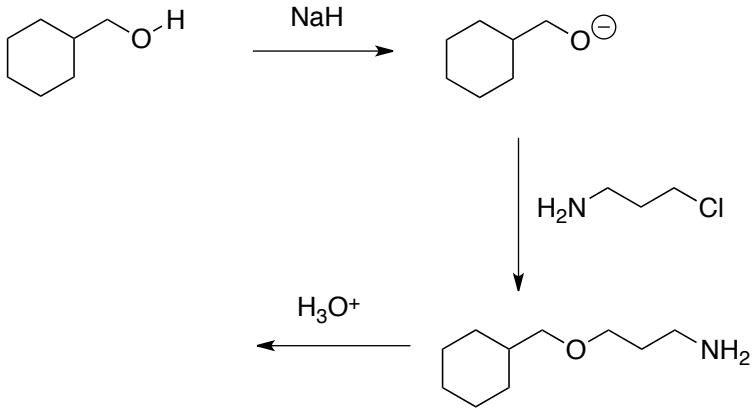
c.



18. Give the full mechanism of the following reaction, including resonance structures.

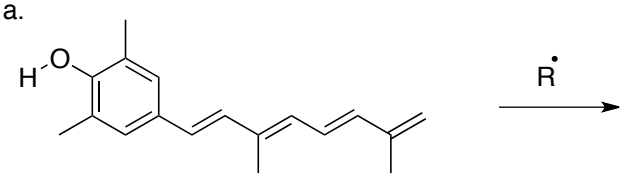


19. Complete the mechanism for each step of the following reaction and predict the structure of the final product.



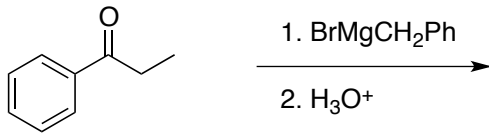
20. Give the full mechanism for each of the following reactions (show the major organic product only).

a.

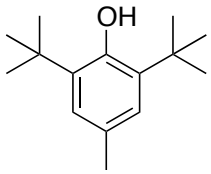


b.

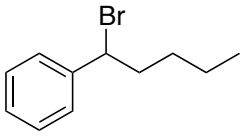
c.



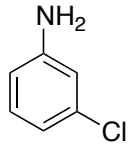
21. Propose a synthesis of the antioxidant BHT, shown below, from phenol (hydroxybenzene) and using any other reagents that you require. You must include a retrosynthesis.



22. Propose a synthesis of the following compound from benzene and using any other reagents that you require.

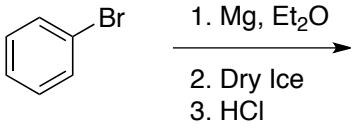


23. Propose a synthesis of the following compound from benzene and using any other reagents that you require. An analysis and brainstorming are also required.



24. BH_3 is stabilized for storage through a reaction with a solvent such as diethyl ether (Et_2O). Propose a mechanism for that reaction.

25. Consider the Grignard reaction of bromobenzene.



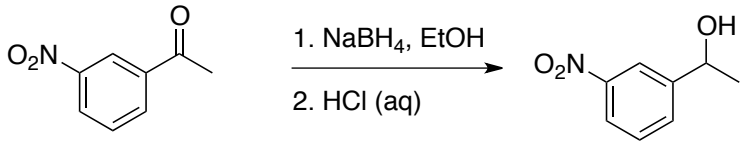
a. Draw the Lewis structure of dry ice.

b. The literature mp of benzoic acid is 122 °C. If you obtain a melting point of 115 °C, what does that tell you about your product?

c. When the solution boils during this reaction, what is present in the bubbles? Name the molecule(s), as appropriate.

d. Draw and label the apparatus used in that reaction.

26. Consider the reduction of nitroacetophenone:



Procedure: After adding a solution of 3M HCl to the reaction mixture, pour the mixture into a separatory funnel and rinse the flask with approximately 5 mL of dichloromethane (density = 1.32 g/mL). Extract the aqueous layer with 2 additional portions of 5 mL portions of dichloromethane and collect all the organic extracts in the same flask.

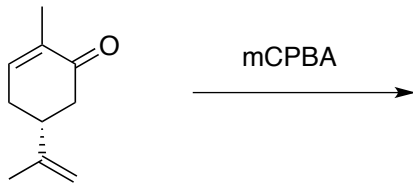
a. Draw and label a diagram of the separatory funnel when the mixture (and dichloromethane) are first poured in.

b. Draw two mechanisms to explain the two key roles of the HCl.

c. A solution of HCl (aq) contains almost no HCl. What are the species that are actually present?

27.

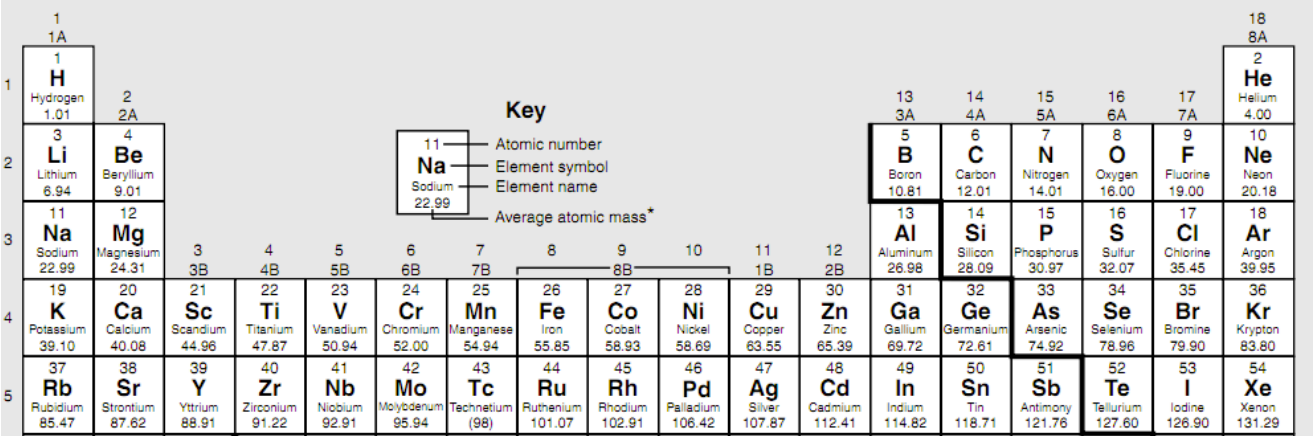
a. Draw the mechanism for the reaction of carvone with mCPBA.



b. Explain the regioselectivity of the reaction (i.e. why does one π bond react preferentially over the other)?

c. When you did a TLC of the reaction mixture, you dipped the TLC plate in a solution of potassium permanganate (the purple solution). Why did the spots on the TLC change colour?

d. This (R) enantiomer of carvone smells like spearmint, while the (S) enantiomer smells like caraway (a spice). Explain why there is a difference in smells when the structures are so similar.



1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 **H** Hydrogen 1.01																	2 **He** Helium 4.00
3 **Li** Lithium 6.94	4 **Be** Beryllium 9.01											5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	10 **Ne** Neon 20.18
11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31											13 **Al** Aluminum 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.95
19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93	28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92	34 **Se** Selenium 78.96	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29

Acid	Approximate pK_a
$HSbF_6$	<-12
HI	-10
H_2SO_4	-9
HBr	-9
HCl	-7
$C_6H_5SO_3H$	-6.5
$(CH_3)_2\overset{+}{O}H$	-3.8
$(CH_3)_2C{=}\overset{+}{O}H$	-2.9
$CH_3\overset{+}{O}H_2$	-2.5
H_3O^+	-1.74
HNO_3	-1.4
CF_3CO_2H	0.18
HF	3.2
$C_6H_5CO_2H$	4.21
$C_6H_5NH_3^+$	4.63
CH_3CO_2H	4.75
H_2CO_3	6.35
$CH_3COCH_2COCH_3$	9.0
NH_4^+	9.2
C_6H_5OH	9.9
HCO_3^-	10.2
$CH_3NH_3^+$	10.6
H_2O	15.7
CH_3CH_2OH	16
$(CH_3)_3COH$	18
CH_3COCH_3	19.2
$HC{\equiv}CH$	25
H_2	35
NH_3	38
$CH_2{=}CH_2$	44
CH_3CH_3	50