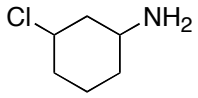
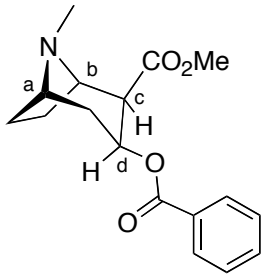
**Problem Set 3** **Name_____**

1) Consider the following molecule:




(16 pts) Draw all the possible stereoisomers, and label the stereocenters in each drawing as *R*, or *S*. (**Use wedged and hatched bonds** to represent stereochemistry - **not chair conformations**.)

2) Consider the structural formula for cocaine:




a) (4 pts) Label the stereocenters (**a**, **b**, **c**, and **d**) either *R* or *S*. Build a model to see how carbon ***a*** is configured. It can be hard to see.
b) (4 pts) Draw the full structure of cocaine having the opposite stereochemistry at the stereocenter labeled **c** and **d**.

c) (2 pts) What is the relationship between the molecule you just drew and cocaine drawn above?

3) (4 pts) Draw (in the most stable chair conformation) the meso isomer of 1,3-dibromocyclohexane.

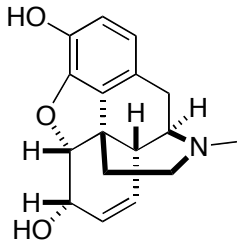
4) Using wedged and hatched bonds:

a) (4 pts) Draw (2*R*,3*R*)-2,3-dichlorobutane.

b) (4 pts) Draw the enantiomer of the molecule you drew above.

c) (4 pts) Draw a diastereomer. Is this diastereomer chiral?

5) Morphine is the most medicinally useful of the opium alkaloids. Alkaloids are amines isolated from natural (usually plant) sources. To date, the best way of obtaining morphine is through isolation from the opium poppy.




(-)-Morphine

a) (10 pts) Identify the five chiral centers as either *R* or *S*.

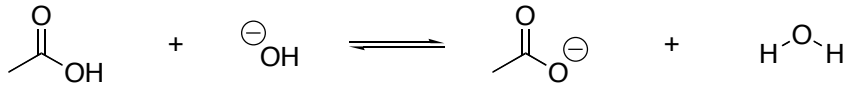
b) (4 pts) How many stereoisomers are possible (assuming no meso isomers)?

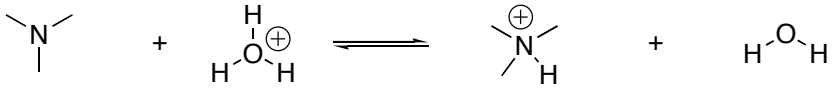
c) (5 pts) A research group devised a synthesis of (-)-morphine. At the end of the synthesis, they measured an optical rotation for their synthetic morphine of -5.0˚ using a 1 dm length sample tube with a concentration of 0.04 g/ml in methanol at 25˚ C.

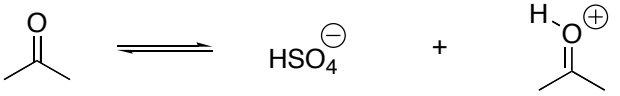
Calculate the specific rotation:

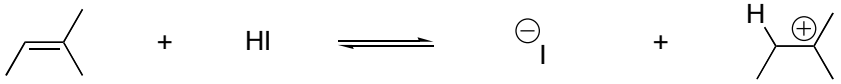
d) (4 pts) What is the percent optical purity of the synthetic morphine if the known specific rotation of pure (-)-morphine at 25˚ C is -132˚?

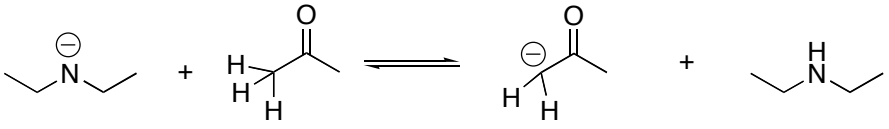
6) (5 pts each) For each of the following reaction equations, label the acid and base on the left side of the reaction arrow, and label the conjugate acid and the conjugate base on the right side of the reaction arrow.

A) 

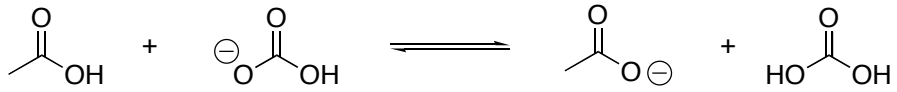
B) 

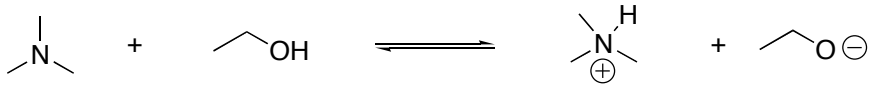
C) $H_2SO_4$ + 

D) 

E) 

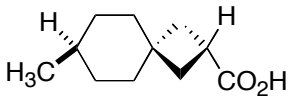
7) (5 pts each) Circle the side of the equation on which the equilibrium for each reaction lies.

A) 

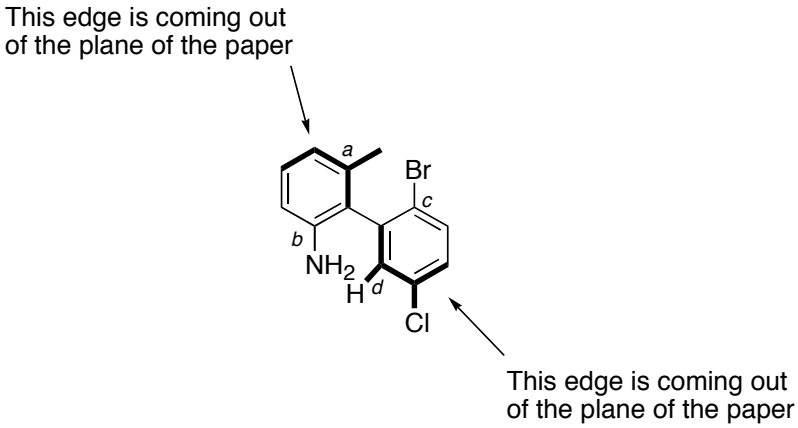

B) 

**Extra Credit:** (10 pts) For each of the following molecules, decide if the molecule is chiral or achiral. Hint: build models so you can more easily see the 3-D structure.

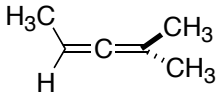
A)




B) The substituents on the carbons labeled ***a, b, c,***and ***d*** prohibit free rotation about the single bond connecting the two rings (steric strain is too high). Because they can't freely rotate, "conformations" can't be interconverted (they are called "atropisomers" rather than conformations). Given that information, is this molecule chiral?




C)




D) How many stereocenters are there TOTAL for the three structures?