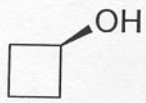
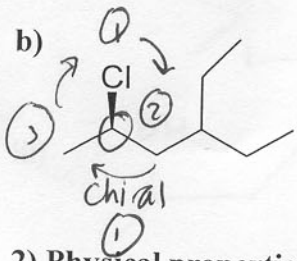
1) Nomenclature and Chirality (5 marks): Give the IUPAC name for the following molecules. Circle any chiral centres and indicate whether the centre is R or S (show your work)

a)



cyclobutanol (1)
achiral (1)

b)



2-chloro-4-ethylhexane (1)

R (1)

2) Physical properties:

a) (1 mark) Why does ethanol (CH_3CH_2OH) boil at a higher temperature than dimethylether (CH_3OCH_3)?

H-bonding in ethanol is stronger than H-bonding (minimal) in ether. Ether has only dipole-dipole

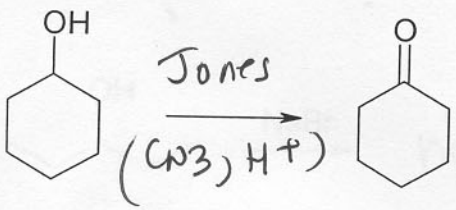
b) (1 mark) Why is bromomethane (CH_3Br) less water soluble than methanol (CH_3OH)?

CH_3Br cannot H-bond effectively with H_2O (due to size of Br), methanol can.

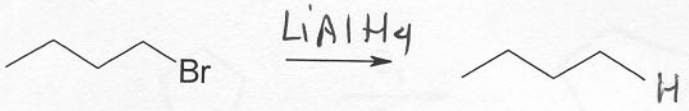
3) Chemistry:

a) Show the reagents necessary for each reaction. (Write the reagents over the arrows) **(8 marks)**

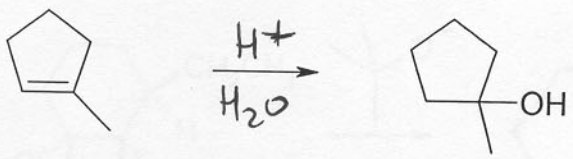
i)



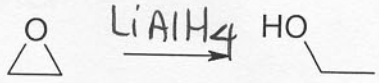
ii)



iii)

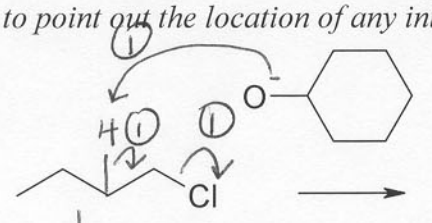


iv)



4. Mechanisms:

a) **(10 marks)** Which type of mechanism (S_N1, S_N2, E1, or E2) do you think occurred in the reaction shown below? *Justify your choice for full marks.* Draw out the mechanism using curved arrows to show electron movement. *Be sure to draw in all intermediates or transition states.* Draw the energy diagram that corresponds to this mechanism. *Be sure to point out the location of any intermediates or transition states on the diagram.*



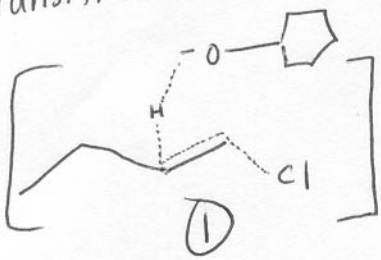
① Look at the products
double bond = elimination

② bulky base ⇒ can't be substitution

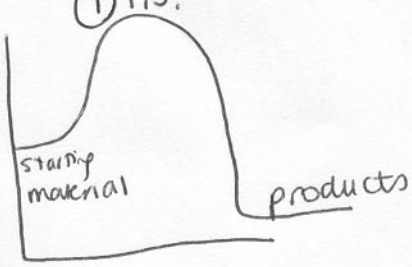
③ 1° alkyl halide ⇒ can't make a stable carbocation ∴ E2

3 marks

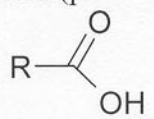
Transition state



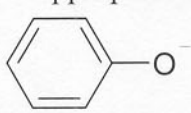
① T.S.



b) pKa (4 marks): Is the phenolate anion (pKa = 10) a strong enough base to deprotonate a carboxylic acid (pKa = 5)? Use the appropriate chemical equations to show your work.

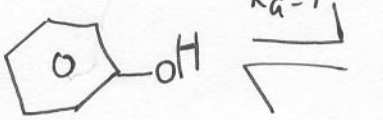


carboxylic acid

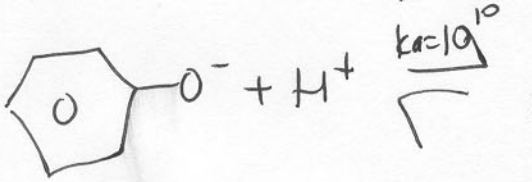


phenolate

$RCOOH \rightleftharpoons RCOO^- + H^+$ $K_a = 10^{-5}$



$K_a = 10^{-10}$ $+ H^+ \Rightarrow$ invert



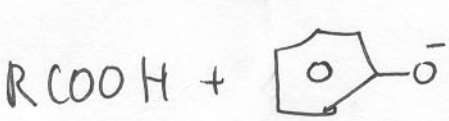
$K_a = 10^{10}$

$K = (10^{10})(10^{-5})$

$= 10^5$

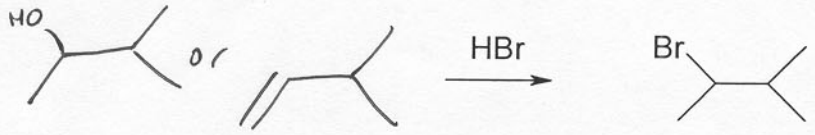
> 1

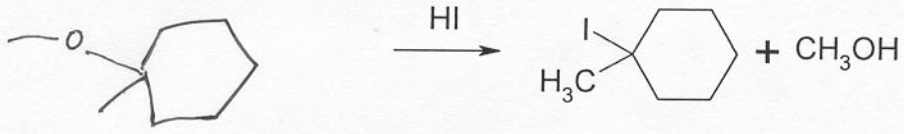
$\therefore$ YES!

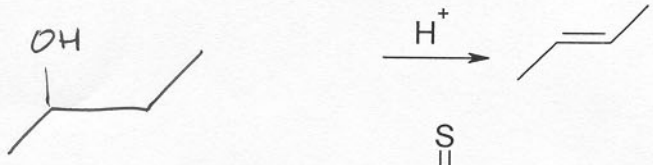


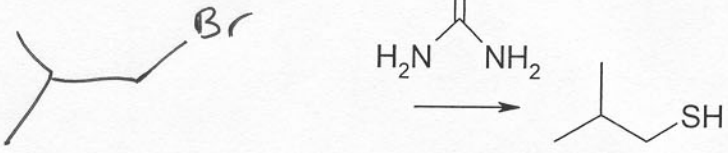
K

b) Show the starting material that will lead to the product shown. (Fill in the blank space on the left of the arrow) **(8 marks)**

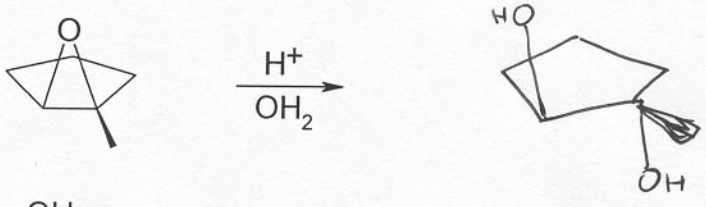
i) 

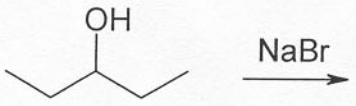
ii) 

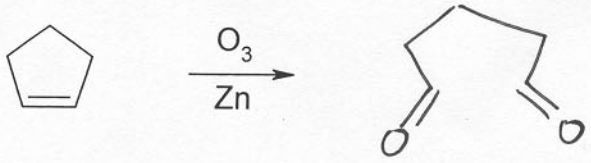
iii) 

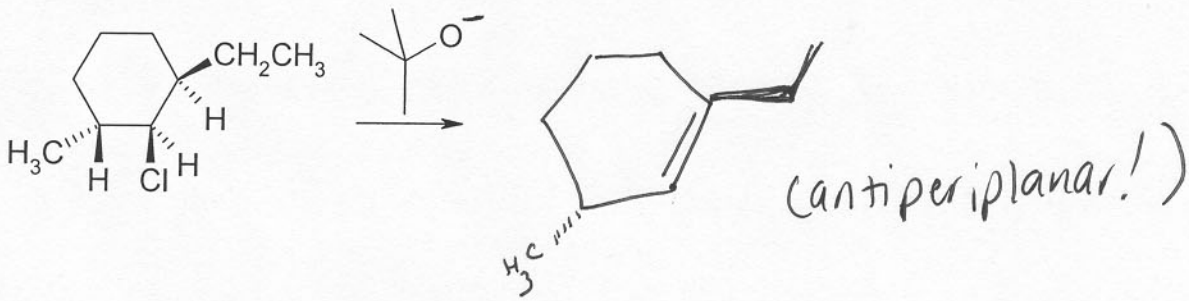
iv) 

c) Show the *major* expected product for the following reactions. (Fill in the blank space on the right of the arrow—don't forget regiochemistry and stereochemistry, when necessary) **(8 marks)**

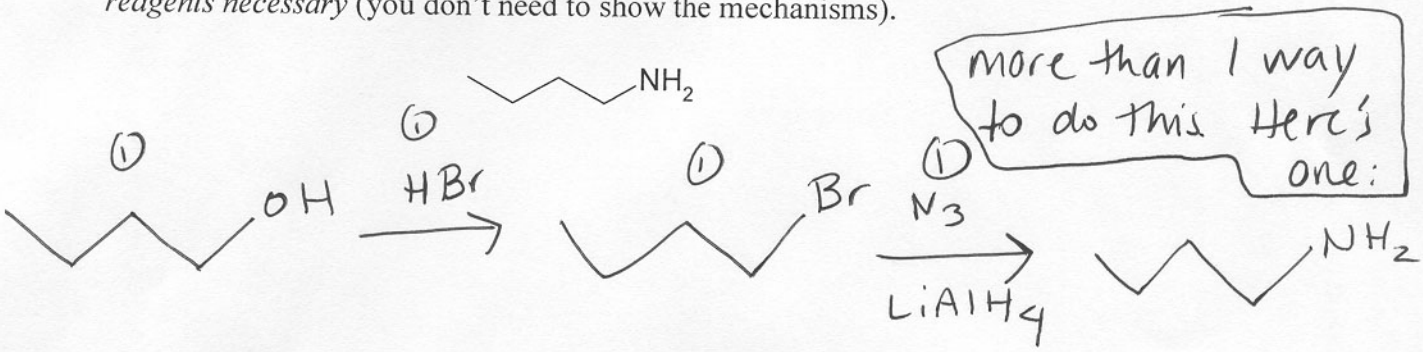
i) 

ii) 

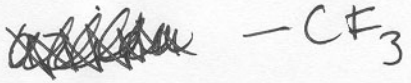
iii) 

iv) 

5. Synthesis (5 marks):
How would you synthesize the molecule below from an *alcohol*? Write out all the reactions you will need to get to this final product. *Show all the starting materials and reagents necessary* (you don't need to show the mechanisms).



Bonus: (1 mark) What functional group in Prozac makes it effective in the treatment of depression?



Rough work or for extra space