

CHUKA UNIVERSITY

SECOND YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE)

CHEM 231: ORGANIC CHEMISTRY II

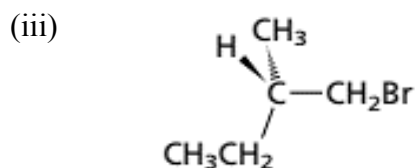
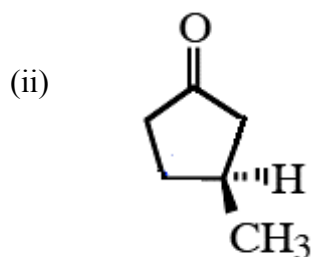
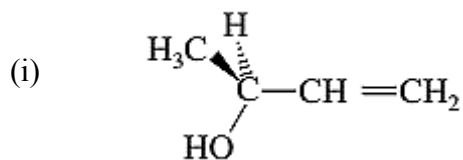
STREAMS: BED SCI & BSC (Chemistry, Industrial chemistry, Biochemistry, Biomedical science and technology, Biology and Mathematics)

INSTRUCTIONS

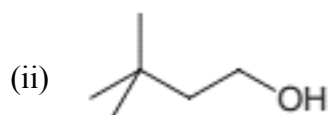
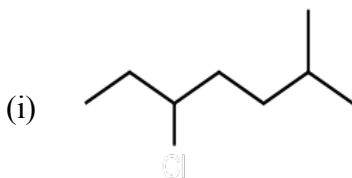
Answer question **One** (Compulsory) and any other **Two** questions

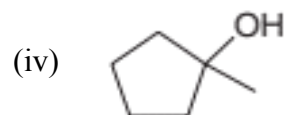
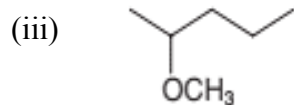
QUESTION ONE (30 MARKS)

a) Assign the R and S designation to each of the following stereocenters (6 marks)



b) Give the IUPAC names of the following compounds (4 marks)





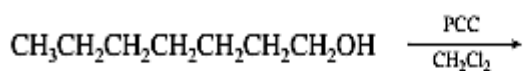
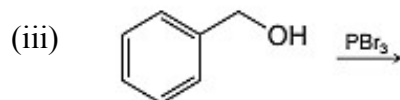
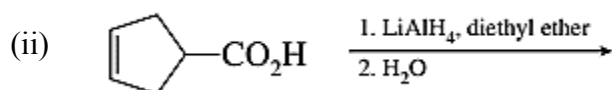
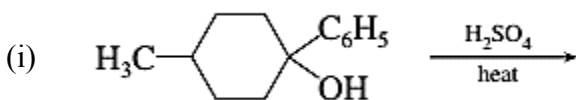
c) 0.050 g of sample is dissolved in 2.0 mL of ethanol, and this solution is placed in a 2.0-cm polarimeter tube. The observed rotation is $+0.043^\circ$. Calculate the specific rotations of the sample taken at 25°C using the sodium D line. (2 marks)

d) Consider the following $E2$ reaction:



- What is the rate equation for this reaction? (1 mark)
- Using proper Lewis structures and curved arrow formalism, propose a mechanism for this process (2 marks)
- Draw an energy diagram. Label the axes, starting materials, products and draw the structure of the transition state for the rate limiting step (2 marks)

e) Predict the major product of each of the following reactions (8 marks)



(iv)

f) Give the mechanistic symbols (SN1, SN2, E1, E2) that are most consistent with each of the following statements: (3 marks)

(i) Methyl halides react with sodium ethoxide in ethanol only by this mechanism.

(ii) When cyclohexyl bromide is treated with sodium ethoxide in ethanol, the major product is formed by this mechanism.

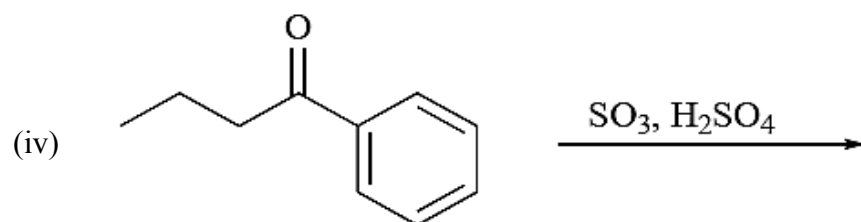
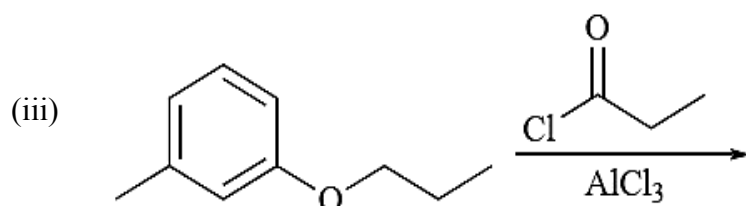
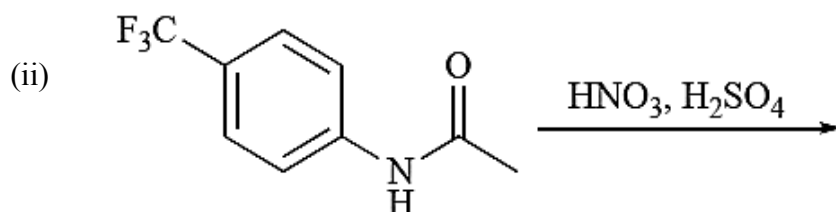
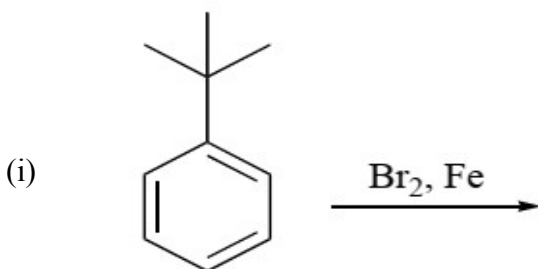
(iii) The substitution product obtained by solvolysis of *tert*-butyl bromide in ethanol arises by this mechanism.

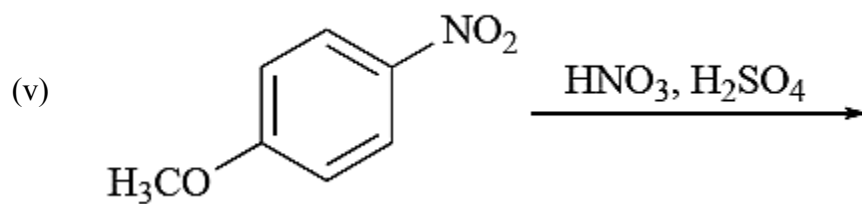
g) State two physical properties of alcohols

(2 marks)

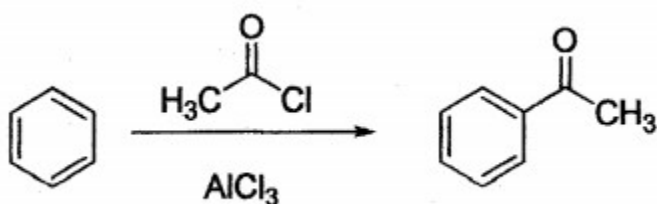
QUESTION TWO (20 MARKS)

a) Draw the major product in each of the following reactions (10 marks)

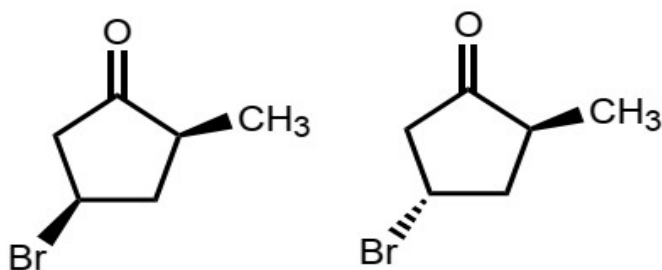




b) Write a stepwise mechanism for the following reaction using curved arrows to show the flow of electrons in each step. Include all important resonance structures. (8 marks)

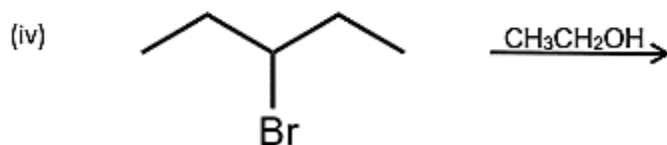
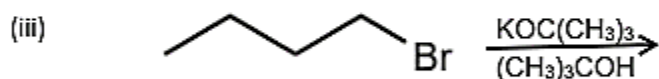
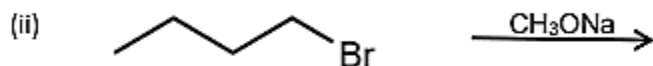


c) State whether it is possible to separate the pair of compounds below by distillation. Briefly explain your answer. (2 marks)



QUESTION THREE (20 MARKS)

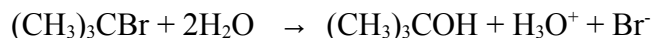
a) Give the product(s) of each of the following reactions. In each case, predict the relative amount of each (i.e. would the product be the only product, major product or minor product). (8 marks)



b) When *tert*-butyl bromide is heated with an equal amount of ethanol in an inert solvent, one of the products is ethyl *tert*-butyl ether. Briefly explain what happens to the reaction rate if; (3 marks)

- (i) The concentration of ethanol is doubled?
- (ii) The concentration of *tert*-butyl bromide is tripled and the concentration of ethanol is doubled?

c) Consider the reaction below:



- i. Write the mechanism of the reaction (5 marks)
- ii. Write the rate equation for the reaction (1 mark)
- iii. Draw the energy diagram illustrating the mechanism (3 marks)

QUESTION FOUR (20 MARKS)

a) Draw the structures of the following compounds

(6 marks)

- (i) *o*-Dibromobenzene
- (ii) *p*-Chlorophenol
- (iii) 2,4,6-Tribromoaniline
- (iv) *o*-Xylene
- (v) *p*-Diisopropylbenzene

(vi) 2,4-Dichlorobenzoic acid

b) Give two factors that account for the resistance to rotation through the high-energy eclipsed conformation. (2 marks)

c)(i) Using Newman projections, draw the various 2-methylbutane conformations that arise from rotation about C₂-C₃ bond at each 60° of rotation. Place C₂ in front represented by three bonds coming together in a Y-shape and C₃ at the back, represented by a circle with three bonds pointing out from it. (6 marks)

(ii) Sketch a graph of potential energy vs dihedral angle showing the relative energy differences that arise from rotation about C₂-C₃ bond of 2-methylbutane. Include in your drawing the staggered and eclipsed Newman projections (4 marks)

d) Give 2 uses of alkyl halides (2 marks)