UNIVERSITY OF RUHUNA

BACHELOR OF SCIENCE SPECIAL DEGREE LEVEL-I (SEMESTER II) EXAMINATIONS DECEMBER - 2016

SUBJECT: CHEMISTRY

COURSE UNIT: CHE 4213 **(Advanced Organic Chemistry)** **TIME: Three (03)** hours

Answer **ALL** the Questions

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01 Answer **all** parts.

(a) (i) What is meant by "Ethnopharmacology"?

(ii) List five (05) solvent extraction methods used in Natural Product extraction.

(iii) State the limitation when water is used as a solvent in natural product extractions.

(20 marks)

(b) (i) What are possible functions of alkaloids in plants?

(ii) List main characteristics of alkaloids. Giving an example, explain briefly "Protoalkaloids".

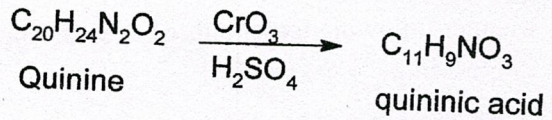
(iii) Write down the steps that would be followed in extraction of volatile alkaloids from a plant.

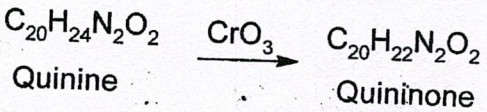
(iv) Name three tests that can be used to detect the presence of alkaloids in a plant extract. Write down the observation for each test.

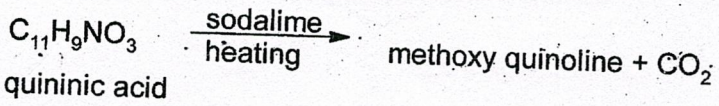
(24 marks)

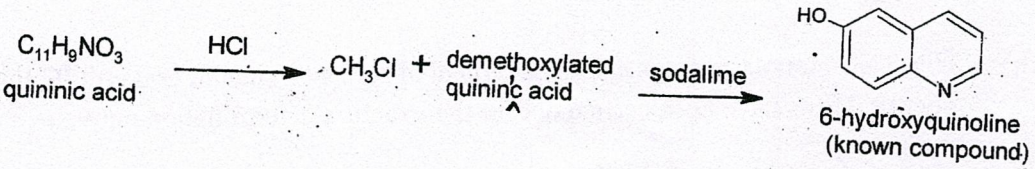
(c) Quinine is the main alkaloid present in Cinchona bark and used as the treatment of Malaria. The molecular formula of quinine has been determined as $C_{20}H_{24}N_2O_2$

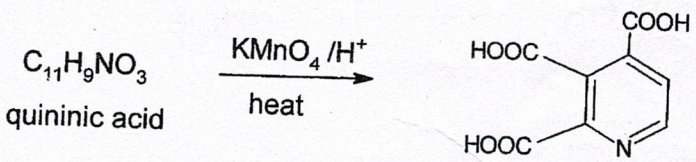
(i) Using the results of the chemical analysis given below, deduce the structure of Quininic acid which is the basic unit involved in the formation of quinine.









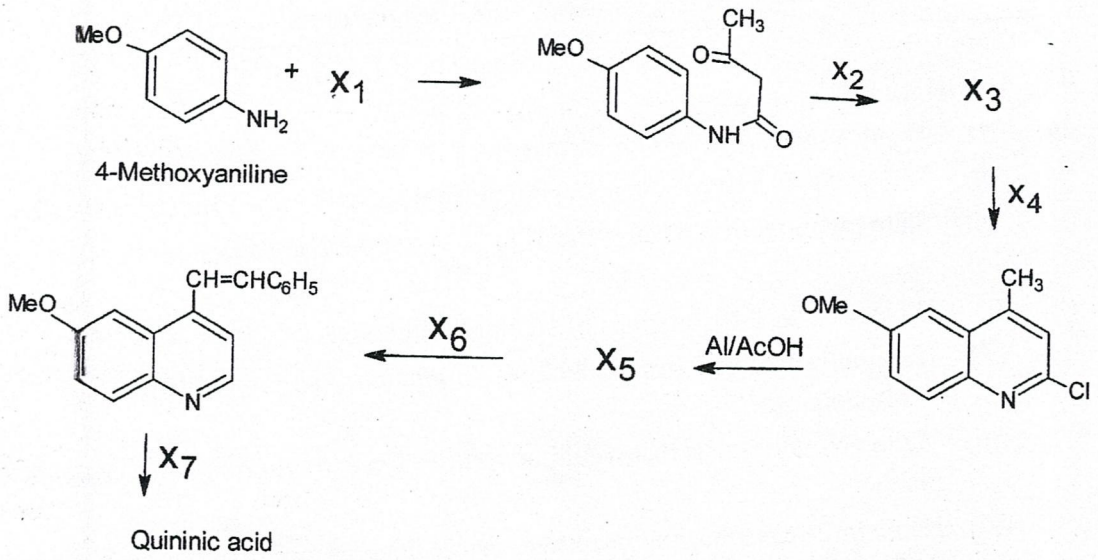


pyridine-2,3,4-tricarboxylic acid

(ii) Explain the observations of above reactions using the structure proposed for quininic acid.

(24 marks)

(iii) Complete the synthesis of quninic acid given below by filling the missing reagents and intermediate states $X_1 - X_7$.

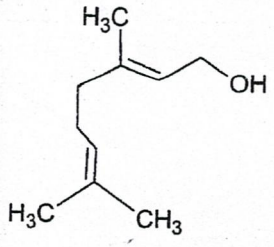


(32 marks)

02 Answer **all** parts.

(a) (i) Draw the structure of isoprene unit.

(ii) State isoprene rule and show whether following terpenoids obey with isoprene rule.



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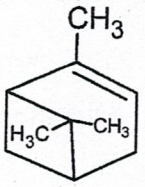
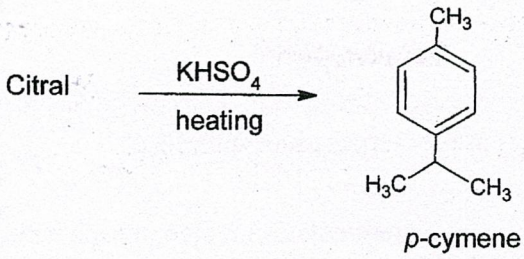


II

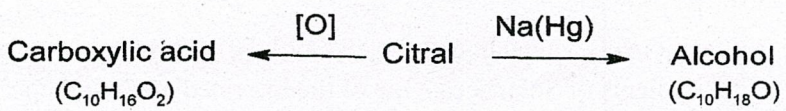
(20 marks)

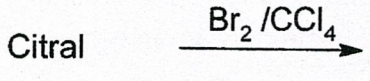
(b) Citral is a monoterpenoids and main terpenoid present in lemon grass oil. Following chemical tests have been carried out for the structure determination purpose of citral.

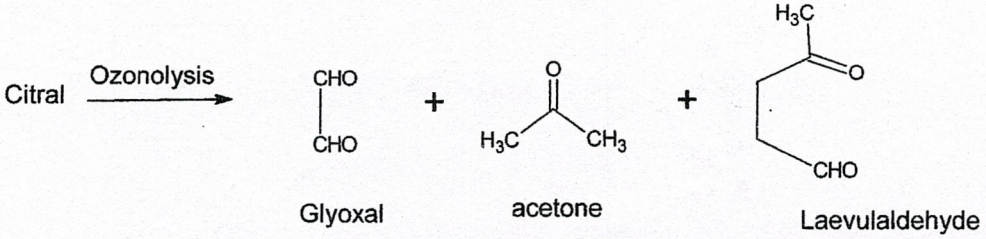
Citral ($C_{10}H_{16}O$) + NH_2OH ⟶ oxime



p-cymene





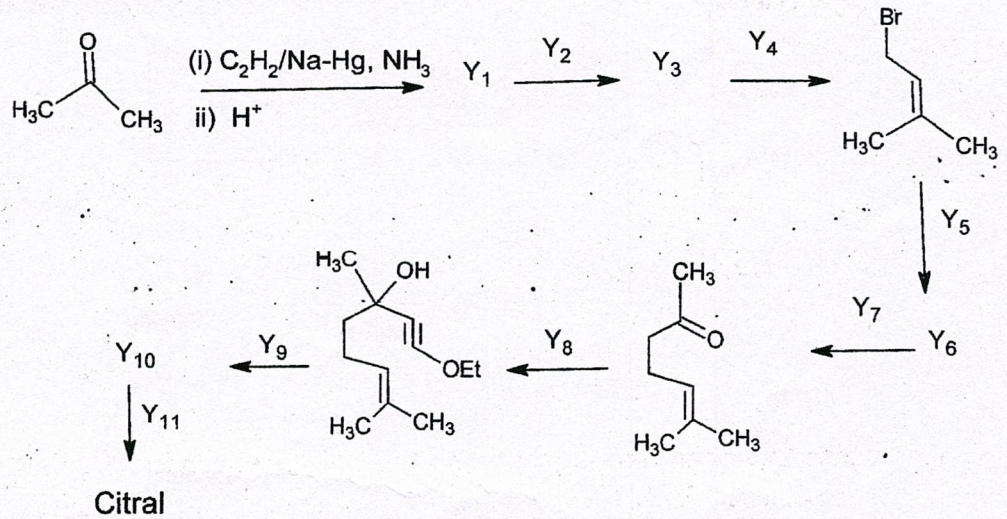


Glyoxal acetone Laevulaldehyde

(i) Based on the results of the chemical analyses above, deduce the structure of *Citral.*
(ii) Using the structure proposed in (i), explain the formation of products in each reaction above.

(26 marks)

(c) (i) Complete the synthesis scheme of Citral given below by proving missing reagents and intermediates formed, Y_1 - Y_{11}.



(ii) Citral exits in two isomeric forms. Draw the structures of the two isomers of citral.
(iii) Give analytical methods to identify two isomers drawn above.

. (36 marks)

(d) (i) Write down the steps that would follow to extract steroids from a plant/part of a plant.
(ii) What is the main biochemical role(s) of cholesterol?

(18 marks)

03 Answer **all** parts.

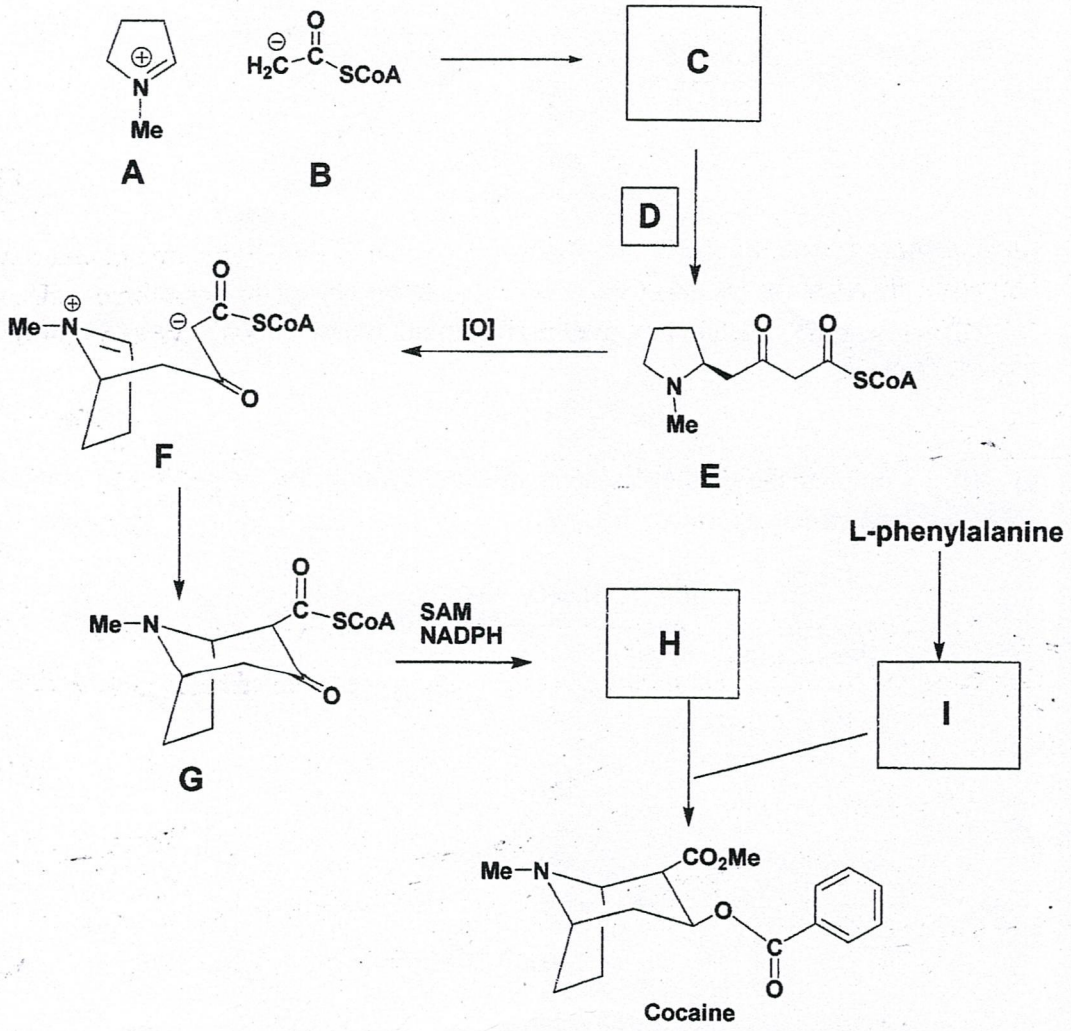
(a) (i) Name the major pathways use for terpene biosynthesis.

(10 marks)

(ii) Draw the structures of the main intermediates involve in each pathway.

(18 marks)

(b) Cocaine is a medicinally valuable tropane alkaloid derived from L-ornithine and L-phenylalanine in plants of Solanacea. One of the intermediate involve in biosynthesis of cocaine is N-methyl-Δ'-pyrrolinium cation(**A**) starting from L-ornithine. The biosynthesis pathway for cocaine starting from the above cation **A** is given below.



(i) Draw the structures of missing intermediates and reagents **C**, **D**, **H** and **I**.

(ii) Write down the mechanism from the formation of **G** from **F**.

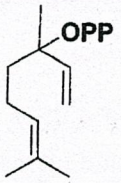
(iii) Name the reaction involved in **F** to **G**.

(iv) Which type of transformations take place from **E** to **F**.

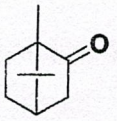
(24 marks)

(c) Giving suitable mechanism(s) show how following biosynthesis take place in living organisms.

(i) Campher and camphene from linalyl pyrophosphate(LPP)



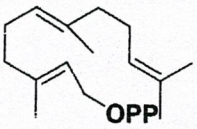
linalyl PP (LPP)



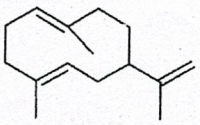
camphor

camphene

(ii) GermacreneA from farnesyl pyrophosphate (FPP)



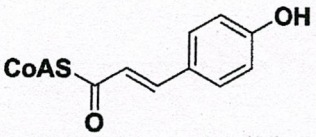
FPP



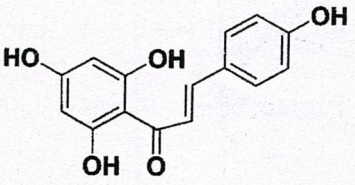
Germacrene A

(28 marks)

(d) Chalcones are the precursors for most of flavanoid compounds. Formation of chalcones in organisms involves the reaction between 4-hydroxycinnamoyl-CoA and three molecules of malonyl-CoA to form polyketide. Depending on the nature of the enzyme responsible, polyketide can be folded to two ways.



4-hydroxycinnamoyl-CoA

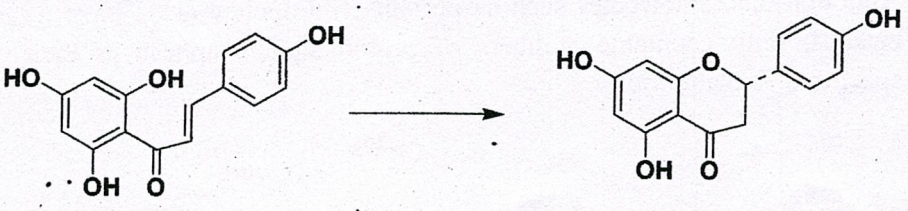


naringenin chalcone

(i) Give the suitable reaction scheme to biosynthesis naringenin chalcone from 4-hydroxycinnamoyl-CoA.

(15 marks)

(ii) Write down the mechanism for the following conversion.



naringenin chalcone

naringenin (a flavanone)

(05 marks)

04 Answer **all** parts.

(a) Answer the following questions pertaining to *J-coupling* in NMR spectroscopy.

(i) Define the term *J-coupling*.

(05 marks)

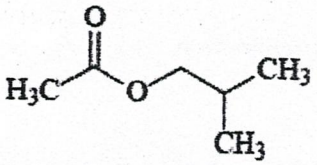
(ii) Sketch the stick diagrams for the coupling patterns of AX_1, AX_2 and AX_3 spin systems in ^1H NMR spectroscopy and derive each multiplet and intensity ratio of the multiplet.

(15 marks)

(iii) Discuss how the splitting patterns of AMX spin system differ from AX_2 spin system by using suitable stick diagrams.

(10 marks)

(b) Answer the following questions based on the compound **M** ($C_6H_{12}O_2$) whose structure is shown below:



(i) Sketch the ^1H- and ^{13}C-{^1H} NMR spectra of **M** separately and describe each of them.

(20 marks)

(ii) What are the differences in ^{13}C DEPT-135 spectrum of the above compound compared to ^{13}C-{^1H} NMR spectrum?

(10 marks)

(iii) Explain briefly the above differences in ^{13}C DEPT-135 spectrum.

(10 marks)

(c) 2D NMR is a useful technique that is widely used in NMR spectroscopy.

(i) Describe briefly the TOCSY and NOESY techniques used in NMR spectroscopy.

(15 marks)

(ii) Although macromolecules such as proteins and nucleic acids have a large number of protons, only countable numbers of proton signals appear in their $^1H/^{15}N$ HSQC spectrum. Explain briefly.

(15 marks)

05 Answer **all** parts.

(a) Explain the differences between the chemical ionization mass spectrum for a compound and its corresponding electron impact ionization mass spectrum.

(10 marks)

(b) A peptide molecule was analyzed by electro spray ionization (ESI) mass spectrometry. It was found that a tetramer of the molecule appears with a residual charge of +7 in a region without interference at an apparent m/z = 791.

What is the mass of the peptide (monomer)?

(15 marks)

(c) The parent ion peak in the mass spectrum for dibromobenzene actually consists of more than one peak.

(i) How many parent ion peaks would there be for dibromobenzene?

(ii) At what masses would they be found, and

(iii) What are their relative intensities? Explain.

(15 marks)

(d) How would the following pairs of isomeric compounds be differentiated by mass spectrometry? Rationalize by fragmentation pathway only

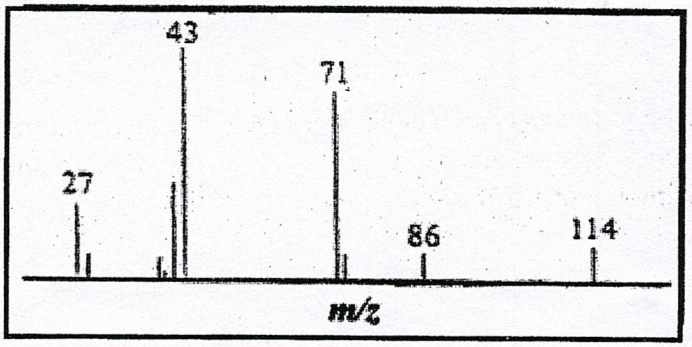
(i) $C_6H_5COCH_2CH_3$ and $C_6H_5CH_2COCH_3$

(ii) $C_6H_5CH_2CH_2CH_3$ and $C_6H_5CH(CH_3)_2$

(iii) $CH_3CH(OH)CH_2CH_3$ and $(CH_3)_3COH$

(40 marks)

(e) The mass spectrum of a compound known to be either 3- or 4-heptanone is shown below. Which ketone is most consistent with the spectrum? Assign the fragments which lead to the peaks at m/z 114, 86, 71, and 43.



(20 marks)

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