



UNIVERSITY EXAMINATIONS

**EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN
CHEMISTRY AND BACHELOR OF SCIENCE IN BIOLOGY**

CHEM 446: CHEMISTRY OF NATURAL PRODUCTS

STREAMS: BSC (CHEMISTRY), BSC (BIO)

TIME: 2 HOURS

DAY/DATE: FRIDAY 06/12/2019

8.30 A.M. – 10.30 A.M.

INSTRUCTIONS:

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

QUESTION ONE [30 MARKS]

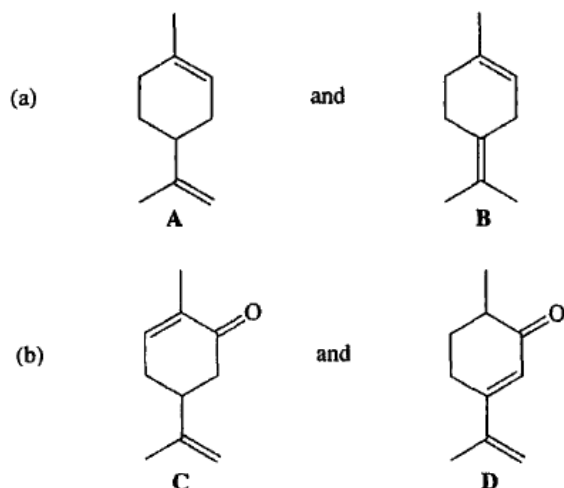
(a) Identify the isoprene units in each of the terpenes. Classify each terpene as monoterpene, diterpene, etc. **(4 Marks)**

(b) Write the stepwise mechanism for biosynthesis of α -pinene from geranyl pyrophosphate **(6 Marks)**

α -pinene

(c) Discuss the commercial importance of terpenoids and steroids. **(4 Marks)**

(d) Explain how each of the following pairs can be distinguished using a physical and a chemical method. **(4 marks)**

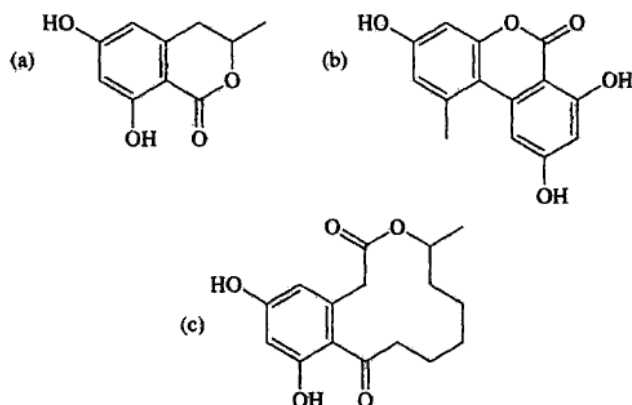


(e) Discuss the four stages of determining the structures of natural products. **(8 marks)**

(f) Explain four roles of secondary metabolites in plants and animals. **(4 marks)**

QUESTION TWO [20 MARKS]

(a) Identify the acetate units in each of the following compounds. **(3 marks)**



(b) Describe how alkaloids are isolated from plant materials. **(6 marks)**

(c) A volatile plant product M, $C_8H_{14}O$, has strong IR absorption at 1717 cm^{-1} . It possess ^1H NMR signals at δ_{H} 1.65 (3H, s), 2.15 (3H, s), 2.4 (4H, m) and 5.20 (1H, t). On ozonolysis, compound M gives, among other products, propanone, and on treatment with iodine and alkali it gives triiodomethane (iodoform). What structural formula can be obtained from:

(i) Its molecular formula **(2 marks)**

(ii) Its IR spectrum **(1 mark)**

(iii) Its ^1H NMR spectrum **(3 marks)**

(iv) Its chemical reactions **(2 marks)**

(v) Deduce the structure of compound M

(3 marks)

QUESTION THREE [20 MARKS]

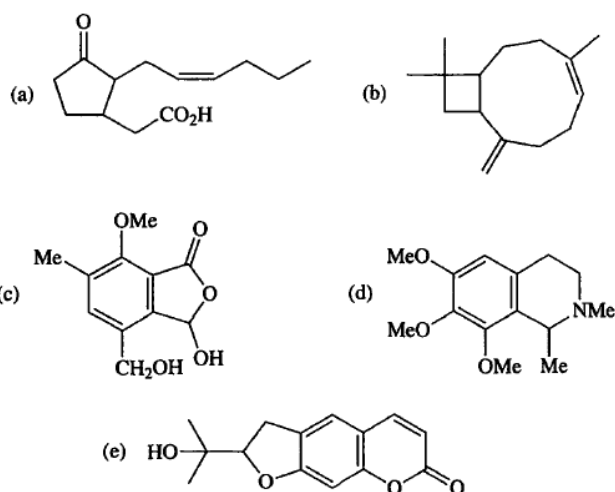
Alkaloid **G**, $C_8H_{13}NO$, is a tertiary base. It has IR absorption at 3500 cm^{-1} and 1H NMR signals at δ 3.0 (5H, m), 3.8 (2H, s) and 5.4 (1H, t, $J = 7\text{ Hz}$). It can be oxidized under mild conditions with MnO_2 to give compound **H**, $C_8H_{11}NO$, which had an IR absorption at 1680 cm^{-1} and a UV absorption at 229 nm. Compound **H** formed a deep-red dinitrophenylhydrazone. On catalytic hydrogenation, **G** absorbed 1 mole of hydrogen to give **I**. This readily formed a monotoluene-*p*-sulfonate, which on reduction with $LiAlH_4$ gave **J**, $C_8H_{15}N$. When **J** was submitted to three successive Hofmann degradations with a hydrogenation after each stage, the C_8 hydrocarbon 3-methylheptane was obtained. Deduce the structure of **G**. (20 marks)

QUESTION FOUR [20 MARKS]

(a) Describe the stepwise biosynthesis of penicillins and cephalosporins. (6 marks)

(b) Explain the mode of action of penicillins and cephalosporins. (2 marks)

(c) State the functions of Vitamin A. (2 marks)

(d) Indicate the biosynthetic structural units [acetate, C_1 (methionine), C_5 (isoprene), C_6-C_3 (shikimate)] that form the carbon skeletons of the following compounds. Some of these compounds may be formed by combination of more than one pathway. (5 marks)

(e) Describe the biosynthesis of steroid hormones from farnesyl pyrophosphate. (5 marks)

