

**CHUKA UNIVERSITY EXAMINATIONS (2019/2020)**

**CHEM 446: CHEMISTRY OF NATURAL PRODUCTS**

**STREAMS: BSc (CHEMISTRY); BSc(Bio)**

**TIME: 2 HRS**

**INSTRUCTIONS**

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

**QUESTION ONE [30 MARKS]**

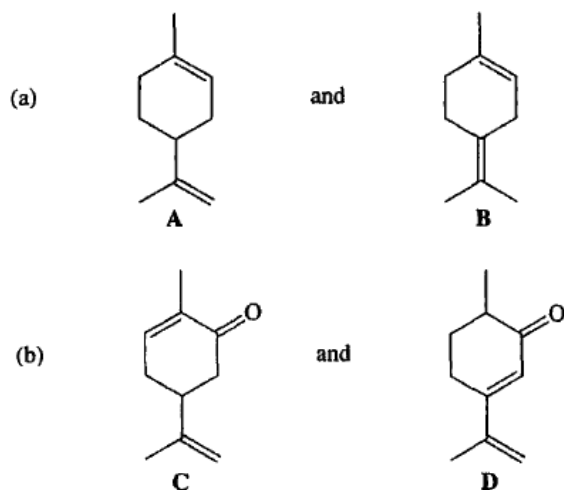
(a) Identify the isoprene units in each of the terpenes. Classify each terpe~~rne~~ as monoterpene, diterpene, etc (**4 Marks**)

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

$\alpha$ -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**)

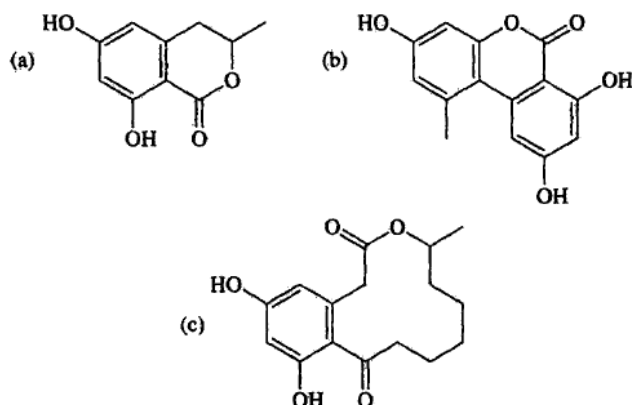


(e) Discuss the four stages of determining the structures of natural products (**8 marks**)

(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  $1717\text{ cm}^{-1}$ . It possess  $^1\text{H}$  NMR signals at  $\delta_{\text{H}}$  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 marks**)

(iii) Its  $^1\text{H}$  NMR spectrum (**3 marks**)

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

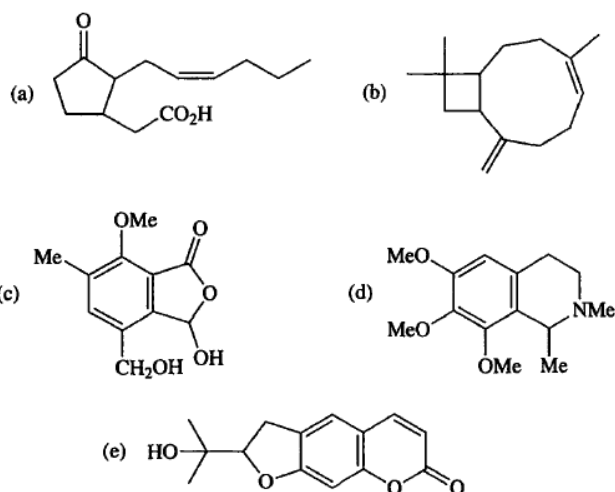
(v) Deduce the structure of compound M (**3 marks**)

### QUESTION THREE [20 MARKS]

Alkaloid **G**,  $C_8H_{13}NO$ , is a tertiary base. It has IR absorption at  $3500\text{ cm}^{-1}$  and  $^1H$  NMR signals at  $\delta$  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  $1680\text{ cm}^{-1}$  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)