

National Exams  
04-BS-12, Organic Chemistry  
December 2013

3 hours duration

Notes

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.  
No calculator is allowed.
3. ANSWER ALL FIVE PROBLEMS
4. Each problem is of equal value
5. Note that the questions (a), (b), (c), (d), (e), (f) or (g) of each problem can be treated independently

**Problem No. 1 (20 points total)**

a) 10 points

2,2,4—trimethyl pentane also called iso-octane, is the standard of excellence used for determining the octane rating of gasoline. Draw the structural and condensed formula of this molecule.

b) 6 points

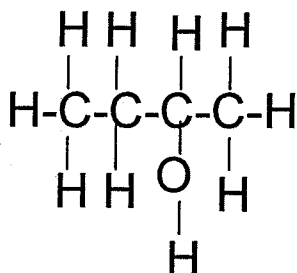
Classify each of the carbon atoms in the following structures as either primary, secondary or tertiary

- i) 2,2-dimethyl butane
- ii)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}_3$
- iii) Hexane

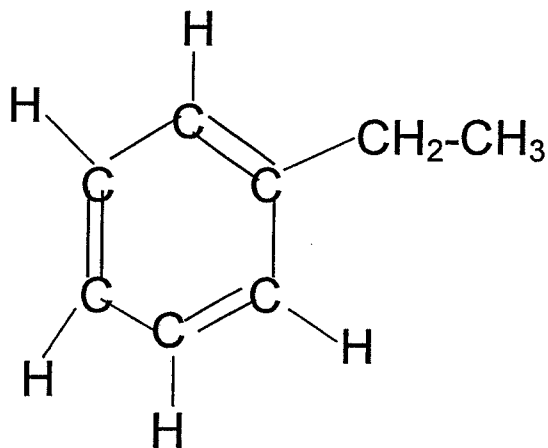
a) (4 points)

Indicate and explain in a concise manner to which family of organic compounds, the following compounds belong?

i)



ii)



**Problem No. 2 (20 points total)**

a) 10 points

i) Provide a concise definition of an isomer (also called structural or constitutional isomer)

ii) Draw all the constitutional isomers having the molecular formula  $C_6H_{14}$

b) 5 points

Write the combustion reaction of cyclohexane in the presence of excess molecular oxygen, to produce carbon dioxide and water and large amounts of energy as heat.

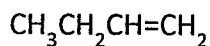
c) 5 points

Write the balanced equation of the mono-chlorination reaction of propane.

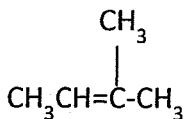
**Problem No. 3 (20 points total)**

a) 10 points

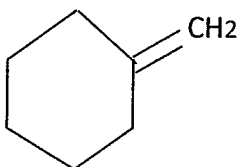
What would be the major product obtained from the addition of HBr to each of the following compounds?



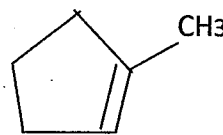
(i)



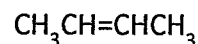
(ii)



(iii)



(iv)



(v)

b) 4 points

Propose a chemical structure for the compounds that have the following chemical formulas:

(i) An amine having the formula  $C_3H_9N$

(ii) An ether that has the formula  $C_4H_{10}O$

c) 6 points

Propose a synthesis method for ethanol ( $CH_3CH_2OH$ ) from methanol ( $CH_3OH$ )

**Problem No. 4 (20 points total)**

(a) 10 points

What is structure of the products of the reaction of 1 mole of pentyne-2 with the following reactants?

(i) 1 mole of  $H_2$  in the presence of  $Pd/BaSO_4$

2

(ii) 2 moles of  $H_2$  in the presence of nickel

2

(iii) 1 mole of  $Cl_2$

2

(iv) 1 mole of  $HCl$

2

(v) 2 moles of  $HCl$

2

b) 10 points

i) Write the structural formula of the isomers of the alcohol of formula  $C_4H_{10}O$

4

ii) What simple reactions would permit to identify them?

4

iii) Show that one of these reactions is an oxidation-reduction reaction

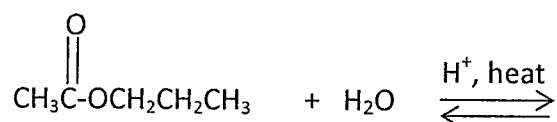
2

**Problem NO. 5 (20 points total)**

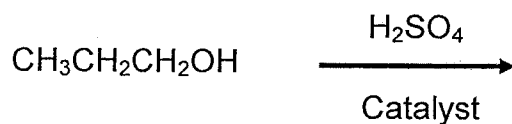
a) 10 points

Complete each of the following reactions and provide expected products:

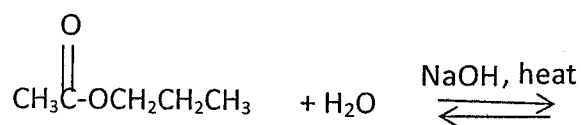
i)



ii)



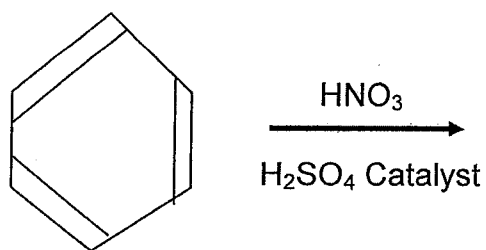
iii)



iv)



(v)



b) 4 points

What are the products of dehydration of:

i) 3-methyl-2-butanol?

ii) CH<sub>3</sub>CH<sub>2</sub>OH?

c) 6 points

Write the balanced equations for the hydrogenation of:

- i) 1-butene
- ii) cis-2 butene
- iii) Dimethylacetylene