AS
ACADEMIC STUDIO

PRACTICE EXAM

Organic Chemistry 2

15 problems · one per page · show all your work

Name _____ Date _____ Score _____ / 15

Before you start

Draw every structure as you work. For spectroscopy problems, write the formula and degrees of unsaturation first.

How to use this exam

Give yourself about 2 hours and plenty of scratch paper. Work each problem on its own page, then check your answers with the separate answer key.

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PROBLEM 1 OF 15

IR spectroscopy

Three isomers of C_3H_6O give these IR spectra. Identify each. (a) Strong peak at 1715 cm^{-1}, nothing at 2720 or 3300. (b) Strong peak at 1730 cm^{-1} plus two weak peaks near 2720 and 2820 cm^{-1}. (c) Broad peak at 3300 cm^{-1} and a peak at 1645 cm^{-1}, no peak near 1700.

PROBLEM 2 OF 15

^{1}H NMR

$C_4H_8O_2$ shows δ 1.26 (triplet, 3H), 2.05 (singlet, 3H), 4.12 (quartet, 2H). Identify it.

PROBLEM 3 OF 15

Degrees of unsaturation

C_8H_{10} shows ^1H NMR peaks at δ 7.1–7.3 (multiplet, 5H), 2.63 (quartet, 2H) and 1.23 (triplet, 3H). Identify it.

PROBLEM 4 OF 15

Mass spectrometry with NMR

A compound has molecular ion peaks at m/z 122 and 124 in a 1:1 ratio. Its ^{1}H NMR shows δ 1.71 (doublet, 6H) and 4.21 (septet, 1H). Identify it.

PROBLEM 5 OF 15

Conjugated dienes: kinetic vs thermodynamic

1,3-Butadiene reacts with HBr. What is the major product at −80 °C, and at 40 °C?

PROBLEM 6 OF 15

Diels–Alder

What forms when 1,3-butadiene reacts with maleic anhydride (a cis dienophile)?

PROBLEM 7 OF 15

Aromaticity

Classify each as aromatic, antiaromatic or nonaromatic: benzene, cyclobutadiene, cyclooctatetraene, cyclopentadienyl anion, cycloheptatrienyl (tropylium) cation, pyridine.

PROBLEM 8 OF 15

Electrophilic aromatic substitution: directing effects

(a) Rank by rate of nitration: benzene, toluene, nitrobenzene, anisole, chlorobenzene. (b) Where does the nitro group go on anisole and on nitrobenzene?

PROBLEM 9 OF 15

Synthesis order on a benzene ring

From benzene, make (a) m-bromonitrobenzene and (b) p-bromonitrobenzene.

PROBLEM 10 OF 15

Oxidizing alcohols

Give the products: (a) 1-butanol + PCC; (b) 1-butanol + $Na_2Cr_2O_7$, H_2SO_4; (c) 2-butanol + PCC; (d) 2-methyl-2-propanol + $Na_2Cr_2O_7$, H_2SO_4.

PROBLEM 11 OF 15

Opening epoxides

2,2-Dimethyloxirane is opened (a) with $NaOCH_3$ in CH_3OH and (b) with CH_3OH and a little H_2SO_4. Give each product.

PROBLEM 12 OF 15

Grignard synthesis

Give three Grignard routes to 2-phenyl-2-butanol, $C_6H_5C(OH)(CH_3)CH_2CH_3$.

PROBLEM 13 OF 15

Carboxylic acid derivatives

(a) Rank by reactivity: amide, acid chloride, ester, anhydride. (b) Predict: acetyl chloride + methanol; methyl acetate + NH_3; acetamide + methanol.

PROBLEM 14 OF 15

Aldol reaction

Propanal is treated with dilute NaOH. Give the aldol product, then the product after heating.

PROBLEM 15 OF 15

Acetoacetic ester synthesis

Show how to make 2-pentanone from ethyl acetoacetate.