CHEMISTRY 2323: Fundamentals of Organic Chemistry I

Final Exam

December 9, 2025

Prof. Ognjen Š. Miljanić

Name: Answer Key (print legibly) Last First

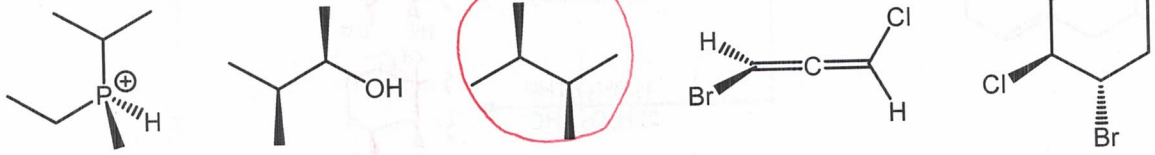
Student ID Number: N/A

Read all directions very carefully. Write your answer legibly in the designated spaces. Total number of points is 400. This exam is printed on both sides and should have eight pages, with the last two intentionally left empty.

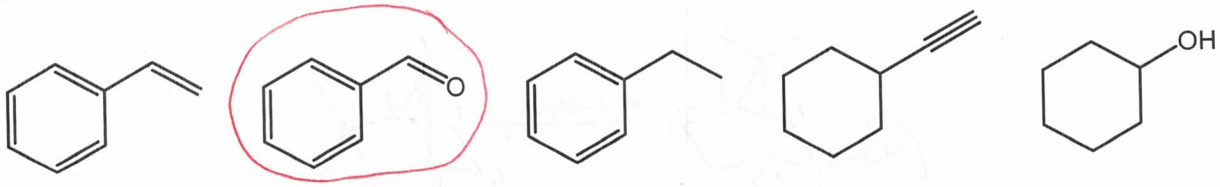
40

1. This question has several parts. In each, **circle only one entry**. *5×8 = 40 points*

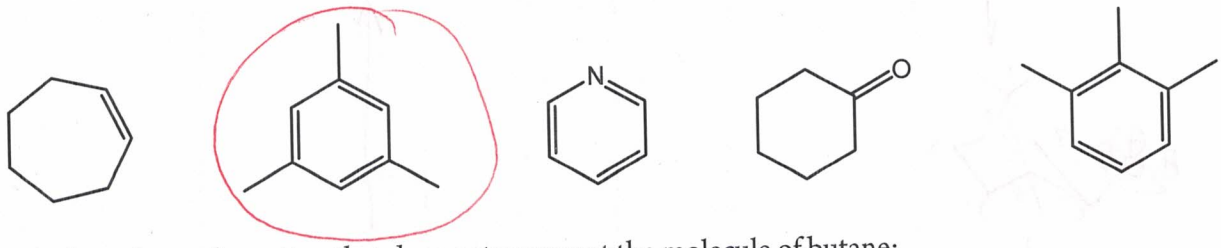
Circle the only achiral compound:



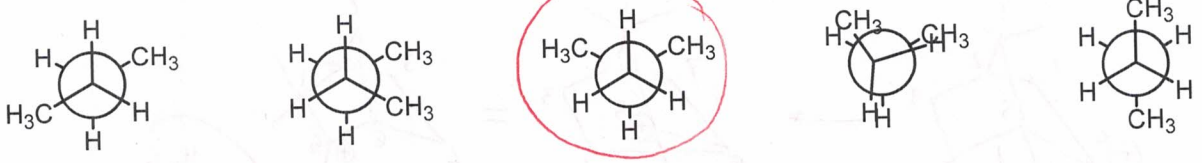
Circle the only compound that would show a strong IR absorption around 1700 cm^{-1}:



Circle the only compound which would show only singlets in an ^1H NMR spectrum:



Circle the only conformation that does not represent the molecule of butane:



Circle the approximate barrier to the rotation around the C–C bond in ethane:

160 kcal mol^{-1} 3 kcal mol^{-1} −30 kcal mol^{-1} 150 pm 10^4 kcal mol^{-1}

DO NOT WRITE IN THIS SPACE

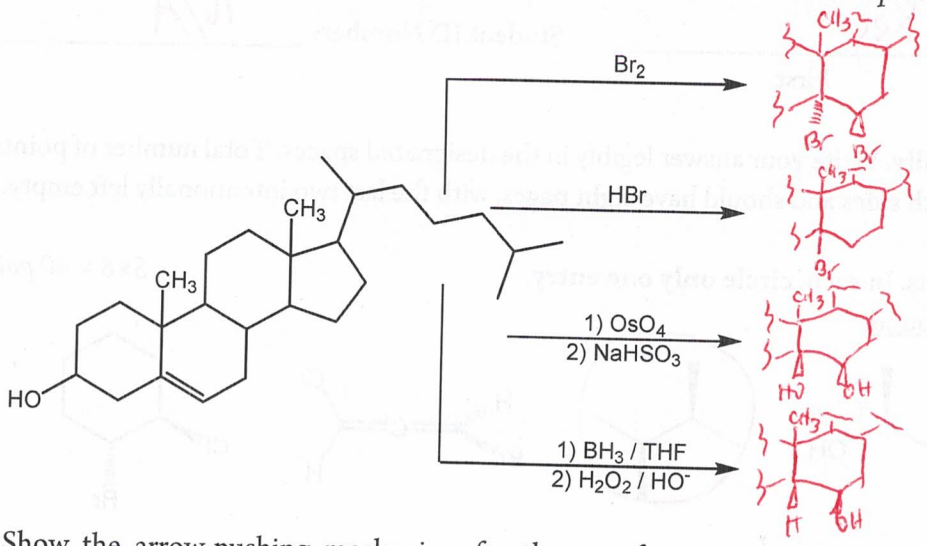
FINAL SCORE

60

2. Predict the products of the following reactions. Don't worry about the size of the molecule; concentrate on the functional groups.

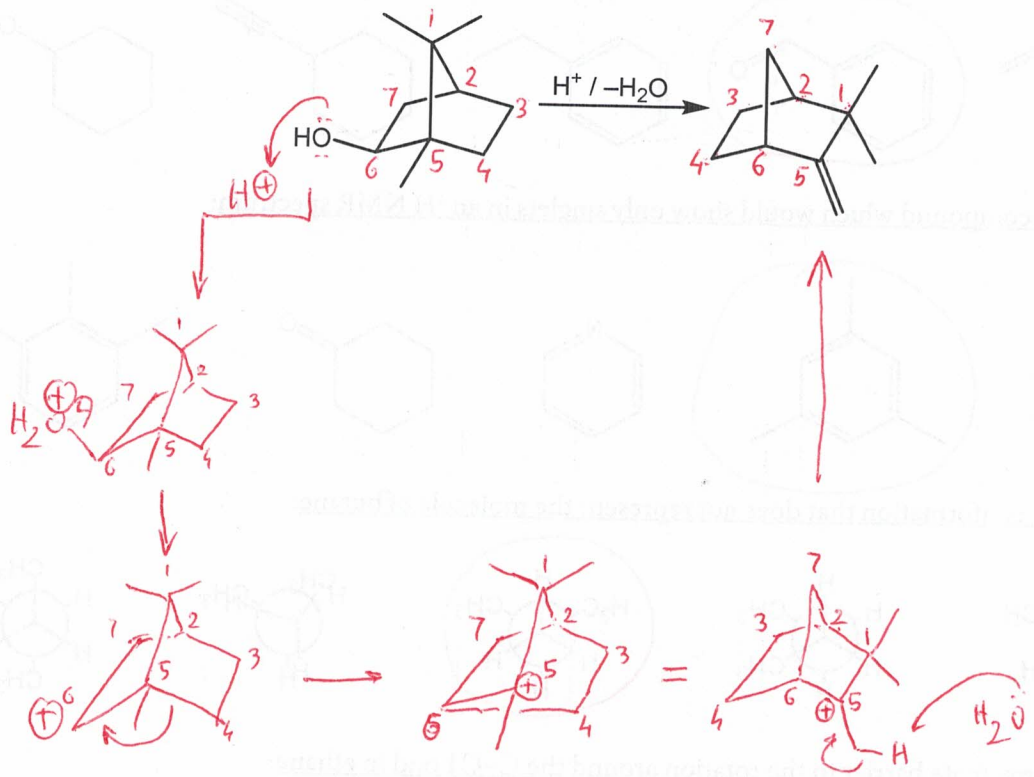
60 points

Textbook problem 8-46 (McMurry, 10th edition)



50

3. Show the arrow-pushing mechanism for the transformation shown below, which involves carbocations intermediate and their rearrangement. HINT: Number the carbon atoms and keep track of them! *50 points*



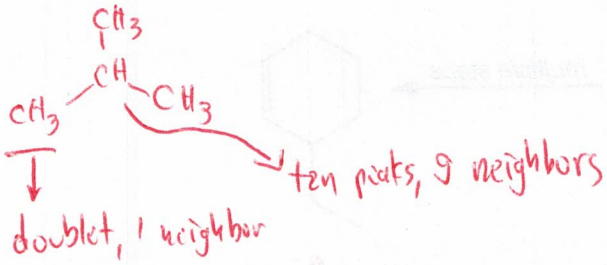
60

4. Predict the splitting pattern for each kind of hydrogen in the following molecules: (*a*) $(CH_3)_3CH$; (*b*) $CH_3CH_2CO_2CH_3$, and (*c*) trans-2-butene.

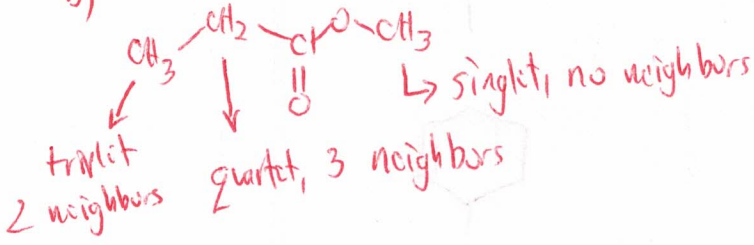
60 points

Textbook problem 13-38 (McMurry, 10th edition)

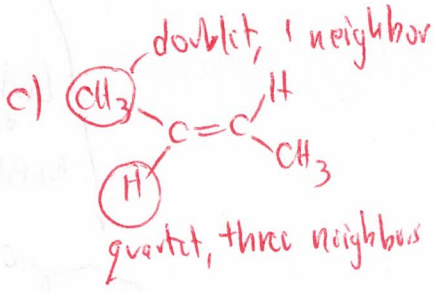
a)



b)



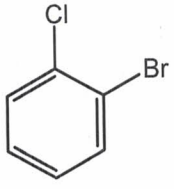
c)



50

5. Carefully examine the structure of 1-bromo-2-chlorobenzene, shown below. In its mass spectrum, how many molecular ions would you expect, what would be their masses, and their relative rations? In its ^{1}H NMR spectrum, how many peaks would you expect? What would be their multiplicities (singlet, doublet, triplet…) and relative size ratios (integration)?

50 points



MASS SPECTRUM: 3 MOLECULAR IONS

$C_6H_4{}^{35}Cl^{79}Br$ — 190 g/mol — $3/4 \times 1/2 = 3/8$) 3/8

$C_6H_4{}^{35}Cl^{81}Br$) 192 g/mol — $3/4 \times 1/2 = 3/8$) 4/8

$C_6H_4{}^{37}Cl^{79}Br$) — $1/4 \times 1/2 = 1/8$)

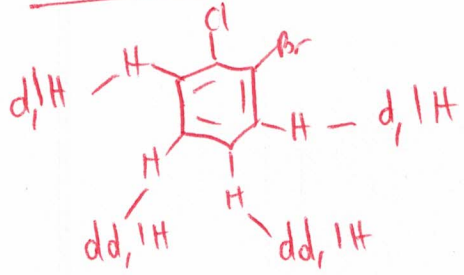
$C_6H_4{}^{37}Cl^{81}Br$ — 194 g/mol — $1/4 \times 1/2 = 1/8$) 1/8

ratio

3 | 4 | 1

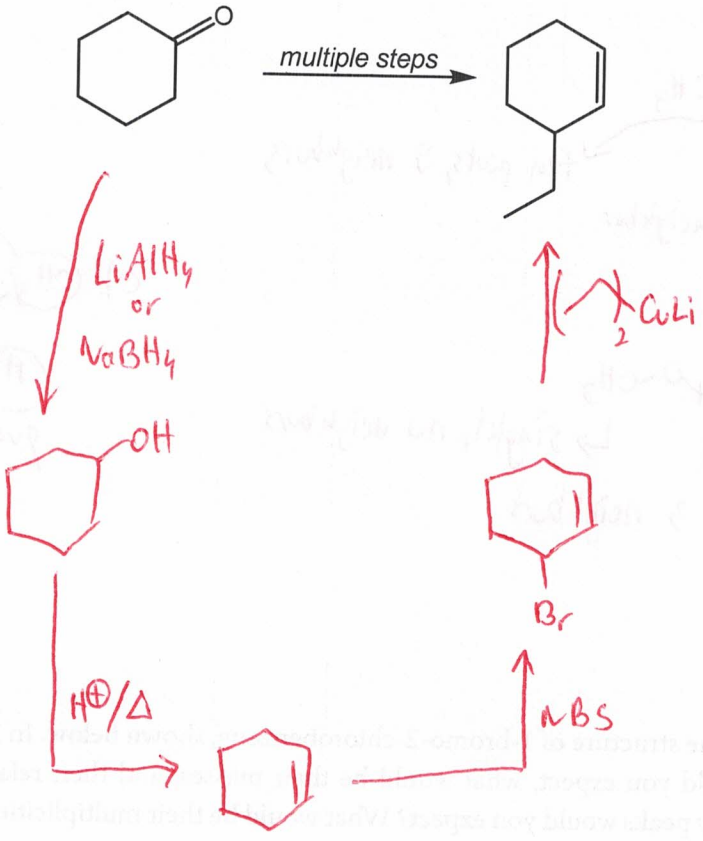
190 192 194

^{1}H NMR SPECTRUM



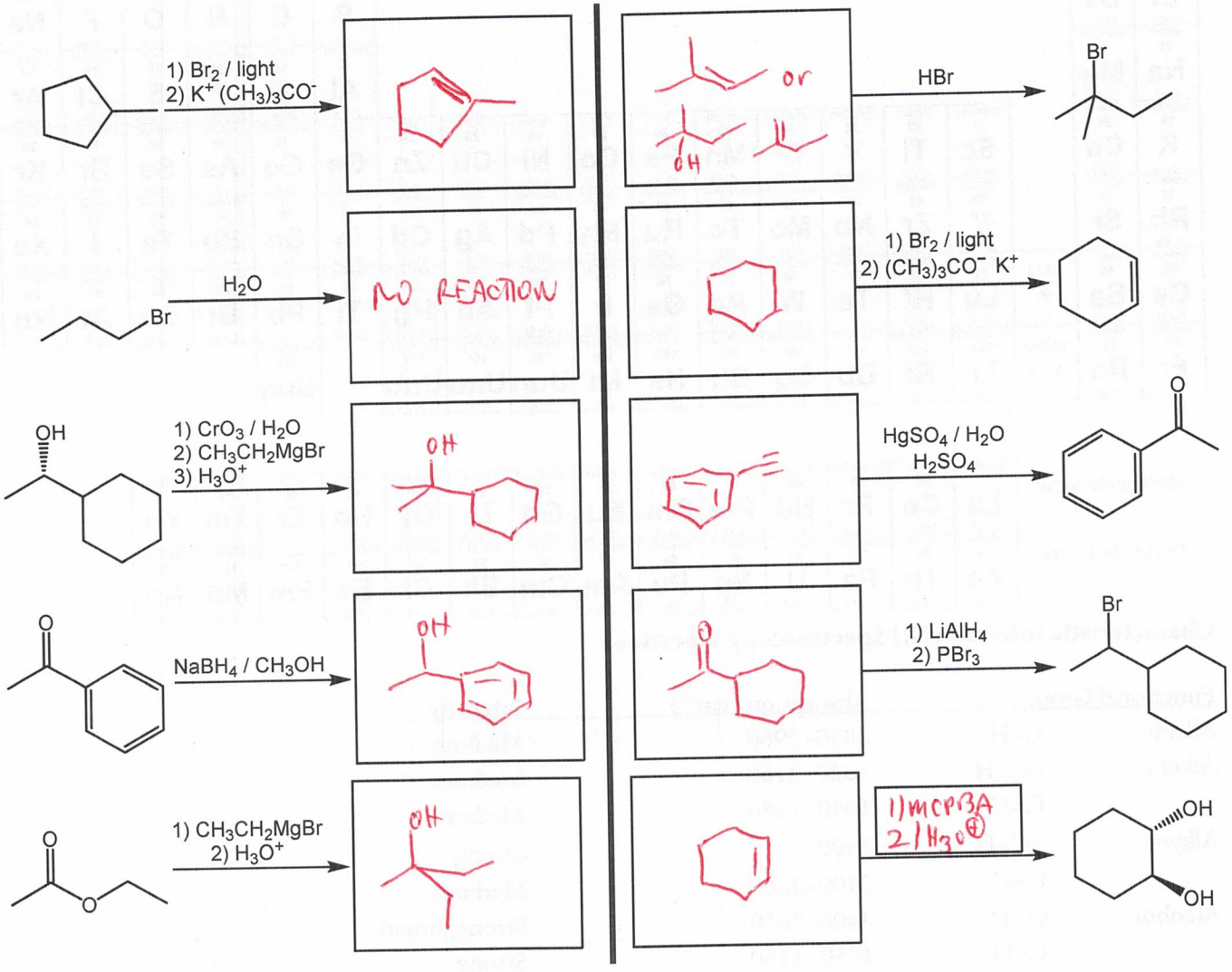
60

6. How would you efficiently accomplish the following synthetic transformation? Multiple reactions steps will be needed to accomplish this synthesis: draw them all out, but do not include mechanisms. *60 points*



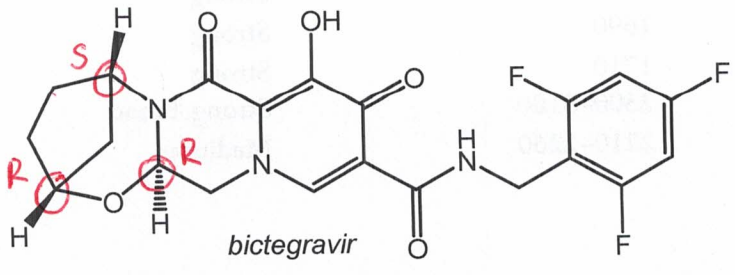
100

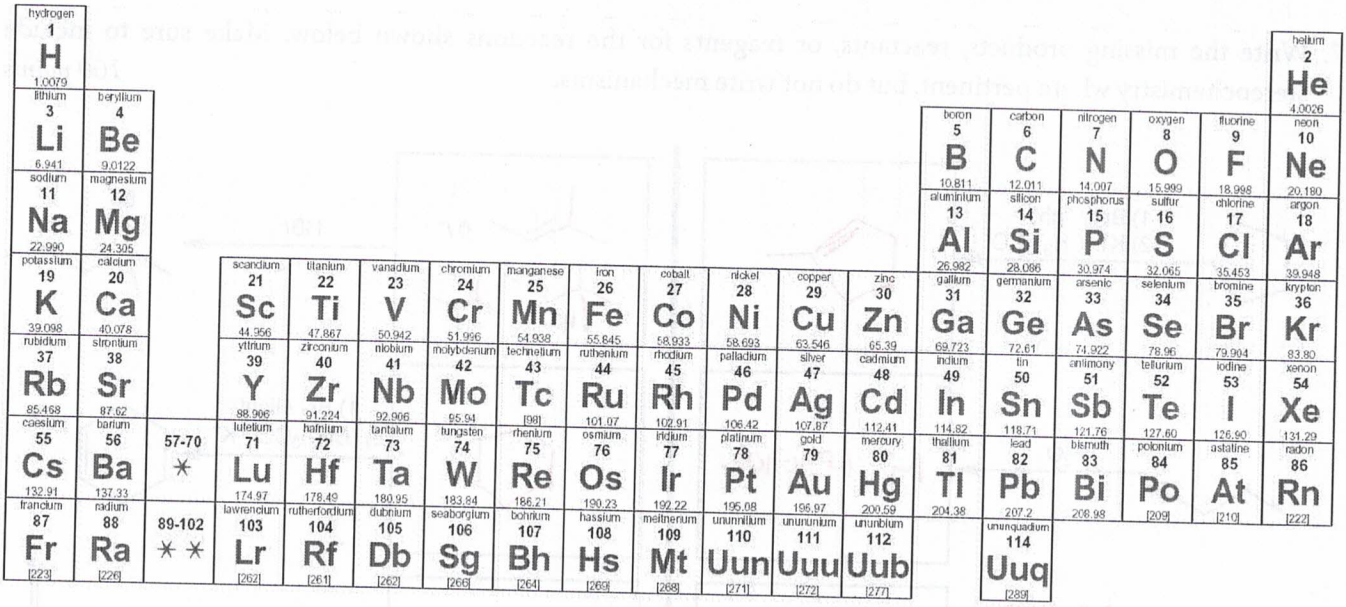
7. Write the missing products, reactants, or reagents for the reactions shown below. Make sure to include stereochemistry where pertinent, but do not write mechanisms. *100 points*



20

8. Bictegravir is one of the three compounds used in the modern blockbuster drug mix that suppresses the replication of the HIV virus. It is also a chiral molecule. Circle all its chiral centers and determine the $(R)/(S)$ configuration of any one of them. *20 points*





Characteristic Infrared (IR) Spectroscopy Vibrations

Functional Group		Absorption (cm^{-1})	Intensity
Alkane	C–H	2850–2960	Medium
Alkene	=C–H	3020–3100	Medium
	C=C	1640–1680	Medium
Alkyne	≡C–H	3300	Strong
	C≡C	2100–2260	Medium
Alcohol	O–H	3400–3650	Strong, broad
	C–O	1050–1150	Strong
Amine	N–H	3300–3500	Medium
	C–N	1030–1230	Medium
Carbonyls	C=O	1670–1780	Strong
Aldehyde		1730	Strong
Ketone		1715	Strong
Ester		1735	Strong
Amide		1690	Strong
Carboxylic acid		1710	Strong
Carboxylic acid	O–H	2500–3100	Strong, broad
Nitrile	C≡N	2210–2260	Medium