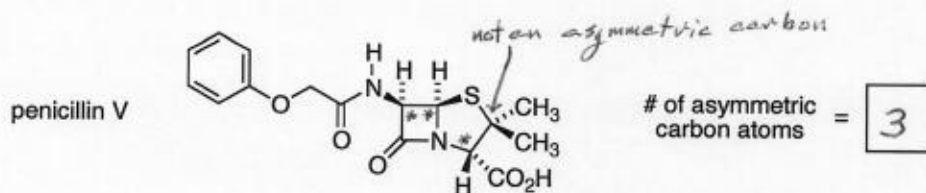
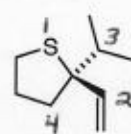
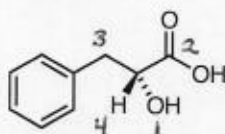
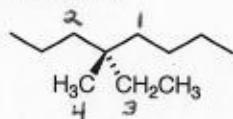


Name: Solutions

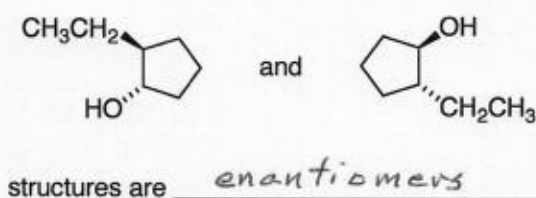
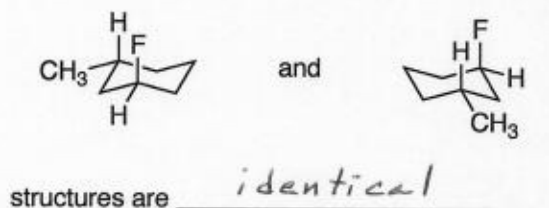
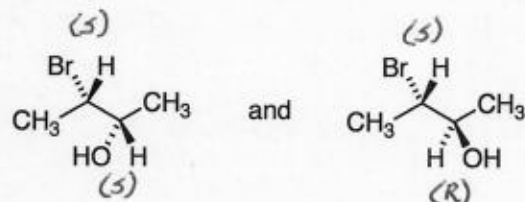
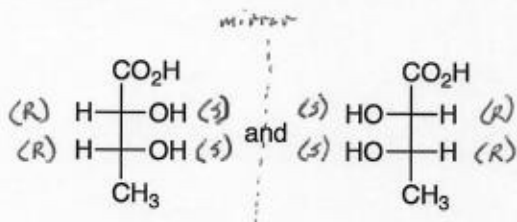
1. Indicate in the box how many asymmetric carbon atoms are present in the structure of penicillin V. [3 pts]



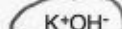
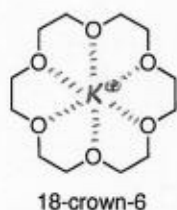
2. Indicate the stereochemical configuration, (*R*) or (*S*), for each of the following compounds in the boxes provided. [9 pts; 3 pts each]



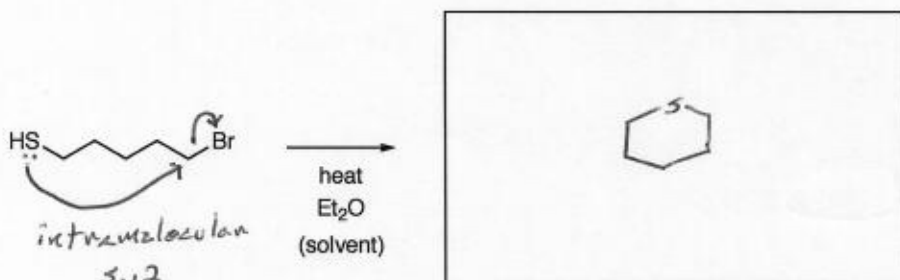
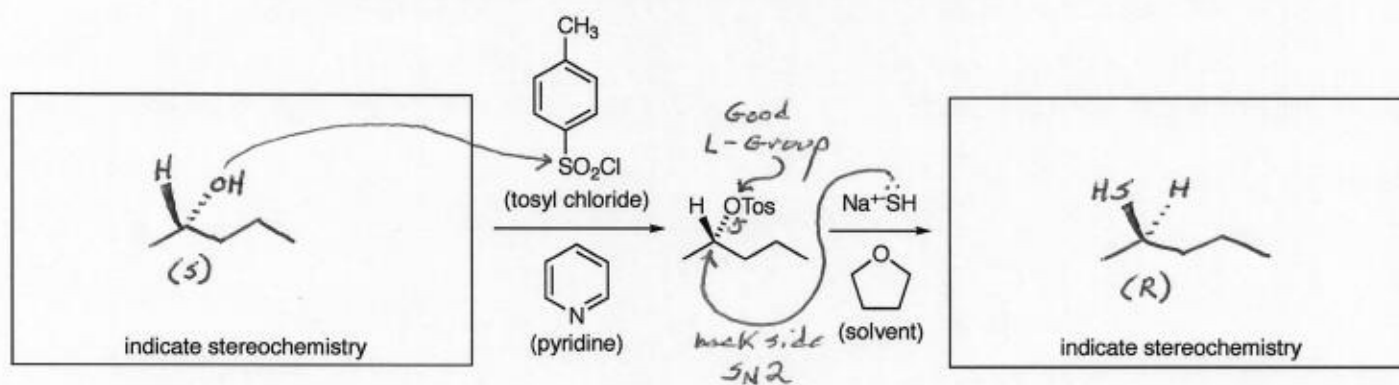
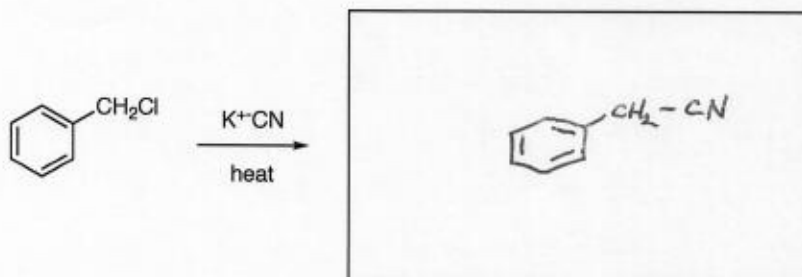
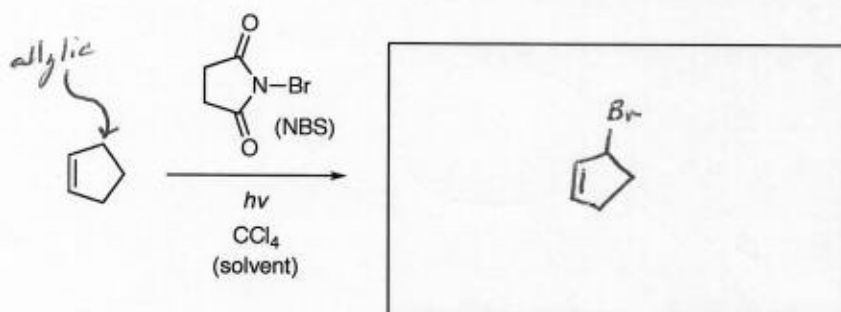
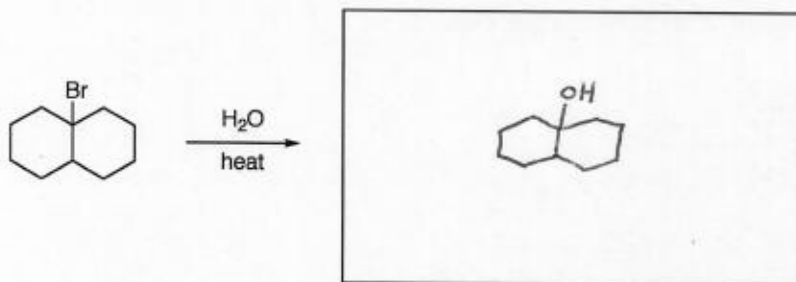
3. For each pair of stereoisomers indicate whether the two structures are identical, enantiomers or diastereomers. [12 pts; 3 pts each]



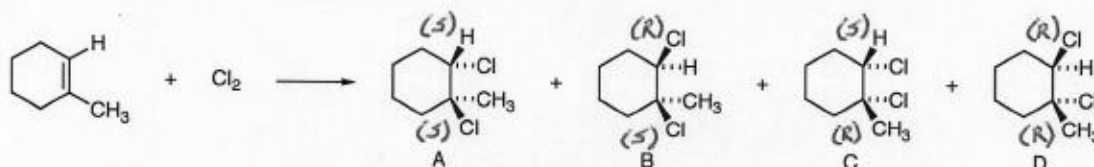
4. Crown ethers often are added to reactions to help solubilize inorganic salts in organic solvents. Crown ethers bind alkali cations selectively based on size. Circle the salt that 18-crown-6 will bind to with the highest affinity. [3 pts]



5. Provide the missing starting material or major product(s) in the reactions below. Show stereochemistry where indicated using dashed lines and wedges for compounds that have stereocenters. [24 pts; 4 pts each]



6. Consider reaction 1 below in which chlorine adds across the C=C bond to form a mixture of all possible stereoisomers of 1,2-dichloro-1-methylcyclohexane (A-D).



- a. Which product is (1S,2R)-1,2-dichloro-1-methylcyclohexane. Write the letter in the box. [3 pts]

B

- b. Which product is the enantiomer of product A? Write the letter in the box. [3 pts]

D

- c. What is the stereochemical relationship between products C and D? Circle your answer. [3 pts]

enantiomers

diastereomers

meso compound

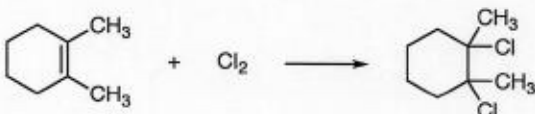
conformers

- d. Will a pure sample of compound C be optically active or inactive in a polarimeter? Circle your answer. [3 pts]

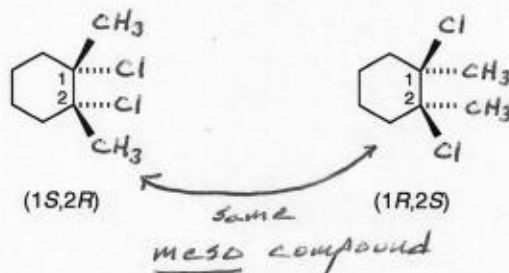
the mixture will be optically active

the mixture will be optically inactive

Consider reaction 2 below in which chlorine adds across the C=C double bond to form a mixture of products containing all possible stereoisomers of 1,2-dichloro-1,2-dimethylcyclohexane (shown without stereochemistry below).



- e. Draw the structures of (1S,2R)- and (1R,2S)-1,2-dichloro-1,2-dimethylcyclohexane below using the templates provided. [4 pts]



- f. How many unique stereoisomers form as products in reaction 2? Circle your answer. [3 pts]

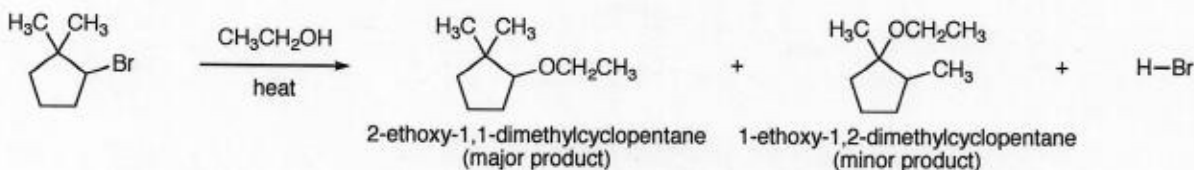
one product

two products

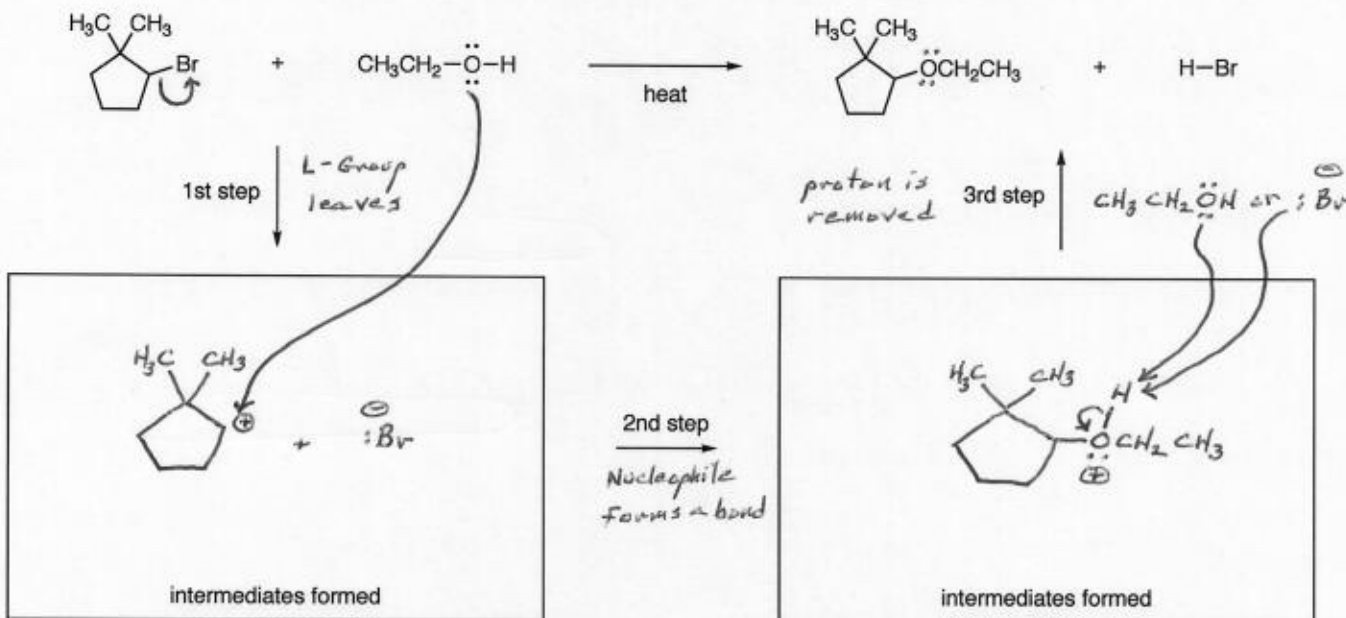
three products

four products

7. You react 2-bromo-1,1-dimethylcyclopentane with ethanol to synthesize 2-ethoxy-1,1-dimethylcyclopentane (major product) via S_N1 solvolysis. Analysis shows the reaction gives a mixture of two products, as shown below.



- a. Write a step-by-step reaction mechanism that shows how the major product 2-ethoxy-1,1-dimethylcyclopentane forms using the reaction template below. Your mechanism should show the intermediates that form after steps 1 and 2 in the boxes provided. Your reaction mechanism also should include *arrows that show the movement of lone pairs and bonding pairs of electrons* at each step where bonds are broken or formed. [9 pts]



- b. How will the rate of the reaction change if the concentration of the nucleophile ethanol is increased? Circle your answer. [3 pts]

the rate will increase

the rate will not change

the rate will decrease

 S_N1 rxn

- c. How will the rate of the reaction change if the substrate and nucleophile (i.e., 2-bromo-1,1-dimethylcyclopentane and ethanol) are placed in a polar aprotic solvent such as diethyl ether (Et-O-Et) instead of using ethanol as both the nucleophile and solvent (i.e., a solvolysis reaction)? Circle your answer. [3 pts]

the rate will increase

the rate will not change

the rate will decrease

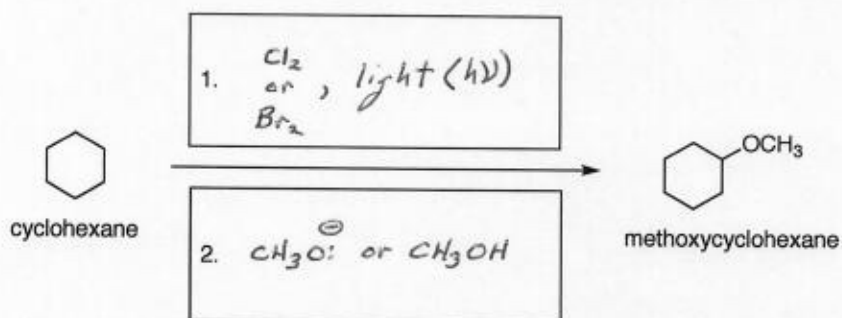
- d. The reaction produces a minor amount of 1-ethoxy-1,2-dimethylcyclopentane as an unwanted side product due to rearrangement, where a methyl group shifts from carbon 1 to carbon 2 during the reaction. Circle the most reasonable explanation for why the methyl shift occurs. [3 pts]

I. The methyl group shifts to form a more substituted carbocation intermediate that is lower in energy.

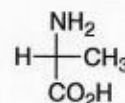
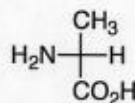
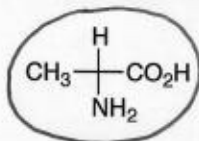
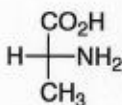
II. The methyl group shifts to allow the nucleophile to approach with less steric hinderance.

III. The methyl group shifts to reduce strain between the methyl substituents.

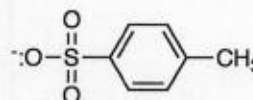
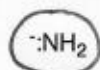
8. Propose a two-step synthesis (i.e., two separate sequential reactions) to convert cyclohexane into methoxycyclohexane by providing in the missing reagents/conditions on the boxes provided below. [3 pts; 1.5 pts each]



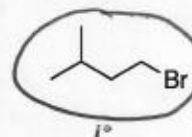
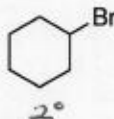
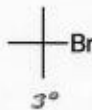
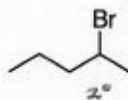
9. Circle the Fischer projection in which the asymmetric carbon atom has (S) stereochemical configuration. [3 pts]



10. Circle the strongest (most reactive) nucleophile. [3 pts]



11. Circle the compound below that will react at the fastest rate in an $\text{S}_\text{N}2$ reaction. [3 pts]



1.0

H

Hydrogen

2.0

He

Helium

Relative atomic mass

Symbol

Atomic number

Key

Those numbers appearing within brackets are the mass numbers of common isotopes

Those elements underlined are radioactive

N

element is a gas

Li

element is a liquid

Li

element is a solid

at room temperature and pressure

6.9	9.0																	12	14	14.0	16.0	19.9	20.2		
Li	Be																	B	C	N	O	F	Ne		
Lithium	Beryllium																	Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon		
23.0	24.3																	27.0	28.1	31.0	32.1	35.5	39.9		
Na	Mg																	Al	Si	P	S	Cl	Ar		
Sodium	Magnesium																	Aluminium	Silicon	Phosphorus	Sulphur	Chlorine	Argon		
39.1	40.1	3	4	5	6	7	8	9	10	11	12					68.7	72.6	74.9	78.9	79.9	83.8				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn					Ga	Ge	As	Se	Br	Kr				
Potassium	Calcium	Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc					Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton				
85.5	87.6	88.9	91.2	92.9	95.9	(99)	101.1	102.9	106.4	107.9	112.4					114.8	118.7	121.8	127.6	126.9	131.3				
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd					In	Sn	Sb	Te	I	Xe				
Rubidium	Strontium	Yttrium	Zirconium	Niobium	Molybdenum	Technetium	Ruthenium	Rhodium	Palladium	Silver	Cadmium					Indium	Tin	Antimony	Tellurium	Iodine	Xenon				
132.9	137.3	136.9	178.5	181.0	183.9	186.2	190.2	192.2	196.1	197.0	200.6					204.4	207.2	209.0	(210)	(210)	(222)				
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg					Tl	Pb	Bi	Po	At	Rn				
Cesium	Barium	Lanthanum	Hafnium	Tantalum	Tungsten	Rhenium	Osmium	Iridium	Platinum	Gold	Mercury					Thallium	Lead	Bismuth	Polonium	Astatine	Radon				
(223)	(226)	(237)	(261)	(262)	(263)	(265)	(266)	(266)																	
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt																	
Francium	Radium	Actinium	Rutherfordium	Dubnium	Seaborgium	Berkelium	Hassium	Moscovium																	

* 50-71 Lanthanide series

† 90-103 Actinide series

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