

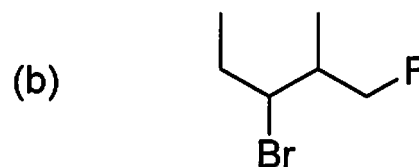
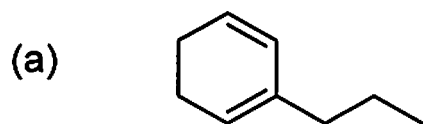
Name _____

If you do not want your graded exam placed in the box outside my office, then please mark a cross here _____

1-10 Are True/False (10pts)

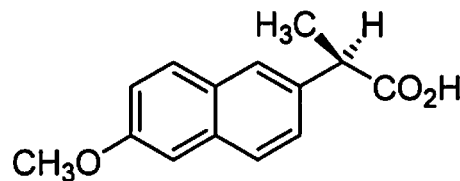
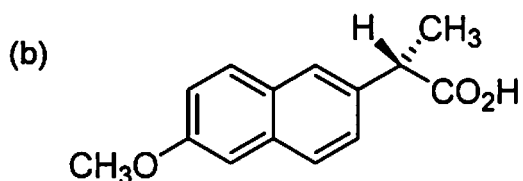
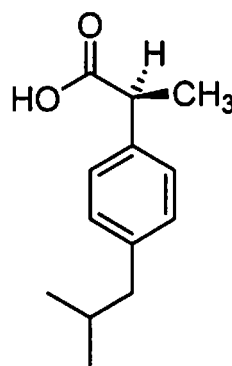
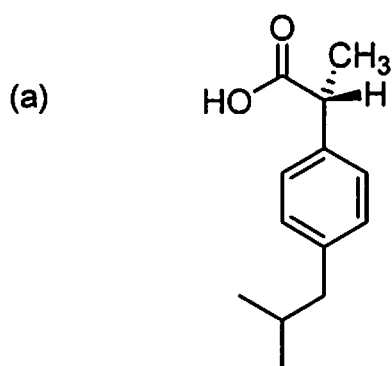
- 1) S_N1 and E1 reactions are both types of *addition* reaction.
- 2) The terms R or S are assigned to an enantiomeric stereocenter by application of the Convention rules established by Professor Kai Rality.
- 3) Mercury acetate, water and sodium borohydride can be used to react with an alkene via an overall addition of H and Br, with Markovnikov regiochemistry, and Anti stereochemistry.
- 4) Zaitsev's (Saytzeff's) Rule predicts the major product from an elimination to be the more alkyl-substituted π bonded product.
- 5) The rate determining step in both S_N1 and E1 reactions is the step where the carbocation is generated.
- 6) Cyclobutene is a structural isomer of buta-1,3-diene.
- 7) π Bonds are formed by the sideways overlap of aligned p orbitals on adjacent atoms.
- 8) π Bonds are weaker than σ bonds, and so it is the π bond of a C=C double bond that reacts as the nucleophile.
- 9) E2 reactions are stereospecific because they very strongly prefer the anti-coplanar alignment of proton and leaving group.
- 10) An object is chiral if it is different from its mirror image.

11) Provide the correct full IUPAC names for the following molecules.
(3+3=6pts)



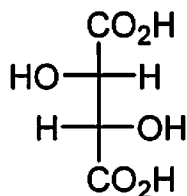
12) The following molecules are commercial drugs that both treat pain and inflammation. But in both cases, only the S enantiomer exhibits those properties.

Circle the active enantiomer for both (a) and (b). (2+2 pts)



+1 BONUS POINT for providing the (common/trivial) name of the nonsteroidal anti-inflammatory drug (NSAID) medication in part (a) – it starts with “I”.

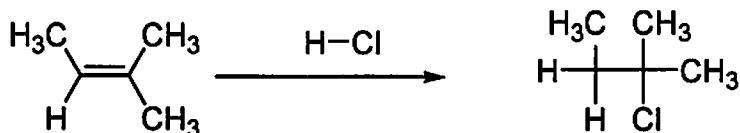
13) (1+2=3pts) Below is tartaric acid that is commonly found on the corks of wine bottles, shown in Fischer projection.



How many chiral centers are there?

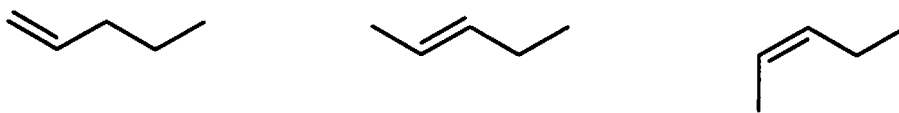
How many of the chiral centers are R?

14) Write the mechanism (*curly arrows*) for the below electrophilic addition. (3pts)



What is the *regiochemistry* of the above reaction? (1pt)

15) (1+1+1=3pts) Here are the three pentene isomers:

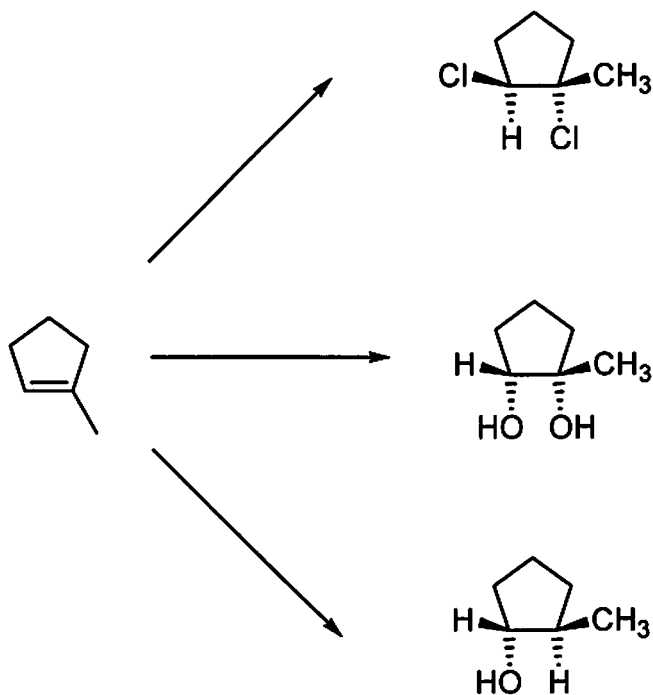


a) Which one is most stable?

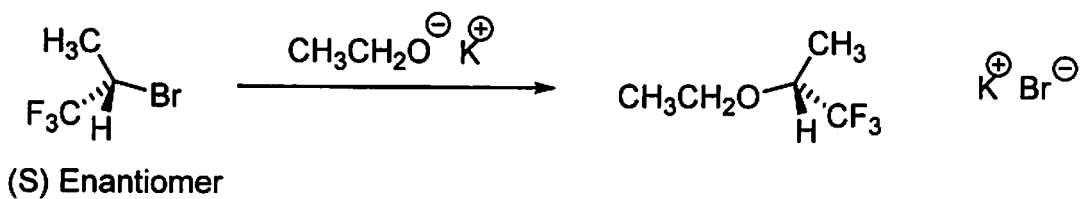
b) How many of them would require the stereodescriptor Z or E in their full IUPAC name? (You do NOT need to provide the IUPAC names).

c) Why is pent-3-ene NOT included in this list?

16) Provide the reagents that accomplish each of the three transformations shown. (6pts)

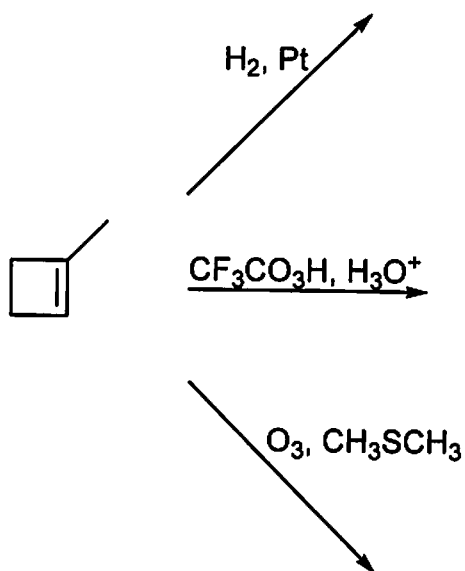


17) (1+1+1+1+1=5pts) For the following reaction:



- Is this a *substitution*, *elimination* or *addition*?
- What is the *nucleophile* in this reaction?
- What is the designation of the chiral center in the product?
- If the product is generated as a single enantiomer as shown, what does that tell you about the reaction mechanism?
- In a single sentence explain your answer to (d).

18) Provide the products that are generated in each of the three transformations shown. (6pts)



19) Draw the mechanism (i.e. curly arrows) for the following E2 elimination. (3pts)



****BONUS POINTS (up to 2 points)****

Draw a *meso* compound, and state what makes it “meso”.

hydrogen	1	H	1.0079	beryllium	4	Be	9.0122	helium	2	He	4.0026
lithium	3	Li	6.941	sodium	11	Na	22.990	neon	10	Ne	20.180
beryllium	4	Be	9.0122	magnesium	12	Mg	24.305	argon	18	Ar	39.948
sodium	11	Na	22.990	calcium	20	Ca	40.078	potassium	19	K	39.098
magnesium	12	Mg	24.305	strontium	38	Sr	87.62	rubidium	37	Rb	85.468
calcium	20	Ca	40.078	yttrium	39	Y	88.906	barium	56	Ba	137.33
potassium	19	K	39.098	zirconium	40	Zr	91.224	lanthanum	57	La	138.91
rubidium	37	Rb	85.468	niobium	41	Nb	92.906	cerium	58	Ce	140.12
strontium	38	Sr	87.62	molybdenum	42	Mo	95.94	praseodymium	59	Pr	140.91
yttrium	39	Y	88.906	technetium	43	Tc	[98]	neodymium	60	Nd	144.24
zirconium	40	Zr	91.224	ruthenium	44	Ru	101.07	promethium	61	Pm	[145]
niobium	41	Nb	92.906	rhodium	45	Rh	102.91	samarium	62	Sm	150.36
molybdenum	42	Mo	95.94	palladium	46	Pd	106.42	europium	63	Eu	151.96
technetium	43	Tc	[98]	silver	47	Ag	107.87	gadolinium	64	Gd	157.25
ruthenium	44	Ru	101.07	cadmium	48	Cd	112.41	terbium	65	Tb	158.93
rhodium	45	Rh	102.91	indium	49	In	114.82	dysprosium	66	Dy	162.50
palladium	46	Pd	106.42	tin	50	Sn	118.71	holmium	67	Ho	164.93
silver	47	Ag	107.87	antimony	51	Sb	121.76	erbium	68	Er	167.26
cadmium	48	Cd	112.41	tellurium	52	Te	127.60	thulium	69	Tm	168.93
indium	49	In	114.82	lead	82	Pb	207.2	ytterbium	70	Yb	173.04
tin	50	Sn	118.71	bismuth	83	Bi	208.98	lutetium	71	Lu	174.97
antimony	51	Sb	121.76	polonium	84	Po	[209]	berkelium	97	Bk	[247]
tellurium	52	Te	127.60	astatine	85	At	[210]	californium	98	Cf	[251]
lead	82	Pb	207.2	radon	86	Rn	[222]	einsteinium	99	Es	[252]
bismuth	83	Bi	208.98	francium	87	Fr	[223]	fermium	100	Fm	[257]
polonium	84	Po	[209]	actinium	89	Ac	[227]	mendeleevium	101	Md	[258]
astatine	85	At	[210]	thorium	90	Th	232.04	nobelium	102	No	[259]
radon	86	Rn	[222]	protactinium	91	Pa	231.04	lawrencium	103	Lr	[260]
actinium	89	Ac	[227]	uranium	92	U	238.03	rutherfordium	104	Rf	[261]
thorium	90	Th	232.04	neptunium	93	Np	[237]	rhodium	105	Rh	[262]
protactinium	91	Pa	231.04	plutonium	94	Pu	[244]	seaborgium	106	Sg	[266]
uranium	92	U	238.03	americium	95	Am	[243]	bohrium	107	Bh	[264]
neptunium	93	Np	[237]	curium	96	Cm	[247]	hassium	108	Hs	[265]
plutonium	94	Pu	[244]	berkelium	97	Bk	[247]	meitnerium	109	Mt	[268]
americium	95	Am	[243]	californium	98	Cf	[251]	rutherfordium	110	Rf	[261]
curium	96	Cm	[247]	einsteinium	99	Es	[252]	unnilium	111	Uun	[271]
berkelium	97	Bk	[247]	fermium	100	Fm	[257]	ununium	112	Uuu	[272]
californium	98	Cf	[251]	mendeleevium	101	Md	[258]	ununium	113	Uuu	[273]
einsteinium	99	Es	[252]	nobelium	102	No	[259]	ununium	114	Uuq	[284]
fermium	100	Fm	[257]	lawrencium	103	Lr	[260]	ununium	115	Uuu	[285]
mendeleevium	101	Md	[258]	actinium	89	Ac	[227]	ununium	116	Uuu	[286]
nobelium	102	No	[259]	thorium	90	Th	232.04	ununium	117	Uuu	[287]
lawrencium	103	Lr	[260]	protactinium	91	Pa	231.04	ununium	118	Uuu	[288]
berkelium	97	Bk	[247]	uranium	92	U	238.03	ununium	119	Uuu	[289]
californium	98	Cf	[251]	neptunium	93	Np	[237]	ununium	120	Uuu	[290]
einsteinium	99	Es	[252]	plutonium	94	Pu	[244]	ununium	121	Uuu	[291]
fermium	100	Fm	[257]	americium	95	Am	[243]	ununium	122	Uuu	[292]
mendeleevium	101	Md	[258]	curium	96	Cm	[247]	ununium	123	Uuu	[293]
nobelium	102	No	[259]	berkelium	97	Bk	[247]	ununium	124	Uuu	[294]
lawrencium	103	Lr	[260]	californium	98	Cf	[251]	ununium	125	Uuu	[295]
				einsteinium	99	Es	[252]	ununium	126	Uuu	[296]
				fermium	100	Fm	[257]	ununium	127	Uuu	[297]
				mendeleevium	101	Md	[258]	ununium	128	Uuu	[298]
				nobelium	102	No	[259]	ununium	129	Uuu	[299]
				lawrencium	103	Lr	[260]	ununium	130	Uuu	[300]

* Lanthanide series

** Actinide series

Lanthanum	57	La	138.91	cerium	58	Ce	140.12	praseodymium	59	Pr	140.91	neodymium	60	Nd	144.24	promethium	61	Pm	[145]	samarium	62	Sm	150.36	europium	63	Eu	151.96	gadolinium	64	Gd	157.25	terbium	65	Tb	158.93	dysprosium	66	Dy	162.50	holmium	67	Ho	164.93	erbium	68	Er	167.26	thulium	69	Tm	168.93	ytterbium	70	Yb	173.04	lutetium	71	Lu	174.97
actinium	89	Ac	[227]	thorium	90	Th	232.04	protactinium	91	Pa	231.04	uranium	92	U	238.03	neptunium	93	Np	[237]	plutonium	94	Pu	[244]	americium	95	Am	[243]	curium	96	Cm	[247]	berkelium	97	Bk	[247]	californium	98	Cf	[251]	einsteinium	99	Es	[252]	fermium	100	Fm	[257]	mendeleevium	101	Md	[258]	nobelium	102	No	[259]	lawrencium	103	Lr	[260]

Name

Kai Rality

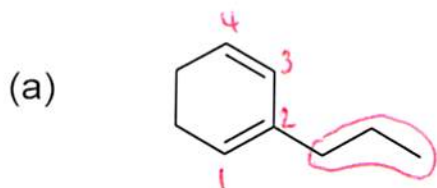
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1-10 Are True/False (10pts)

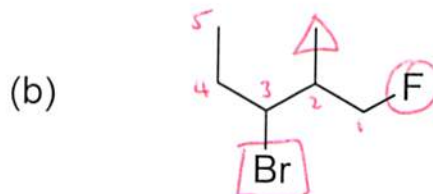
- 1) S_N1 and $E1$ reactions are both types of *addition* reaction. F
- 2) The terms R or S are assigned to an enantiomeric stereocenter by application of the Convention rules established by Professor Kai Rality. F
- 3) Mercury acetate, water and sodium borohydride can be used to react with an alkene via an overall addition of H and Br, with Markovnikov regiochemistry, and Anti stereochemistry. F
- 4) Zaitsev's (Saytzeff's) Rule predicts the major product from an elimination to be the more alkyl-substituted π bonded product. True
- 5) The rate determining step in both S_N1 and $E1$ reactions is the step where the carbocation is generated. True
- 6) Cyclobutene is a structural isomer of buta-1,3-diene. True
- 7) π Bonds are formed by the sideways overlap of aligned p orbitals on adjacent atoms. True
- 8) π Bonds are weaker than σ bonds, and so it is the π bond of a $C=C$ double bond that reacts as the nucleophile. True
- 9) $E2$ reactions are stereospecific because they very strongly prefer the anti-coplanar alignment of proton and leaving group. True
- 10) An object is chiral if it is different from its mirror image. True



11) Provide the correct full IUPAC names for the following molecules. (3+3=6pts)



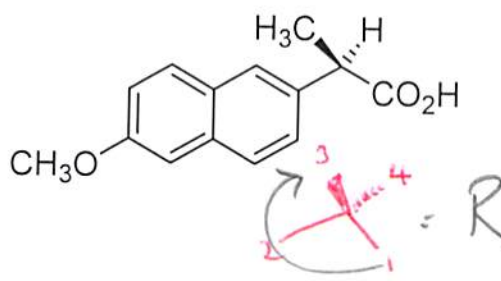
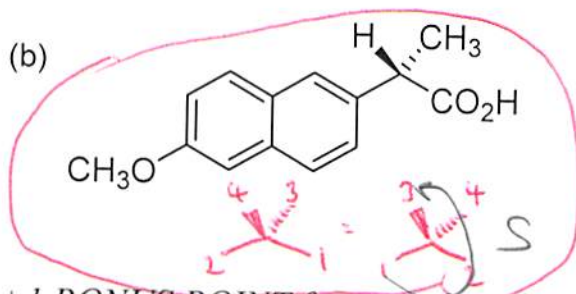
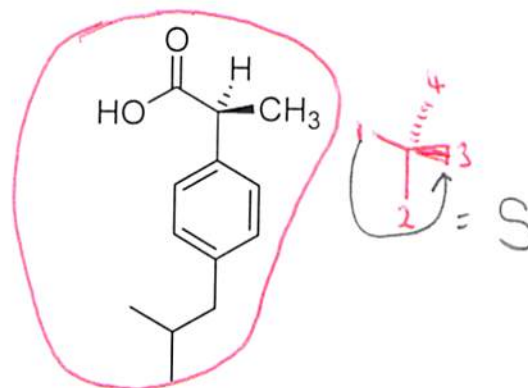
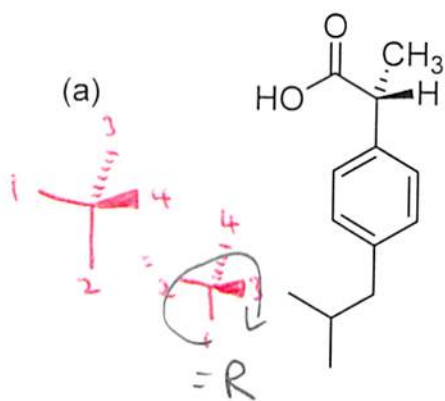
2-PROPYL CYCLOHEXA-1,3-DIENE



3-BROMO-1-FLUORO-2-METHYLPENTANE

12) The following molecules are commercial drugs that both treat pain and inflammation. But in both cases, only the S enantiomer exhibits those properties.

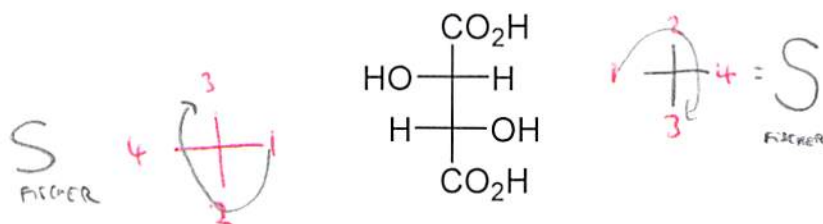
Circle the active enantiomer for both (a) and (b). (2+2 pts)



+1 BONUS POINT for providing the (common/trivial) name of the nonsteroidal anti-inflammatory drug (NSAID) medication in part (a) – it starts with "I".

Ibuprofen

13) (1+2=3pts) Below is tartaric acid that is commonly found on the corks of wine bottles, shown in Fischer projection.



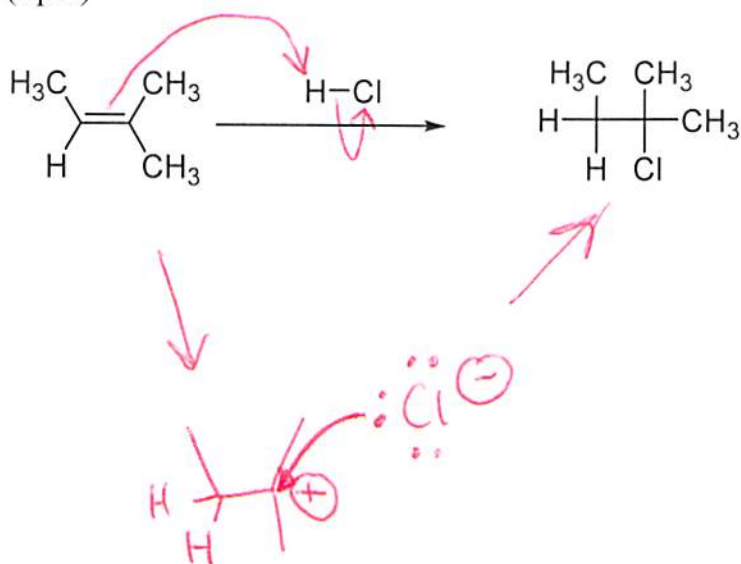
How many chiral centers are there?

TWO

How many of the chiral centers are R?

ZERO

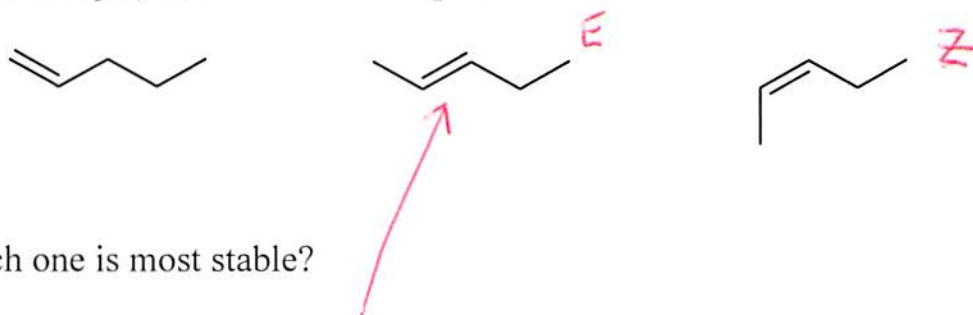
14) Write the mechanism (*curly arrows*) for the below electrophilic addition. (3pts)



What is the *regiochemistry* of the above reaction? (1pt)

Markovnikov

15) (1+1+1=3pts) Here are the three pentene isomers:



a) Which one is most stable?

b) How many of them would require the stereodescriptor Z or E in their full IUPAC name? (You do NOT need to provide the IUPAC names).

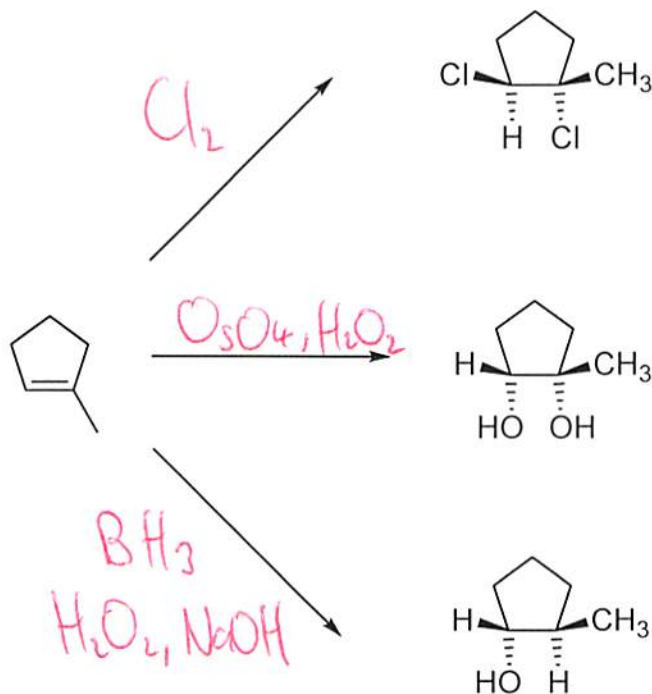
Two

c) Why is pent-3-ene NOT included in this list?

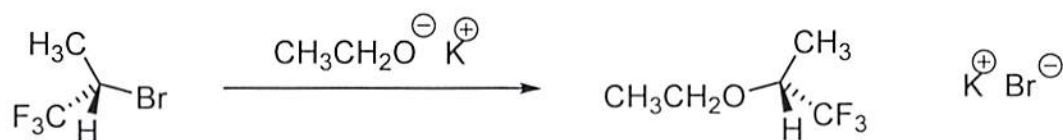


(Also IUPAC numbering should start at the end nearest the double bond).

16) Provide the reagents that accomplish each of the three transformations shown. (6pts)



17) (1+1+1+1+1=5pts) For the following reaction:



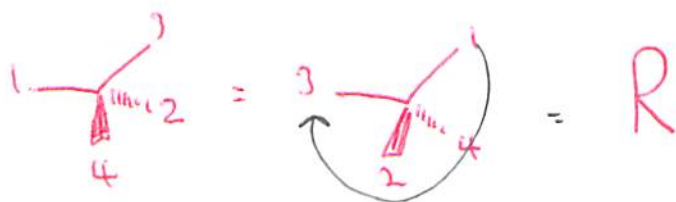
(S) Enantiomer

a) Is this a substitution, *elimination* or *addition*?

b) What is the *nucleophile* in this reaction?



c) What is the designation of the chiral center in the product?



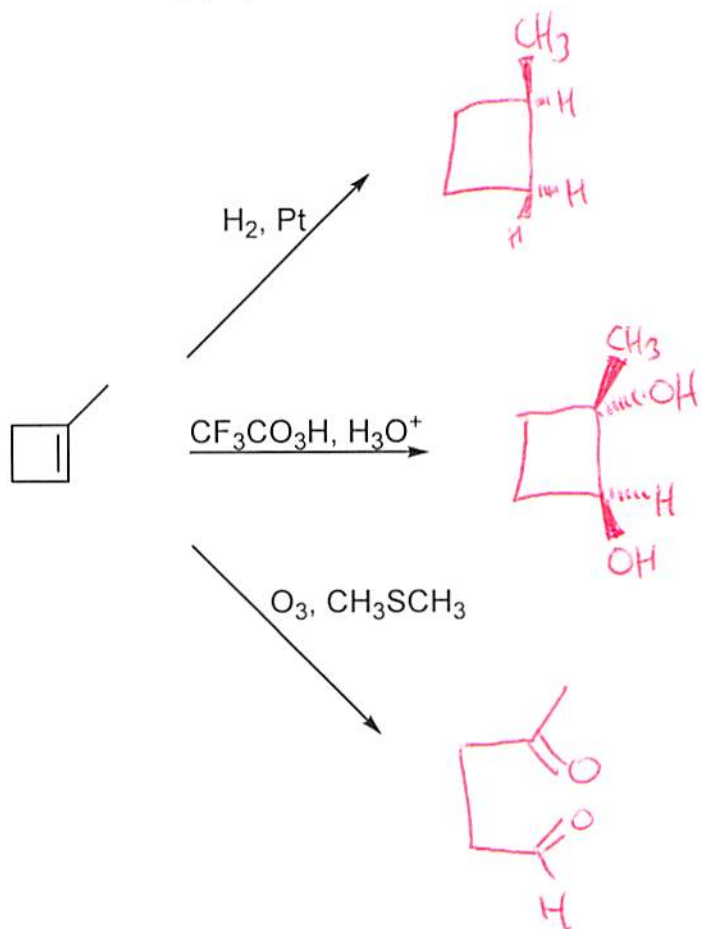
d) If the product is generated as a single enantiomer as shown, what does that tell you about the reaction mechanism?

Inversion of the stereochemistry implies $\text{S}_{\text{N}}2$ mechanism.

e) In a single sentence explain your answer to (d).

This nucleophilic substitution has occurred with 100% inversion of stereochemistry at the chiral reaction center, and this is only consistent with an $\text{S}_{\text{N}}2$ mechanism.

18) Provide the products that are generated in each of the three transformations shown. (6pts)



19) Draw the mechanism (i.e. curly arrows) for the following E2 elimination. (3pts)



****BONUS POINTS (up to 2 points)****

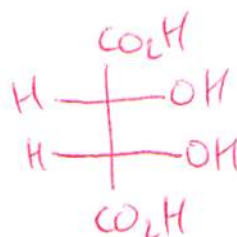
Draw a *meso* compound, and state what makes it "meso".

"Meso" means achiral, but contains chiral centers or elements.

eg



or



or

