

No electronic devices (calculators, cell phones, laptops, etc) may be used or consulted during the exam. All scrap work should be done on the extra page provided; no additional paper may be used. **Your name and Panther ID should be placed in three places;** at the end of this paragraph to indicate acceptance of all policies, on page 7 of the exam (Part B) and on your answer sheet. Be sure to include **the form of your exam on the answer sheet.**

Name _____ Panther ID _____

Part A – (75 points) Answer on Scantron sheet with number 2 pencil

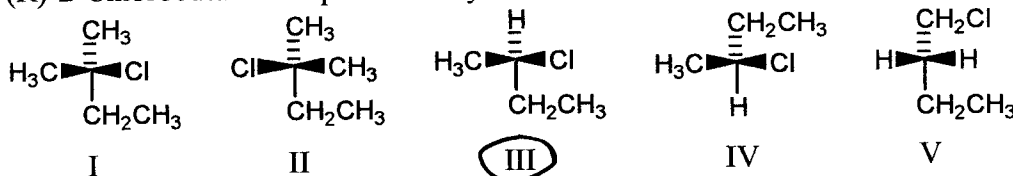
1. The molecules below are:



- A) constitutional isomers.
B) enantiomers.
C) diastereomers.

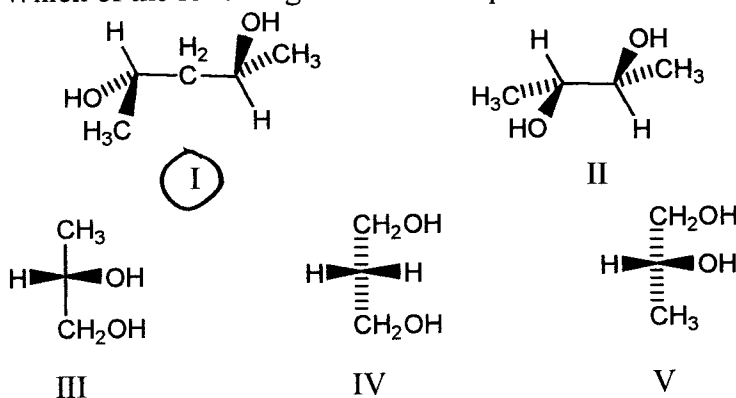
D) identical.
E) None of these

2. (R)-2-Chlorobutane is represented by:



- A) I B) II C) III D) IV E) V

3. Which of the following is a *meso* compound?



- A) I B) II C) III D) IV E) V

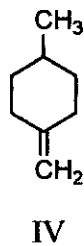
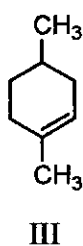
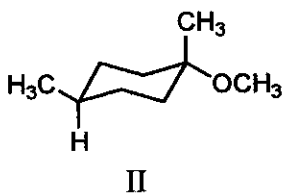
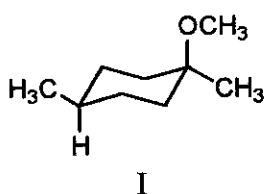
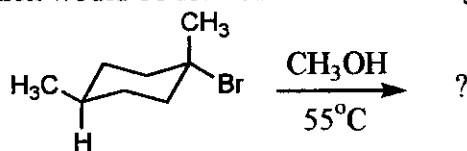
4. Consider the S_N2 reaction of 1-chloro-5-methylhexane with CN⁻ ion.



Assuming no other changes, what effect on the rate would result from simultaneously doubling the concentrations of both 1-chloro-5-methylhexane and CN⁻ ion?

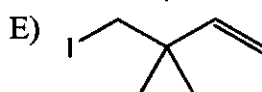
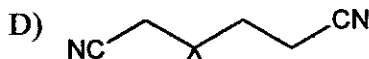
- A) No effect. **(D)** It would increase the rate four times.
 B) It would double the rate. E) It would increase the rate six times.
 C) It would triple the rate.

5. Which would be formed in the following reaction?



- A) I B) II C) III D) IV **(E)** All of the above

6. When 1,4-diiodo-2,2-dimethylbutane (0.10 mol) is treated with 0.10 mol of NaCN in dimethyl sulfoxide at 30°C, the product formed is:



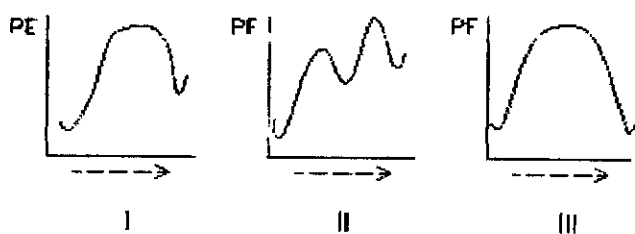
- C) both A) and B).

7. A true statement about the transition state(s) of an S_N2 reaction is:
- A) the two transition states are of unequal energy.
 - B) the transition states precede and follow an unstable reaction intermediate.
 - C) the single transition state represents the point of maximum free energy of the reaction.
 - D) the first transition state will be lower energy than the starting material.
 - E) the transition state will always have a net charge of +1.
8. Elimination reactions are favored over nucleophilic substitution reactions:
- A) at high temperatures.
 - B) when *tert*-butoxide ion is used.
 - C) when 3° alkyl halides are used as substrates.
 - D) when nucleophiles are used which are strong bases and the substrate is a 2° alkyl halide.
 - E) in all of these cases.
9. The hybridization state of the charged carbon in a carbocation is
- A) sp^4
 - B) sp^3
 - C) sp^2
 - D) sp
 - E) s

10. Identify the nucleophile in the following reaction:

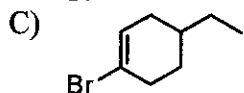
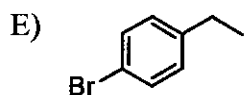
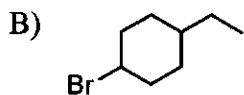
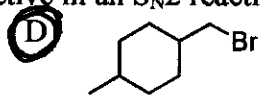
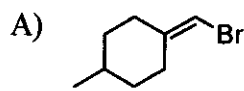
- A) X^- B) H_3O^+ C) ROH D) H_2O E) RX

11. Select the potential energy diagram that represents an exothermic (exergonic) reaction.



- A) I B) II C) III D) IV E) V

12. Which of the following would be most reactive in an S_N2 reaction?



13. Which alkyl halide, when treated with sodium ethoxide in ethanol, would afford a product mixture consisting of more than one elimination product?

A) 1-bromo-3,3-dimethylpentane

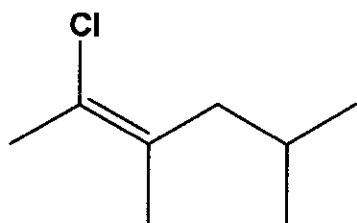
B) 1-bromo-2,3-dimethylpentane

C) 2-bromo-3,4-dimethylpentane

D) 2-bromo-3,3-dimethylpentane

E) None of the above would yield more than one elimination product

14. The correct IUPAC name for the following compound is:



A) (Z)-2-Chloro-3,5-dimethyl-2-hexene

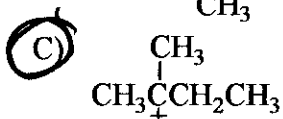
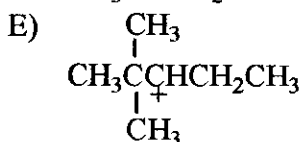
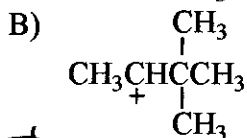
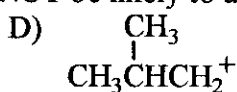
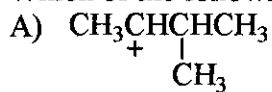
B) (E)-2-Chloro-3-methyl-4-isopropylbutane

C) cis-2-Chloro-3,5-dimethyl-2-hexene

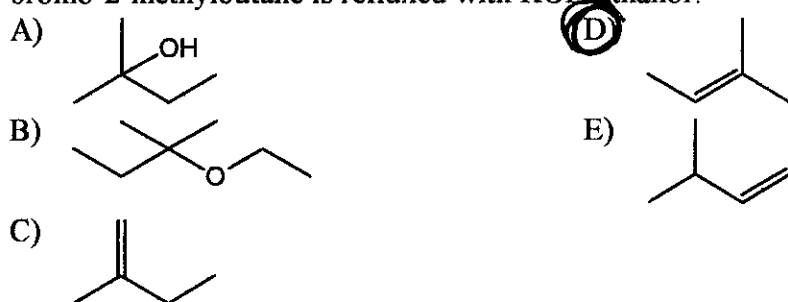
D) syn-2-Chloro-3,5-dimethyl-2-hexene

E) (E)-2-Chloro-3,5-dimethyl-2-hexene

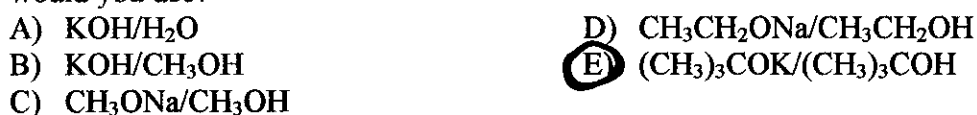
15. Which of the following carbocations would NOT be likely to undergo rearrangement?



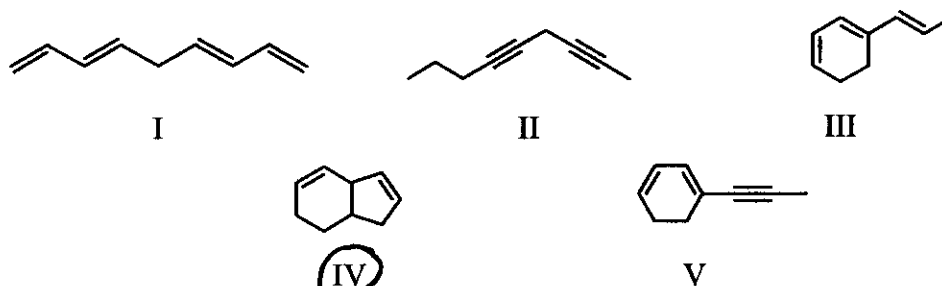
16. Which compound listed below would you expect to be the major product when 2-bromo-2-methylbutane is refluxed with KOH/ethanol?



17. Your task is to convert 2-bromobutane to 1-butene in highest yield. Which reagents would you use?

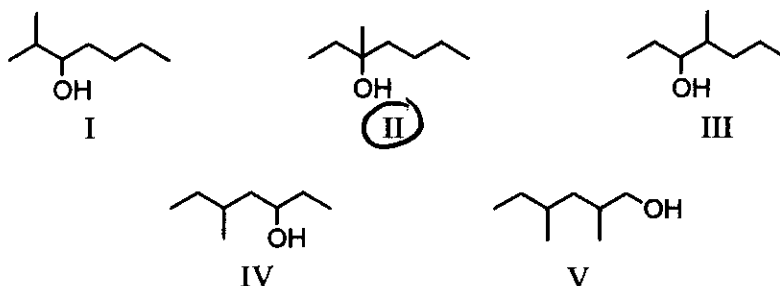


18. On hydrogenation, a compound C₉H₁₂ absorbs 2 mol of hydrogen. Which of the following is a possible structure for the compound?



A) I B) II C) III **(D)** IV E) V

19. Which one of the following alcohols would dehydrate most rapidly when treated with sulfuric acid?

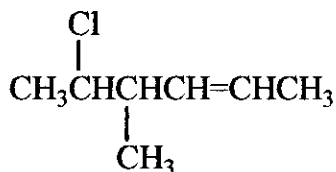


A) I **(B)** II C) III D) IV E) V

20. What is the simplest alkene, i.e., the one with the smallest molecular weight, which can exhibit optical activity?

- A) 3-methyl-1-pentene
 B) 3-methyl-2-pentene
 C) 4-methyl-1-pentene
 D) 3-methyl-1-butene
 E) 4-methyl-2-hexene

21. Determine the total number of stereoisomers which can occur with this general structure:



- A) 2 B) 3 C) 4 D) 6 E) 8

22. For which of the following is cis-trans isomerism impossible?

- A) 2-Hexene
 B) 3-Methyl-2-pentene
 C) 3-Hexene
 D) 2-Methyl-2-butene
 E) 2-Pentene

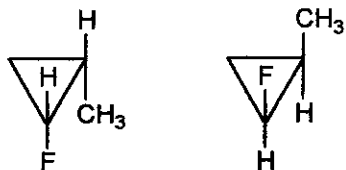
23. Which one of the following can exist in optically active forms?

- A) cis-1,3-Dichlorocyclohexane
 B) trans-1,3-Dichlorocyclohexane
 C) cis-1,4-Dichlorocyclohexane
 D) trans-1,4-Dichlorocyclohexane
 E) cis-1,2-Dichlorocyclohexane

24. What can be said with certainty if a compound has $[\alpha]_D^{25} = -9.25^\circ$?

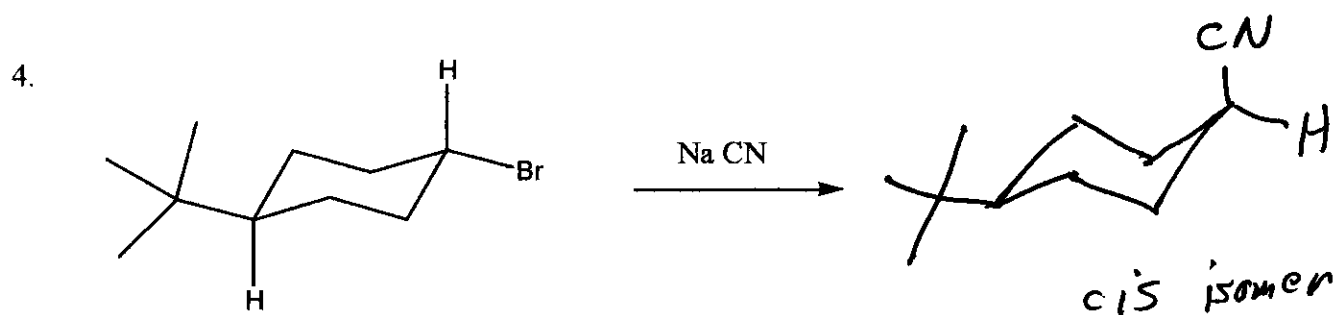
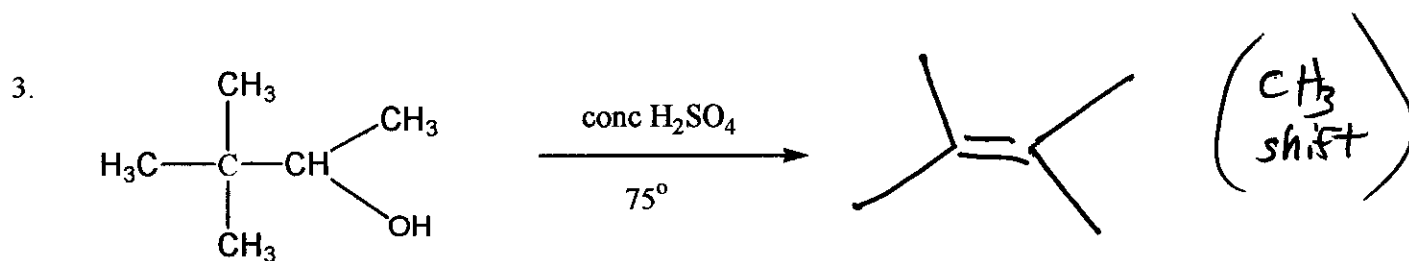
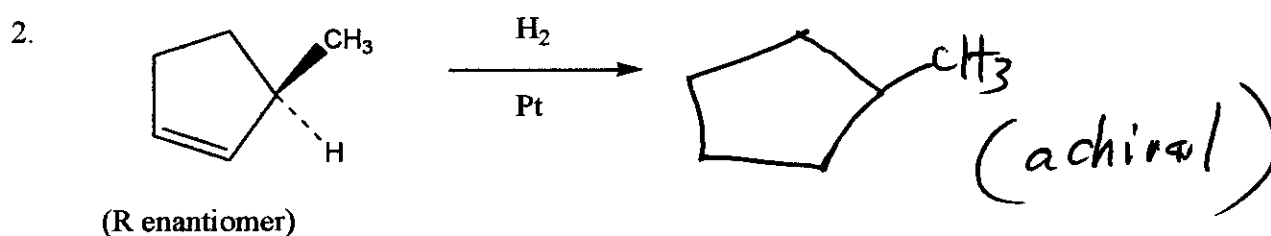
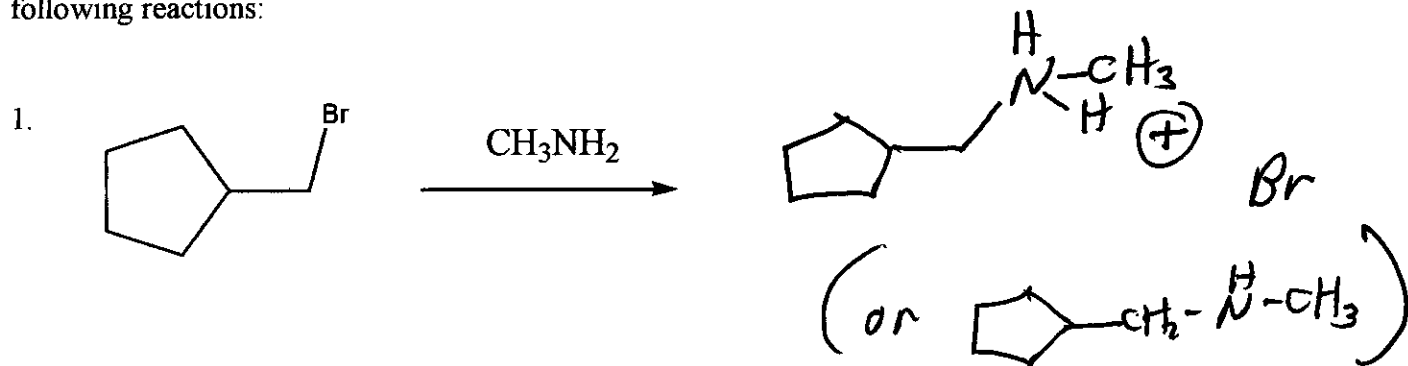
- A) The compound has the (S) configuration.
 B) The compound has the (R) configuration.
 C) The compound is not a meso form.
 D) The compound possesses only one stereogenic center.
 E) The compound has an optical purity of less than 100%.

25. The molecules shown are:



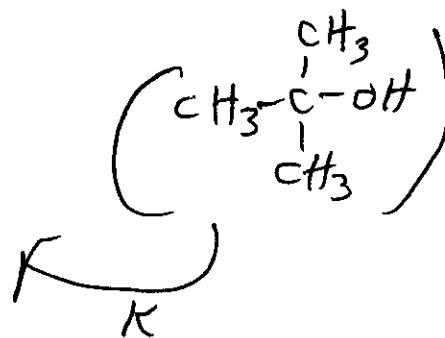
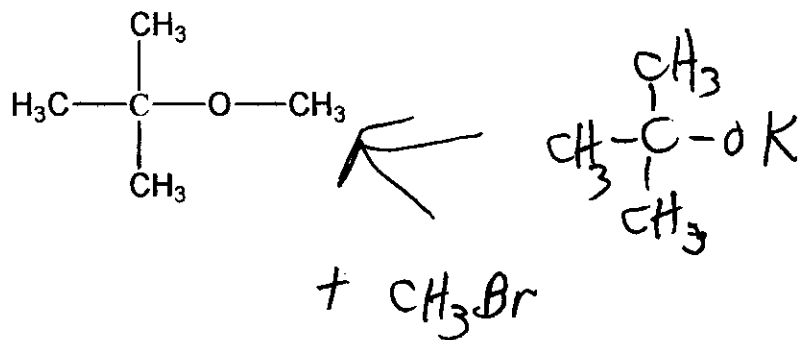
- A) constitutional isomers.
 B) enantiomers.
 C) diastereomers.
 D) identical.
 E) trans isomers.

Part B (16 points) Give the major organic product, including stereochemistry when applicable for the following reactions:

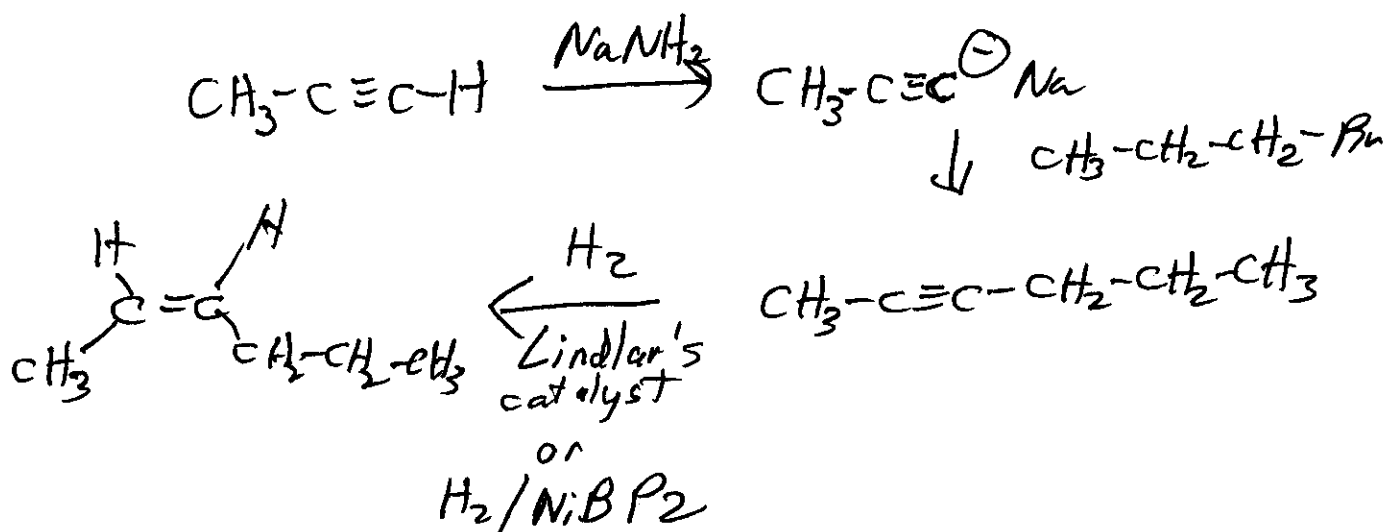


Part C (10 points): From any organic compounds of 4 carbons or fewer, and any needed inorganic reagents provide a reasonable synthetic path to make the indicated compounds. Show all reactants and reagents.

1.



2. *cis*-2-hexene



Bonus (2 points): When 2,3-dimethylbutan-2,3-diol is treated with acid, the product shows a strong infrared absorption at 1710 cm⁻¹. Identify the product and give a mechanism for its formation

