ACS Review Reactions of Alkenes - Addition Reactions

1. Which one of the following is not a metal catalyst for the hydrogenation of an alkene?

   A. Pd
   B. Pt
   C. Na
   D. Ni

2. What is(are) the product(s) in the Pd-catalyzed hydrogenation of 1,2-dimethylcyclopentene?

   A. *trans*-1,2-dimethylcyclopentane
   B. *cis*-1,2-dimethylcyclopentane
   C. a mixture of *trans* and *cis*-1,2-dimethylcyclopentane
   D. 1,1-dimethylcyclopentane

3. Which of the following alkenes is expected to have the highest heat of hydrogenation?

   A. 1-pentene
   B. *trans*-2-pentene
   C. *cis*-2-pentene
   D. 2-methyl-2-butene

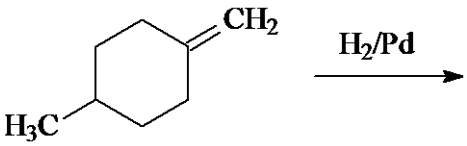
4. Which alkene below is thermodynamically the most stable?

   A. 1-hexene
   B. *trans*-3-hexene
   C. *cis*-3-hexene
   D. 2-methyl-2-pentene

5. The stereochemical pathway for the hydrogenation of an alkene with a metal catalyst, such as platinum, occurs *via*:

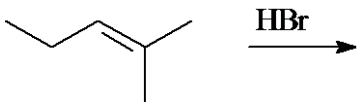
   A. syn addition
   B. anti addition
   C. Markovnikov addition
   D. anti-Markovnikov addition

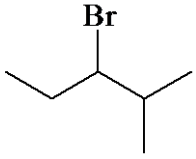
6. The product(s) in the following reaction is(are):

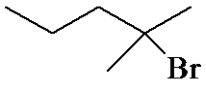


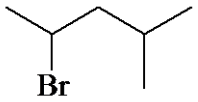
   A. only *trans*-1-4-dimethylcyclohexane
   B. only *cis*-1-4-dimethylcyclohexane
   C. both *trans* and *cis*-1-4-dimethylcyclohexane
   D. methylcyclohexane

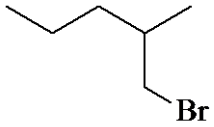
7. What is the major product of the following reaction?



A) 

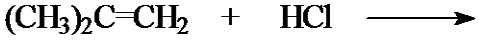
B) 

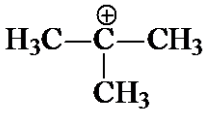
C) 

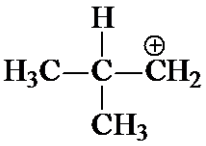
D) 

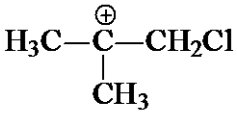
A. A
B. B
C. C
D. D

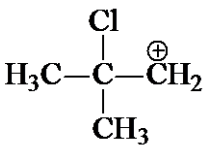
8. What is the intermediate in the following reaction?



A) 

B) 

C) 

D) 

A. A
B. B
C. C
D. D

9. Which of the following is not a possible reaction of a carbocation?

A. addition of a nucleophile
B. rearrangement to a more stable carbocation
C. addition of a proton to form an alkane
D. loss of a ß-hydrogen to form an alkene

10. Addition of HCl to 3-methyl-1-pentene gives two products. One of these is 2-chloro-3-methylpentane. What is the other product?

A. 1-chloro-3-methylpentane
B. 3-chloro-3-methylpentane
C. 3-chloro-2-methylpentane
D. 2-chloro-2-methylpentane

11. Predict which of the following alkenes reacts the fastest with HCl?

A. $CH_3CH_2CH_2CH_2CH{=}CH_2$
B. *cis*-$CH_3CH_2CH{=}CHCH_2CH_3$
C. *trans*-$CH_3CH_2CH{=}CHCH_2CH_3$
D. $(CH_3)_2C{=}CHCH_2CH_3$

12. Which species below is the intermediate in the free radical addition of HBr to 1-butene?

A) $H_3C-CH_2-\dot{C}H-CH_3$

B) $H_3C-CH_2-CH_2-\dot{C}H_2$

C) $H_3C-CH_2-\dot{C}H-CH_2Br$

D) $H_3C-CH_2-\underset{\displaystyle Br}{\underset{|}{CH}}-\dot{C}H_2$

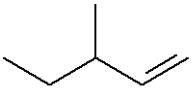
A. A
B. B
C. C
D. D

13. Which reagent(s) below would work best in converting 2-methyl-2-hexene to 2-methyl-3-hexanol?

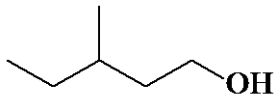
A) (1) H_2SO_4 (2) H_2O
B) 50% H_2SO_4/H_2O
C) (1) BH_3/THF (2) H_2O_2, NaOH
D) Br_2/H_2O

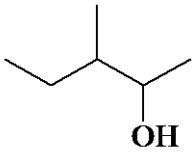
A. A
B. B
C. C
D. D

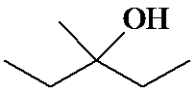
14. What is the major product of the following reaction?

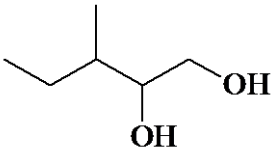


$\xrightarrow[\text{2) } H_2O_2, \text{ NaOH}]{\text{1) } B_2H_6, \text{ diglyme}}$

A) 

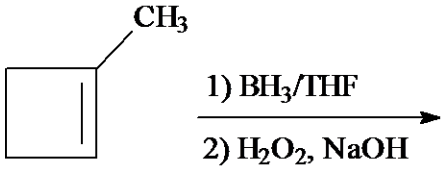
B) 

C) 

D) 

A. A
B. B
C. C
D. D

15. What is(are) the product(s) of the following hydroboration-oxidation reaction?

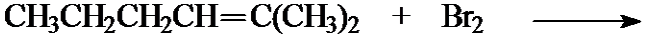


A. 1-methylcyclobutanol
B. *trans*-2-methylcyclobutanol
C. *cis*-2-methylcyclobutanol
D. equal amounts of 2 and 3

16. The hydroboration-oxidation reaction can be characterized as the _____ to an alkene.

A. anti-Markovnikov syn addition of water
B. anti-Markovnikov anti addition of water
C. Markovnikov syn addition of water
D. Markovnikov anti addition of water

17. What is the major product of the following reaction?



A. 1,2-dibromo-2-methylhexane
B. 2,2-dibromo-2-methylhexane
C. 2,3-dibromo-2-methylhexane
D. 2,4-dibromo-2-methylhexane

18. Which of the following alkenes gives 1-bromo-2-methyl-2-pentanol upon reaction with Br_2/H_2O?

A) $CH_3CH{=}CHCH(CH_3)_2$

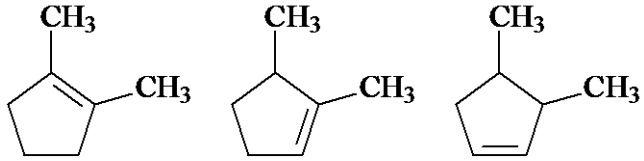
B) $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCH{=}CH_2$

C) $CH_3CH_2CH{=}C(CH_3)_2$

D) $CH_3CH_2CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}{=}CH_2$

A. A
B. B
C. C
D. D

19. Rank the following in order of decreasing reactivity with bromine, Br_2.



I II III

A. I > II > III
B. II > III > I
C. III > I > II
D. III > II > I

20. Which of the following is least likely to react with an alkene?

A) H_3O^+

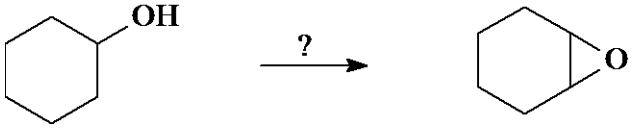
B) BrCl

C) $CH_3\dot{C}H_2$ (ethyl radical)

D) $NaOCH_2CH_3$

A. A
B. B
C. C
D. D

21. Which of the following series of reactions would convert cyclohexanol to 1,2-epoxycyclohexane?



A) (1) $NaOCH_2CH_3$ (2) Br_2, H_2O

B) (1) Br_2, light (2) $NaOCH_2CH_3$

C) (1) H_2SO_4, heat (2) $CH_3\overset{\overset{O}{\|}}{C}OOH$, CH_3CO_2H

D) (1) H_2SO_4, heat (2) O_3 (3) Zn, H_2O

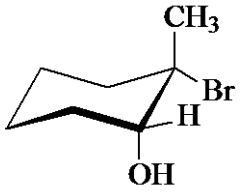
A. A
B. B
C. C
D. D

22. Which species below acts as the nucleophile in the acid-catalyzed addition of water to an alkene?

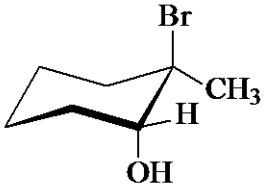
A. H_3O^+
B. the carbocation
C. OH^-
D. H_2O

23. Addition of hypobromous acid, HOBr, to 1-methylcyclohexene gives:

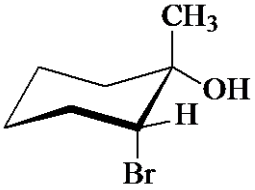
A)



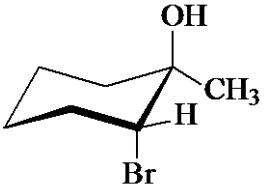
B)



C)



D)



A. A
B. B
C. C
D. D

24. A compound, $C_{15}H_{24}$, is reacted with excess hydrogen using a metal catalyst. One equivalent of the compound consumed three equivalents of hydrogen. How many rings did the original compound have?

A. 1 only
B. 2 only
C. 3 only
D. none

25. A compound, $C_{20}H_{30}$, can be hydrogenated with platinum metal and hydrogen to give a compound $C_{20}H_{38}$. How many double bonds (DB) and rings (R) does the original compound have? (The original compound has no triple bonds.)

A. 4 DB, 2 R
B. 4 DB, 1 R
C. 3 DB, 3 R
D. 2 DB, 4 R

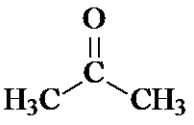
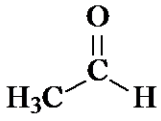
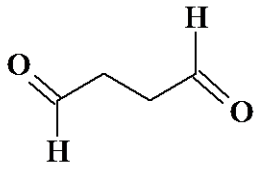
26. Determine the SODAR (sum of double bonds and rings) for a compound with the formula of C_6H_9BrO.

A. one
B. two
C. three
D. four

27. The reaction of 1-butene with bromine, Br_2, in aqueous solution gives primarily 1-bromo-2-butanol. Identify the nucleophilic species in the reaction.

A. Br_2
B. $Br^{\ominus}$
C. H_2O
D. HOBr

28. A compound is treated with ozone followed by zinc in water to give the following three products. Which structure below best fits the data?

A) $CH_3CH{=}CH(CH_2)_3CH{=}C(CH_3)_2$

B) $(CH_3)_2C{=}CHCH_2CH_2CH{=}CHCH_3$

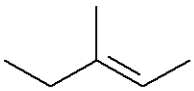
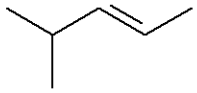
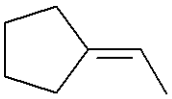
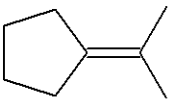
C) $H_2C{=}C(CH_3)CH_2CH_2C(CH_3){=}CHCH_3$

D) $H_2C{=}CHCH_2CH_2C(CH_3){=}C(CH_3)_2$

A. A
B. B

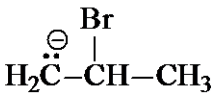
C. C
D. D

29. Which of the following gives acetone, $(CH_3)_2C=O$, as one of the products of its ozonolysis?

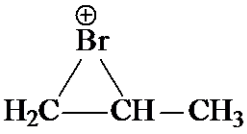
A)  B)  C)  D) 

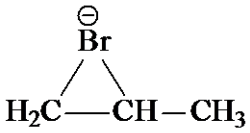
A. A
B. B
C. C
D. D

30. Which of the following species is the intermediate in the bromination of propene?

A) 

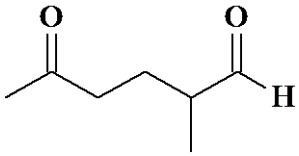
B) 

C) 

D) 

A. A
B. B
C. C
D. D

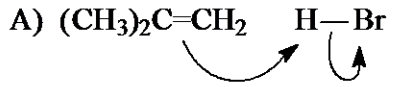
31. A compound, $C_7H_{13}Cl$, is reacted with sodium ethoxide and gives a single elimination product, C_7H_{12}. Treatment with ozone followed by zinc and water gives the compound below. Identify the original compound.

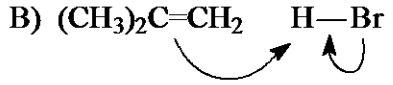


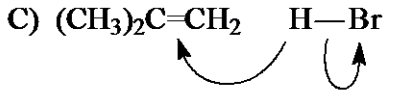
A. 2-chloro-1,1-dimethylcyclopentane
B. 1-chloro-1,2-dimethylcyclopentane
C. 4-chloro-1,2-dimethylcyclopentane

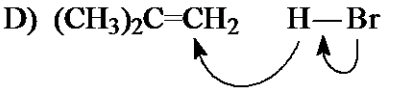
D. 2-chloro-1,3-dimethylcyclopentane

32. Which of the following correctly depicts the mechanistic first step in the addition of HBr to 2-methylpropene?

A) 

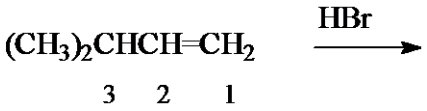
B) 

C) 

D) 

A. A
B. B
C. C
D. D

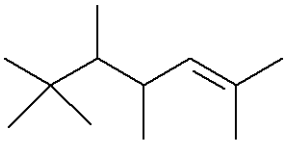
33. The rearrangement which occurs in the following reaction can be described as a:

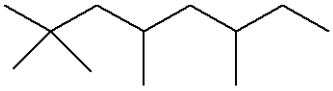


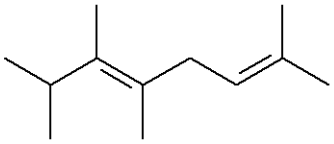
A. hydride shift from C-2 to C-1
B. hydride shift from C-3 to C-2
C. proton shift from C-2 to C-1
D. methyl group shift from C-3 to C-2

34. Which structure corresponds to the trimer of $(CH_3)_2C=CH_2$ formed under conditions of cationic polymerization?

A) 

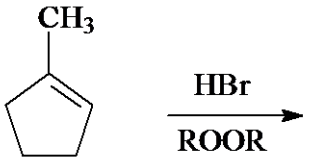
B) 

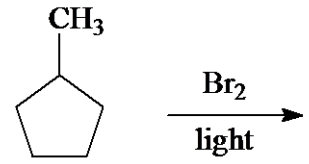
C) 

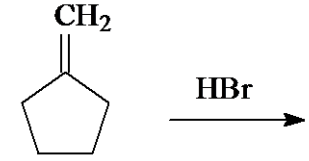
D) 

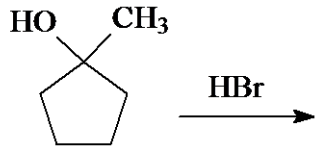
A. A
B. B
C. C
D. D

35. Which of the following does <u>not</u> give 1-bromo-1-methylcyclopentane as the major product?

A) 

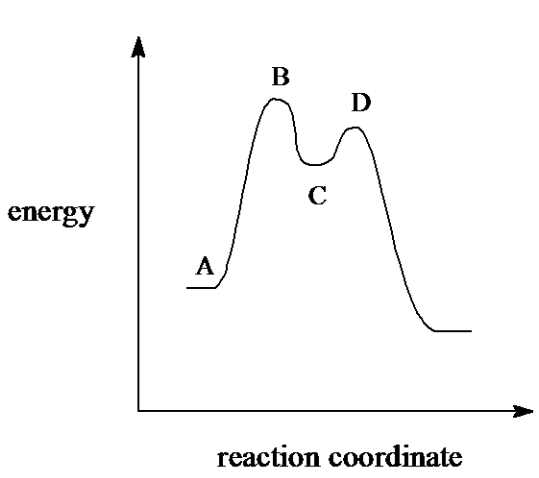
B) 

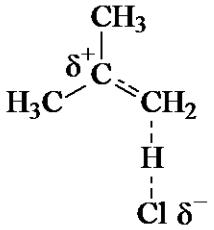
C) 

D) 

A. A
B. B
C. C
D. D

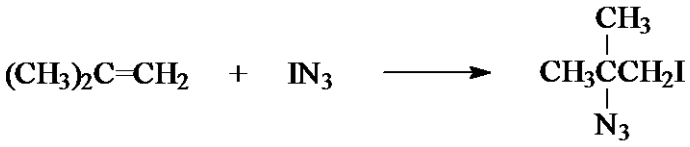
36. Which point on the potential energy diagram corresponds to the species below for the reaction of 2-methylpropene with hydrogen chloride?





A. A
B. B
C. C
D. D

37. Identify the nucleophile in the following electrophilic addition reaction.



A) $N_3^{\ominus}$

B) $N_3^{\oplus}$

C) $I^{\oplus}$

D) $I^{\ominus}$

A. A
B. B
C. C
D. D

38. Which of the following is the rate-determining step in the acid-catalyzed addition of water to 2-methylpropene?

A) $(CH_3)_2C{=}CH_2 + H_3O^+ \longrightarrow (CH_3)_3C^+ + H_2O$

B) $(CH_3)_3C^+ + H_2O \longrightarrow (CH_3)_3C\text{-}OH_2^+$

C) $(CH_3)_3C\text{-}OH_2^+ + H_2O \longrightarrow (CH_3)_3C\text{-}OH + H_3O^+$

D) $(CH_3)_3^+ + H_2O \longrightarrow (CH_3)_2C{=}CH_2 + H_3O^+$

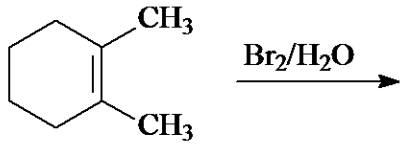
A. A
B. B
C. C
D. D

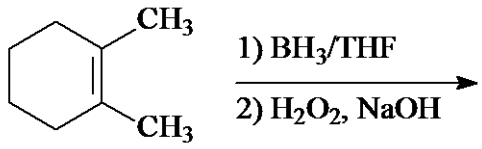
39. Which reaction sequence below would work best in converting 3-pentanol into 2,3-dibromopentane?

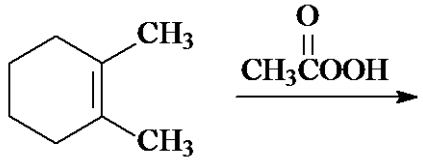
A) (1) H_2SO_4, heat (2) HBr (3) Br_2, light
B) (1) H_2SO_4, heat (2) H_2/Pt (3) 2 Br_2, light
C) (1) Br_2, light (2) H_2SO_4, heat (3) H_2/Pt
D) (1) H_2SO_4, heat (2) Br_2

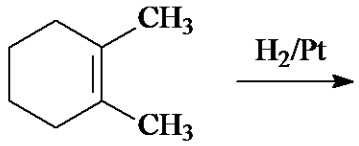
A. A
B. B
C. C
D. D

40. Which reaction proceeds by anti addition?

A) 

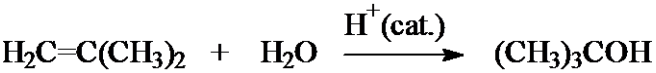
B) 

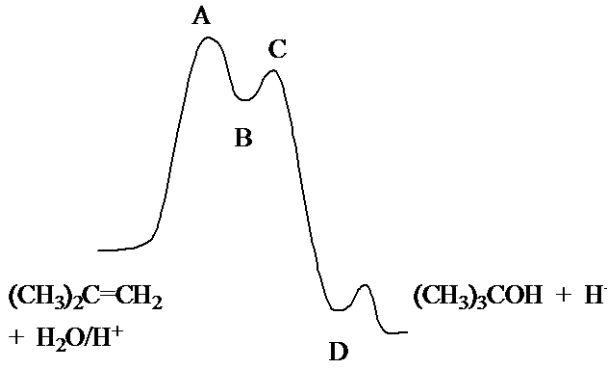
C) 

D) 

A. A
B. B
C. C
D. D

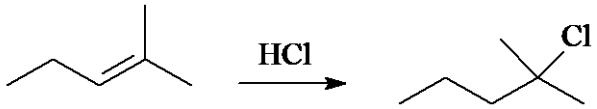
41. Which point on the potential energy diagram corresponds to the carbocation intermediate, $(CH_3)_3C^+$, for the reaction shown below?

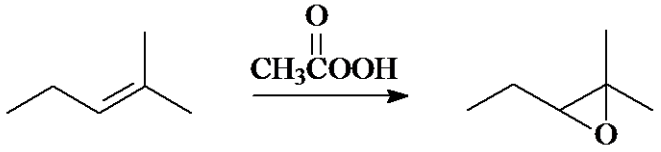


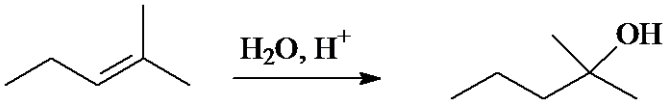


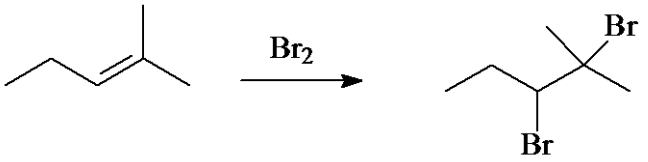
A. A
B. B
C. C
D. D

42. Which of the following reactions occurs by a one-step mechanism as opposed to a two-step mechanism?

A) 

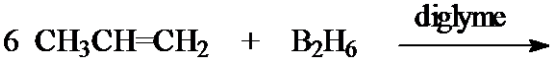
B) 

C) 

D) 

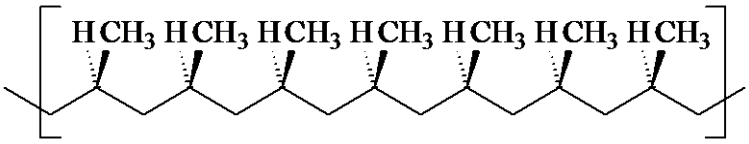
A. A
B. B
C. C
D. D

43. What is the product in the following reaction?



A. $(CH_3CH_2CH_2)_3B$
B. $[(CH_3)_2CH]_3B$
C. $CH_3CH_2CH_3$
D. polypropylene

44. Identify the following polymer.



A. polyethylene
B. polypropylene
C. polyisobutylene
D. polybutylene

ACS Review Reactions of Alkenes - Addition Reactions KEY

1. C
2. B
3. A
4. D
5. A
6. C
7. B
8. A
9. C
10. B
11. D
12. C
13. C
14. A
15. B
16. A
17. C
18. D
19. A
20. D
21. C
22. D
23. D
24. A
25. A
26. B
27. C
28. B
29. D
30. C
31. D
32. A
33. B
34. A
35. A
36. B
37. A
38. A
39. D
40. A
41. B
42. B
43. A
44. B