

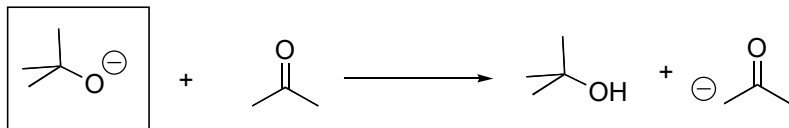
Chapter 3

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

1. Is the indicated compound acting an acid or a base in the following reaction?



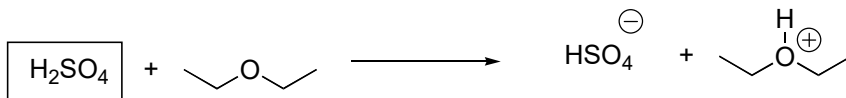
- A. Acid
 B. Base
 C. Neither
 Ans: B

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

2. Is the indicated compound acting an acid or a base in the following reaction?



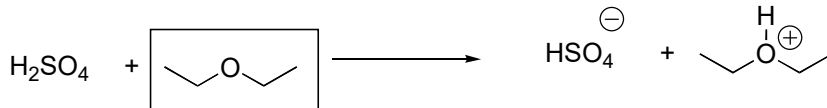
- A. Acid
 B. Base
 C. Neither
 Ans: A

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

3. Is the indicated compound acting an acid or a base in the following reaction?



- A. Acid
 B. Base
 C. Neither
 Ans: B

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

4. Is the indicated compound acting an acid or a base in the following reaction?



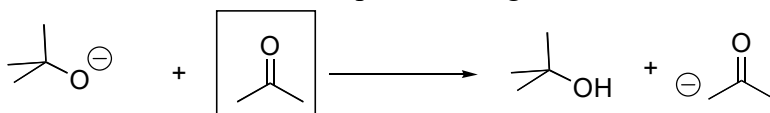
- A. Acid
 - B. Base
 - C. Neither
- Ans: B

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

5. Is the indicated compound acting an acid or a base in the following reaction?



- A. Acid
 - B. Base
 - C. Neither
- Ans: A

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Medium

6. Provide a definition of a Bronsted-Lowry acid.

Ans: A Bronsted-Lowry acid is a proton donor

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Medium

7. What is the conjugate base of the following acid?

H₂O

Ans: HO⁻

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Medium

8. What is the conjugate base of the following acid?

NH₄⁺

NH₄

Ans: NH₃

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

9. Which of the following is the conjugate base of the following acid?



- A. SH_2 B. SH_3 C. SH_2^{\ominus} D. OH^{\ominus}

Ans: A

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Easy

10. Which of the following is the conjugate acid of the following base?



- A. NH_4^{\oplus} B. NH_3^{\oplus} C. NH_3 D. NH^{-2}

Ans: C

Topic: Introduction to Bronsted-Lowry Acids and Bases

Section 3.1

Difficulty Level: Medium

11. What is an ionic reaction?

Ans: It is a reaction in which ions participate as the reactants.

Topic: Curved Arrow Notation

Section 3.2

Difficulty Level: Hard

12. In the following reaction, identify the acid and base as well as the conjugate acid and base.



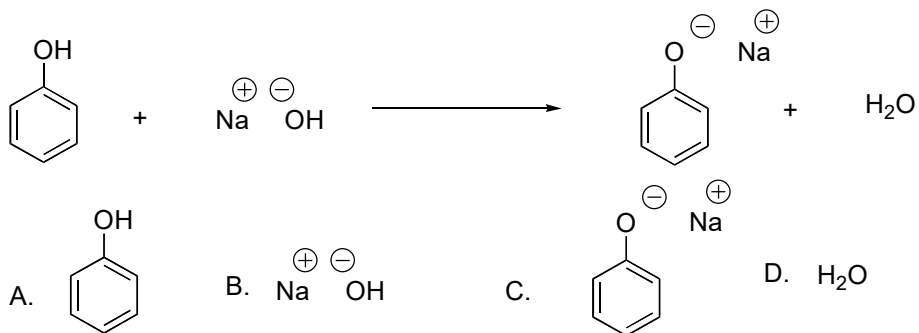
Ans: Acid, Base, Conjugate Base, Conjugate Acid

Topic: Curved Arrow Notation

Section 2

Difficulty Level: Easy

13. Which is the conjugate acid in the following reaction?



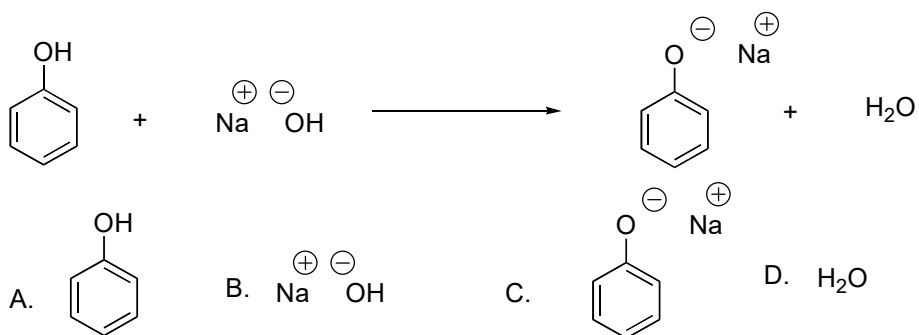
Ans: D

Topic: Curved Arrow Notation

Section 2

Difficulty Level: Easy

14. Which is the conjugate base in the following reaction?



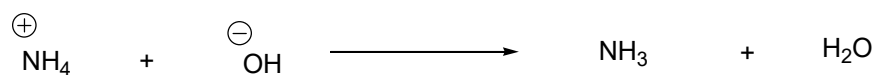
Ans: C

Topic: Curved Arrow Notation

Section 2

Difficulty Level: Medium

15. Draw arrows to indicate the movement of electrons in the following reaction.



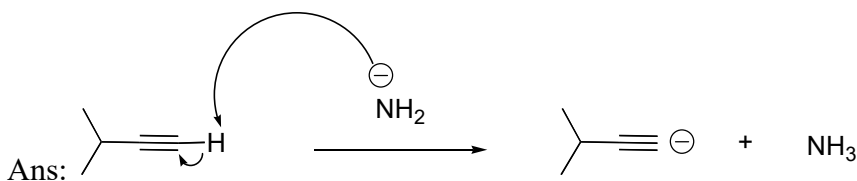
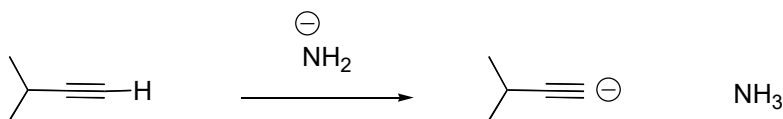


Topic: Curved Arrow Notation

Section 2

Difficulty Level: Medium

16. Draw arrows to indicate the movement of electrons in the following reaction.

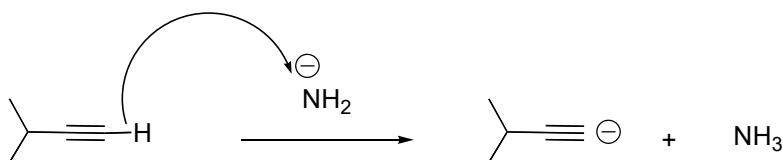


Topic: Curved Arrow Notation

Section 2

Difficulty Level: Easy

17. What is wrong with the following arrow?



- A. It should start on the alkyne carbon.
- B. It should start on a hydrogen attached to the nitrogen.
- C. It should start on the anion on nitrogen, end at the H on the alkyne, and a second arrow should start at the bond between the C and H on the alkyne and end on the terminal carbon of the alkyne.
- D. There should be two arrows – one from nitrogen and one from the alkyne carbon.

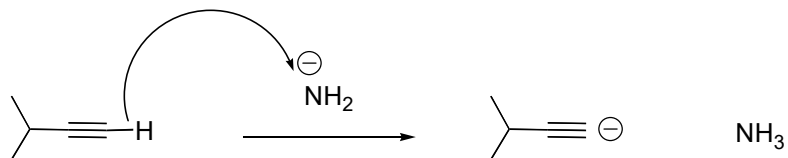
Ans: C

Topic: Curved Arrow Notation

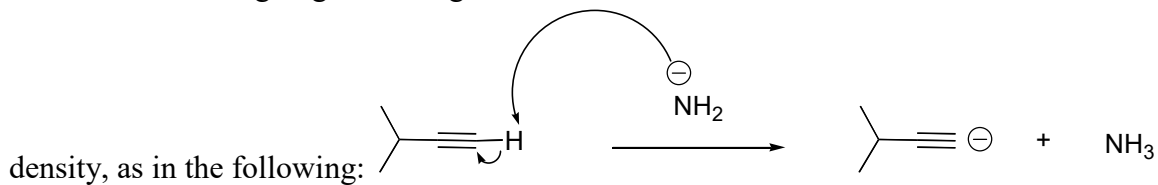
Section 2

Difficulty Level: Hard

18. What is wrong with the following arrow? Please draw the correct mechanism.

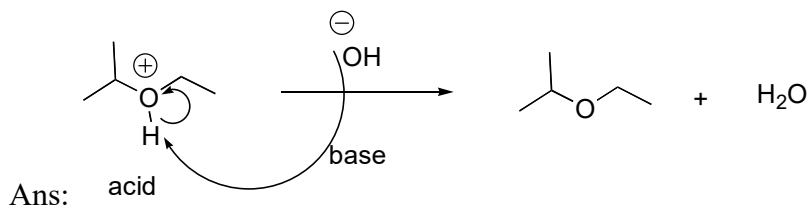
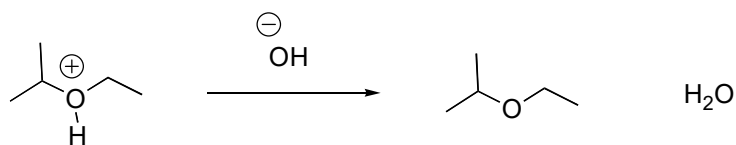


Ans: The arrow is going the wrong direction. It should start at the source of electron



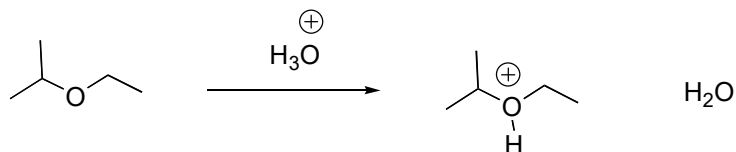
Topic: Curved Arrow Notation
 Section 2
 Difficulty Level: Medium

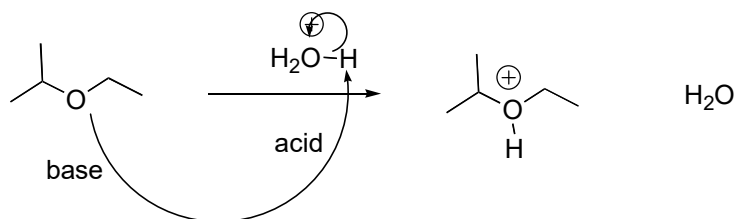
19. Identify the acid and the base and draw the mechanism.



Topic: Curved Arrow Notation
 Section 2
 Difficulty Level: Medium

20. Identify the acid and the base and draw the mechanism.





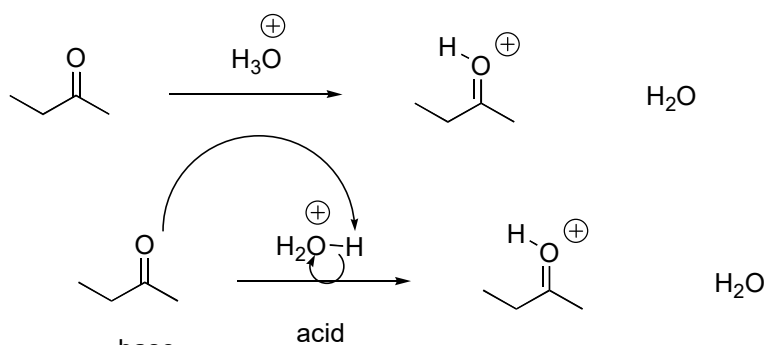
Ans:

Topic: Curved Arrow Notation

Section 2

Difficulty Level: Medium

21. Identify the acid and the base and draw the mechanism.



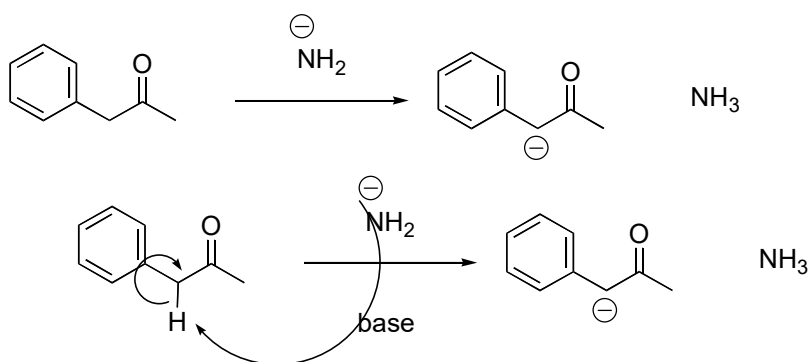
Ans:

Topic: Curved Arrow Notation

Section 2

Difficulty Level: Hard

22. Identify the acid and the base and draw the mechanism.



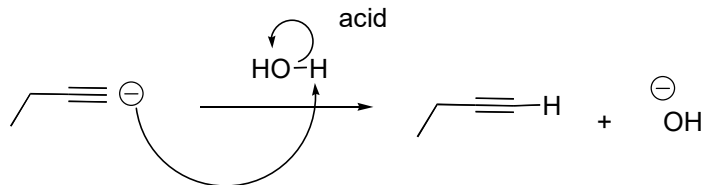
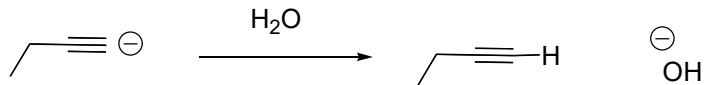
Ans:

Topic: Curved Arrow Notation

Section 2

Difficulty Level: Medium

23. Identify the acid and the base and draw the mechanism.



Ans: base

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Easy

24. Which of the following is the most acidic?


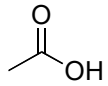
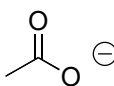
- A. HCl B. Cl^- C. H₂O D. NH₃
- Ans: A

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Easy

25. Which of the following is the most acidic?

- A.  B.  C.  D. NH₃
- Ans: B

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Easy

26. Which of the following is most basic?

- A. HCl B. Cl^- C. H₂O D. NH₃
- Ans: D

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Easy

27. Which of the following is the most basic?



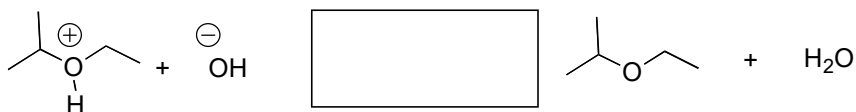
Ans: D

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Medium

28. Which side will the following acid-base reaction favor?



A. The right

B. The left

C. Neither

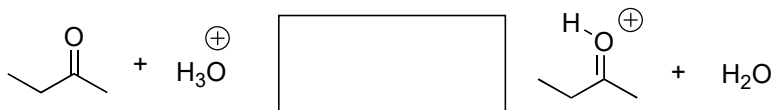
Ans: A

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Medium

29. Which side will the following acid-base reaction favor?



A. The right

B. The left

C. Neither

Ans: B

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Medium

30. Which side will the following acid-base reaction favor?



- A. The right
- B. The left
- C. Neither

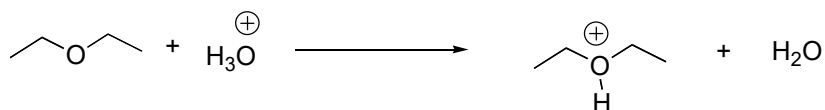
Ans: A

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Hard

31. Provide the correct K_{eq} for the following reaction.



$$K_{\text{eq}} = \frac{[\text{CH}_3\text{CH}_2\text{OH}^+\text{CH}_2\text{CH}_3][\text{H}_2\text{O}]}{[\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3][\text{H}_3\text{O}^+]}$$

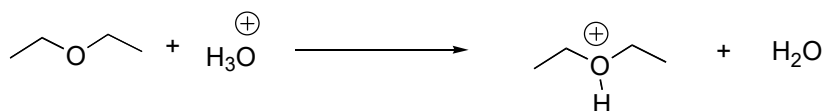
Ans:

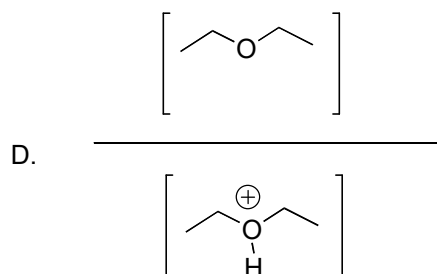
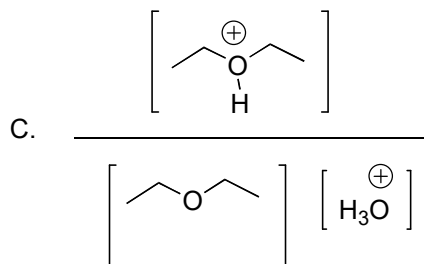
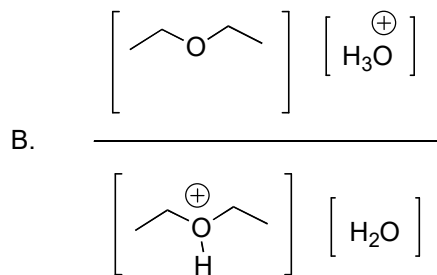
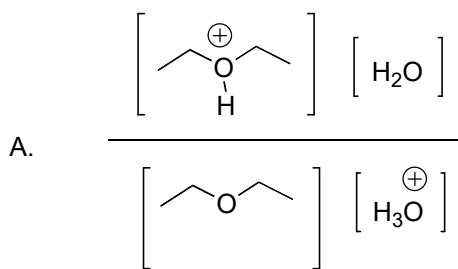
Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Medium

32. Which of the following is the correct K_{eq} for the following reaction?





Ans: A

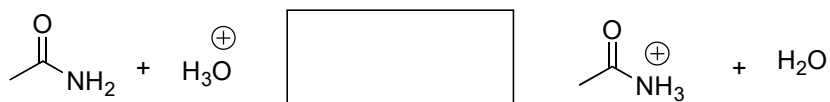
Topic: Quantitative Bronsted-Lowry Acidity
Section 3
Difficulty Level: Medium

33. What is the difference between K_a and pK_a ?

Ans: $pK_a = -\log K_a$

Topic: Quantitative Bronsted-Lowry Acidity
Section 3
Difficulty Level: Medium

34. Which side will the following acid-base reaction favor?



- A. The right
- B. The left
- C. Neither

Ans: A

Topic: Quantitative Bronsted-Lowry Acidity
Section 3
Difficulty Level: Medium

35. Which side will the following acid-base reaction favor?



- A. The right
- B. The left
- C. Neither

Ans: A

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Medium

36. Which side will the following acid-base reaction favor?



- A. The right
- B. The left
- C. Neither

Ans: A

Topic: Quantitative Bronsted-Lowry Acidity

Section 3

Difficulty Level: Medium

37. Which side will the following acid-base reaction favor?



- A. The right
- B. The left
- C. Neither

Ans: A

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

38. Which of the following is the strongest acid?

- A. HF
- B. HBr
- C. HCl
- D. HI

Ans: D

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

39. Which of the following is the strongest acid?

- A. H₂SO₄
- B. H₂SO₃
- C. H₂SO₂
- D. H₂SO

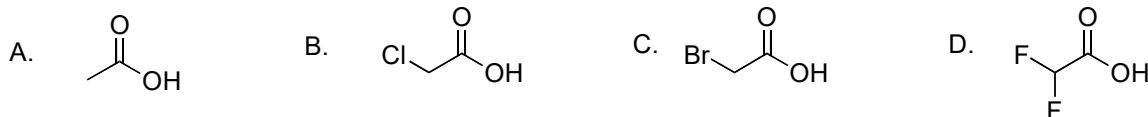
Ans: D

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

40. Which of the following is the strongest acid?



Ans: D

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

41. Which of the following is the strongest acid?



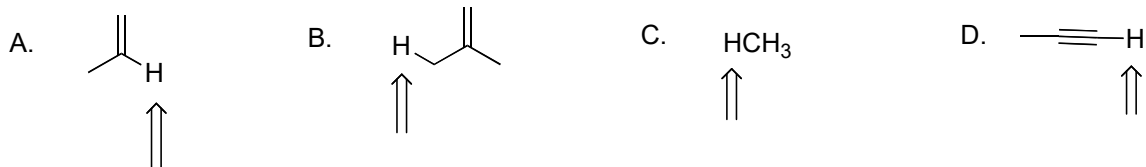
Ans: C

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

42. Which of the following indicated H's is the most acidic?



Ans: D

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Medium

43. What are two factors that influence the acidity of a compound?

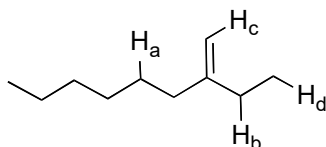
Ans: 1. Type of atom charge is on, 2. Resonance of the conjugate base anion, 3. Inductive effect, 4. Hybridization of the orbital

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

44. Identify the most acidic proton on the following compound.



- A. Ha
- B. Hb
- C. Hc
- D. Hd

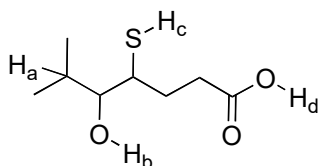
Ans: B

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Easy

45. Identify the most acidic proton on the following compound.



- A. Ha
- B. Hb
- C. Hc
- D. Hd

Ans: D

Topic: Qualitative Bronsted-Lowry Acidity

Section 4

Difficulty Level: Hard

46. Why is acetic acid more acidic than ethanol when the acidic proton in both cases is attached to oxygen?

Ans: The conjugate base of acetic acid has resonance delocalization of the anion, which is not the case in the conjugate base of ethanol.

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

47. Predict the position of equilibrium for the following reaction.



- A. To the left
- B. To the right
- C. No reaction

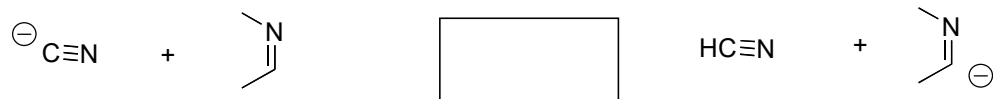
Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

48. Predict the position of equilibrium for the following reaction.



- A. To the left
- B. To the right
- C. No reaction

Ans: A

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

49. Predict the position of equilibrium for the following reaction.



- A. To the left
- B. To the right
- C. No reaction

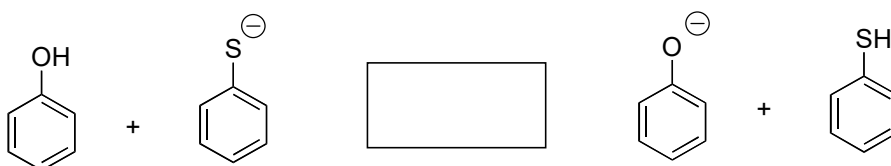
Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

50. Predict the position of equilibrium for the following reaction.



- A. To the left
- B. To the right
- C. No reaction

Ans: A

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

51. Could water protonate the following compound?



- A. Yes
- B. No

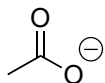
Ans: A

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

52. Could water protonate the following compound?



- A. Yes
- B. No

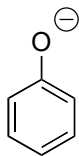
Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

53. Could water protonate the following compound?



A. Yes

B. No

Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

54. Could water protonate the following compound?



A. Yes

B. No

Ans: A

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

55. Could hydroxide deprotonate CH₄?

A. Yes

B. No

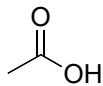
Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

56. Could hydroxide deprotonate the following compound?



A. Yes

B. No

Ans: A

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

57. Could ammonia (NH_3) deprotonate CH_4 ?

A. Yes

B. No

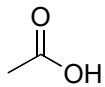
Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

58. Could ammonia (NH_3) deprotonate the following compound?



A. Yes

B. No

Ans: A

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

59. Could the amide anion (NH_2^-) deprotonate CH_4 ?

A. Yes

B. No

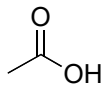
Ans: B

Topic: Position of Equilibrium

Section 5

Difficulty Level: Easy

60. Could the amide anion (NH_2^-) deprotonate the following compound?



A. Yes

B. No

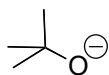
Ans: A

Topic: Choice of Solvent

Section 6

Difficulty Level: Easy

61. Can this base exist in water?



A. Yes

B. No

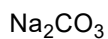
Ans: B

Topic: Choice of Solvent

Section 6

Difficulty Level: Easy

62. Can this base exist in water?



A. Yes

B. No

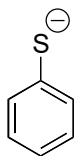
Ans: B

Topic: Choice of Solvent

Section 6

Difficulty Level: Easy

63. Can this base exist in water?



A. Yes

B. No

Ans: A

Topic: Choice of Solvent

Section 6

Difficulty Level: Easy

64. Can this base exist in water?



A. Yes

B. No

Ans: A

Topic: Choice of Solvent

Section 6

Difficulty Level: Easy

65. Can this base exist in water?



- A. Yes
B. No
Ans: B

Topic: Choice of Solvent
Section 6
Difficulty Level: Hard

66. Explain the leveling effect.

Ans: The leveling effect says that the strongest acid or base you can have in a given solvent is the protonated version of that solvent (for acids) or the deprotonated version of that solvent (for bases).

Topic: Choice of Solvent
Section 6
Difficulty Level: Medium

67. What is the strongest base that can exist in water?

Ans: Hydroxide

Topic: Choice of Solvent
Section 6
Difficulty Level: Easy

68. Can this base exist in hexane?



- A. Yes
B. No
Ans: A

Topic: Choice of Solvent
Section 6
Difficulty Level: Easy

69. Can this base exist in liquid ammonia?



- A. Yes
B. No
Ans: B

Topic: Counterions

Section 8

Difficulty Level: Medium

70. What is a cation?

Ans: A positively charged ion.

Topic: Counterions

Section 8

Difficulty Level: Easy

71. What is the counterion to methoxide in the following compound?

NaOMe

A. Na^+

B. O

C. Me

D. OMe

Ans: A

Topic: Counterions

Section 8

Difficulty Level: Easy

72. What is the counterion of iodide in the following compound?

AgI

A. I

B. Ag^+

C. gI

D. AI

Ans: B

Topic: Counterions

Section 8

Difficulty Level: Easy

73. What is the counterion of the t-butyl carbanion in the following compound?



A. tert-butyl

B. C

C. Li^+

D. H

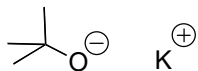
Ans: C

Topic: Counterions

Section 8

Difficulty Level: Easy

74. What is the counterion of t-butoxide in the following compound?



- A. K^+
- B. O
- C. tert-butoxide
- D. tert-butyl

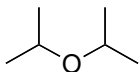
Ans: A

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

75. Into which of the following categories does the following compound belong?



- A. Bronsted-Lowry Acid
- B. Bronsted-Lowry Base
- C. Lewis Acid
- D. Lewis Base

Ans: D and B

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

76. Into which of the following categories does the following compound belong?



- A. Bronsted-Lowry Acid
- B. Bronsted-Lowry Base
- C. Lewis Acid
- D. Lewis Base

Ans: C

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

77. Into which of the following categories does the following compound belong?



- A. Bronsted-Lowry Acid
- B. Bronsted-Lowry Base
- C. Lewis Acid
- D. Lewis Base

Ans: C

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

78. Into which of the following categories does the following compound belong?



- A. Bronsted-Lowry Acid
- B. Bronsted-Lowry Base
- C. Lewis Acid
- D. Lewis Base

Ans: D and B

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

79. Into which of the following categories does the following compound belong?



- A. Bronsted-Lowry Acid
- B. Bronsted-Lowry Base
- C. Lewis Acid
- D. Lewis Base

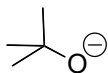
Ans: D

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

80. Which is the best descriptor for the following compound?



- A. Bronsted-Lowry Acid
- B. Bronsted-Lowry Base
- C. Lewis Acid
- D. Lewis Base

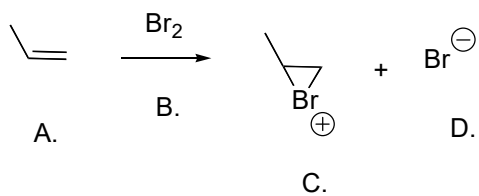
Ans: B

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

81. Identify the Lewis acid in the following reaction.



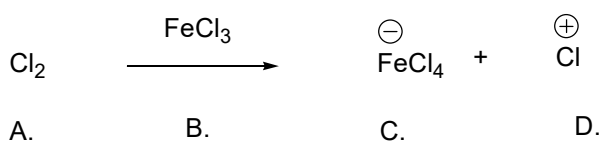
Ans: B

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

82. Identify the Lewis acid in the following reaction.



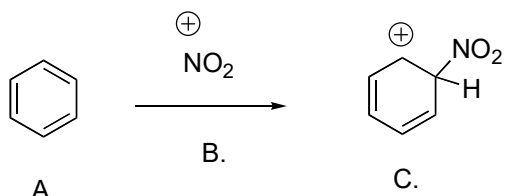
Ans: B

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

83. Identify the Lewis acid in the following reaction.



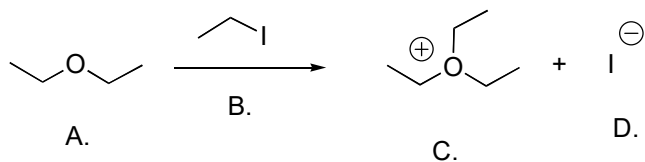
Ans: B

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

84. Identify the Lewis base in the following reaction.



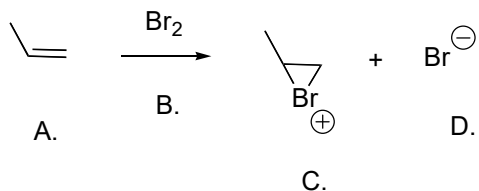
Ans: A

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

85. Identify the Lewis base in the following reaction.



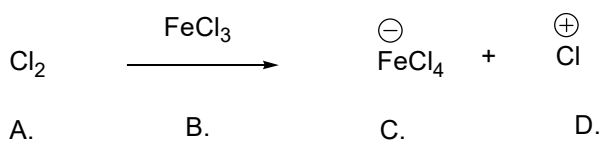
Ans: A

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

86. Identify the Lewis base in the following reaction.



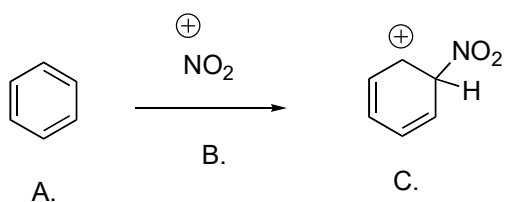
Ans: A

Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Easy

87. Identify the Lewis base in the following reaction.



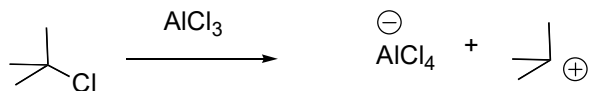
Ans: A

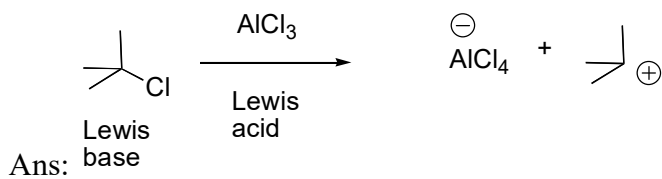
Topic: Lewis Acids and Bases

Section 9

Difficulty Level: Medium

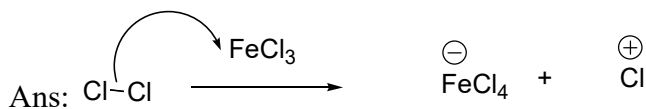
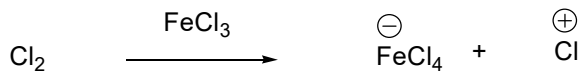
88. In the following reaction, identify the Lewis acid and the Lewis base.





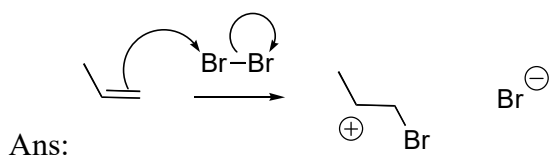
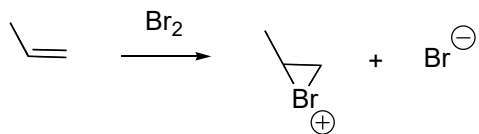
Topic: Lewis Acids and Bases
 Section 9
 Difficulty Level: Hard

89. For the following reaction, draw the mechanism.



Topic: Lewis Acids and Bases
 Section 9
 Difficulty Level: Hard

90. For the following reaction, draw the mechanism.



Topic: Lewis Acids and Bases
 Section 9
 Difficulty Level: Hard

91. For the following reaction, draw the mechanism.

