Essential Organic Chemistry Canadian 3rd Edition Bruice Test Bank

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Essential Organic Chemistry, 3e (Bruice) Chapter 2 Acids and Bases: Central to Understanding Organic Chemistry

Which of the following is <u>not</u> a conjugate acid-base pair?
 A) H₂O, HO B) H₂O, H₃O+
 C) HSO₄-, H₂SO₄
 D) -OH, O² E) NO₃-, NO₂ Answer: E
 Diff: 1
 Section: 2-1
 Objective: G2, G3
 LO: 2.1

2) What is the product of the following acid-base reaction?

•• CH3OH + :NH3 ≓ •• A) $CH_3O^- + +NH_4$ B) $CH_2OH + +NH_3$ C) $CH_3OH_2^+ + -NH_2$ D) $CH_3NH_2 + H_2O$ E) CH4 + NH2OHAnswer: A Diff: 3 Section: 2-4 Objective: G2, G3 LO: 2.1 3) The conjugate acid of H₂O is _____. A) H₃O-B) H3O C) H3O+ D) HO-E) H2O+ Answer: C Diff: 2 Section: 2-1 Objective: G2, G3 LO: 2.1

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4) Which of the following is the strongest acid?
A) HB) HOC) HSO4D) H₂O
E) H₃O+
Answer: E
Diff: 2
Section: 2-1
Objective: G2, G3
LO: 2.1

5) Which two species act as bases in the acid-base reaction shown below?

 \oplus Θ $H_2SO_4 + HNO_3 \rightleftharpoons H_2NO_3 + HSO_4$ 1 2 3 4 A) 1 and 2 B) 3 and 4 C) 2 and 4 D) 1 and 3 E) 2 and 3 Answer: C Diff: 2 Section: 2-1 Objective: G2, G3 LO: 2.1 6) What is the conjugate acid of NH3? A) +NH3 B) -NH C) +NH4 D) -NH2 E) +NH2 Answer: C Diff: 2 Section: 2-1 Objective: G2, G3 LO: 2.1

7) What is the conjugate acid of CH₃NH₂? A) CH₃NH₃+ B) CH3NH-C) $+NH_4$ D) -NH2 Answer: A Diff: 2 Section: 2-1 Objective: G2, G3 LO: 2.1 8) What is the conjugate base of CH₃NH₂? A) CH₃NH₃+ B) CH3NH- $C) + NH_4$ D) -NH2 Answer: B Diff: 2 Section: 2-1 Objective: G2, G3 LO: 2.1 9) What is the pH of a 0.1 M solution of HCl? A) 6 B) -6 C) 1 D) -8 E) -1 Answer: C Diff: 2 Section: 2-2 Objective: G2, G3 LO: 2.2

10) Which is a stronger acid, A or B?



A A) A B) B Answer: A Diff: 2 Section: 2-3 Objective: G2, G3 LO: 2.3

12) Does water act as an acid or a base in the following reaction?

В

$$\begin{array}{c} 0 \\ H_{3}C \\ OH \end{array} + H_{2}O \\ \end{array}$$
A) Acid
B) Base
C) Neither
D) Both
Answer: B
Diff: 2
Section: 2-4
Objective: G2, G3
LO: 2.5

13) Does methyl alcohol act as an acid or a base in the following reaction?

H₃C $\stackrel{\textcircled{\baselineskip}{\label{eq:H3}} + CH_3OH \longrightarrow$ A) Acid B) Base C) Neither D) Both Answer: B Diff: 2 Section: 2-4 Objective: G2, G3 LO: 2.5

14) Does acetic acid act as an acid or a base in the following reaction?

A) Acid B) Base C) Neither D) Both Answer: A Diff: 2 Section: 2-4 Objective: G2, G3 LO: 2.5

15) Which are favored at equilibrium, reactants or products?

H₃0 € H₃C NH2 + H₂O NH₃ H₃C² A) Reactants B) Products C) Both D) Neither Answer: A Diff: 2 Section: 2-5 Objective: G2, G3 LO: 2.6

16) Which are favored at equilibrium, reactants or products?

_____ н₃с′ . ⊙[⊖] + CH₃NH₃ A) Reactants **B)** Products C) Both D) Neither Answer: B Diff: 2 Section: 2-5 Objective: G2, G3 LO: 2.6 17) Which of the following is the strongest acid? A) CH₃OH B) CH₃OH₂+ C) $-NH_2$ D) CH₃NH₂ E) CH₃NH₃+ Answer: B Diff: 2 Section: 2-6 Objective: G2, G3 LO: 2.7 18) The p K_a of CH₃COOH is 4.8 and the p K_a of HCOOH is 3.8. Given this information, one knows that A) CH3COOH completely ionizes in water B) HCOOH is a weaker acid than CH₃COOH C) HCOO- is a weaker base than CH₃COO-D) CH3COOH reacts with HO- while HCOOH does not E) HCOOH reacts with HO- while CH3COOH does not Answer: C Diff: 2 Section: 2-6 Objective: G2, G3 LO: 2.7

19) Which of the following is the strongest acid? A) HF B) H₂O C) NH3 D) CH4 E) CH₃OH Answer: A Diff: 2 Section: 2-6 Objective: G2, G3 LO: 2.7 20) Which of the following is the strongest acid? A) CH3CH2OH B) CH3OCH3 C) CH₃NHCH₃ D) CH3C≡CH E) CH₃CH=CH₂ Answer: A Diff: 2 Section: 2-6 Objective: G2, G3 LO: 2.7 21) Which of the following has the highest pK_a ? A) CH₃NH₂ B) CH₃OH C) CH3COOH D) H₂O E) CH3NH3+ Answer: A Diff: 2 Section: 2-6 Objective: G2, G3 LO: 2.7

22) Which of the following has the highest pKa?
A) CH₃CH₃
B) HCCH
C) CH₂CH₂
D) CH₃OH
E) CH₃NH₂
Answer: A
Diff: 2
Section: 2-6
Objective: G2, G3
LO: 2.7

23) Which of the following carboxylic acids is the strongest acid?
A) ICH₂COOH
B) BrCH₂COOH
C) CH₃COOH
D) FCH₂COOH
E) CICH₂COOH
Answer: D
Diff: 2
Section: 2-7
Objective: G2, G3
LO: 2.8

24) The p K_a of CH₃COOH is 4.8. If the pH of an aqueous solution of CH₃COOH and

CH₃COO- is 4.8, then one knows _____ A) CH₃COOH is completely ionized B) [CH₃COOH] > [CH₃COO-] C) [CH₃COOH] = [CH₃COO-] D) [CH₃COOH] < [CH₃COO-] E) CH₃COOH is completely unionized Answer: C Diff: 2 Section: 2-10 Objective: G2, G3 LO: 2.11 25) When a small amount of CH₃(CH₂)₄CO₂H, (p $K_a \sim 4.8$) is added to a separatory funnel that contains ether and water with a pH = 2.0, it is found mainly in the _____ layer as _____. A) ether; CH₃(CH₂)₄CO₂-B) water; CH₃(CH₂)₄CO₂-C) ether; CH₃(CH₂)₄CO₂H D) water; CH₃(CH₂)₄CO₂H E) none of the above Answer: C Diff: 2 Section: 2-10 Objective: G2, G3 LO: 2.12

26) When a small amount of CH₃(CH₂)₄CO₂H ($pK_a \sim 4.8$) is added to a separatory funnel that contains ether and water with a pH = 12.0, it is found mainly in the _____ layer as _____. A) ether; CH₃(CH₂)₄CO₂-B) water; CH₃(CH₂)₄CO₂-C) ether; CH₃(CH₂)₄CO₂H D) water; CH₃(CH₂)₄CO₂H E) none of the above Answer: B Diff: 2 Section: 2-10 Objective: G2, G3 LO: 2.12 27) HA is an acid with a $pK_a = 4.5$. Which of the following statements about an aqueous solution

27) HA is an acid with a $pK_a = 4.5$. Which of the following statements about an aqueous solution of HA is true? A) At pH = 4.5, the solution contains more H-A than A-B) At pH = 4.5, the solution contains more A- than H-A C) At pH = 3.5, the solution contains much more HA than A-. E) At pH = 6.5, the solution contains about the same amount of A- and HA. Answer: E Diff: 3 Section: 2-10 Objective: G2, G3 LO: 2.11 28) A buffer is used to maintain the pH of human blood at ~ 7.4. Which acid/base pair buffers the blood?

A) H₂O / HO⁻ B) H₃O⁺ / H₂O C) H₂CO₃ / HCO₃⁻ D) NH₄⁺ / NH₃ E) HCl / Cl⁻ Answer: C Diff: 2 Section: 2-11 Objective: G2, G3 LO: 2.14

29) What is the conjugate acid and the conjugate base of HSO4-? Answer: conjugate acid: H₂SO4 conjugate base: SO4²⁻ Diff: 3 Section: 2-1 Objective: G2, G3 LO: 2.1

30) Write the products of the following acid-base reaction:

 $HCO_2H + -NH_2 \rightarrow$

Answer: $HCO_2H + -NH_2 \rightarrow HCO_2 + NH_3$ Diff: 3 Section: 2-3 Objective: G2, G3 LO: 2.1

31) If H₂O has a p K_a value of 15.7 and HF has a p K_a value of 3.2, which is a stronger base, HOor F-? Explain.

Answer: HO⁻ is a stronger base than F⁻ because HF is a stronger acid than H₂O, and the stronger the acid the weaker its conjugate base. Diff: 3 Section: 2-2 Objective: G2, G3

LO: 2.2

32) Draw the conjugate base of the following compound:

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(CH3)2CHOH
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Answer:

$$H_{3}C \xrightarrow{C} C \xrightarrow{C} CH_{3}$$

$$H_{3}C \xrightarrow{H} C$$

$$H_{3}C \xrightarrow{H} CH_{3}$$

$$H_{3}$$

33) Rank NH3, HF, and H₂O in order of increasing acidity and explain your rationale. Answer: $NH_3 < H_2O < HF$

Because N, F, and O are about the same size, we know that the strongest acid has its H attached to the most electronegative atom. Of the three atoms, F is the most electronegative and N is the least electronegative. Therefore, NH₃ is the weakest acid and HF is the strongest acid. Diff: 3 Section: 2-6 Objective: G2, G3 LO: 2.7

34) Explain why NF3 is a weaker base than NH3.

Answer: Fluorine has an electron withdrawing effect that reduces the availability of the pair of electrons on nitrogen. Thus the basicity of : NF3 is less than that of : NH3. Diff: 3 Section: 2-7 Objective: G2, G3 LO: 2.8

35) Is CH₃CHBrCO₂- or CH₃CHFCO₂- the stronger base? Explain your choice.

Answer: CH₃CHBrCO₂- is the stronger base. F is better at withdrawing electrons inductively than Br because F is more electronegative. This greater electron withdrawal stabilizes CH₃CHFCO₂- relative to CH₃CHBrCO₂-, which makes the latter a stronger base. Diff: 3 Section: 2-7 Objective: G2, G3 LO: 2.8

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36) Draw a resonance contributor and the resonance hybrid for HOCO₂-.

Answer: resonance contributor: resonance hybrid:



Diff: 3 Section: 2-8 Objective: G2, G3 LO: 2.9

37) The amino acid (H₃N+CH₂CO₂H) has two acidic H's, one with a $pK_a = 2.34$ and the other with a $pK_a = 9.60$. Draw the structure of the amino acid that predominates at pH =12. Answer:

Section: 2-10 Objective: G2, G3 LO: 2.11

38) HC=N has a $pK_a = 9.1$. What form of the compound, HC=N or HC=N-, predominates in a solution with pH = 7.0 Answer: HCN Diff: 1 Section: 2-10 Objective: G2, G3 LO: 2.11

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