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Acids and Bases

Exam — Acids, Bases & pH

70 Pre-med/IB-style questions covering Arrhenius vs Brønsted–Lowry vs Lewis definitions, conjugate pairs, amphiprotic species, strong/weak vs concentrated/dilute, pH/pOH and K_w , buffers, titrations, salt hydrolysis, and common conceptual traps.

70 items — Printable Exam

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Generated February 20, 2026

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1 In Brønsted–Lowry theory, an acid is best defined as:



- A A substance that increases $[\text{OH}^-]$ in water
- B A proton (H^+) donor
- C An electron-pair donor
- D A substance with $\text{pH} > 7$
- E Any molecule containing hydrogen

2 In Brønsted–Lowry theory, a base is best defined as:



- A A proton (H^+) acceptor
- B A proton (H^+) donor
- C A substance that always contains OH^- in its formula
- D A substance with $\text{pH} < 7$
- E A substance that releases electrons into solution

3 Which statement matches the Arrhenius definition of an acid?



- A A substance that donates an electron pair
- B A substance that accepts a proton
- C A substance that increases the concentration of H_3O^+ in aqueous solution
- D A substance that always reacts with metals to produce hydrogen gas
- E A substance that is always molecular





4 Which statement correctly defines a Lewis acid?



- A A proton donor
- B An electron-pair acceptor
- C An electron-pair donor
- D A substance that increases $[\text{OH}^-]$ in water
- E A substance with a bitter taste

5 In the reaction $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$, which species is the Brønsted-Lowry acid?



- A NH_3
- B H_2O
- C NH_4^+
- D OH^-
- E All species are acids

6 In the reaction $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$, what is the conjugate acid of NH_3 ?



- A H_2O
- B NH_2^-
- C NH_4^+
- D OH^-
- E H_3O^+





7 Which species is amphiprotic (can act as BOTH a Brønsted acid and a Brønsted base)?



- A Cl^-
- B NH_4^+
- C HCO_3^-
- D Na^+
- E CH_4

8 Which of the following is commonly classified as a strong acid in water?



- A CH_3COOH
- B HF
- C HCl
- D H_2CO_3
- E NH_4^+

9 Which of the following is commonly classified as a strong base in water (in typical high-school chemistry)?



- A NH_3
- B NaOH
- C CH_3COO^-
- D H_2O
- E CO_2





10 Which statement correctly distinguishes a strong acid from a concentrated acid?



- A A strong acid has a low pH, while a concentrated acid has $\text{pH} = 0$
- B A strong acid fully ionizes in water, while a concentrated acid simply has a high molar concentration
- C A strong acid always contains oxygen, while a concentrated acid does not
- D A strong acid is always dangerous, while a concentrated acid is always safe
- E Strong acids have higher molar mass than concentrated acids

11 At 25°C, the pH of pure water is closest to:



- A 0
- B 7
- C 14
- D 1
- E Depends only on the container size

12 A solution has $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-3} \text{ M}$. What is its pH (approximately)?



- A 3
- B 7
- C 11
- D -3





E 0.001

13 If pH = 2, the hydronium concentration is closest to:



- A 1×10^{-2} M
- B 2×10^{-2} M
- C 1×10^{-12} M
- D 2 M
- E 1×10^2 M

14 If $[\text{OH}^-] = 1.0 \times 10^{-4}$ M at 25°C, what is the pH (approximately)?



- A 4
- B 7
- C 10
- D 14
- E 18

15 Which statement about pH is correct?



- A A pH change of 1 unit means $[\text{H}_3\text{O}^+]$ changes by a factor of 2
- B Lower pH means higher $[\text{H}_3\text{O}^+]$
- C pH is directly equal to $[\text{H}_3\text{O}^+]$





- D Neutral solutions always have pH 7 at any temperature
- E pH can never be below 0

16 At 25°C, if $[H_3O^+] = [OH^-]$, the solution is:



- A Always acidic ($pH < 7$)
- B Always basic ($pH > 7$)
- C Neutral ($pH = 7$)
- D Impossible because $[H_3O^+]$ and $[OH^-]$ cannot be equal
- E Neutral only if the solution contains NaCl

17 Which statement about polyprotic acids is correct?



- A They can donate more than one proton per molecule
- B They must be strong acids
- C They always donate all protons completely in water
- D They have exactly one conjugate base
- E They cannot form buffers

18 For the acid H_2CO_3 , what is the conjugate base after it donates ONE proton?



- A CO_3^{2-}
- B HCO_3^-





- C H_3CO_3^+
- D CO_2
- E OH^-

19 Which conjugate acid–base pair differs by exactly one proton (H^+)?



- A HCl / Cl_2
- B $\text{H}_2\text{O} / \text{O}_2^-$
- C $\text{NH}_4^+ / \text{NH}_3$
- D $\text{H}_2\text{CO}_3 / \text{CO}_2$
- E $\text{NaOH} / \text{Na}^+$

20 Which statement about H_2SO_4 in water is most accurate at an introductory level?



- A Both protons dissociate completely with equal strength
- B The first dissociation is strong; the second dissociation is weaker (partial)
- C H_2SO_4 is a weak acid because it has two protons
- D H_2SO_4 cannot donate protons because sulfate is stable
- E H_2SO_4 is a base because it contains oxygen

21 In the reaction $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{Cl}^- + \text{H}_3\text{O}^+$, which species is the Brønsted base?





- A HCl
- B H₂O
- C Cl⁻
- D H₃O⁺
- E None; this is not an acid–base reaction

22 What is the conjugate base of H₃O⁺?



- A H₂O
- B OH⁻
- C H₂O₂
- D O₂
- E H⁺

23 Which statement about K_a is correct?



- A A larger K_a means a weaker acid
- B A larger K_a means a stronger acid
- C K_a is only defined for bases
- D K_a increases when an acid is diluted because it ionizes more
- E K_a equals the pH of the solution





24 Which statement about pKa is correct?



- A Lower pKa means stronger acid
- B Higher pKa means stronger acid
- C pKa is the same as pH
- D pKa is only used for strong acids
- E pKa increases when temperature decreases for all acids

25 Which is the best explanation for why HF is a weak acid in water while HCl is a strong acid?



- A HF has a stronger H-F bond that is harder to break (less ionization)
- B Fluorine is less electronegative than chlorine
- C HF contains oxygen, which makes acids weak
- D HCl is weak because it has a larger molar mass
- E HF is strong in water but looks weak due to pH scale limits

26 Which trend is generally correct for the acidity of hydrogen halides in water (HX) down Group 17?



- A $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$
- B $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$
- C $\text{HCl} > \text{HI} > \text{HF} > \text{HBr}$
- D All hydrogen halides have identical acidity
- E Acidity depends only on electronegativity, so HF is strongest





27 Which order best describes the strength of the oxyacids of chlorine (from strongest to weakest)?



- A $\text{HClO} > \text{HClO}_2 > \text{HClO}_3 > \text{HClO}_4$
- B $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HClO}$
- C $\text{HClO}_2 > \text{HClO}_4 > \text{HClO} > \text{HClO}_3$
- D All have the same strength because they all contain chlorine
- E Strength depends only on the number of hydrogens, so they are equal

28 Which statement best describes why chloroacetic acid (ClCH_2COOH) is stronger than acetic acid (CH_3COOH)?



- A Chloroacetic acid has a higher molar mass
- B Chlorine withdraws electron density, stabilizing the conjugate base
- C Chlorine donates electrons, destabilizing the conjugate base
- D Acetic acid cannot form hydrogen bonds, but chloroacetic acid can
- E Chloroacetic acid is strong because it fully dissociates like HCl

29 What is the pH of 0.010 M HCl (assuming complete dissociation and ignoring water's contribution)?



- A 1
- B 2
- C 7
- D 12





E 14

30 What is the pH of 0.010 M NaOH (assuming complete dissociation) at 25°C?



A 2

B 7

C 10

D 12

E 14

31 A solution has pH 5. Compared to a solution with pH 3, it has:



A 100 times higher $[H_3O^+]$

B 10 times higher $[H_3O^+]$

C 10 times lower $[H_3O^+]$

D 100 times lower $[H_3O^+]$

E The same $[H_3O^+]$

32 Which mixture would form a buffer solution?



A $HCl(aq) + NaCl(aq)$

B $NaOH(aq) + NaCl(aq)$

C $CH_3COOH(aq) + CH_3COONa(aq)$





- D $\text{HNO}_3(\text{aq}) + \text{KNO}_3(\text{aq})$
- E Pure water + sugar

33 Which description best matches how a buffer resists a decrease in pH when a small amount of acid is added?



- A The weak acid component reacts with the added acid
- B The conjugate base component neutralizes added H_3O^+ (or H^+)
- C The buffer prevents any reaction from happening
- D The buffer makes pH stay exactly 7 always
- E The buffer works because it is concentrated

34 In the buffer system HA/A^- , when a small amount of strong base is added, the primary reaction is:



- A $\text{A}^- + \text{OH}^- \rightarrow \text{HA}$
- B $\text{HA} + \text{OH}^- \rightarrow \text{A}^- + \text{H}_2\text{O}$
- C $\text{HA} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{A}^-$ (goes to completion)
- D $\text{A}^- + \text{H}_2\text{O} \rightarrow \text{HA} + \text{OH}^-$ (goes to completion)
- E No reaction occurs in a buffer

35 A buffer works best when:



- A $[\text{HA}]$ is much larger than $[\text{A}^-]$





- B $[A^-]$ is much larger than $[HA]$
- C $[HA]$ and $[A^-]$ are comparable in magnitude
- D The buffer contains a strong acid and a strong base
- E The buffer is diluted as much as possible

36 For a weak acid buffer, which statement is true when $[A^-] = [HA]$?



- A $pH = 7$ always
- B $pH = pK_a$
- C $pH = 14 - pK_a$
- D $pH = 0$
- E pH is undefined for buffers

37 Which titration has an equivalence point at $pH = 7$ (at $25^\circ C$)?



- A Strong acid + strong base
- B Weak acid + strong base
- C Strong acid + weak base
- D Weak acid + weak base
- E Any neutralization always ends at $pH = 7$

38 At equivalence in a weak acid–strong base titration, the pH is typically:





- A Less than 7, because acids always dominate
- B Exactly 7, because moles acid = moles base
- C Greater than 7, because the conjugate base of the weak acid hydrolyzes to form OH^-
- D Exactly 14, because base was added
- E Impossible to predict

39 At equivalence in a strong acid–weak base titration, the pH is typically:



- A Greater than 7
- B Exactly 7
- C Less than 7, because the conjugate acid of the weak base hydrolyzes to form H_3O^+
- D Exactly 0
- E Always 14

40 Which indicator is MOST suitable for a strong acid–weak base titration (equivalence point < 7)?



- A An indicator that changes color around pH 3–4
- B An indicator that changes color around pH 7
- C An indicator that changes color around pH 9–10
- D Any indicator works equally well
- E No indicator can be used for titrations





41 Which indicator is MOST suitable for a weak acid–strong base titration (equivalence point > 7)?



- A An indicator that changes color around pH 3–4
- B An indicator that changes color around pH 7
- C An indicator that changes color around pH 9–10
- D Any indicator works equally well
- E Indicators only work for strong acid–strong base titrations

42 Which salt solution is expected to be approximately neutral (pH ≈ 7) at 25°C?



- A NH_4Cl
- B CH_3COONa
- C NaCl
- D Na_2CO_3
- E AlCl_3

43 Which salt solution is expected to be acidic?



- A NaNO_3
- B KCl
- C NH_4Cl
- D CH_3COONa
- E NaF





44 Which salt solution is expected to be basic?



- A NaCl
- B NH_4NO_3
- C CH_3COONa
- D KBr
- E $\text{HCl}(\text{aq})$

45 Which oxide is amphoteric (can react with both acids and bases) at a basic high-school level?



- A CO_2
- B SO_3
- C CaO
- D Al_2O_3
- E Na_2O

46 Which statement about neutralization is correct?



- A Neutralization always produces a solution with pH exactly 7
- B Neutralization always produces CO_2 gas
- C A key net ionic step is often $\text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2\text{H}_2\text{O}$
- D Neutralization can only happen between strong acids and strong bases
- E Neutralization means removing all ions from solution





47 Which solution is expected to conduct electricity BEST (at the same molar concentration)?



- A $\text{CH}_3\text{COOH}(\text{aq})$
- B $\text{NH}_3(\text{aq})$
- C $\text{HCl}(\text{aq})$
- D Pure water
- E Sugar solution

48 Which relationship is true for a conjugate acid–base pair at 25°C ?



- A $K_a + K_b = K_w$
- B $K_a \times K_b = K_w$
- C $K_a = K_b$ always
- D $K_a = 1/K_b$
- E K_a and K_b are unrelated

49 If K_a for an acid HA is very large, then K_b for its conjugate base A^- is:



- A Very large
- B Very small
- C Exactly 1
- D Equal to K_a
- E Impossible to relate





50 Which conjugate base is the **STRONGEST** base (in water) among the following?



- A Cl^-
- B NO_3^-
- C CH_3COO^-
- D ClO_4^-
- E I^-

51 You mix 50.0 mL of 0.10 M HCl with 50.0 mL of 0.10 M NaOH. Assuming ideal behavior and complete reaction, the resulting solution is closest to:



- A pH 2 (acidic)
- B pH 7 (neutral)
- C pH 12 (basic)
- D pH 1 (very acidic)
- E pH 9 (slightly basic)

52 You mix 10.0 mL of 0.10 M HCl with 5.0 mL of 0.10 M NaOH. What best describes the result (qualitatively)?



- A Neutral, because any acid mixed with any base becomes neutral
- B Acidic, because there are more moles of HCl than NaOH
- C Basic, because NaOH is a strong base
- D Neutral, because HCl is strong
- E Cannot determine without K_a values





53 Which statement about the pH of a 0.10 M strong acid solution vs a 0.10 M weak acid solution is correct?



- A** They must have the same pH because concentration is the same
- B** The strong acid solution has lower pH because it produces more H_3O^+ at the same concentration
- C** The weak acid solution has lower pH because weak acids are 'more reactive'
- D** Weak acids produce more H_3O^+ because they do not dissociate fully
- E** pH depends only on molar mass, not dissociation

54 Which statement is TRUE about adding water to a solution of strong acid (no reaction, just dilution)?



- A** The number of moles of H_3O^+ increases
- B** The number of moles of H_3O^+ stays (approximately) the same, but $[\text{H}_3\text{O}^+]$ decreases
- C** pH decreases because dilution makes acids stronger
- D** pH becomes exactly 7 regardless of how much acid was present
- E** Dilution changes K_a

55 A student says: 'Weak acids are dangerous, strong acids are safe.' Which correction is most accurate?



- A** Correct: weak acids always have higher pH than strong acids at any concentration, so they cannot harm you
- B** Incorrect: strength describes ionization, but safety depends on concentration, reactivity, and exposure; both can be hazardous
- C** Correct: weak acids never donate protons





- D Incorrect: strong acids do not ionize at all
- E Correct: strong acids are always dilute by definition

56 Which statement about buffer capacity is correct?



- A A buffer can neutralize unlimited acid/base without changing pH
- B A buffer has a limited capacity; once HA or A⁻ is used up, pH can change rapidly
- C A buffer works only if its pH is exactly 7
- D Buffers only resist changes when base is added, not acid
- E Buffers work by preventing any equilibrium shifts

57 Which pair is a major physiological buffer system often taught at high-school level?



- A HCl / Cl⁻
- B H₂CO₃ / HCO₃⁻
- C NaOH / Na⁺
- D H₂SO₄ / SO₄²⁻
- E HNO₃ / NO₃⁻

58 In the Henderson–Hasselbalch relationship, if the ratio [A⁻]/[HA] increases by a factor of 10, the pH changes by approximately:



- A -1 unit





- B 0 units
- C +1 unit
- D +10 units
- E It becomes exactly 7

59 Which statement best describes the common ion effect for HF in water when NaF is added?



- A HF dissociates more because F^- reacts with water to form H^+
- B HF dissociates less because added F^- shifts $HF \rightleftharpoons H^+ + F^-$ to the left
- C HF becomes a strong acid because sodium is a metal
- D The pH must drop because NaF is a salt
- E Nothing changes because equilibrium constants depend only on temperature

60 Which statement correctly compares conjugate base strengths?



- A The conjugate base of a strong acid is strong
- B The conjugate base of a strong acid is weak
- C All conjugate bases are equally basic
- D A stronger acid always has a stronger conjugate base
- E Conjugate base strength depends only on charge, not on the acid





61 Which species is the strongest Brønsted base in water (qualitatively)?



- A Cl⁻
- B CH₃COO⁻
- C NH₃
- D OH⁻
- E H₂O

62 Which statement about the pH of an extremely dilute strong acid solution (e.g., 1.0×10^{-8} M HCl) is most accurate?



- A pH = 8 exactly, because $\text{pH} = -\log(1.0 \times 10^{-8})$
- B pH is close to 7, because water's autoionization contributes significantly to [H₃O⁺]
- C pH must be 14 because it is dilute
- D pH becomes undefined below 1.0×10^{-7} M
- E pH depends only on the acid's molar mass at such low concentration

63 Which statement best describes a Lewis base?



- A Electron-pair acceptor
- B Electron-pair donor
- C Proton donor
- D Substance with pH < 7 only
- E Substance that forms salts only





64 In the reaction $\text{BF}_3 + \text{NH}_3 \rightarrow \text{F}_3\text{B} \leftarrow \text{NH}_3$, which is the Lewis acid and why?



- A NH_3 , because it donates a proton
- B NH_3 , because it accepts an electron pair
- C BF_3 , because it accepts an electron pair
- D BF_3 , because it donates an electron pair
- E Neither; this is not an acid–base reaction

65 Which salt solution's pH is mainly determined by whether K_a of the cation (as an acid) is larger or smaller than K_b of the anion (as a base)?



- A NaCl (strong acid + strong base)
- B CH_3COONa (weak acid + strong base)
- C NH_4Cl (strong acid + weak base)
- D $\text{NH}_4\text{CH}_3\text{COO}$ (weak acid + weak base)
- E HCl(aq) (not a salt)

66 Which of the following solutions is expected to have $\text{pH} > 7$ (basic) at 25°C ?



- A NaF(aq)
- B NaCl(aq)
- C $\text{NH}_4\text{Cl(aq)}$
- D HCl(aq)
- E $\text{HNO}_3\text{(aq)}$





67 Which reaction best shows a basic oxide reacting with an acid?



- A $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$
- B $\text{CaO} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O}$
- C $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$
- D $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$
- E $\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-$

68 Which statement best explains why carbonates (CO_3^{2-}) react with acids to produce CO_2 gas?



- A CO_3^{2-} is a strong acid, so it decomposes into CO_2
- B Acid protonates carbonate to form carbonic acid (H_2CO_3), which decomposes to CO_2 and H_2O
- C CO_2 is produced because the acid oxidizes carbon
- D CO_2 forms because carbonates contain oxygen, which releases CO_2
- E CO_2 is produced only if the acid is strong; weak acids cannot produce CO_2

69 In the reaction $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{OH}^-$, HCO_3^- is acting as:



- A A Brønsted acid (proton donor)
- B A Brønsted base (proton acceptor)
- C Neither acid nor base
- D A Lewis acid only
- E A spectator ion





70 Which statement about the relationship between pH and acidity is correct for a solution at 25°C?

- A** A solution with pH 6 is 10 times more acidic than a solution with pH 5
- B** A solution with pH 5 has 10 times higher $[H_3O^+]$ than a solution with pH 6
- C** pH measures $[OH^-]$ directly, not $[H_3O^+]$
- D** pH differences only matter for strong acids, not weak acids
- E** If pH decreases by 2, $[H_3O^+]$ decreases by a factor of 100







#	Ans	Answer Text
	B	
2	A	A proton (H^+) acceptor
	C	
4	B	An electron-pair acceptor
	B	
6	C	NH_4^+
	C	
8	C	HCl
	B	
10	B	A strong acid fully ionizes in water, while a concentrated acid simply h...
	B	
12	A	3
	A	
14	C	10
	B	
16	C	Neutral ($pH = 7$)
	A	
18	B	HCO_3^-
	C	
20	B	The first dissociation is strong; the second dissociation is weaker (par...
	B	
22	A	H_2O
	B	
24	A	Lower pK_a means stronger acid
	A	
26	B	$HI > HBr > HCl > HF$
	B	
28	B	Chlorine withdraws electron density, stabilizing the conjugate base
	B	
30	D	12
	D	
32	C	$CH_3COOH(aq) + CH_3COONa(aq)$
	B	
34	B	$HA + OH^- \rightarrow A^- + H_2O$
	C	
36	B	$pH = pK_a$
	A	
38	C	Greater than 7, because the conjugate base of the weak acid hydrolyzes t...



