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1. The dipole moment in a water molecule Which statement about hydrogen bonds is NOT true?
   A) Hydrogen bonds account for the anomalously high boiling point of water.
   B) In liquid water, the average water molecule forms hydrogen bonds with three to four other water molecules.
   C) Individual hydrogen bonds are much weaker than covalent bonds.
   D) Individual hydrogen bonds in liquid water exist for many seconds and sometimes for minutes.
   E) The strength of a hydrogen bond depends on the linearity of the three atoms involved in the bond.

2. A TRUE statement about hydrophobic interactions is that they:
   A) are the driving force in the formation of micelles of amphipathic compounds in water.
   B) do not contribute to the structure of water-soluble proteins.
   C) have bonding energies of approximately 20–40 Kjoule per mole.
   D) involve the ability of water to denature proteins.
   E) primarily involve the effect of polar solutes on the entropy of aqueous systems.

3. Hydrophobic interactions make important energetic contributions to:
   A) binding of a hormone to its receptor protein.
   B) enzyme-substrate interactions.
   C) membrane structure.
   D) three-dimensional folding of a polypeptide chain.
   E) All of the answers are correct.

4. Dissolved solutes alter some physical (colligative) properties of the solvent water because they change the:
   A) concentration of the water.
   B) hydrogen bonding of the water.
   C) ionic bonding of the water.
   D) pH of the water.
   E) temperature of the water.

5. Osmosis is movement of a:
   A) charged solute molecule (ion) across a membrane.
   B) gas molecule across a membrane.
   C) nonpolar solute molecule across a membrane.
   D) polar solute molecule across a membrane.
   E) water molecule across a membrane.

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6. A hydronium ion:
   A) has the structure H_3O^+.
   B) is a hydrated hydrogen ion.
   C) is a hydrated proton.
   D) is the usual form of one of the dissociation products of water in solution.
   E) All of the answers are correct.

7. The pH of a solution of 1 M HCl is:
   A) 0.
   B) 0.1.
   C) 1.
   D) 10.
   E) –1.

8. The pH of a solution of 0.1 M NaOH is:
   A) 0.1.
   B) 1.0.
   C) 12.8.
   D) 13.
   E) 14.

9. Which statement is TRUE about the properties of aqueous solutions?
   A) A pH change from 5.0 to 6.0 reflects an increase in the hydroxide ion concentration ($[OH^-]$) of 20%.
   B) A pH change from 8.0 to 6.0 reflects a decrease in the proton concentration ($[H^+]$) by a factor of 100.
   C) Charged molecules are generally insoluble in water.
   D) Hydrogen bonds form readily in aqueous solutions.
   E) The pH can be calculated by adding 7 to the value of the pOH.

10. The pH of a sample of blood is 7.4, while gastric juice is pH 1.4. The blood sample has:
   A) 0.189 times the $[H^+]$ as the gastric juice.
   B) 5.29 times lower $[H^+]$ than the gastric juice.
   C) 6 times lower $[H^+]$ than the gastric juice.
   D) 6000 times lower $[H^+]$ than the gastric juice.
   E) one million times lower $[H^+]$ than the gastric juice.

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11. The aqueous solution with the LOWEST pH is:
    A) 0.01 M HCl.
    B) 0.1 M acetic acid ($pK_a = 4.86$).
    C) 0.1 M formic acid ($pK_a = 3.75$).
    D) 0.1 M HCl.
    E) 10^{-12} M NaOH.

12. The aqueous solution with the HIGHEST pH is:
    A) 1 M HCl.
    B) 1 M NH_3 ($pK_a = 9.25$).
    C) 0.5 M $NaHCO_3$ ($pK_a = 3.77$).
    D) 0.1 M NaOH.
    E) 0.001 M NaOH.

13. Phosphoric acid is tribasic, with pK_a's of 2.14, 6.86, and 12.4. The ionic form that predominates at pH 3.2 is:
    A) H_3PO_4.
    B) $H_2PO_4^-$.
    C) HPO_4^{2-}.
    D) PO_4^{3-}.
    E) None of the answers is correct.

14. Which statement about buffers is TRUE?
    A) A buffer composed of a weak acid of $pK_a = 5$ is stronger at pH 4 than at pH 6.
    B) At pH values lower than the pK_a, the salt concentration is higher than that of the acid.
    C) The pH of a buffered solution remains constant no matter how much acid or base is added to the solution.
    D) The strongest buffers are those composed of strong acids and strong bases.
    E) When pH = pK_a, the weak acid and salt concentrations in a buffer are equal.

15. A compound has a pK_a of 7.4. To 100 mL of a 1.0 M solution of this compound at pH 8.0 is added 30 mL of 1.0 M hydrochloric acid. The resulting solution is pH:
    A) 6.5.
    B) 6.8.
    C) 7.2.
    D) 7.4.
    E) 7.5.

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16. The Henderson-Hasselbalch equation:
    A) allows the graphic determination of the molecular weight of a weak acid from its pH alone.
    B) does not explain the behavior of di- or tri-basic weak acids.
    C) employs the same value for pK_a for all weak acids.
    D) is equally useful with solutions of acetic acid and of hydrochloric acid.
    E) relates the pH of a solution to the pK_a and the concentrations of acid and conjugate base.

17. Consider an acetate buffer, initially at the same pH as its pK_a (4.76). When sodium hydroxide (NaOH) is mixed with this buffer, the:
    A) pH remains constant.
    B) pH rises more than if an equal amount of NaOH is added to an acetate buffer initially at pH 6.76.
    C) pH rises more than if an equal amount of NaOH is added to unbuffered water at pH 4.76.
    D) ratio of acetic acid to sodium acetate in the buffer falls.
    E) sodium acetate formed precipitates because it is less soluble than acetic acid.

18. A compound is known to have a free amino group with a pK_a of 8.8, and one other ionizable group with a pK_a between 5 and 7. To 100 mL of a 0.2 M solution of this compound at pH 8.2 was added 40 mL of a solution of 0.2 M hydrochloric acid. The pH changed to 6.2. The pK_a of the second ionizable group is:
    A) The pH cannot be determined from this information.
    B) 5.4.
    C) 5.6.
    D) 6.0.
    E) 6.2.

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19. Three buffers are made by combining a 1 M solution of acetic acid with a 1 M solution of sodium acetate in the ratios shown below.

	1 M acetic acid	1 M sodium acetate
Buffer 1:	10 mL	90 mL
Buffer 2:	50 mL	50 mL
Buffer 3:	90 mL	10 mL

Which statement is TRUE of the resulting buffers?

A) pH of buffer 1 < pH of buffer 2 < pH of buffer 3
B) pH of buffer 1 = pH of buffer 2 = pH of buffer 3
C) pH of buffer 1 > pH of buffer 2 > pH of buffer 3
D) The problem cannot be solved without knowing the value of pK_a.
E) None of the statements is true.

20. A 1.0 M solution of a compound with 2 ionizable groups (p*K*a's = 6.2 and 9.5; 100 mL total) has a pH of 6.8. If a biochemist adds 60 mL of 1.0 M HCl to this solution, the solution will change to pH:

A) 5.60.
B) 8.90.
C) 9.13.
D) 9.32.
E) The pH cannot be determined from this information.

21. You want to maintain pH = 7.0 for an enzyme-catalyzed reaction that will produce hydrogen ions along with the desired product. At equal concentrations, which weak acid, if any, will serve as the better buffer for the reaction: acid A, with pK_a = 6.5, or acid B, with pK_a = 7.5?

A) acid A
B) Water is as good as either of the acids available.
C) acid B
D) Both are equally effective.

22. In which reaction does water NOT participate as a reactant (rather than as a product)?

A) conversion of an acid anhydride to two acids
B) conversion of an ester to an acid and an alcohol
C) conversion of ATP to ADP
D) photosynthesis
E) production of gaseous carbon dioxide from bicarbonate

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23. Which property of water does NOT contribute to the fitness of the aqueous environment for living organisms?
    A) cohesion of liquid water due to hydrogen bonding
    B) high heat of vaporization
    C) high specific heat
    D) the density of water being greater than the density of ice
    E) the very low molecular weight of water

24. The ionization of water is due to the strongly electronegative element:
    A) hydrogen donating an electron to oxygen.
    B) oxygen donating an electron to hydrogen.
    C) hydrogen receiving an electron from oxygen.
    D) oxygen receiving an electron from hydrogen.
    E) None of the answers is correct.

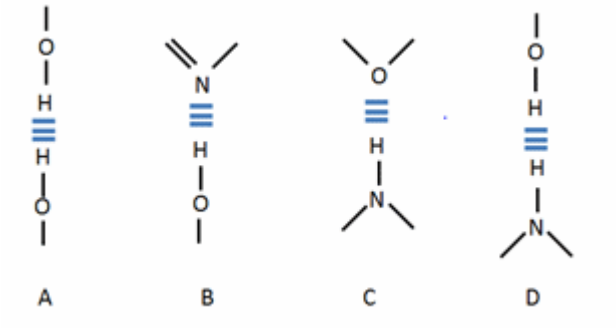
25. Which attribute contributes to water's unusual properties?
    A) the geometry of the molecule
    B) the polarity of the molecule
    C) the ability of water molecules to hydrogen bond
    D) the dipole moment in a water molecule
    E) All of the answers are correct.

26. Which factor contributes to the bent shape of a water molecule?
    A) the dipole moment in a water molecule
    B) the unshared electron pairs on the oxygen atom
    C) the electronegativity difference between hydrogen and oxygen
    D) the unequal electron sharing between hydrogen and oxygen
    E) All of the answers are correct.

27. Ice is _____ than water because _____.
    A) less dense; frozen water maintains more hydrogen bonds than liquid water
    B) less dense; liquid water maintains more hydrogen bonds than frozen water
    C) denser; frozen water maintains more hydrogen bonds than liquid water
    D) denser; liquid water maintains more hydrogen bonds than frozen water
    E) denser; frozen water cannot hydrogen bond

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28. Which diagram CORRECTLY represent a hydrogen bond?



A) A and D
B) A and C
C) B and C
D) C and D
E) B and D

29. Which statement about biologically important gases is TRUE?
A) O_2 and CO_2 are the most important gases for living things and are therefore very soluble in water.
B) O_2 and CO_2 are both polar and are therefore very soluble in water.
C) O_2 and CO_2 are both nonpolar molecules and are therefore both poorly soluble in water.
D) CO_2 contains polar bonds but O_2 is nonpolar; therefore, CO_2 is very soluble in water, but O_2 is poorly soluble in water.
E) All biologically important gases are very soluble in water.

30. Which statement about hydrogen bonds is NOT true?
A) Hydrogen bonds are highly directional.
B) Hydrogen bonds are capable of holding molecules in a specific geometric arrangement.
C) Hydrogen bonds are strongest when the three atoms in the bond are in a straight line.
D) Hydrogen bonds are strongest when the oxygen atom is perpendicular to the hydrogen donor.
E) Hydrogen bonds place a hydrogen ion directly between two partial negative charges.

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31. Which compound would result in the formation of a clathrate structure?
    A) CH_2O
    B) CH_4
    C) NH_3
    D) CH_3CH_2OH
    E) None of the answers is correct.

32. Which diagram CORRECTLY illustrates the clustering of lipids in the formation of a micelle?



A B

    A) A
    B) B
    C) both A and B
    D) neither A nor B

33. Dissolving a nonpolar solute in water _____ the order of the solvent and _____ the dynamic interplay among water molecules that occurs in pure water.
    A) increases; decreases
    B) increases; increases
    C) decreases; decreases
    D) decreases; increases
    E) decreases; stabilizes

34. Which statement regarding long-chain fatty acids in aqueous solution is NOT true?
    A) Fatty acids in small concentrations are surrounded by highly ordered water molecules in a “cage-like” structure.
    B) Fatty acids will cluster together to minimize the lipid surface area.
    C) Fatty acids will form micelles to sequester hydrophobic groups from water.
    D) The driving force of solubilizing fatty acids is increasing entropy of the fatty acid.
    E) All the statements are true.

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35. Which statement CORRECTLY describes the forces that drive micelle formation from amphipathic molecules, such as fatty acids, dissolved in water?
    A) Head groups of the molecules are sequestered in the interior of the micelle, maximizing hydrogen bonding of the hydrophobic tail with surrounding solvent molecules.
    B) Head groups of the molecules are exposed on the outer surface of the micelle, maximizing hydrogen bonding between hydrophobic tails.
    C) Head groups of the molecules are exposed on the outer surface of the micelle, minimizing the order of the surrounding solvent molecules.
    D) Hydrophilic tails are exposed on the outer surface of the micelle, maximizing hydrogen bonding between the tails and surrounding solvent molecules.
    E) Hydrophobic tails are exposed on the outer surface of the micelle, maximizing hydrogen bonding between head groups.

36. Which force plays the GREATEST role in stabilizing biological structures in membranes?
    A) hydrogen bonding, because it a strong non-covalent bond
    B) hydrophobic interactions that increase solvent entropy
    C) covalent interactions, because they are very stable interactions
    D) electrostatic interactions between oppositely charged ions
    E) van der Waals interactions, because of the attraction between transient dipoles

37. Which result influences the lower limit for an atom's van der Waals radius?
    A) The electron clouds begin to repel each other.
    B) The nuclei begin to repel each other.
    C) The transient dipole is cancelled out by the neighboring atom.
    D) The electron clouds begin to attract each other.
    E) The nuclei begin to attract each other.

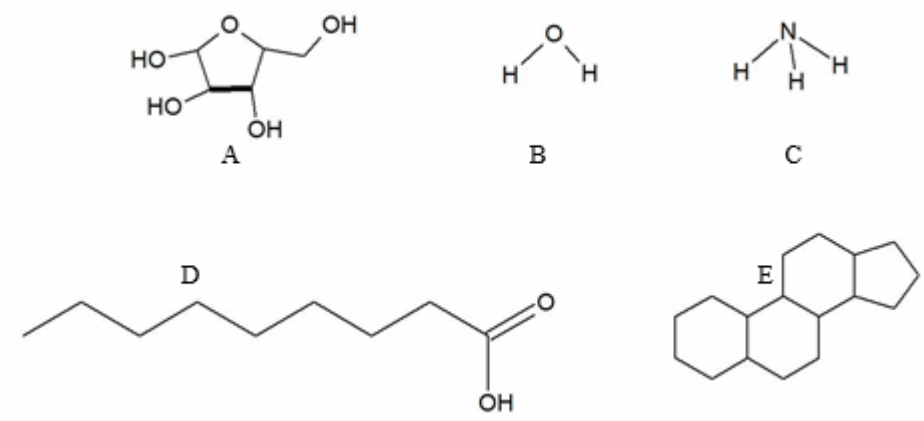
38. Which list correctly shows bond/interaction strength in DECREASING order (strongest to weakest)?
    A) covalent bond > hydrogen bond > ionic bond > van der Waals interaction
    B) covalent bond > ionic bond > hydrogen bond > van der Waals interaction
    C) ionic bond > covalent bond > hydrogen bond > van der Waals interaction
    D) covalent bond > van der Waals interaction > ionic bond > hydrogen bond
    E) hydrogen bond > ionic bond > van der Waals interaction > covalent bond

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39. When two atoms are joined together covalently, the van der Waals radius of the atoms in the covalent bond are _____ than the radius of the atoms alone because the joined atoms are _____.
    A) shorter; pulled together by the shared electron pair
    B) shorter; pulled together by the attraction of the nucleus to the bonded atom
    C) shorter; pulled together by hydrogen bonding
    D) longer; repelled due to the shared electron pair
    E) longer; repelled due to the nuclear repulsion between bonded atoms

40. Which process would NOT disrupt the weak interactions between two biomolecules in solution?
    A) heating the solution
    B) cooling the solution
    C) lowering the pH of the solution
    D) increasing the ionic strength of the solution
    E) All of the answer choices would disrupt interactions between biomolecules

41. Which diagram illustrates an amphipathic molecule?

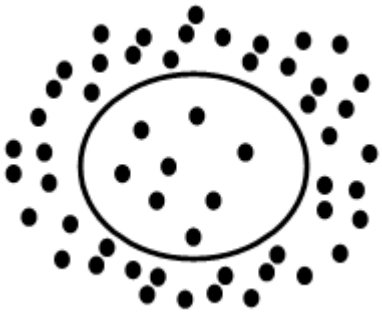


42. When water is found in a crystal structure of a biomolecule, which statement is NOT true?
    A) The properties of the bound water molecules are different from those of the “bulk” water of the solvent.
    B) The bound water molecules may provide a path for “proton hopping.”
    C) The bound water molecules can form an essential part of the protein's ligand binding site.
    D) The orientation of bound water molecules is precise.
    E) All of the statements are true.

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43. Which of the following would have the GREATEST effect on osmotic pressure?
    A) M NaCl (MW = 58 g/mol)
    B) M $CaCl_2$ (MW = 111 g/mol)
    C) M glucose (MW = 180 g/mol)
    D) M sucrose (MW = 342 g/mol)
    E) All of the answer choices would have the same effect.

44. Which statement CORRECTLY describes the situation of the cell in the diagram? The black dots represent solute molecules.



    A) The cell is in a hypotonic solution; water will move in and cause the cell to swell.
    B) The cell is in a hypotonic solution; solutes will move in and cause the cell to swell.
    C) The cell is in a hypotonic solution; water will move out and cause the cell to shrink.
    D) The cell is in a hypertonic solution; solutes will move in and cause the cell to swell.
    E) The cell is in a hypertonic solution; water will move out and cause the cell to shrink.

45. Which statement does NOT describe a strategy used by multicellular animals to maintain osmotic balance with their surroundings?
    A) Cells have a contractile vacuole, an organelle that pumps water out of the cell.
    B) Animals have a high concentration of albumin and other proteins in blood plasma.
    C) Cells actively pump out Na^+ and other ions.
    D) Cells store fuel as a polysaccharide instead of as simple sugars.
    E) All of the statements describe a strategy to maintain osmotic balance.

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46. "Proton hopping" essentially means that:
    A) an individual proton "jumps" from one electronegative group to the next.
    B) a free proton moves from one hydroxyl group of ionized water to the next.
    C) several protons move between hydrogen bonded water molecules causing the net movement of a photon over a long distance in a short time.
    D) individual protons are freer to move among and between water molecules in solution.
    E) hydronium ions are freer to move among and between water molecules in solution.

47. Distilled white vinegar has a pH of 2.4 Water as a Reactant. What is the $[H^+]$ of distilled white vinegar?
    A) 2.4 Water as a Reactant$0 \times 10^{0}\ M$
    B) 2.5 The Fitness of the Aqueous Environment$1 \times 10^{-12}\ M$
    C) 2.5 The Fitness of the Aqueous Environment$1 \times 10^{-3} M$
    D) $3.98 \times 10^{-3}\ M$
    E) $3.98 \times 10^{-6}\ M$

48. If the pH of a solution is 5.5, what is the pOH?
    A) 8.5
    B) –5.5
    C) –8.5
    D) 14
    E) 6.5

49. Milk of magnesia has a pH of 10.2. What is the $[OH^-]$ of milk of magnesia?
    A) $6.31 \times 10^{-11}\ M$
    B) $1.58 \times 10^{-4}\ M$
    C) $1.58 \times 10^{-5}\ M$
    D) $1.02 \times 10^{-3}\ M$
    E) $6.31 \times 10^{-4}\ M$

50. The H^+ concentration of a solution is $5.6 \times 10^{-5}\ M$. What is the pH?
    A) –4.25
    B) 4.25
    C) 5.65
    D) –9.75
    E) 9.75

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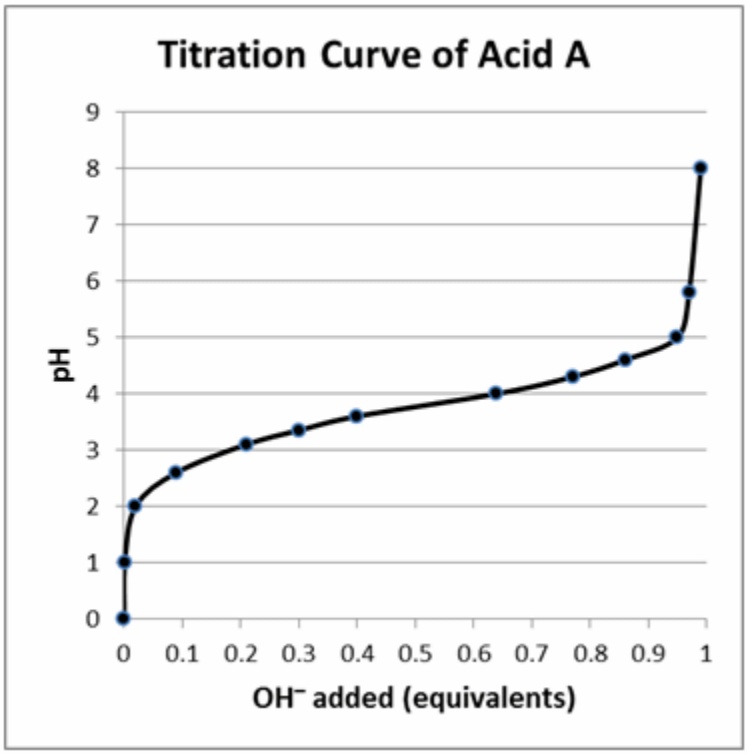
51. The OH^- concentration of a solution is 4.3×10^{-10} *M*. What is the pH?
    A) –9.37
    B) 9.37
    C) –4.63
    D) 4.63
    E) 13.4

52. If the K_a of an acid is 1.38×10^{-7}, what is the pK_a?
    A) 6.86
    B) 7.14
    C) 8.68
    D) 10.7
    E) 1.38

53. The conjugate base of $H_2PO_4^{-1}$ is:
    A) H_3PO_4.
    B) $H_2PO_4^{2-}$.
    C) HPO_4^{2-}.
    D) HPO_4^{3-}.
    E) PO_4^{3-}.

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54. According to the titration curve to the right, acid A is _____ because the pH _____.



A) weak; resists change when 50% titrated.
B) strong; resists change when 50% titrated.
C) weak; changes dramatically when 100% titrated.
D) strong; changes dramatically when 100% titrated.
E) It cannot be determined from the information given.

55. According to the titration curve to the right, acid A has a pK_a of:
A) 0.2.
B) 0.5.
C) 3.2.
D) 3.8.
E) 4.8.

56. According to the titration curve above, acid A has a buffering range of:
A) 0.3 *M* to 0.8 *M* OH.
B) 0.9 to 1.0 *M* OH.
C) pH 3.5 to pH 4.2.
D) pH 2.8 to pH 3.8.
E) pH 2.8 to pH 4.8.

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57. Formic acid is used in the venom of some species of ants. What is the pH of a 0.2 *M* solution of formic acid ($K_a = 1.78 \times 10^{-4}$ *M*)?
    A) 8.90
    B) 4.45
    C) 3.75
    D) 2.2 Ionization of Water, Weak Acids, and Weak Bases2
    E) 1.72

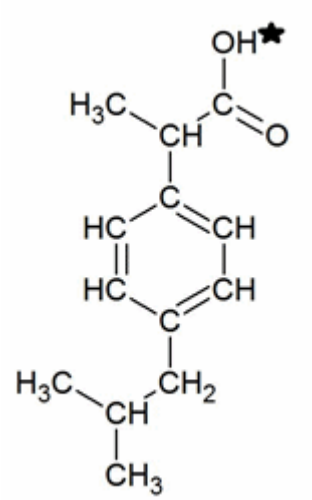
58. List the acids in INCREASING order of strength (weakest to strongest):

    nitrous acid ($K_a = 4.0 \times 10^{-4}$); carbonic acid ($K_a = 4.4 \times 10^{-7}$); acetic acid ($K_a = 1.7 \times 10^{-5}$); phosphoric acid ($K_a = 7.3 \times 10^{-3}$)
    A) acetic acid, carbonic acid, nitrous acid, phosphoric acid
    B) carbonic acid, acetic acid, nitrous acid, phosphoric acid
    C) acetic acid, nitrous acid, carbonic acid, phosphoric acid
    D) phosphoric acid, nitrous acid, acetic acid, carbonic acid
    E) carbonic acid, phosphoric acid, nitrous acid, acetic acid

59. A 0.6 *M* solution of a weak acid had a pH of 5.8. What is the pK_a of the solution?
    A) 11.3
    B) 10.5
    C) 8.2
    D) 5.7
    E) 2.9

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60. Ibuprofen is a weak acid with a pK_a of 4.9 (shown with the ionizable hydrogen with a star). It is absorbed through the stomach and the small intestine as a function of polarity—charged and very polar molecules are absorbed slowly; neutral hydrophobic molecules absorb quickly. If the stomach pH is about 1.5 and the small intestine pH is about 6, where (and why) will more ibuprofen be absorbed into the bloodstream?

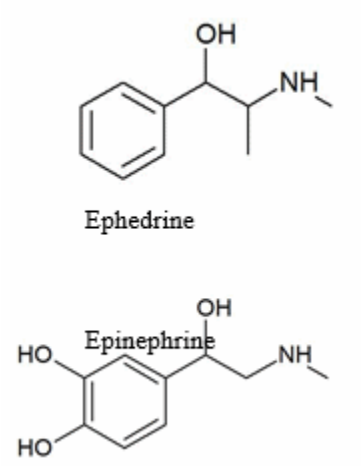


A) More ibuprofen will be absorbed in the small intestine because it will be uncharged due to the pH being greater than the pK_a.
B) More ibuprofen will be absorbed in the stomach because it will be uncharged due to the pH being lower than the pK_a.
C) More ibuprofen will be absorbed in the small intestine because it will be charged due to the pH being greater than the pK_a.
D) More ibuprofen will be absorbed in the stomach because it will be charged due to the pH being lower than the pK_a.
E) Ibuprofen will be absorbed equally well in both the stomach and small intestine.

61. Which compound acts as a diprotic acid?
A) CH_3COOH
B) NH_4^+
C) H_2CO_3
D) H_3PO_4
E) CH_3CH_2OH

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62. Polar molecules cannot easily pass through the cell membrane, but hydrophobic molecules can easily pass through the membrane. The two molecules shown in the diagram both have effects that include raising blood pressure. Comparing two molecules to the right, which statement is TRUE?



A) Ephedrine can more easily pass through the cell membrane than epinephrine.
B) Epinephrine can more easily pass through the cell membrane than ephedrine.
C) Both epinephrine and ephedrine can pass through the cell membrane equally well.
D) Neither epinephrine nor ephedrine can pass through the cell membrane.
E) None of the statements is true.

63. According to the Henderson-Hasselbalch equation, when is the pH equal to the pK_a?
A) when the concentration of acid is close to zero
B) when the pH approaches 7
C) when the concentration of the conjugate base is equal to the ionization constant for water
D) when the concentration of the conjugate base is equal to the concentration of the acid.
E) None of the answers is correct.

64. If a person is suffering from acidosis, which treatment/action would NOT be a wise choice?
A) intravenous administration of bicarbonate
B) hyperventilating
C) breathing into a paper bag
D) vigorous exercise
E) All of these treatments/actions could be used to counteract acidosis.

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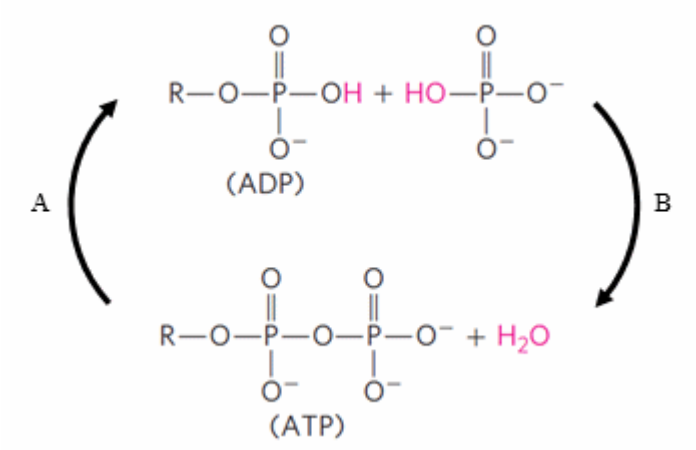
65. Biological buffering systems include:
A) histidine.
B) bicarbonate.
C) phosphate.
D) bicarbonate and phosphate.
E) histidine, bicarbonate, and phosphate.

66. Of the seven the steps listed below, which four—in the CORRECT order—are needed to prepare 1 L of a 0.02M Tris buffer solution, pH 7.6? You have at your lab station a 0.1 M solution of Tris in its protonated form, 0.1 M solutions or HCl and NaOH, and plentiful distilled water. The K_a of Tris is 8.32×10^{-9}.
1. Calculate the volume of 0.1 M Tris to use ($C_1V_1 = C_2V_2$).
2. Calculate the volume of 0.1 M HCl to use ($C_1V_1 = C_2V_2$).
3. Calculate the volume of 0.1 M NaOH to use ($C_1V_1 = C_2V_2$).
4. Use the Henderson-Hasselbalch equation to calculate the ratio of Tris base to protonated Tris.
5. Adjust the pH to 7.6 by adding 0.1 M NaOH.
6. Adjust the pH to 7.6 by adding 0.1 M HCl.
7. Fill to 1 L with distilled water.

A) 1→4→6→7
B) 1→4→5→7
C) 1→2→4→7
D) 1→3→4→7
E) 1→7→4→6

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67. What is the CORRECT terminology for reactions A and B in the diagram?



A) A = hydrolysis, B = condensation
B) A = condensation, B = hydrolysis
C) A = dehydrolysis, B = condensation
D) A = phosphorylation, B = phosphatase
E) A = metabolism, B = catabolism

68. Camels live in very dry habitats and do not need to consume water as frequently as animals in wetter habitats. What is a partial reason for this?
A) Metabolic water is produced by oxidation of fuels such as glucose.
B) Metabolic water is produced by acid/base dehydration reactions.
C) Metabolic water is produced by symbiotic bacteria in the camel's gut.
D) Metabolic water is produced by splitting carbon dioxide.
E) None of the answers is correct.

69. Carbon dioxide, produced by glucose oxidation, is not very soluble. How does the body transport this molecule through blood to be exhaled from the lungs?
A) CO_2 can be directly bound to hemoglobin for transport.
B) CO_2 can be converted to the more soluble CO for transport.
C) CO_2 can be converted to the more soluble HCO_3^{-1} for transport.
D) CO_2 can be bound by erythrocytes for transport.
E) CO_2 is only produced in the lungs.

70. Water can act as _____ in biological reactions.
A) a solvent
B) a reactant
C) a product
D) both a solvent and reactant
E) a solvent, reactant, and product

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71. Which statement does NOT describe a reason that water can act as a heat buffer for cells and organisms?
    A) Water has a high specific heat.
    B) Water has an extended hydrogen-bonding network.
    C) Water can auto-ionize.
    D) A large amount of heat is required to raise the temperature of water by 1 °C.
    E) All of the statements describe reasons that water can act as a heat buffer.

72. The high degree of cohesion of water molecules influences which processe?
    A) Plants can transport dissolved nutrients from roots to leaves.
    B) Water can combine with carbon dioxide to form glucose.
    C) Loss of water causes lettuce leaves to wilt.
    D) Water is split by the energy of sunlight through photosynthesis.
    E) Water can be used as a product in respiration.

73. Which property of water has had the MOST profound consequence for aquatic organisms?
    A) Water has a high specific heat.
    B) Water has a high heat of vaporization.
    C) Due to hydrogen bonding, solid water is less dense than liquid water.
    D) Water has a high melting point.
    E) Nonpolar molecules are poorly soluble in water.

74. Name and briefly define five types of noncovalent interactions that occur between biological molecules.

75. Explain the fact that ethanol (CH_3CH_2OH) is more soluble in water than is ethane (CH_3CH_3).

76. Explain the fact that triethylammonium chloride ($(CH_3CH_2)_3N$-HCl) is more soluble in water than is triethylamine ($(CH_3CH_2)_3N$).

77. Explain with an appropriate diagram why amphipathic molecules tend to form micelles in water. What force drives micelle formation?

78. Briefly define “isotonic,” “hypotonic,” and “hypertonic” solutions. (b) Describe what happens when a cell is placed in each of these types of solutions.

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79. For each of the pairs below, circle the conjugate base.

RCOOH	$RCOO^-$
RNH_2	RNH_3^+
$H_2PO_4^-$	H_3PO_4
H_2CO_3	HCO_3^-

80. Phosphoric acid (H_3PO_4) has three dissociable protons, with the pK_a's shown below. Which form of phosphoric acid predominates in a solution at pH 4? Explain your answer.

Acid	pK_a
H_3PO_4	2.14
$H_2PO_4^-$	6.86
HPO_4^{2-}	12.4

81. Define pK_a for a weak acid in the following two ways: (1) in relation to its acid dissociation constant, K_a, and (2) by reference to a titration curve for the weak acid.

82. Give the general Henderson-Hasselbalch equation and indicate the region in which the buffering capacity of the system is greatest.

83. What is the pH of a solution containing 0.2 M acetic acid (pK_a = 4.7) and 0.1 M sodium acetate?

84. You have just made a solution by combining 50 mL of a 0.1 M sodium acetate solution with 150 mL of 1 M acetic acid (pK_a = 4.7). What is the pH of the resulting solution?

85. For a weak acid with a pK_a of 6.0, show how you would calculate the ratio of acid to salt at pH 5.

86. Suppose you have just added 100 mL of a solution containing 0.5 mol of acetic acid per liter to 400 mL of 0.5 M NaOH. What is the final pH? (The pK_a of acetic acid is 4.7.)

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87. A weak acid HA, has a pK_a of 5.0. If 1.0 mol of this acid and 0.1 mol of NaOH were dissolved in one liter of water, what would the final pH be?

88. In proteins, the amino acid histidine (His) plays an important role in many biological reactions. The pK_a for the protonation of His to form $HisH^+$ = 6.0. When pH = 7.0, what is the fraction of total histidine that will be in the $HisH^+$ form?

89. $$H^+ + HCO_3^- \quad \Delta\ H_2CO_3\ \Delta\ CO_2 + H_2O$$

Severe diarrhea is accompanied by a loss of HCO_3^-. If untreated, will the condition result in acidosis or alkalosis? Use the bicarbonate buffer system given in the scheme above and Le Chatelier's Principle to explain your answer.

90. Give an example of a biological reaction in which water participates as a reactant and a reaction in which it participates as a product.

91. If ice were denser than water, how would that affect life on earth?

92. As two atoms get nearer to each other, do van der Waals attractive forces always increase?

93. Speculate why weak forces, not strong forces, are the basis for molecular recognition among biomolecules.

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Answer Key

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

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45. A
46. C
47. D
48. A
49. B
50. B
51. D
52. A
53. C
54. A
55. D
56. E
57. D
58. B
59. A
60. B
61. C
62. A
63. D
64. B
65. E
66. B
67. A
68. A
69. C
70. E
71. C
72. A
73. C
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91.
92.
93.

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