| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.008 | | | | | | | | | | | | | | | | | 2 He 4.003 |
| 3 Li 6.941 | 4 Be 9.012 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 22.99 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 |
| 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.87 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.38 | 31 Ga 69.72 | 32 Ge 72.64 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.07 | 45 Rh 102.91 | 46 Pd 106.42 | 47 Ag 107.87 | 48 Cd 112.41 | 49 In 114.82 | 50 Sn 118.71 | 51 Sb 121.76 | 52 Te 127.60 | 53 I 126.90 | 54 Xe 131.29 |
| 55 Cs 132.91 | 56 Ba 137.33 | 57 La 138.91 | 72 Hf 178.49 | 73 Ta 180.95 | 74 W 183.84 | 75 Re 186.21 | 76 Os 190.23 | 77 Ir 192.22 | 78 Pt 195.08 | 79 Au 196.97 | 80 Hg 200.59 | 81 Tl 204.38 | 82 Pb 207.20 | 83 Bi 208.98 | 84 Po (209) | 85 At (210) | 86 Rn (222) |
| 87 Fr (223) | 88 Ra (226) | 89 Ac (227) | 104 Rf (267) | 105 Db (268) | 106 Sg (269) | 107 Bh (270) | 108 Hs (270) | 109 Mt (278) | 110 Ds (281) | 111 Rg (282) | 112 Cn (285) | 113 Nh (286) | 114 Fl (289) | 115 Mc (290) | 116 Lv (293) | 117 Ts (294) | 118 Og (294) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 Ce 140.12 | 59 Pr 140.91 | 60 Nd 144.24 | 61 Pm (145) | 62 Sm 150.36 | 63 Eu 151.96 | 64 Gd 157.25 | 65 Tb 158.93 | 66 Dy 162.50 | 67 Ho 164.93 | 68 Er 167.26 | 69 Tm 168.93 | 70 Yb 173.04 | 71 Lu 174.97 |
| 90 Th 232.04 | 91 Pa 231.04 | 92 U 238.03 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (266) |

## constants

$R = 0.08206$ L atm/mol K

$R = 8.314$ J/mol K

$N_A = 6.022 \times 10^{23}$ /mol

$h = 6.626 \times 10^{-34}$ J·s

$c = 3.00 \times 10^{8}$ m/s

$g = 9.81$ m/s$^2$

## conversions

1 atm = 760 torr

1 atm = 101325 Pa

1 atm = 1.01325 bar

1 bar = $10^5$ Pa

°F = °C(1.8) + 32

K = °C + 273.15

## conversions

1 in = 2.54 cm

1 ft = 12 in

1 yd = 3 ft

1 mi = 5280 ft

1 lb = 453.6 g

1 ton = 2000 lbs

1 tonne = 1000 kg

1 gal = 3.785 L

1 gal = 231 in$^3$

1 gal = 128 fl oz

1 fl oz = 29.57 mL

## water data

$C_{s,ice} = 2.09$ J/g °C

$C_{s,water} = 4.184$ J/g °C

$C_{s,steam} = 2.03$ J/g °C

$\rho_{water} = 1.00$ g/mL

$\rho_{ice} = 0.9167$ g/mL

$\rho_{seawater} = 1.024$ g/mL

$\Delta H_{fus} = 334$ J/g

$\Delta H_{vap} = 2260$ J/g

$K_w = 1.0 \times 10^{-14}$

This extra practice set can be used to test your knowledge for the upcoming exam.

1. Most weak acids and weak bases fall into which range of ionization given below when they are dissolved into water?

●a. 1% or less

b. just below 100%

c. 60% to 75%

d. 30% to 50%

e. 10% to 20%

**Explanation:** The majority of all weak acids and bases ionize below 1%.

---

2. A titration is performed by adding a strong acid to fully neutralize a weak base analyte. The titration is run exactly to the equivalence point (where there are equal moles of the strong acid added and the initial weak base solution). What is the generic reaction for this experiment?

a. Strong Acid + Weak Base $\longrightarrow$ Weak Base + Water

b. Strong Acid + Weak Base $\longrightarrow$ Strong Acid + Water

c. Strong Acid + Weak Base $\longrightarrow$ Strong Base + Water

●d. Strong Acid + Weak Base $\longrightarrow$ Weak Acid + Water

**Explanation:** The addition of a strong acid to a weak base forms a weak acid salt plus water.

---

3. When writing out the expression for an equilibrium constant, which of the species listed are left *out* of the expression?

a. aqueous species

●b. solids

c. gases

**Explanation:** Only gases (partial pressures) and aqueous species (molarities) are in equilibrium expressions. All solids and liquids drop out of the expression.

---

4. Solution A has a hydronium ion concentration, $[H_3O^+]$, that is one thousand times higher than Solution B at identical temperature and pressure. Which of the following statements must be true?

a. Solution A has a pH that is 3 units greater than Solution B.

b. Solution A can have the same pH as Solution B.

c. Solution A has a pH that is 1/1000 times that of Solution B.

●d. Solution A has a pH that is 3 units less than Solution B.

**Explanation:** The pH scale is a negative log scale. A solution with a hydronium ion concentration that is 1000 times greater will be 3 units less than the other solution.

---

5. What is $[OH^-]$ in a 0.025 M solution of $Sr(OH)_2$?

a. 0.013 M

b. 0.025 M

●c. 0.050 M

d. approximately 1% or less of 0.025 M

**Explanation:** $Sr(OH)_2$ is a strong base that gives 2 $[OH^-]$. $[OH^-] = 0.050$ M.

---

6. Calculate the pH of a 0.0337 M $HNO_3$ solution.

●a. 1.472

b. 5.599

c. 0.925

d. 8.529

e. 0.0337

**Explanation:** 1.472 = -log(.00337)

---

7. A 0.020 M solution of citric acid has a pH of 2.46. A 0.020 M solution of ascorbic acid has a pH of 2.93. Which of these is the stronger acid?

● a. citric acid

b. ascorbic acid

c. You cannot tell from the information provided.

**Explanation:** Citric acid has the lower pH and is therefore the stronger acid.

---

8. When a person hyperventilates, the primary problem is not that they are inhaling too much oxygen. Rather, they are exhaling too much carbon dioxide, which can affect blood pH. The process of carbon dioxide dissolving in blood and dissociating as carbonic acid is shown in the steps below:

$$CO_2(g) \rightleftharpoons CO_2(aq)$$
$$H_2O(\ell) + CO_2(aq) \rightleftharpoons H_2CO_3(aq)$$
$$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

Select the answer that best describes the effect of exhaling too much carbon dioxide.

● a. blood pH increases

b. blood pH decreases

**Explanation:** The whole system above is in balance - equilibrium. If one hyperventilates, $CO_2(g)$ is removed too quickly thus shifting the equilibrium backwards (to the left). The reactions are all linked which means the 2nd and 3rd reactions also shift to the left. In the third reaction you can see that going to the left *removes* H+ from the solution (or blood in this case). Removal of H+ then drops the concentration and raises the pH.

---

9. A salon wants to neutralize 55.0 gallons of water that have become contaminated with facial peel acids, resulting in a pH of 3.25. What volume of 0.015 M NaOH solution are needed to neutralize the acidic waste?

a. $1.6 \times 10^{-8}$ gal

b. 0.0375 gal

● c. 2.06 gal

d. 3.09 gal

e. $1 \times 10^{-3.25}$ gallons

**Explanation:** This is a neutralization reaction where $C_{H^+}V_{H^+} = C_{OH^-}V_{OH^-}$. Before you can plug this in, you must convert pH into $[H^+] = 10^{-3.25}$. Now solve:

$$2.06\,\text{gal} = \frac{(10^{-3.25}\,\text{M})(55.0\,\text{gal})}{(0.0150\,\text{M})}$$

---

10. What is the $[OH^-]$ of an aqueous solution if $[H_3O^+] = 3.31 \times 10^{-4}$ M?

a. $6.12 \times 10^{10}$ M

● b. $3.02 \times 10^{-11}$ M

c. $3.02 \times 10^{10}$ M

d. $3.31 \times 10^{-18}$ M

e. $3.31 \times 10^{-4}$ M

**Explanation:** Use $K_w = 10^{-14} = [H_3O^+][OH^-]$ to solve for $[OH^-]$:

$$3.02 \times 10^{-11} = \frac{10^{-14}}{3.31 \times 10^{-4}}$$

---

11. Identify the conjugate base of formic acid, HCOOH?

a. $COO^{2-}$

b. $H_3O^+$

● c. $HCOO^-$

d. $OH^-$

e. $H_2O$

**Explanation:** The conjugate base is the product of the deprotonation of formic acid: $HCOO^-$.

---

12. What is the pH of a weak base solution that has a percent ionization of 1.8% at 0.25 M?

a. 9.45

●b. 11.65

c. 12.68

d. 2.35

e. 13.40

**Explanation:** The provided percent ionization suggests that 1.8% of the 0.25 M ionizes to form $[OH^-]$. This is equal to 0.0045 M. Now convert this value into a pH by obtaining pOH and then switching over to pH.

$$\text{pOH} = -\log(0.0045)$$

$$\text{pH} = 14 - \text{pOH} = 11.65$$

---

13. What does it mean to say that a weak acid ($HA_1$) has a greater $K_a$ than a second weak acid ($HA_2$)?

a. The ratio of products to reactants for $HA_1$ is less than it is for $HA_2$

●b. The ratio of products to reactants for $HA_1$ is greater than it is for $HA_2$

c. $HA_1$ will produce a more basic solution

d. $HA_2$ must have a greater percent ionization

**Explanation:** A larger K value will give more products. In this case, that will be a more acidic solution and a greater percent ionization for $HA_1$.

---

14. How does water dissolve an ionic compound?

a. The nonpolar nature of water allows the water molecules to surround a full ionic compound without separating the charged ions.

●b. The polarity of water allows the negative pole to surround cations and the positive pole to surround anions.

c. The nonpolar nature of water allows the water molecules to dissociate ionic compounds and non-selectively surround anions and cations.

d. The polarity of water allows the negative pole to surround anions and the positive pole to surround cations.

**Explanation:** The polarity of water allows the negative pole to surround cations and the positive pole to surround anions.

---

15. Calculate the molarity of $[H^+]$ when 12.0 grams of HCl are dissolved to make a 1.36 gallon solution.

●a. 0.0639 M

b. 8.82 M

c. 15.6 M

d. 0.013 M

e. 0.287 M

**Explanation:** Convert grams to moles and gallons to liter, and then divide to solve for molarity (mol/L).

0.32912781 mol = 12.0 g / (36.46 g/mol)

5.1476 L = 1.36 gal × 3.785 L/gal

= 0.06393811 M

---

16. Water is amphiprotic, which means it can act as an acid and a base. Consider the following reaction:

$$HCl(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + Cl^-(aq)$$

Is water acting as an acid or a base in this reaction?

a. acid

b. neither

●c. base

**Explanation:** Water is accepting a proton here, meaning it is behaving as a base.

---

17. When pure water is carbonated with $CO_2$ gas the pH tends to rise slightly above 7 due to the alkaline nature of carbonate.

●a. false

b. true

**Explanation:** When $CO_2$ dissolves in water, it forms carbonic acid - thus making the water slightly acidic which means the pH is below 7.

---

18. Which of the following species can get into into the air and cause "acid rain"?

a. methane

b. ozone

●c. sulfur oxides

d. carbon dioxide

e. nitrogen

**Explanation:** Sulfur oxides react with water droplets and make sulfuric acid which is acid rain. Carbon dioxide merely makes water slightly acidic and does not fit the definition of "acid rain".

---

19. Which of the following species contributes most to the natural acidity of rain?

a. nitrogen

b. sulfur oxides

●c. carbon dioxide

d. ozone

e. methane

**Explanation:** Sulfur oxides react with water droplets and make sulfuric acid which is acid rain. Carbon dioxide accounts for the natural acidity of rain.

---

20. Assume that each of the following bases are mixed at the same concentration of 0.05 mol/L. Which one will give the most basic solution?

ammonia, $K_b = 1.8 \times 10^{-5}$

hydrazine, $K_b = 1.7 \times 10^{-6}$

methylamine, $K_b = 1.7 \times 10^{-9}$

ethylamine, $K_b = 5.6 \times 10^{-4}$

a. methylamine

●b. ethylamine

c. hydrazine

d. All solutions have the same concentration and will therefore have the same basicity.

e. ammonia

**Explanation:** The larger the value of $K$, the more products are formed. The highest $K_b$ is ethylamine, which is $5.6 \times 10^{-4}$. This will yield the most basic solution because more hydroxide will be formed as a product.

---

21. Select the set of compounds which contains NO strong acids.

a. $Ca(OH)_2$, HI, $CH_3COOH$

●b. $Ca(OH)_2$, HF, $CH_3COOH$

c. $CH_3COOH$ , $HNO_3$, $CaCO_3$

d. $CaCO_3$ , NaCl, HCl

e. HBr, $HClO_4$, $CaCO_3$

**Explanation:** None of the following are strong acids: $Ca(OH)_2$, HF, $CH_3COOH$.

---

22. A weak acid, HA, has a 2.5% ionization in a 0.10 M solution. What is the pH of this solution?

a. 0.0025

b. 1.00

c. 3.38

d. 5.24

e. 2.12

●f. 2.60

**Explanation:** The $H^+$ concentration is equal to the percent ionization times the concentration. In other words, 2.5% of that .10 M solution will ionize. This will be equal to .0025 M. Then solve for pH. 2.60 = -log(.0025).

---

23. The $K_a$ for nitrous acid ($HNO_2$) is $4.0 \times 10^{-4}$. What is the $K_b$ for nitrite, $NO_2^-$ ?

a. $5.2 \times 10^{-10}$

b. $4.0 \times 10^{-18}$

c. $2.5 \times 10^{3}$

●d. $2.5 \times 10^{-11}$

e. $2.0 \times 10^{-8}$

**Explanation:** $K_w = K_a K_b$

$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{4.0 \times 10^{-4}}$$

$$K_b = \frac{K_w}{K_a} = 2.5 \times 10^{-11}$$

---

24. Which of the following pH values is slightly acidic but still capable of sustaining the majority of aquatic life?

a. pH = 7.0

●b. pH = 6.6

c. pH = 8.6

d. pH = 11.9

e. pH = 2.7

**Explanation:** There are two pH values listed that are acidic: pH = 6.6 and pH = 2.7. If the pH = 2.7, it is way too low to sustain life. If the pH = 6.6, the ecosystem would be very mildly acidic and still capable of sustaining the majority of aquatic life.

---

25. Calculate the pOH of 0.012 M $Ba(OH)_2$.

a. 12.1

b. 1.92

c. 2.34

d. 12.4

●e. 1.62

**Explanation:** $1.62 = -\log(0.012 \times 2)$

---

Remember to bubble in ALL your answers BEFORE time is called. Double check your name, uteid, and version number before you turn in your bubblesheet. You must keep your exam for future reference. Please do not lose it. We will not replace it.