Periodic Table of the Elements

1A (1)												3A (13)	4A (14)	5A (15)	6A (16)	7A (17)	8A (18)
1 H 1.0079	2A (2)																2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
11 Na 22.9898	12 Mg 24.3050	3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8	8B (9)	10	1B (11)	2B (12)	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.82	50 Sn 118.710	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.39
55 Cs 132.9054	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.9665	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									

58 Ce 140.115	59 Pr 140.9076	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.9253	66 Dy 162.50	67 Ho 164.9303	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967
90 Th 232.0381	91 Pa 231.0359	92 U 238.0289	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 (260)

This print-out should have 8 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Msci 18 0724

18:08, general, multiple choice, > 1 min, fixed.

001

Which of the following mixtures will be a buffer when dissolved in a liter of water?

1. 0.1 mol $Ca(OH)_2$ and 0.3 mol HI

2. 0.3 mol NaCl and 0.3 mol HCl

3. 0.4 mol NH_3 and 0.4 mol HCl

4. 0.2 mol HBr and 0.1 mol NaOH

5. 0.2 mol HF and 0.1 mol NaOH **correct**

Explanation:

Eliminate answers that are obviously incorrect. The choice with "0.2 mol HBr" and "0.1 mol $Ca(OH)_2$" are strong acids and strong bases respectively; therefore, NOT buffers. The choice with "0.3 mol NaCl" is a combination of spectator ions and a strong acid; this does not form a buffer. Remaining for calculation are choices with "0.4 mol NH_3" and "0.2 mol HF". Now perform the neutralizaton calculations on the remaining possibilities:

Choice with 0.4 mol NH_3

$$NH_3 + H^+ \rightleftharpoons NH_4^+$$

Initial	0.4	0.4	0
Change	−0.4	−0.4	0.4
Final	0	0	0.4

Choice with 0.2 mol HF

$$HF + OH^- \rightleftharpoons F^- + H_2O$$

Initial	0.2	0.1	0	−
Change	−0.1	−0.1	0.1	−
Final	0.1	0	0.1	−

The choice with 0.2 mol HF has both weak acid and weak conjugate base left over, so it is the buffer solution.

ChemPrin3e T10 14

18:99, basic, multiple choice, < 1 min, fixed.

002

Which of the following is the STRONGEST base?

1. methylamine ($pK_b = 3.44$) **correct**

2. morphine ($pK_b = 5.79$)

3. urea ($pK_b = 13.90$)

4. ammonia ($pK_b = 4.75$)

5. pyridine ($pK_b = 8.75$)

Explanation:

ChemPrin3e T10 39

18:99, basic, multiple choice, < 1 min, fixed.

003

Estimate the pH of 10^{-7} M $HClO_4$(aq).

1. 6.8 **correct**

2. 8.0

3. 1.0

4. 5.0

5. 7.0

Explanation:

Msci 18 0882

18:08, general, multiple choice, > 1 min, fixed.

004

A solution is initially 0.0100 M in HClO and 0.0300 M in NaClO.

What is the pH after the addition of 0.0030 mol of solid NaOH to 1.00 L of this solution? Assume no volume change.

1. 5.34

2. 5.33

3. 8.02

4. 8.13 **correct**

5. 9.06

Explanation:
$[HClO] = 0.01$ M $\quad [ClO^-] = 0.03$ M
$K_a = 3.5 \times 10^{-8}$ $\quad$ NaOH $= 0.0030$ mol

	$HClO$	+ NaOH	$\rightarrow$ Na^+	+ ClO^- + H_2O
ini	0.01	0.003	0.03	0.03
Δ	-0.003	-0.003	0.003	0.003
fin	0.007	0	0.033	0.033

Na^+ is a spectator ion. $HClO$ and OCl^- produce a buffer system.

$$\begin{aligned} pH &= pK_a + \log\left(\frac{[ClO^-]}{[HClO]}\right) \\ &= -\log\left(3.5 \times 10^{-8}\right) + \log\left(\frac{0.033}{0.007}\right) \\ &= 8.12935 \end{aligned}$$

ChemPrin3e T10 52
18:99, basic, multiple choice, < 1 min, fixed.
005
Which equation represents K_{a2} for phosphoric acid?

1. $HPO_4^{2-}(aq) + H_2O(\ell) \rightarrow PO_4^{3-}(aq) + H_3O^+(aq)$

2. $H_2PO_4^-(aq) + H_2O(\ell) \rightarrow HPO_4^{2-}(aq) + H_3O^+(aq)$ **correct**

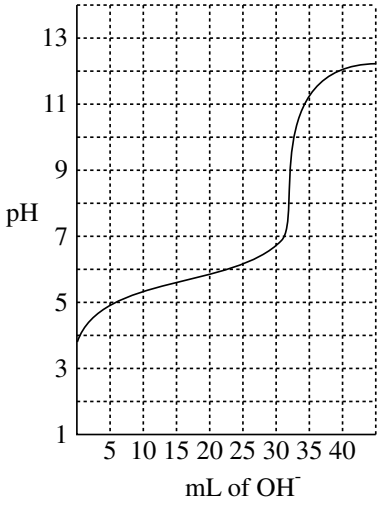
3. $H_3PO_4(aq) + 2\,H_2O(\ell) \rightarrow HPO_4^{2-}(aq) + 2\,H_3O^+(aq)$

4. $HPO_4^{2-}(aq) + H_2O(\ell) \rightarrow H_2PO_4^-(aq) + OH^-(aq)$

5. $H_3PO_4(aq) + H_2O(\ell) \rightarrow H_2PO_4^-(aq) + H_3O^+(aq)$

Explanation:

Msci 19 0751
18:10, general, multiple choice, > 1 min, fixed.
006
What is the pK_a of the acid titrated in this pH curve?



1. 4.7

2. 5.6 **correct**

3. 5.9

4. 6.8

5. 9.0

Explanation:

Msci 19 0618
18:10, general, multiple choice, > 1 min, fixed.
007
Calculate the pH of the solution resulting from the addition of 30.0 mL of 0.200 M $HClO_4$ to 60.0 mL of 0.150 M NaOH.

1. 12.52 **correct**

2. 11.88

3. 7.00

4. 1.48

5. 13.06

Explanation:
Here it's important to find out which of these two species ($HClO_4$ and NaOH) is in excess. The one that is in excess will determine

the pH of this solution. From the formulas of the two compounds, you can expect that they will react in a one-to-one fashion.

So our first order of business will be to determine how many moles of each compound we have.

For $HClO_4$, we have

$$30.0\text{ mL}\left(\frac{1\text{ L}}{1000\text{ mL}}\right)\left(\frac{0.200\text{ mol}}{1\text{ L}}\right) = 0.006\text{ mol } HClO_4$$

Likewise, for NaOH, we have

$$60.0\text{ mL}\left(\frac{1\text{ L}}{1000\text{ mL}}\right)\left(\frac{0.150\text{ mol}}{1\text{ L}}\right) = 0.009\text{ mol NaOH}$$

So when $HClO_4$ and NaOH react, all of the $HClO_4$ will be consumed (it's the limiting reagent) and

$$0.009\text{ mol} - 0.006\text{ mol} = 0.003\text{ mol}$$

will remain. This 0.00300 mol excess of NaOH will determine the pH of this solution. The solution now is

$$30.0\text{ mL} + 60.0\text{ mL} = 90\text{ mL}$$

and, since NaOH is a strong base (*i.e.*, it's completely dissociated), it contains 0.003 mol OH^-. $[OH^-]$ is then

$$[OH^-] = \frac{0.003\text{ mol}}{0.09\text{ L}} = 0.0333333\text{ M}$$

which means that the pOH of this solution is

$$\begin{aligned}\text{pOH} &= -\log[OH^-] = -\log(0.0333333)\\ &= 1.47712\end{aligned}$$

However, we wanted pH. We can use the equation that relates pH to pOH to get pH

$$\begin{aligned}\text{pH} + \text{pOH} &= 14\\ \text{pH} + 1.47712 &= 14\\ \text{pH} &= 12.5229\end{aligned}$$

Msci 19 0619

18:10, general, multiple choice, > 1 min, fixed.

008

What would be the pH if 0.030 moles of solid NaOH were added to 200 mL of 0.200 M acetic acid solution? Assume the volume of the solution does not change when the solid is added. The ionization constant of acetic acid is 1.8×10^{-5}.

1. pH = 4.27

2. pH = 4.87

3. pH = 5.22 **correct**

4. pH = 5.35

5. None of these

Explanation:

$[CH_3COOH] = 0.2$ M $\quad V_{CH_3COOH} = 200$ mL

$K_a = 1.8 \times 10^{-5}$

Initial condition (ini):

$n_{NaOH} = 0.03$ mol

$n_{CH_3COOH} = 0.200 \times 0.200 = 0.04$ mol

$NaOH + CH_3COOH \rightarrow Na^+ + CH_3COO^- + H_2O$			
0.03	0.04	0	0
−0.03	−0.03	0.03	0.03
0	0.01	0.03	0.03

Na^+ is a spectator ion. Both CH_3COOH and CH_3COO^- are present, so the solution is a buffer.

$$\begin{aligned}\text{pH} &= \text{p}K_a + \log\left(\frac{[CH_3COO^-]}{[CH_3COOH]}\right)\\ &= -\log(1.8\times10^{-5})\\ &\quad + \log\left(\frac{0.03\text{ mol}/0.200\text{ L}}{0.01\text{ mol}/0.200\text{ L}}\right)\\ &= 5.22185\end{aligned}$$