

**Chemistry 20 – Lesson 26**  
**pH and pOH**

/76

1.

$$[\text{H}^+_{(\text{aq})}] \times [\text{OH}^-_{(\text{aq})}] = K_w$$

$$[\text{OH}^-_{(\text{aq})}] = \frac{K_w}{[\text{H}^+_{(\text{aq})}]}$$

/3

$$[\text{OH}^-_{(\text{aq})}] = \frac{1.0 \times 10^{-14} (\text{mol/L})^2}{4.40 \times 10^{-3} \text{ mol/L}}$$

$$\boxed{[\text{OH}^-_{(\text{aq})}] = 2.27 \times 10^{-12} \text{ mol/L}}$$

2.

$$[\text{H}^+_{(\text{aq})}] \times [\text{OH}^-_{(\text{aq})}] = K_w$$

$$[\text{H}^+_{(\text{aq})}] = \frac{K_w}{[\text{OH}^-_{(\text{aq})}]}$$

/3

$$[\text{H}^+_{(\text{aq})}] = \frac{1.0 \times 10^{-14} (\text{mol/L})^2}{2.99 \times 10^{-4} \text{ mol/L}}$$

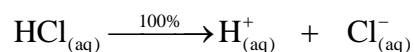
$$\boxed{[\text{H}^+_{(\text{aq})}] = 3.34 \times 10^{-11} \text{ mol/L}}$$

3.

$$n_{\text{HCl}} = \frac{0.37 \text{ g}}{36.46 \frac{\text{g}}{\text{mol}}} = 0.010148 \text{ mol}$$

$$[\text{HCl}_{(\text{aq})}] = \frac{0.010148 \text{ mol}}{0.250 \text{ L}} = 0.040592 \text{ mol/L}$$

/6



$$[\text{H}^+_{(\text{aq})}] = [\text{HCl}_{(\text{aq})}] = 0.040592 \text{ mol/L}$$

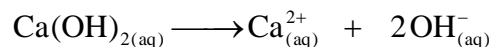
$$[\text{H}^+_{(\text{aq})}] \times [\text{OH}^-_{(\text{aq})}] = K_w$$

$$[\text{OH}^-_{(\text{aq})}] = \frac{K_w}{[\text{H}^+_{(\text{aq})}]}$$

$$[\text{OH}^-_{(\text{aq})}] = \frac{1.0 \times 10^{-14} (\text{mol/L})^2}{0.040592 \text{ mol/L}}$$

$$\boxed{[\text{OH}^-_{(\text{aq})}] = 2.46 \times 10^{-13} \text{ mol/L}}$$

4.



$$[\text{OH}^-_{(\text{aq})}] = 2 \times [\text{Ca}(\text{OH})_{2(\text{aq})}]$$

/5

$$[\text{OH}^-_{(\text{aq})}] = 2 \times [6.9 \times 10^{-3} \text{ mol/L}]$$

$$[\text{OH}^-_{(\text{aq})}] = 1.38 \times 10^{-2} \text{ mol/L}$$

$$[\text{H}^+_{(\text{aq})}] \times [\text{OH}^-_{(\text{aq})}] = K_w$$

$$[\text{H}^+_{(\text{aq})}] = \frac{K_w}{[\text{OH}^-_{(\text{aq})}]}$$

$$[\text{H}^+_{(\text{aq})}] = \frac{1.0 \times 10^{-14} (\text{mol/L})^2}{1.38 \times 10^{-2} \text{ mol/L}}$$

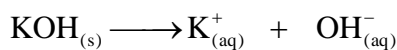
$$\boxed{[\text{H}^+_{(\text{aq})}] = 7.25 \times 10^{-13} \text{ mol/L}}$$

5.

$$n_{\text{KOH}} = \frac{20.0 \text{ g}}{56.11 \frac{\text{g}}{\text{mol}}} = 0.35644 \text{ mol}$$

$$[\text{KOH}_{(\text{aq})}] = \frac{0.35644 \text{ mol}}{0.500 \text{ L}} = 0.7128854 \text{ mol/L}$$

/6



$$[\text{OH}_{(\text{aq})}^{-}] = [\text{KOH}_{(\text{aq})}] = 0.7128854 \text{ mol/L}$$

$$[\text{H}_{(\text{aq})}^{+}] \times [\text{OH}_{(\text{aq})}^{-}] = K_w$$

$$[\text{H}_{(\text{aq})}^{+}] = \frac{K_w}{[\text{OH}_{(\text{aq})}^{-}]}$$

$$[\text{H}_{(\text{aq})}^{+}] = \frac{1.0 \times 10^{-14} (\text{mol/L})^2}{0.7128854 \text{ mol/L}}$$

$$[\text{H}_{(\text{aq})}^{+}] = 1.403 \times 10^{-14} \text{ mol/L}$$

6.

(a)

/9

Food	$[\text{H}_{(\text{aq})}^{+}]$ (mol/L)	$[\text{OH}_{(\text{aq})}^{-}]$ (mol/L)	pH	pOH
oranges	$5.5 \times 10^{-3}$	$1.8 \times 10^{-12}$	<b>2.26</b>	<b>11.74</b>
asparagus	$4 \times 10^{-9}$	$3 \times 10^{-6}$	<b>8.4</b>	5.6
olives	$5.0 \times 10^{-4}$	$2.0 \times 10^{-11}$	<b>3.30</b>	<b>10.70</b>
blackberries	$4.0 \times 10^{-4}$	$2.5 \times 10^{-11}$	<b>3.40</b>	10.60

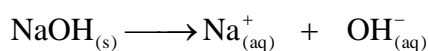
(b) **Oranges** would taste most sour.

7.

$$n_{\text{NaOH}} = \frac{26 \text{ g}}{40.00 \frac{\text{g}}{\text{mol}}} = 0.65 \text{ mol}$$

$$[\text{NaOH}_{(\text{aq})}] = \frac{0.65 \text{ mol}}{0.150 \text{ L}} = 4.33 \text{ mol/L}$$

/6



$$[\text{OH}_{(\text{aq})}^{-}] = [\text{NaOH}_{(\text{aq})}] = 4.33 \text{ mol/L}$$

$$\text{pOH} = -\log[\text{OH}^{-}]$$

$$\text{pOH} = -\log[4.33 \text{ mol/L}]$$

$$\text{pOH} = -0.64$$

Note that negative values for pH and pOH are possible. Further, a negative pH or pOH indicates a very concentrated acidic or basic solution.

$$\text{pH} + \text{pOH} = 14$$

$$\text{pH} = 14 - \text{pOH} = 14 - (-0.64)$$

$$\text{pH} = 14.64$$

8.

$$\text{pH} + \text{pOH} = 14$$

$$\text{pOH} = 14 - \text{pH} = 14 - (11.50)$$

$$\text{pOH} = 2.50$$

/6

$$[\text{OH}_{(\text{aq})}^{-}] = 10^{-\text{pOH}}$$

$$[\text{OH}_{(\text{aq})}^{-}] = 10^{-2.50}$$

$$[\text{OH}_{(\text{aq})}^{-}] = 3.2 \times 10^{-3} \text{ mol/L}$$

$$n_{\text{KOH}} = 3.2 \times 10^{-3} \text{ mol/L} (0.500 \text{ L})$$

$$n_{\text{KOH}} = 1.6 \times 10^{-3} \text{ mol}$$

$$m_{\text{KOH}} = 1.6 \times 10^{-3} \text{ mol} (56.11 \frac{\text{g}}{\text{mol}})$$

$$m_{\text{KOH}} = 0.089 \text{ g}$$

9.

(a) neutral?  $[\text{H}^+] = [\text{OH}^-]$ /3 (b) acidic?  $[\text{H}^+] > [\text{OH}^-]$ (c) basic?  $[\text{H}^+] < [\text{OH}^-]$ 

10.

$$[\text{H}_{(\text{aq})}^+] = \frac{K_w}{[\text{OH}_{(\text{aq})}^-]}$$

$$/6 \quad [\text{H}_{(\text{aq})}^+] = \frac{1.0 \times 10^{-14} (\text{mol/L})^2}{2.5 \times 10^{-7} \text{ mol/L}}$$

$$\boxed{[\text{H}_{(\text{aq})}^+] = 4.0 \times 10^{-8} \text{ mol/L}}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pH} = -\log[4.0 \times 10^{-8} \text{ mol/L}]$$

$$\boxed{\text{pH} = 7.40}$$

11.

$$[\text{H}_{(\text{aq})}^+] = 10^{-\text{pH}}$$

$$/3 \quad [\text{H}_{(\text{aq})}^+] = 10^{-5.6}$$

$$\boxed{[\text{H}_{(\text{aq})}^+] = 2.5 \times 10^{-6} \text{ mol/L}}$$

12.

/2 If the pH decreases by 1, the concentration has increased by a factor of 10. Therefore, a change of 3 pH units is equivalent to a 1000 fold change in concentration.

13.

$$[\text{H}_{(\text{aq})}^+] = 10^{-\text{pH}}$$

$$[\text{H}_{(\text{aq})}^+] = 10^{-1.57}$$

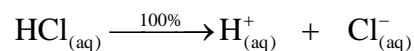
$$/6 \quad [\text{H}_{(\text{aq})}^+] = 2.7 \times 10^{-2} \text{ mol/L}$$

$$n_{\text{HCl}} = 2.7 \times 10^{-2} \text{ mol/L} (0.250\text{L})$$

$$n_{\text{HCl}} = 0.0067288 \text{ mol}$$

$$m_{\text{HCl}} = 0.0067288 \text{ mol} (36.46 \frac{\text{g}}{\text{mol}})$$

$$\boxed{m_{\text{HCl}} = 0.25 \text{ g}}$$



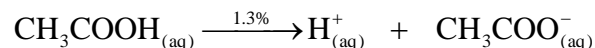
$$[\text{HCl}_{(\text{aq})}] = [\text{H}_{(\text{aq})}^+] = 2.7 \times 10^{-2} \text{ mol/L}$$

14.

$$n_{\text{CH}_3\text{COOH}} = \frac{60.0 \text{ kg}}{60.06 \frac{\text{g}}{\text{mol}}} = 0.999 \text{ kmol}$$

$$[\text{HCl}_{(\text{aq})}] = \frac{0.999 \text{ kmol}}{1.25 \text{ kL}} = 0.7992 \text{ mol/L}$$

/6



$$[\text{H}_{(\text{aq})}^+] = 0.013 [0.7992] = 0.0103896 \text{ mol/L}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pH} = -\log[0.0103896 \text{ mol/L}]$$

$$\boxed{\text{pH} = 1.98}$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{pOH} = 14 - \text{pH} = 14 - 1.98$$

$$\boxed{\text{pOH} = 12.02}$$

15.

$$\text{pH} + \text{pOH} = 14$$

$$\text{pOH} = 14 - \text{pH} = 14 - 10.35$$

$$\text{pOH} = 3.65$$

/6

$$[\text{OH}^-_{(\text{aq})}] = 10^{-\text{pOH}}$$

$$[\text{OH}^-_{(\text{aq})}] = 10^{-3.65}$$

$$[\text{OH}^-_{(\text{aq})}] = 2.24 \times 10^{-4} \text{ mol/L}$$

$$n_{\text{NaOH}} = 2.24 \times 10^{-4} \text{ mol/L} (2.00\text{L})$$

$$n_{\text{NaOH}} = 4.48 \times 10^{-4} \text{ mol}$$

$$m_{\text{NaOH}} = 4.48 \times 10^{-4} \text{ mol} (40.00 \text{ g/mol})$$

$$m_{\text{NaOH}} = 0.018 \text{ g}$$