First Semester Review Problem Set a

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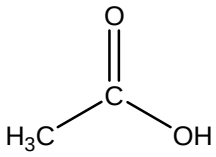
A solution is made using 10.0 mL of acetic acid (density 1.0492 g/mL CRC Handbook of Chemistry and Physics 73rd ed) which is diluted to a volume of 250 mL with deionized water.

-Write a balanced chemical equation for the dissociation of acetic acid

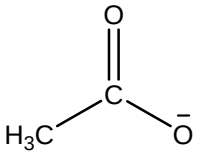
$CH_3COOH \rightarrow CH_3COO^- + H^+$

OR $CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+$

Draw a lewis dot structure for acetic acid



Draw a Lewis dot structure for acetate ion



Based upon the Lewis dot structures for acetic acid and for the acetate ion, do you expect them to be soluble in water?

-Yes, acetic acid and the acetate ion are both polar.

Determine the concentration of the acetic acid solution
Determine the concentration of the acetate ion in solution
Determine the concentration of H+ ion in solution

$V_{acetic\_acid} := 10.0 \cdot mL$

$density_{acetic\_acid} := 1.0492 \cdot \frac{gm}{mL}$

$mass_{acetic\_acid} := density_{acetic\_acid} \cdot V_{acetic\_acid}$

$mass_{acetic\_acid} = 10.492\ gm$

$MW_{acetic\_acid} := (12.011 \cdot 2 + 1.00794 \cdot 4 + 15.9994 \cdot 2) \cdot \frac{gm}{mole}$

$mole_{acetic\_acid} := \frac{mass_{acetic\_acid}}{MW_{acetic\_acid}}$

$mole_{acetic\_acid} = 0.175\ mol$

$V_{solution} := 250 \cdot mL$ $V_{solution} = 0.25\ L$

$C_{acetic\_acid} := \frac{mole_{acetic\_acid}}{V_{solution}}$ $M := \frac{mole}{L}$

$C_{acetic\_acid} = 0.699\ M$

Assuming that the reaction goes to completion, the concentration of acetate ion and the concentration of H+ ion should be the same as the acetic acid concentration.

The pH of this solution is measured using a pH meter. This experiment determines that the concentration of H+ ion in the solution is 0.0035 M. Compare this experimental result with the expected concentration.

This means that the reaction must not go to completion.

This acetic acid solution is titrated with an unknown sodium hydroxide solution. 21.36 mL of the acetic acid is required to reach the endpoint for the titration of 50.00 mL of sodium hydroxide. Determine the concentration of the original sodium hydroxide solution.

At the endpoint to a titration, the reaction goes to completion with no limiting reagent. So the moles of acetic acid should equal the moles of sodium hydroxide.

$V_{acid} := 21.36 \cdot mL$

$mole_{acid} := V_{acid} \cdot C_{acetic\_acid}$

$mole_{acid} = 0.015\ mol$

$mole_{base} := mole_{acid}$

$V_{base} := 50.0 \cdot mL$ $V_{base} = 0.05\ L$

$C_{NaOH} := \frac{mole_{base}}{V_{base}}$

$C_{NaOH} = 0.299\ M$

When the acetic acid is mixed with the sodium hydroxide, the temperature of the solution increases. In the titration described above, if the temperature of the solutions changes from 18.9 ºC to 21.4 ºC what is [delta]Hrxn for this process?

$\Delta T := (21.4 - 18.9)\cdot K$ $\Delta T = 2.5\ K$

$mass := (21.36\cdot mL + 50.0\cdot mL)\cdot 1.00\cdot \frac{gm}{mL}$ $mass = 71.36\ gm$

$E := mass\cdot \Delta T\cdot 4.2\cdot \frac{J}{gm\cdot K}$

$E = 749.28\ J$

The water warms up, so the reaction releases this amount of energy. To find ΔH_{rxn} this needs to be on a per mole basis so:

$\Delta H_{rxn} := \frac{-E}{mole_{acid}}$

$\Delta H_{rxn} = -5.019 \times 10^{4} \frac{J}{mole}$

Acetic acid has a pungent odor. What would you expect to find if you compare the odor for the acetic acid with the acetic acid solution? Based upon your understanding of how molecules behave, explain why you expect this result.

For a molecule to go from a solution to the gas phase it must reach the surface with sufficient kinetic energy to go into the gas phase. In the acetic acid, all the molecules at the surface are acetic acid. In the solution, only a portion of the molecules at the surface are acetic acid. The rest are water molecules. As a result, fewer molecules would go into the gas phase above the acetic acid solution.