

9/23/19
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K_D of Acetic Acid

separates b/w 2 layers

Lab Partner: [redacted]

Purpose:

→ "the partition equilibrium constant"

- determine the K_D of acetic acid by using titrations
- study the effect of solvent layer volume on K_D ✓
- practice using separatory funnels and performing titrations of different solvents

Procedure:

- Rinse burette with 0.1 M NaOH before filling
 - clear burette tip of bubbles
 - don't let burette run empty
 - record starting volume for each titration

Control Experiment 1 - Titrating Acetic Acid in Water

- measure 25 mL water into 250 mL Erlenmeyer flask
- use micropipette to add 2.00 mL white vinegar
- add stir bar, add 2 drops phenolphthalein, stir to 500 rpm
- record starting volume of NaOH to two decimal places: 10.15 mL
- titrate to light pink endpoint
- record final volume of NaOH to two decimal places: 26.30 mL
- Volume NaOH added = 16.15 mL

better to put in organized table at end of procedure call # in some place

Control Experiment 2 - Titrating Acetic Acid in Octanol

lots of pink bubbles

- repeat control experiment 1 with the following adjustments
 - use 25 mL of octanol in place of water
 - add 10 mL of water after adding stir bar
- starting volume of NaOH to two decimal places: 0.21 mL
- final volume of NaOH to two decimal places: 15.58 mL
- volume NaOH added = 15.37 mL

if solution suddenly turns hot pink, let sit for a couple minutes to test if it turns clear or stays hot pink

Experiment 1 - K_D w/ 25 mL water and 25 mL octanol

- close stopcock on separatory funnel

$$13.05 \text{ mL} + 3.18 \text{ mL} = 16.23 \text{ mL}$$

$$9.48 \text{ mL} + 4.95 \text{ mL} = 14.43 \text{ mL}$$

less b/c precision is better?

- add 25 mL of water, 25 mL of octanol, and 2.00 mL of white vinegar
- cap funnel, shake vigorously for one minute
- set in ringstand and allow separation
- drain bottom (water) layer into Erlenmeyer
- repeat titration steps 3-7 in Control Experiment #1
- Starting volume of NaOH to two decimal places: 1.20 mL
- final volume of NaOH to two decimal places: 10.68 mL

Maybe little bit of octanol content in solution

Volume NaOH added = 9.48 mL

- drain top (octanol) layer into different Erlenmeyer
- rinse separatory funnel w 10 mL of distilled water and pour into octanol flask
- repeat titration steps 3-7 in Control Experiment #1
- starting volume of NaOH to two decimal places: 0.11 mL
- final volume of NaOH to two decimal places: 5.06 mL
- Volume NaOH added = 4.95 mL

Experiment 2(3) • K₂ w/ 50 mL water and 25 mL octanol

• repeat Experiment 1, but change volume of water to 50 mL

→ bottom (water) layer

- starting volume of NaOH to two decimal places: 5.06 mL ✓
- final volume of NaOH to two decimal places: 18.11 mL

Volume NaOH added = 13.05 mL more than 9.48 mL

→ top (octanol) layer

- starting volume of NaOH to two decimal places: 18.11 mL
- final volume of NaOH to two decimal places: 21.29 mL

Volume NaOH added = 3.18 mL less than 4.95 mL

Results:

Eq. 1

$$\frac{\text{mL NaOH used}}{1000 \text{ mL NaOH}} \cdot \frac{0.10 \text{ mol NaOH}}{\text{L}} \cdot \frac{\text{mol Acetic Acid}}{\text{mol NaOH}} = \text{mol Acetic Acid in the layer}$$

Eq. 2

$$[\text{Acetic acid}]_{\text{layer}} = \frac{\text{mol acetic acid in layer}}{\text{volume of (layer)}} \text{ (L)}$$

Eq. 3

$$K_p = \frac{[\text{Acetic acid}]_{\text{octanol}}}{[\text{Acetic acid}]_{\text{water}}}$$

Control Exp. 1 - Titrating Acetic Acid in Water

$$16.15 \text{ mL NaOH used} \cdot \frac{\text{L}}{1000 \text{ mL}} \cdot \frac{0.10 \text{ mol NaOH}}{\text{L}} \cdot \frac{\text{mol Acetic Acid}}{\text{mol NaOH}} = .001615 \text{ mol Acetic Acid in layer}$$

$$[\text{Acetic acid}]_{\text{layer}} = \frac{.001615 \text{ mol Acetic Acid in layer}}{.025 \text{ mL water}} = .0646$$

$$K_p = \frac{[\text{Acetic acid}]_{\text{octanol}}}{[\text{Acetic acid}]_{\text{water}}} = \frac{0}{.0646} = 0$$

there is no K_p for control experiment! coz we didn't have the partition equilibrium

Control Exp. 2 - Titrating Acetic Acid in Octanol

$$15.37 \text{ mL NaOH used} \cdot \frac{\text{L}}{1000 \text{ mL}} \cdot \frac{0.10 \text{ mol NaOH}}{\text{L}} \cdot \frac{\text{mol Acetic Acid}}{\text{mol NaOH}} = .001537 \text{ mol Acetic Acid in layer}$$

$$[\text{Acetic acid}]_{\text{octanol layer}} = \frac{.001537 \text{ mol Acetic Acid in layer}}{.025 \text{ mL octanol}} = .06148$$

$$K_p = \frac{[\text{Acetic acid}]_{\text{octanol}}}{[\text{Acetic acid}]_{\text{water}}} = \frac{.06148}{0} = ?$$

Exp. 1 K_p w/ 25 mL water, 25 mL octanol

$$.000948 \text{ mol Acetic Acid in water layer} \quad .000495 \text{ mol Acetic Acid in octanol layer}$$

$$[\text{Acetic Acid}]_{\text{H}_2\text{O layer}} = .03792$$

$$[\text{Acetic Acid}]_{\text{octanol}} = .0198$$

$$K_p = \frac{[\text{Acetic Acid}]_{\text{octanol}}}{[\text{Acetic Acid}]_{\text{water}}} = \frac{.0198}{.03792} = 0.522$$

$$[\text{Acetic Acid}]_{\text{water}} = .03792$$

Exp. 3 K_D w/ 50 mL water, 25 mL octanol

.001305 mol Acetic Acid in H_2O layer

.000319 mol Acetic Acid in Octanol layer

$$[Acetic Acid]_{water} = .0261$$

$$[Acetic Acid]_{octanol} = .01272$$

$$K_D = \frac{[Acetic Acid]_{octanol}}{[Acetic Acid]_{water}} = \frac{.01272}{.0261} = .487$$

$$[Acetic Acid]_{water} = .0261$$

exp #1

CLASS values

25 mL of H_2O + 25 mL octanol

K_D

0.499

0.501

0.49

0.522 ← mine

0.645

exp #2

25 mL of H_2O + 50 mL of octanol

K_D

0.53

0.526

0.5057

exp #3

50 mL of H_2O + 25 mL of octanol

K_D

0.50

0.487 ← mine

0.577

Discussion:

The purpose to determine the K_D of acetic acid by using titrations was met. The K_D value for experiment #1 was determined to be 0.522. The K_D value for experiment #3 was determined to be 0.487. It makes sense that the K_D value went down. K_D is calculated by the concentration of acetic acid in octanol over the concentration of acetic acid in water. In experiment #3, we added much more (+25 mL) of water, making the denominator larger, thus the K_D smaller. In order to better study the effect of solvent

layer volumes on K_D , we could repeat/do more experimentation with differing volumes of solvents. The last objective to practice using separatory funnels and performing titrations of different solvents was met. Experimental errors include failing to rinse burette, letting burette empty, performing titration when burette is full of bubbles, using incorrect volumes of chemicals or forgetting to add chemicals, not stirring solution during titration, reading titration volume wrong, not allowing separation, and mislabeling layers. This experiment leads to further research. How drastic is the effect of changing solvent layer volumes on K_D ? For example, is there a linear relationship? We could study K_D values for other chemicals to compare to acetic acid.

M.E.