Midterm?

a. :)

b.

c. : |

d.

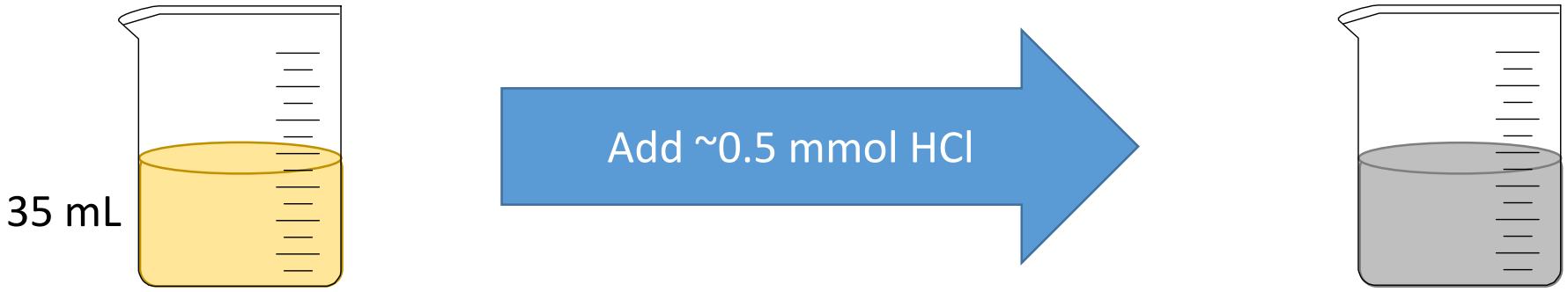
e. : (

Demo: Mixing Acids and Bases

We start with 35 mL of a 0.010 M solution of acetic acid (CH_3COOH). The pK_a of acetic acid is 4.74 – what is the expected pH of this solution?

At equilibrium, this solution contains:

Solution W: 0.01 M CH_3COOH (aq)
pH ~3.4



When the HCl is added, the pH will:

a) Increase dramatically (>1 pH unit)

b) Increase slightly (<1 pH unit)

c) Not change (± 0.1 pH unit)

d) Decrease slightly (<1 pH unit)

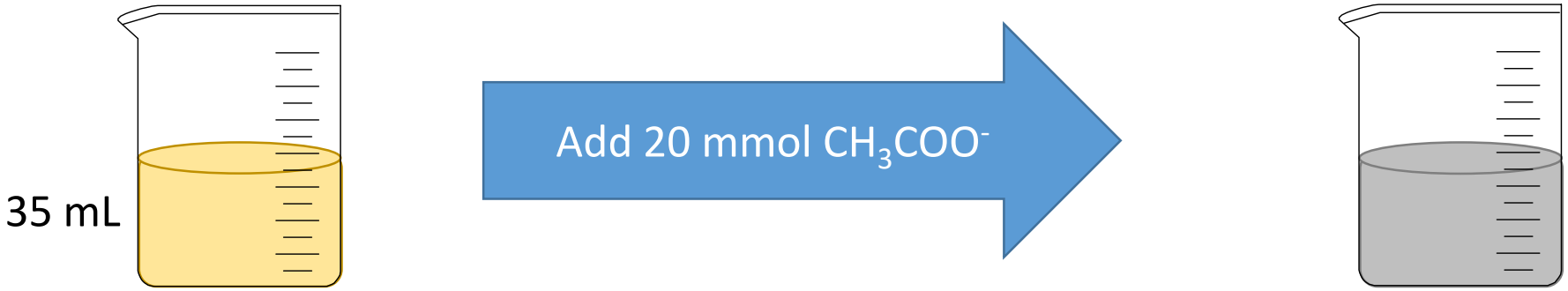
e) Decrease dramatically (>1 pH unit)

Demo: Adding Strong Acid to a Weak Acid

We start with 35 mL of a 0.010 M solution of acetic acid (CH_3COOH). **We add 0.5 mmol of HCl.**
The pK_a of acetic acid is 4.74 – what is the expected pH of this solution?

At equilibrium, this solution contains:

Solution W: 0.01 M CH_3COOH (aq)
pH ~3.4



When the acetate is added, the pH will:

a) Increase dramatically (>1 pH unit)

b) Increase slightly (<1 pH unit)

c) Not change (± 0.1 pH unit)

d) Decrease slightly (<1 pH unit)

e) Decrease dramatically (>1 pH unit)

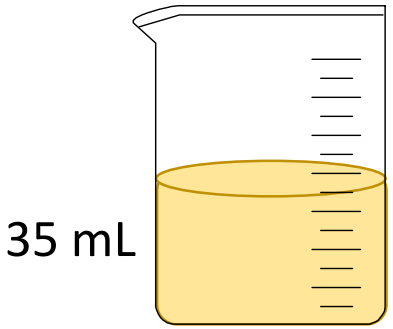
Demo: Mixing Weak Acid and its Conjugate Base

We start with 35 mL of a 0.010 M solution of acetic acid (CH_3COOH). **We add 20 mmol of CH_3COOH.**
The pK_a of acetic acid is 4.74 – what is the expected pH of this solution?

At equilibrium, this solution contains:

Demo: Mixing Strong Acid and its Conjugate Base

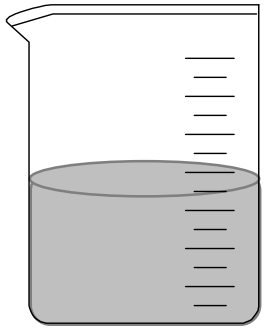
Solution H:
0.01 M HCl (aq)
pH ~2



35 mL

Add 18 mmol Cl^-

Solution H':
0.01 M HCl (aq)
and ~0.24 M Cl^- (aq)
pH ?

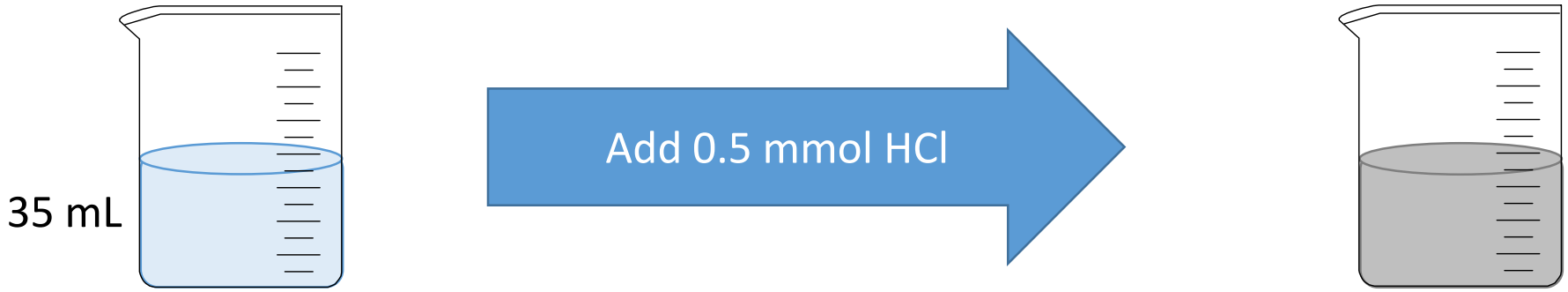


When the Cl^- is added, the pH will:

a. Increase dramatically (>1 pH unit)
b. Increase slightly (<1 pH unit)
c. Not change (± 0.1 pH unit)
d. Decrease slightly (<1 pH unit)
e. Decrease dramatically (>1 pH unit)

Demo: Acid into Water

RO water
pH:

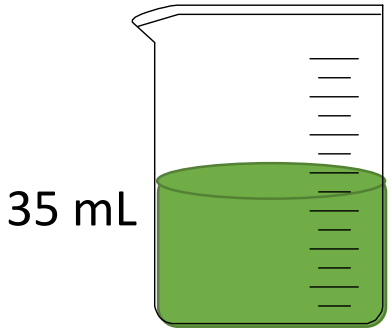


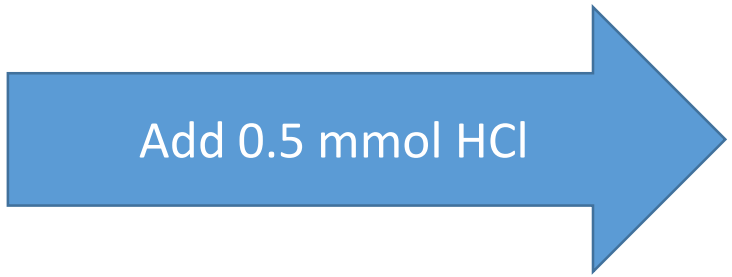
When the HCl is added, the pH will:

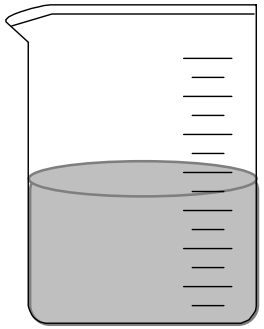
a. Increase dramatically (>1 pH unit)
b. Increase slightly (<1 pH unit)
c. Not change (± 0.1 pH unit)
d. Decrease slightly (<1 pH unit)
e. Decrease dramatically (>1 pH unit)

Demo: Acid into Conjugate Pair Mixture

Solution B:
0.01 M CH_3COOH (aq)
and ~0.24 M CH_3COO^- (aq)







When the HCl is added, the pH will:

a) Increase dramatically (>1 pH unit)

b) Increase slightly (<1 pH unit)

c) Not change (± 0.1 pH unit)

d) Decrease slightly (<1 pH unit)

e) Decrease dramatically (>1 pH unit)

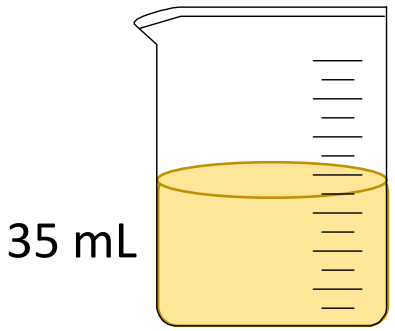
Demo: Acid into Conjugate Pair Mixture

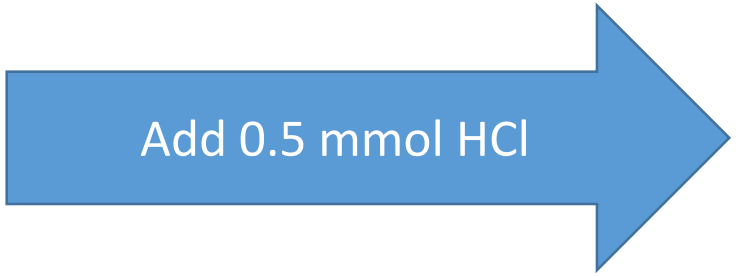
We start with 35 mL of a solution containing 0.35 mmol of CH_3COOH and 18 mmol of CH_3COO^-. **We then add 0.5 mmol of HCl.** The pK_a of acetic acid is 4.74 – what is the expected pH of this solution?

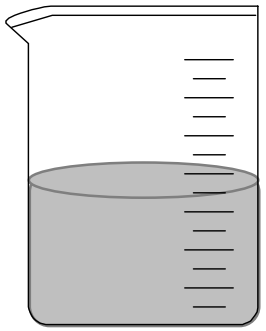
At equilibrium, this solution contains:

Demo: Acid into Conjugate Pair Mixture 2

Solution H:
0.01 M HCl (aq)
pH ~2





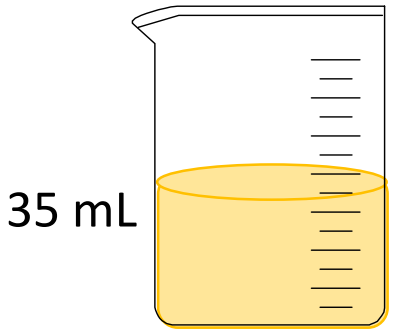


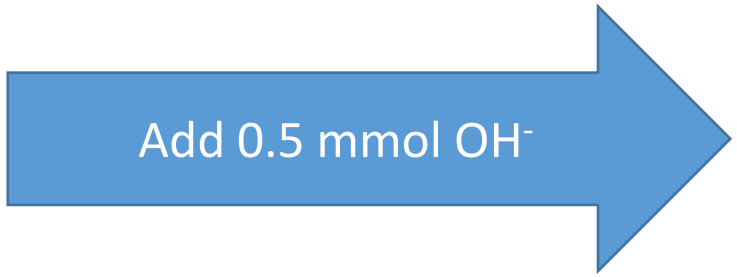
When the HCl is added, the pH will:

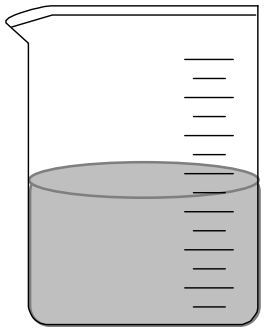
a. Increase dramatically (>1 pH unit)
b. Increase slightly (<1 pH unit)
c. Not change (± 0.1 pH unit)
d. Decrease slightly (<1 pH unit)
e. Decrease dramatically (>1 pH unit)

Demo: Base into Weak Acid

Solution W:
0.01 M CH_3COOH (aq)







When the OH^- is added, the pH will:

a) Increase dramatically (>1 pH unit)

b) Increase slightly (<1 pH unit)

c) Not change (± 0.1 pH unit)

d) Decrease slightly (<1 pH unit)

e) Decrease dramatically (>1 pH unit)

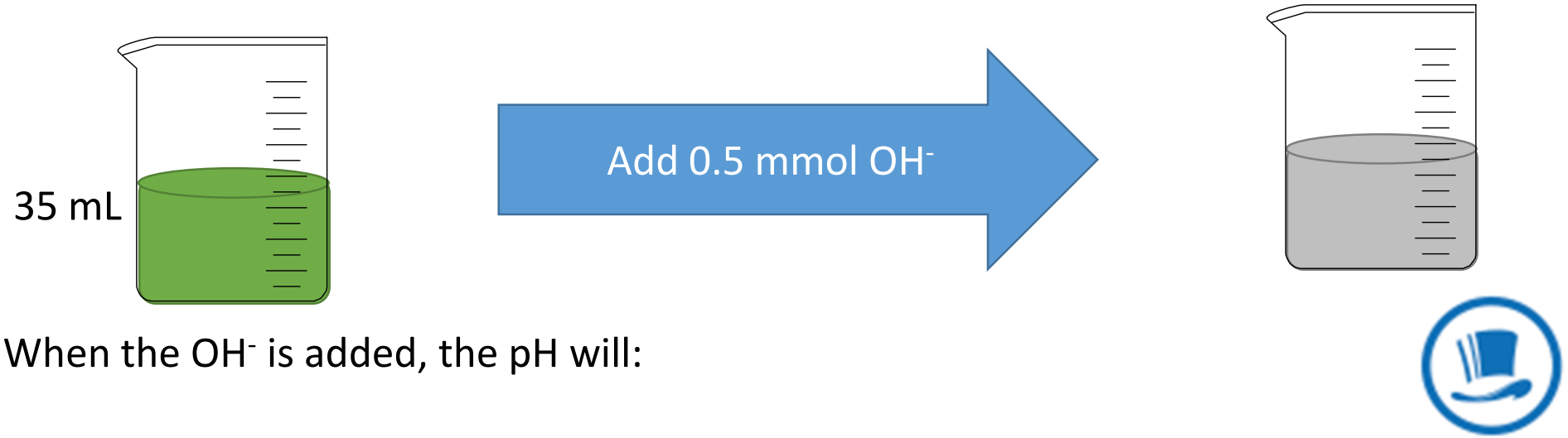
Demo: Base into Weak Acid

We start with 35 mL of a 0.010 M solution of acetic acid (CH_3COOH). **We add 0.5 mmol of NaOH.**
The pK_a of acetic acid is 4.74 – what is the expected pH of this solution?

At equilibrium, this solution contains:

Demo: Base into Conjugate Pair Mixture

Solution B:
0.01 M CH_3COOH (aq)
and ~0.24 M CH_3COO^- (aq)



When the OH^- is added, the pH will:

a) Increase dramatically (>1 pH unit)

b) Increase slightly (<1 pH unit)

c) Not change (± 0.1 pH unit)

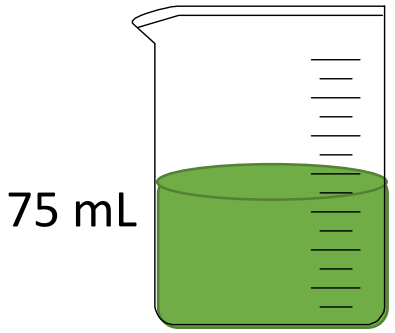
d) Decrease slightly (<1 pH unit)

e) Decrease dramatically (>1 pH unit)

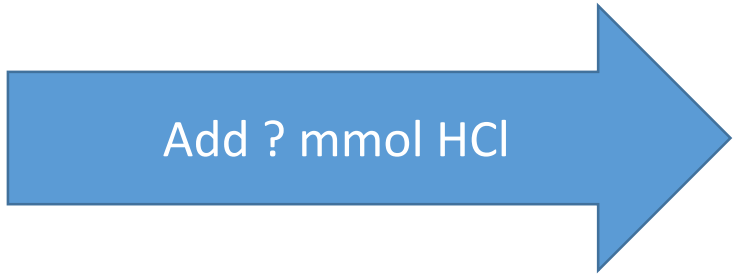
Demo: Acid into Conjugate Pair Mixture 3

Solution B:
0.01 M CH_3COOH (aq)
and ~0.24 M CH_3COO^- (aq)

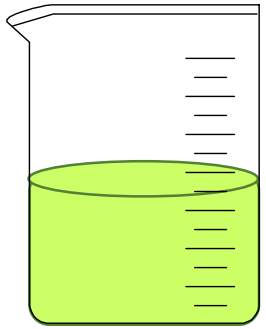
pH ~6



75 mL



pH ~5

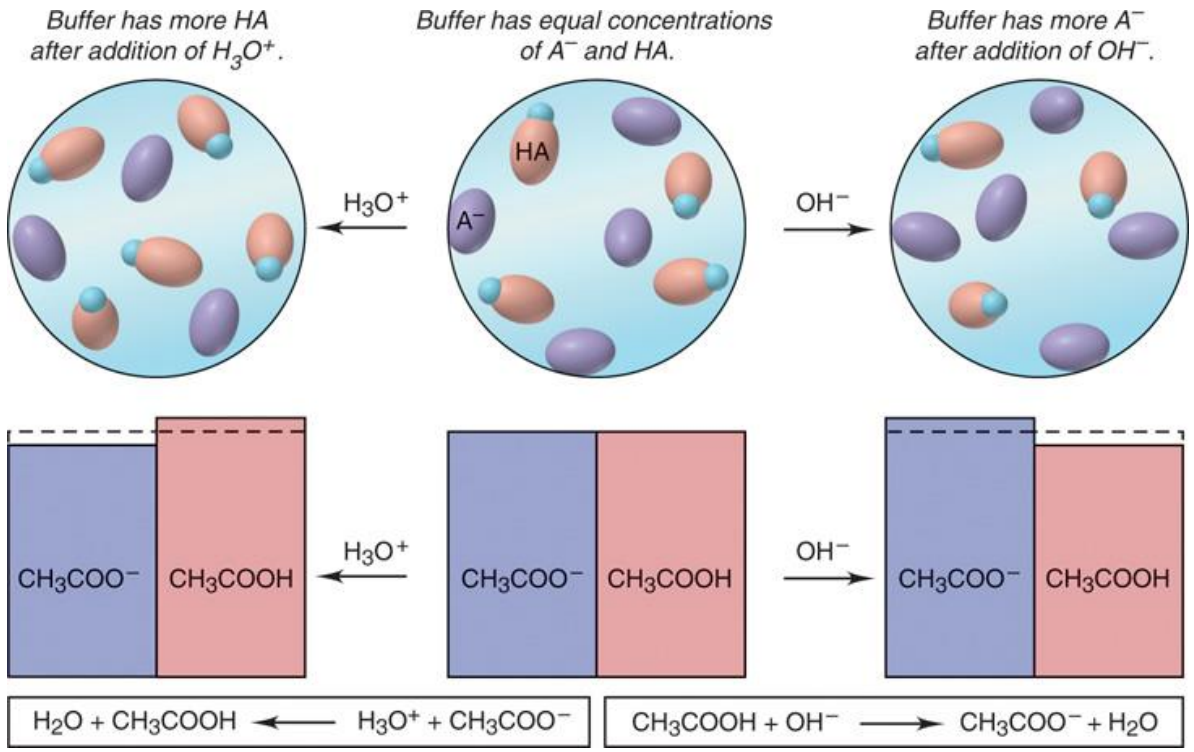


How much 6.0 M HCl would I have to add in order to change the pH by 1 unit?

Buffers

A solution that contains both components of a conjugate acid-base pair is called a **buffer**.

Because these solutions contain both a weak acid and a weak base, the pH will not change significantly on addition of a small amount of strong acid or base.



In order for a system to act as a buffer, the equilibrium concentration of the weak acid/base components must be approximately the same as the initial concentrations of these components. (i.e. K_a is small compared to the concentrations)

Therefore, if we know that a solution is behaving as a buffer, we can say (assuming a HA/A^- generic system):

$$K_a = \frac{[A^-][H_3O^+]}{[HA]}$$

Taking the –log of both sides:

This is the **Hendersen-Hasselbach (HH) Equation**.