

BEGINNING OF EXAM

1. A 5th period element is burned under a bunsen burner and a vibrant red-violet flame is produced. It is seen to also violently react with water. What is the element?

Rb ; Rubidium

2. A student decides to titrate H_3PO_4 , a triprotic acid, with a solution of NaOH. The experiment was completed with 100 mL of a 1.5 M H_3PO_4 solution and 2.0 M NaOH. Calculate the pH of the solution when 200 mL of NaOH is added. ($K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, $K_{a3} = 4.8 \times 10^{-13}$)

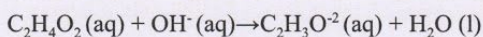
$\text{mol } H_3PO_4 = 0.15 \text{ mol}$
 $\text{mol NaOH} = 0.40 \text{ mol}$
 $7.5 \times 10^{-3} = \frac{x^2}{0.15}$
 $x < 0.0335$
 $6.2 \times 10^{-8} = \frac{x \cdot (0.0335 + x)}{(0.0335 - x)}$
 $x = 5.9 \times 10^{-7}$
 $4.8 \times 10^{-13} = \frac{(0.0335 + x) \cdot x}{0.0335 - x}$
 $x = 4.8 \times 10^{-13}$

$K_{a1} = \frac{[H^+][H_2PO_4^-]}{[H_3PO_4]}$
 $K_{a2} = \frac{[H^+][HPO_4^{2-}]}{[H_2PO_4^-]}$
 $K_{a3} = \frac{[H^+][PO_4^{3-}]}{[HPO_4^{2-}]}$

$H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$
 $H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$
 $HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$

$\text{Total } [H^+] = 0.0335 \cdot 3 = 0.1005 \text{ M}$
 $\text{pH} = 0.998$

3. The titration of a weak acid with a strong base involves the direct transfer of protons from the weak acid to the hydroxide ion. The reaction of the weak acid, acetic acid, with a strong base, NaOH, can be seen below. In the reaction the acid and base react in a one to one ratio.



$M = 2.0 \text{ M}$
 $V = 200 \text{ mL}$
 $\therefore 0.4 \text{ mol}$

$K_a = \frac{[H^+][C_2H_3O_2^-]}{[C_2H_4O_2]}$
 $1.8 \times 10^{-5} = \frac{x^2}{2.0}$
 $x = 6.0 \times 10^{-3}$
 $V = 300 \text{ mL}$

$HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$

I	2.0 M	0	0
C	-x	x	x
E	6.0×10^{-3}	6.0×10^{-3}	$6.0 \times 10^{-3} \text{ M}$

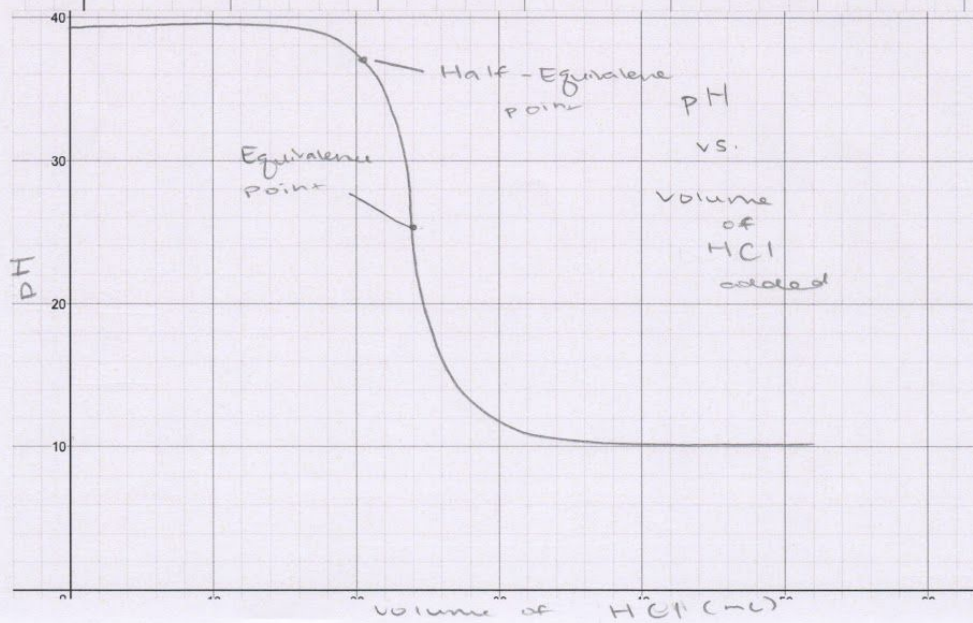
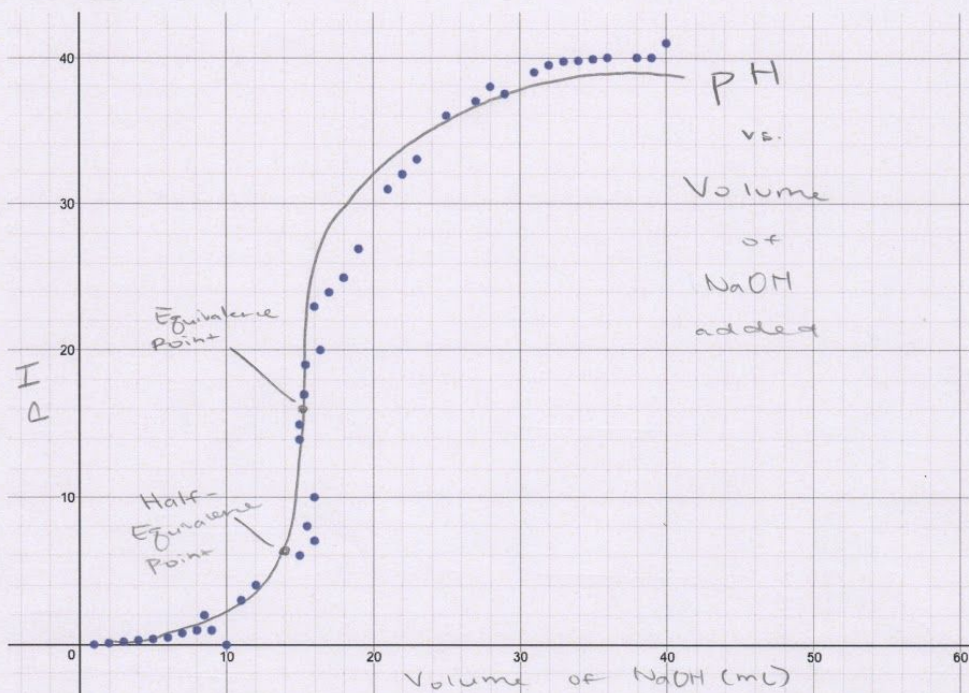
initial pH: 2.22

$OH^- + HC_2H_3O_2 \rightarrow C_2H_3O_2^- + H_2O$

I	0.15 mol	0.4 mol	0	0
C	-0.15 mol	-0.15 mol	+0.15 mol	0
E	0 mol	0.25 mol	0.15 mol	0

$M = 0.82 \text{ M}$ $M = 0.50 \text{ M}$
 $[H^+] \rightarrow 3.0 \times 10^{-5} \text{ M} \rightarrow \text{pH} = 4.52$

4. A student titrates a solution of HCl and NaOH in a lab. Label the axes of the given appropriately, with units, and draw a line of best fit. Add an appropriate title. Label the plot with approximate (half-)equivalence points. Then, sketch in the blank plot the complementary graph of the titration "pH vs. Volume of NaOH" with the same corresponding features. Exact points are not needed.



5. Phenolphthalein, $C_{20}H_{14}O_4$ or "pH" for shorthand, is a common acid-base indicator that turns colorless under acidic conditions and pink under basic conditions. A student uses pH as an indicator for a titration with an acetic acid solution and a solution of NaOH. If some acid is spilled during the transfer of solutions, how will the percent error change in respects to the percentage of acetic acid in vinegar? What will the resulting color be?

Underrepresent the % of acetic acid in vinegar,
lighter pink

6. List the following acids from least to greatest according to strength.

HCl, H_2SO_4 , H_3O^+ , HF, CH_3COOH , H_2 , and H_2S

More stable the conjugate base,
Stronger the acid

H_2 , H_2S , CH_3COOH , HF, H_3O^+ , H_2SO_4 , HCl

H_2S has a very electroneg. and has a strong δ^- charge to keep (8) octet.

organic + IMF vs. inorganic

weak vs. strong

Diprotic vs. Monoprotic

7. An element is a solid at room temperature but soft enough to be cut with an ordinary knife. It reacts violently with water. What is the element?

Na, Sodium

MULTIPLE CHOICE ANSWERS

- 1.) C
- 2.) D
- 3.) D
- 4.) B
- 5.) A
- 6.) C
- 7.) A
- 8.) C
- 9.) D
- 10.) C
- 11.) C
- 12.) A
- 13.) C
- 14.) A
- 15.) D
- 16.) 16a.) Colloid
16b.) None
16c.) Suspension
16d.) Solution
16e.) Solution
16f.) Colloid
16g.) Colloid
- 17.) B
- 18.) C
- 19.) B