← strong acid

1. 0.38 g of HI is dissolved in 500. mL of water. What is the pH of the solution?

Logic: grams + volume (using molecular weight) ⇒ [HI] = [H_3O^+] (because HI is a strong acid) ⇒ pH

mw of HI = 1.008 g/mol + 126.90 = 127.91 g/mol

(amount/volume) $\frac{0.38\text{ g HI}}{500.\text{ mL}} \times \frac{\text{mole HI}}{127.91\text{ g HI}} \times \frac{1000.\text{ mL}}{\text{L}} = 5.\bar{9}42 \times 10^{-3}\ \frac{\text{mol}}{\text{L}} = \text{M} = [\text{HI}] = [H_3O^+]$

$pH = -\log(H_3O^+) = -\log(5.\bar{9}42\times10^{-3}) = 2.2\bar{2}61$

↑ 2 sig figs ↑ = **2.23**

← strong base

2. 4.25 g of NaOH is dissolved in ~~1~~ 1.00 L of water. What is the pH of the solution?

Logic: grams + volume (using molecular wt) ⇒ [NaOH] = [OH^-] ⇒ pOH ⇒ pH

because NaOH is a strong base w/ 1 OH^- per NaOH

mw of NaOH = 22.99 + 16.00 + 1.008 = 40.00 g/mole

(amount/volume) $= \frac{4.25\text{ g}}{1.00\text{ L}} \times \frac{\text{mole}}{40.00\text{ g}} = 0.10\bar{6}25\ \frac{\text{mol}}{\text{L}} = \text{M} = [\text{NaOH}] = [OH^-]$

$pOH = -\log(OH^-) = -\log(0.10\bar{6}25) = 0.97\bar{3}67$

↑ 3 sig figs ↑ = **13.023**

pH + pOH = 13.9965 so pH = 13.9965 − pOH = 13.9965 − 0.97$\bar{3}$67 = 13.02$\bar{2}$8

* See F06 quiz 3 forms C+D, S06 quiz 2 for additional problems like questions 1 & 2.

3. 10.0 mL of a 0.10 M NaOH solution is diluted to 500. mL. What is the pH of the final solution?

Logic: orig. conc + dilution info ⇒ [NaOH] = [OH^-] ⇒ pOH ⇒ pH

for dilutions: moles dil = mol conc

$C_{dil} V_{dil} = C_{conc} V_{conc}$

$C_{dil} = \frac{C_{conc} V_{conc}}{V_{dil}} = 0.10\ \text{NaOH}\left(\frac{10.0\text{ mL}}{500.\text{ mL}}\right)$

$= 2.0\times10^{-3}\ \text{M}$

$= [\text{NaOH}] = [OH^-]$

$pOH = -\log(OH^-) = -\log(2.0\times10^{-3}) = 2.6\bar{9}90$

$pH = 13.9965 - 2.6\bar{9}90 = 11.2\bar{9}75 = \boxed{11.30}$

* See F06 quiz 3 for additional practice on questions like this

4. You want to make 250. mL of a pH 2.50 HI solution. How many grams of HI will you need to weigh out?

← strong acid
↑ acidic solution

Logic:

pH ⟹ $[H_3O^+]$ = [HI] ⟹ grams (using volume + molecular weight)

↑ because HI is a strong acid

$[H_3O^+] = 10^{-pH} = 10^{-2.50} = 3.\bar{1}62 \times 10^{-3}\ M = [HI]$

↑ (2 sig figs)

$$250.\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{3.\bar{1}62 \times 10^{-3}\ \text{mol HI}}{\text{L}} \times \frac{127.91\ \text{g HI}}{\text{mole}} = 0.\bar{1}0111\ \text{g}$$

$$= \boxed{0.10\ \text{g}}$$

* See S07 Quiz 3 for other questions like this.

5. How many mL of a 0.10 M NaOH(aq) solution, will you need to use to make 250. mL of a pH 12.50 solution?

↑ basic soln
↑ strong base

Logic:

pH ⇒ pOH ⇒ $[OH^-]$ = [NaOH] ⇒ mL (using vol + conc. of NaOH soln)

because NaOH is a strong base w/ 1 OH^- per NaOH

pH + pOH = 13.9965

pOH = 13.9965 − pH = 13.9965 − 12.50 = 1.4965

$[OH^-] = 10^{-pOH} = 10^{-1.4\bar{9}65} = 3.\bar{1}88 \times 10^{-2}\ M = [NaOH]$

$$250.\text{mL} \times \frac{\text{L}}{1000\text{mL}} \times \frac{3.188 \times 10^{-2}\ \text{mol NaOH}}{\text{L}} = 7.\bar{9}70 \times 10^{-3}\ \text{mol NaOH}$$

needed for final solution

Obtain moles of NaOH for final solution from the 0.10 M NaOH solution

$$7.\bar{9}70 \times 10^{-3}\ \text{mol NaOH}_{\text{final soln}} \times \frac{\text{L}}{0.1\ \text{mol NaOH}} \times \frac{1000\ \text{mL}}{\text{L}} = 79.\bar{7}0\ \text{mL}$$

$$= \boxed{80.\ \text{mL}}$$

Note - could also solve the last part of the problem by thinking of it as a dilution problem

mol dil = mol conc

$C_{dil} V_{dil} = C_{conc} V_{conc}$ ← solving for V_{conc} that you need to use

$$V_{conc} = \frac{C_{dil} V_{dil}}{C_{conc}} = \frac{(3.\bar{1}88 \times 10^{-2}\ M)(250.\text{mL})}{(0.10\ M)} = 79.\bar{7}\ \text{mL}$$

$$= \boxed{80.\ \text{mL}}$$