

## Panel 1

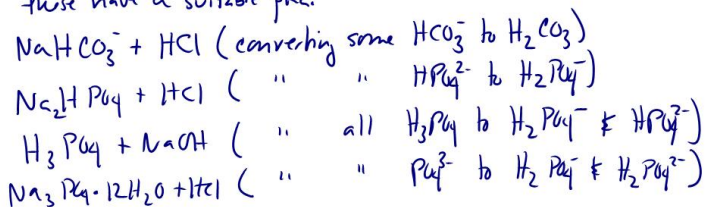
Goal: Prepare a buffer with an initial pH of 6.85. The buffer must be able to consume 0.0010 moles of strong base with a maximum change in pH of 0.20 units. The following reagents are available to you:

Solutions: 6.0 M HCl, 6.0 M  $\text{H}_3\text{PO}_4$ , 6.0 M  $\text{CH}_3\text{COOH}$ , 6 M NaOH

Solids:  $\text{NaHCO}_3$ ,  $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ ,  $\text{Na}_2\text{CO}_3$ ,  $\text{Na}_2\text{HPO}_4$ ,  $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$

Which reagent(s) will you use and why?

There are several choices, each involving either an  $\text{H}_2\text{PO}_4^-/\text{HPO}_4^{2-}$  buffer, or an  $\text{H}_2\text{CO}_3/\text{HCO}_3^-$  buffer as these have a suitable pKa.



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## Panel 2

How many grams of  $\text{NaH}_2\text{PO}_4$  and  $\text{Na}_2\text{HPO}_4$  are needed to make this buffer?

For original solution

$$6.85 = 7.20 + \log \frac{(\text{moles HPO}_4^{2-})_0}{(\text{moles H}_2\text{PO}_4)_0}$$

$$\frac{(\text{moles HPO}_4^{2-})_0}{(\text{moles H}_2\text{PO}_4)_0} = 0.4467$$

$$(\text{moles HPO}_4^{2-})_0 = 0.4467 \times (\text{moles H}_2\text{PO}_4)_0$$

For limit

$$7.05 = 7.20 + \log \frac{\text{moles HPO}_4^{2-}}{\text{moles H}_2\text{PO}_4}$$

$$\frac{\text{moles HPO}_4^{2-}}{\text{moles H}_2\text{PO}_4} = 0.7079$$

$$\frac{(\text{moles HPO}_4^{2-})_0 + 0.001}{(\text{moles H}_2\text{PO}_4)_0 - 0.001} = 0.7079$$

$$\frac{0.4467 \times (\text{moles H}_2\text{PO}_4)_0 + 0.001}{(\text{moles H}_2\text{PO}_4)_0 - 0.001} = 0.7079$$

$$(\text{moles H}_2\text{PO}_4)_0 = 6.54 \times 10^{-3} \rightarrow 0.785 \text{ g NaH}_2\text{PO}_4$$

$$(\text{moles HPO}_4^{2-})_0 = 2.92 \times 10^{-3} \rightarrow 0.415 \text{ g Na}_2\text{HPO}_4$$

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## Panel 3

The combined concentrations of  $\text{HPO}_4^{2-}$  and  $\text{H}_2\text{PO}_4^-$  must be greater than 0.010 M but less than 0.020 M. Given your answer to the previous problem, to what range of volumes can you add the  $\text{Na}_2\text{HPO}_4$  and  $\text{NaH}_2\text{PO}_4$ ?

$$(\text{moles HPO}_4^{2-})_0 + (\text{moles H}_2\text{PO}_4)_0 = \text{total moles}$$

$$2.92 \times 10^{-3} + 6.54 \times 10^{-3} = 9.46 \times 10^{-2} \text{ moles}$$

$$\frac{9.46 \times 10^{-2} \text{ mol}}{0.01 \text{ mol/L}} = 9.46 \text{ L}$$

$$\frac{9.46 \times 10^{-2} \text{ mol}}{0.02 \text{ mol/L}} = 4.73 \text{ L}$$

any volume in here will work

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