# SI Chemistry - Full Discipline Demo

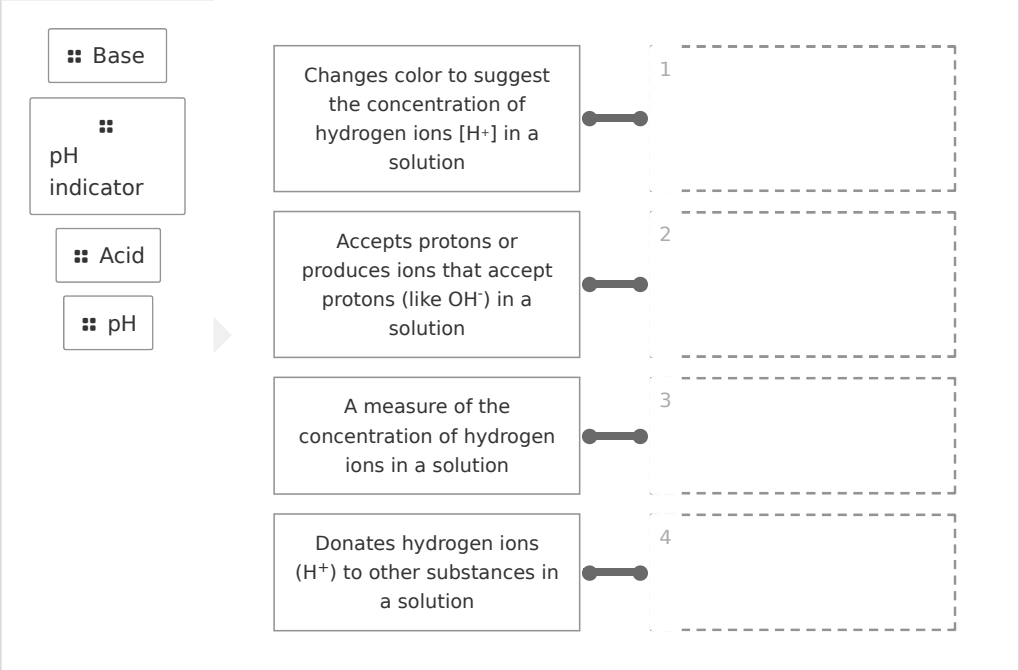
## Digital Acid Base Chemistry - Beyond Labz

## Final Report - Answer Guide

| | |
|---|---|
| **Institution** | Science Interactive University |
| **Session** | SI Chemistry - Full Discipline Demo |
| **Course** | SI Chemistry - Full Discipline Demo |
| **Instructor** | Sales SI Demo |

## Test Your Knowledge

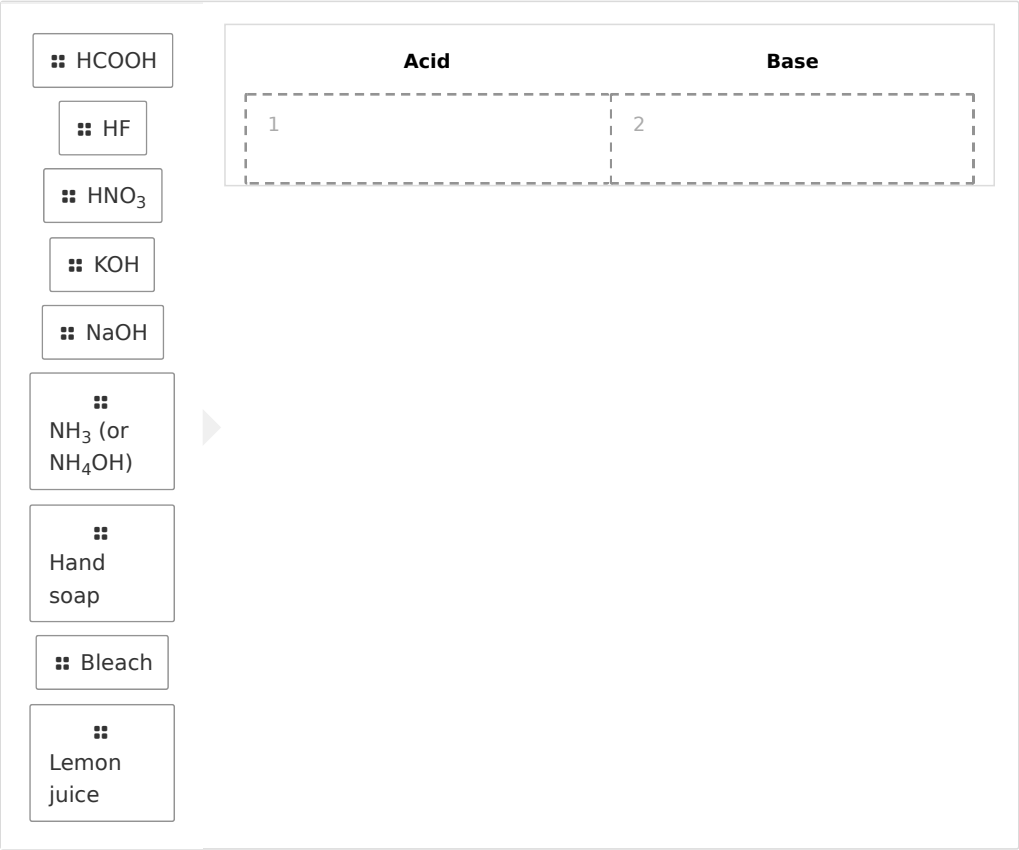
**Match each term with the best description.**




Correct answers:

1 pH indicator 2 Base 3 pH 4 Acid

**Classify each substance as an acid or base.**

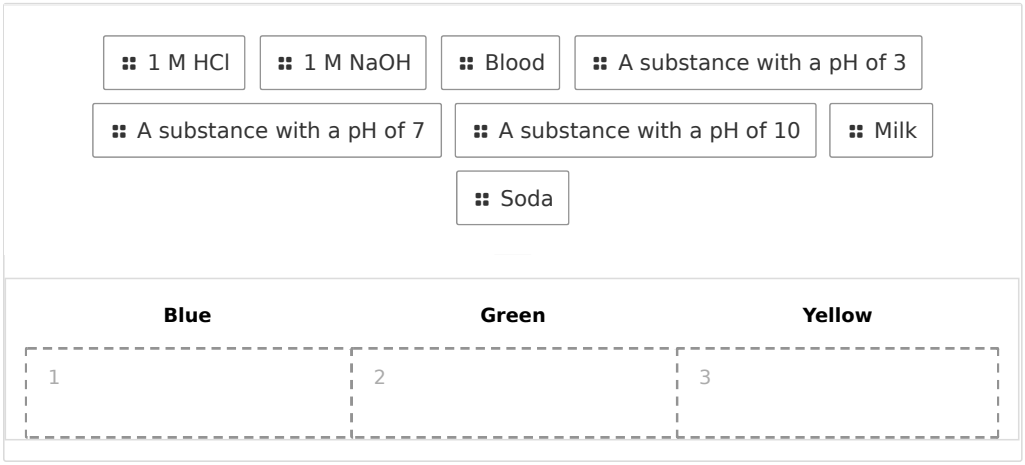



Correct answers:

1 HF HCOOH $HNO_3$ Lemon juice

2 KOH Bleach Hand soap $NH_3$ (or $NH_4OH$) NaOH

**Predict the color that results from adding a drop of bromothymol blue (BTB) to each solution.**




Correct answers:

1 1 M NaOH A substance with a pH of 10

2 A substance with a pH of 7 Blood Milk

3 1 M HCl A substance with a pH of 3 Soda

## Exploration

**Weak bases are not hazardous no matter their concentration.**

- True
- False ✔

**Acids are substances that produce _____.**

- fats and oils
- $H^+$ ions ✔
- toxicity
- $OH^-$ ions

**The logarithm for pH is based on the concentration of _____ in solution.**

- [x] $H^+$ ions
- [ ] salt
- [ ] $OH^-$ ions
- [ ] water

**A pH _____ changes color at different pH values.**

- [ ] scale
- [x] indicator
- [ ] value
- [ ] None of the above

## Exercise 1

**Rank the chemicals listed in Data Table 1 from the lowest to highest pH.**

(lowest pH) $H_2SO_4$, HCl, $H_2SO_3$, $CH_3COOH$, HCN, $NH_4Cl$, $KNO_3$, $NaCH_3COO$, $NaHCO_3$, NaCN, $NH_3$, $Na_3PO_4$, NaOH (highest pH)

**When you created hypotheses to guess whether each chemical was an acid or base, what specifically did you look for in the chemical formulas?**

If a chemical appears to ionize to create hydrogen ions, students should guess it is an acid. If students think it would accept a hydrogen or create hydroxide ions, students should guess it is a base. (Students may discuss basic salts having a sodium atom in the formula as a clue that a hydrogen could be accepted there.)

**Write the chemical equation of $HNO_3$ dissociating in a solution to form ions. Based on how the chemical dissociates, is $HNO_3$ an acid or a base? Explain how you know.**

$HNO_3(aq) \rightleftharpoons H^+(aq) + NO_3^-(aq)$

$HNO_3$ is an acid because it dissociates to form $H^+$ ions

**Write the chemical equation of KOH dissociating in a solution to form ions. Based on how the chemical dissociates, is KOH an acid or a base? Explain how you know.**

$KOH(aq) \rightleftharpoons K^+(aq) + OH^-(aq)$

KOH is a base because it forms the $H^+$ acceptor $OH^-$ in solution.

**Consider putting a drop of bromocresol purple into a sample, which turns purple. Can you tell whether this liquid is acidic, basic, or neutral? Describe what you can and cannot differentiate between.**

The sample is not an acid, but we cannot distinguish between whether it is basic or neutral.

**Consider putting a drop of bromocresol purple into a sample of a solution, and it turns yellow. Can you tell the pH of the solution? What is the advantage of a pH meter instead of pH indicators?**

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**Consider putting a drop of bromocresol purple into a sample which turns light blue. What is the approximate range of possible pH values for this solution? Can you tell whether this acid is strong or weak?**

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**Why is it important to ensure that the solutions you tested are at the same concentration in order to compare them? Hint: Check the pH of undiluted $NH_3$ in the simulation.**

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Data Table 1: Acidic and Basic Solution Prediction
(SAMPLE ANSWER BELOW)

| | **Acid, base, or neutral?** | **pH** | **Solution indicator color** |
|---|---|---|---|
| $NH_4Cl$ | acid | 5.20 | yellow |
| $H_2SO_3$ | acid | 1.53 | yellow |
| $NaHCO_3$ | base | 9.59 | purple |
| HCN | acid | 5.10 | yellow |
| $CH_3COOH$ ("HAc") | acid | 2.88 | yellow |
| NaOH | base | 12.92 | purple |
| $KNO_3$ | neural | 7.00 | purple |
| HCl | acid | 1.07 | yellow |
| $Na_3PO_4$ | base | 12.08 | purple |
| NaCN | base | 11.00 | purple |
| $NH_3$ | base | 11.11 | purple |
| $NaCH_3COO$ ("NaAc") | base | 8.79 | purple |
| $H_2SO_4$ | acid | 1.02 | yellow |

Data Table 2: Making Solutions from Solids
(SAMPLE ANSWER BELOW)

| **Solid** | **Molecular mass (g/mol)** | **Approx mass needed (g)** | **Actual mass (g)** | **Volume water needed (mL)** | **Actual volume water (mL)** | **Final molarity (M)** |
|---|---|---|---|---|---|---|
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| $NH_4Cl$ | 53.49 | 0.134 | 0.1461 | 27.31 | 27.39 | 0.09972 |
| $NaHCO_3$ | 84.01 | 0.210 | 0.2023 | 24.08 | 24.06 | 0.1001 |
| $KNO_3$ | 101.10 | 0.253 | 0.2558 | 25.30 | 25.31 | 0.09997 |

Data Table 3: Making Solutions from Stocks
(SAMPLE ANSWER BELOW)

| **Stock solution** | **Amnt of soln delivered (mL)** | **Total volume needed (mL)** | **Volume water needed (mL)** | **Actual volume water (mL)** | **Final molarity (M)** |
|---|---|---|---|---|---|
| $H_2SO_4$ | 25.19 | 28.04 | 2.85 | 2.86 | 0.09995 |
| HCN | 25.11 | 25.56 | 0.45 | 0.45 | 0.1000 |
| $CH_3COOH$ ("HAc") | 25.20 | 26.03 | 0.83 | 0.82 | 0.1000 |
| NaOH | 24.90 | 27.49 | 2.59 | 2.54 | 0.1002 |
| HCl | 24.79 | 25.56 | 0.77 | 0.75 | 0.1001 |
| $Na_3PO_4$ | 24.84 | 25.19 | 0.35 | 0.35 | 0.1000 |
| NaCN | 25.09 | 27.52 | 2.43 | 2.42 | 0.1000 |
| $NH_3$ | 24.90 | 123.23 | 98.33 | 98.55 | 0.09982 |
| $NaCH_3COO$ ("NaAc") | 24.91 | 28.80 | 3.89 | 3.87 | 0.1001 |
| $H_2SO_4$ | 25.22 | 62.72 | 37.50 | 37.49 | 0.1000 |

## Competency Review

**Acids are substances that are characterized by their ability to donate _____, or _____ ions.**

- neutrons; hydrogen
- protons; hydrogen ✔
- protons; hydroxide
- None of the above

**The greater the number of hydroxide ions in a solution, the more acidic the solution.**

- True
- False ✔

**Concentrated acids and bases are found in everyday substances such as coffee and hand soap.**

- True
- False ✔

**Based on the logarithm for pH, a pH of 2 is _____ times more acidic than a pH of 4.**

- 1
- 2
- 10
- 100 ✔

**A neutral substance is a substance that has a pH of 0.**

- True
- False ✔

**A pH of ___ indicates an acidic solution.**

- 3 ✔
- 7
- 12
- None of the above

**pH is a measure of the concentration of _____ ions in a solution.**

- sodium
- water
- hydroxide
- hydrogen ✔

**Weaker acids ____ dissociate in water and have a ____ pH than strong acids.**

- partially; higher ✔
- fully; higher
- partially; lower
- fully; lower

**You dispense 25.00 mL of a stock solution with a molarity of 0.5401 M. To get a standard solution with a molarity of 0.2000 M, you must dispense an additional ____ mL of water. Start by using the following equation:**

$$\text{mL total needed} = x \text{ mL soln delivered} \times \frac{x \text{ mol soln}}{\text{L soln}} \times \frac{\text{L}}{0.2000 \text{ mol}}$$

- 135.02
- 110.02
- 67.51
- 42.51 ✔

**Bromocresol purple turns ____ in a strong acidic solution.**

- Light blue
- Purple
- Yellow ✔
- Green

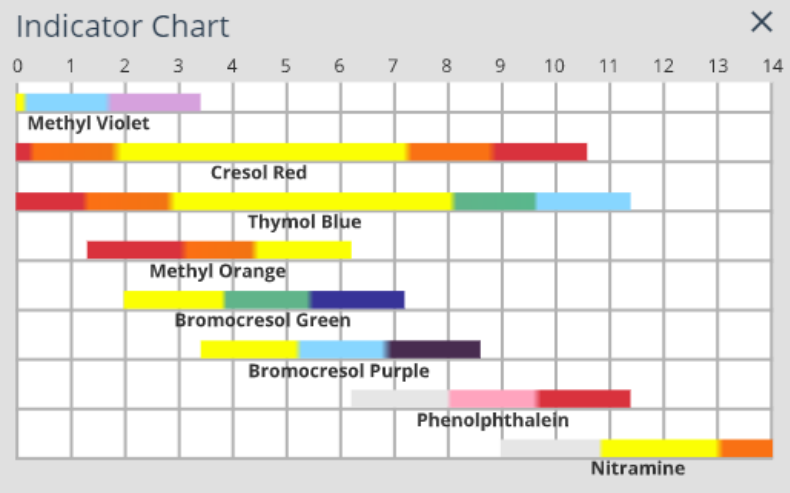
**Suppose you are trying to create a standard solution from a solid with a molecular weight of 60.21 g/mol. You intend to create approximately 50 mL of a 0.3000 M solution. Which of these is an appropriate mass of solid to begin with? Start by using the following equation:**

$$\text{grams solid} = 0.050 \text{ L soln} \times \frac{0.3000 \text{ mol solid}}{\text{L}} \times \frac{x \text{ g solid}}{1 \text{ mol solid}}$$

- 908.2 g
- 0.9502 g ✔
- 10.0521 g
- 0.0021 g

## Extension Questions

**A scientist has a bottle of nitric acid at an unknown concentration. She adds a drop of bromocresol green to a small sample from the bottle, and the solution turns green. Is it possible that this acid is a strong acid? Use the indicator chart to help you decide. Explain your reasoning.**




(SAMPLE ANSWER BELOW)

Yes, it is possible that it is a strong acid. The pH is related to the amount of $H^+$ in solution, and nitric acid produces $H^+$, so if it is a dilute nitric acid solution, it is reasonable for the pH to be between 3.8-5.4, where bromocresol blue is green.