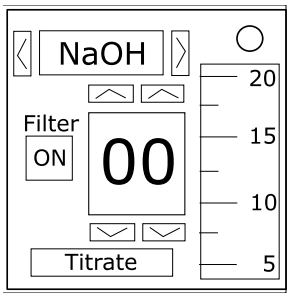
# On the Subject of Neutralization




*The rules are simple: neutralize or be neutralized.*

- The module is disarmed by successfully neutralizing an acid contained in a tube by titrating it with a chemical base.
- In order to solve the module, the type of base, amount of base, and filter state must all be correct.
- Once the appropriate conditions are set, press "Titrate" to confirm the solution.
- An incorrect input yields a strike. The correct answer remains unchanged.
- Useful info may be found in **Appendix NT27: Chemical Information.**

## Determining Titrants

The acid type can be determined using the following chart:

| Solution Color | Acid Type |
|---|---|
| Red | Hydrogen bromide |
| Yellow | Hydrogen fluoride |
| Green | Hydrogen chloride |
| Blue | Hydrogen iodide |

The base that must be used to titrate can be determined via the following ruleset:

- If the bomb has an NSA indicator and exactly 3 batteries, add ammonia.
- Otherwise, if the bomb has a lit CAR, FRQ, or IND indicator, add potassium hydroxide.
- Otherwise, if the bomb has no ports and the serial number has a vowel, add lithium hydroxide.
- Otherwise, if the acid's chemical formula has a letter in common with an indicator present on the bomb, add potassium hydroxide.
- Otherwise, if the number of D batteries is greater than the number of AA batteries, add ammonia.
- Otherwise, if the anion's atomic number is less than 20, add sodium hydroxide.
- Otherwise, add lithium hydroxide.

## Determining Concentrations

The concentration of the acid can be determined via the following process:

- Start with the atomic number of the anion of the acid.
- Subtract the atomic number of the cation of the base.
- If the anion or cation has a vowel in the chemical symbol, subtract 4.
- If the anion and cation's chemical symbols have the same number of characters, multiply by 3.
- Take the least significant digit of the result (removing negative signs).
- If the number is 0, the number becomes the volume of acid doubled then divided by 5.
- Divide by 10. This is the concentration of the acid.

The concentration of the base can be determined via the following ruleset:

- If there are more battery holders than port types and more battery holders than indicators, the concentration is 5.
- If there are more port types than battery holders and more port types than indicators, the concentration is 10.
- If there are more indicators than battery holders and more indicators than port types, the concentration is 20.
- If there is a tie for the most, the concentration is either 5, 10, or 20, whichever is closest to the cation's atomic number.
- However, if the titration combination is HI and KOH or HCl and $NH_3$, the concentration is always 20.

## Determining Drop Count

- Start with 20 and divide by the concentration of the base.
- Multiply by the volume of acid and concentration of the acid.
- The result is the number of drops required to successfully titrate.

## Determining Solubility

- If the module's acid/base combination on the following chart has "NS" for "Not Soluble", the filter must be turned ON before the base is added.
- Otherwise, the filter must be turned OFF.

| | $NH_3$ | KOH | LiOH | NaOH |
|---|---|---|---|---|
| HBr | S | NS | NS | S |
| HF | NS | S | NS | S |
| HCl | NS | NS | S | NS |
| HI | S | S | S | NS |

# APPENDIX NT27: Chemical Information

## NT27.1: Bases

| Name | Chemical Formula | Cation | Chemical Symbol | Atomic Number |
|---|---|---|---|---|
| Ammonia | $NH_3$ | Hydrogen | H | 1 |
| Lithium hydroxide | LiOH | Lithium | Li | 3 |
| Sodium hydroxide | NaOH | Sodium | Na | 11 |
| Potassium hydroxide | KOH | Potassium | K | 19 |

## NT27.2: Acids

| Name | Chemical Formula | Anion | Chemical Symbol | Atomic Number |
|---|---|---|---|---|
| Hydrofluoric acid | HF | Fluorine | F | 9 |
| Hydrochloric acid | HCl | Chlorine | Cl | 17 |
| Hydrobromic acid | HBr | Bromine | Br | 35 |
| Hydroiodic acid | HI | Iodine | I | 53 |