# CHEMISTRY

**The Acidic Environment: Neutralisation and Safety**

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*Analyse information from secondary sources to assess the use of neutralisation reactions as a safety measure or to minimise damage in accidents or chemical spills*

**1. What are the hazards (dangerous properties) of strong acids e.g. Conc. $H_2SO_4$ and strong bases e.g. conc. or solid NaOH**

**(i) For users**
**(ii) For the immediate surroundings**
**(iii) For the environment e.g. local waterways?**

| Strong Acids | | Strong Bases |
|---|---|---|
| • Highly corrosive to skin and eyes, and may cause permanent damage or severe burns<br>• If heated, toxic, irritating fumes can be produced, which can cause fluid on the lungs | **Users** | • Highly corrosive to skin and eyes, and may cause permanent damage or severe burns<br>• Can also irritate or burn digestive and respiratory tracts |
| • Colourless liquid, therefore hard to detect<br>• Hygroscopic- attracts moisture from the atmosphere<br>• Corrosive to metals<br>• Releases toxic fumes into surrounding area | **Immediate Surroundings** | • Hygroscopic<br>• Releases toxic fumes into surrounding area<br>• Corrodes most substances<br>• Reacts with most metals, forming $H_{2(g)}$, which reacts with oxygen |
| • Miscible in all concentrations with water<br>• Strongly exothermic<br>• Reacts violently with water and alkalis<br>• Harmful to aquatic life as it decreases the pH of water and can prevent regular cellular functioning | **Environment** | • Extremely exothermic<br>• Absorbs $CO_2$ from the air<br>• Reacts violently with water and acids<br>• Raises the alkalinity of water and can disrupt delicate ecosystems |

**2. Explain why neutralisation reactions are important ways of dealing with accidents or spills of strong acid or strong base? (Why can't you just pour water over them? What does neutralisation do to the pH?)**

Neutralisation changes the pH of substances to bring it closer to 7, which indicates a neutral substance (e.g. water). This reduces their corrosiveness and other harmful effects, such as being strongly exothermic, as the substances are reacted with a corresponding, weak acid or base and are converted to water and a salt. However, the salts that are produced may not have a pH of 7, so care must still be exercised when dealing with these 'neutralised' substances as they can still be corrosive and dangerous.

Strong acids and bases are hygroscopic and often react violently with water, which can act as both an acid and a base, depending on the substance it is mixed with. Hence, combining strong substances with water can trigger a reaction, rather than simply dilute it. If this solution was then flushed into a river or sewage system, the delicate balance of the ecosystem would be affected as enzymes function best at a certain pH, and conditions too far outside this inhibit regular cellular function.

**3. Explain why a weak acid or base is more suitable than a strong acid or base for neutralisation processes after accidental spillage of strong base or strong acid. Include examples, including one equation.**

Firstly, strong acids and bases are dangerous as they are extremely corrosive and can often release toxic vapours. By using weak acids or bases (e.g. Acetic acid, sodium carbonate) for neutralisation, unnecessary risks are removed as these substances are less likely to be harmful to users or the wider environment. This also reduces the risk that the neutralised substance will become dangerous again if an excess of neutralising agent is used.

Another reason why weak acids and bases are used to neutralize stronger substances is that when two strong chemicals are combined, the reaction can be very dangerous. For instance, many strong acid-base reactions are highly exothermic; e.g. Conc. HCl + Conc. NaOH $\rightarrow$ NaCl + $H_2O$ + Heat Energy. Whilst using weaker products to neutralise a reaction will still release a certain amount of heat and energy, these substances slows down the rate of reaction significantly and make cleaning up chemical spills much safer.

**4. What do you do to the mess after you've neutralised it? (Do NOT mention lawyers or suing someone!)**

If solution has been significantly diluted (according to safety standards, as sewage companies have strict limits on the pH of discharge, as it can affect the balance of bacteria that help break down wastes), residue can be flushed into the sewer/ down the drain. The solid salt formed can be collected and disposed of separately, or recycled if appropriate. Depending on the size of the spill, the neutralised substance may also be able to be absorbed then disposed of.

**5. Be ready to choose one neutralizing substance from a list and justify your choice.**

Sodium hydrogen carbonate ($NaHCO_3$) is an ideal substance to use to neutralise any spill as it contains both basic $OH^-$ ions to neutralise an acid, and $H^+$ ions to neutralise a base. Hence, it can be said that hydrogen carbonate ion ($HCO_3^-$) is an amphiprotic ion as it can neutralise both acidic and basic spills, or can be used safely on an unknown substance.

i.e. $H^+ + HCO_3^- \rightarrow H_2O + CO_2$

$OH^- + HCO_3 \rightarrow H_2O + CO_3^{-2}$

As Sodium hydrogen carbonate is solid (powdered), it is safe and easy to handle and transport. It is cheap and readily available, which means that it can be employed quickly if a spill occurs. Also, it is a weak substance and therefore does not pose any safety risks if used in excess.