Using indigestion tablets to neutralise an acid

A student sheet with the full method and follow-up questions along with full teacher notes is available at: rsc.li/3NHeVNY

Equipment

Per person:

- Eye protection: safety glasses to EN166 F or (EN) ISO 16321 C.

Per group:

- Burette, 30 cm^3 or 50 cm^3 capacity
- Conical flask, 100 cm^3
- Beaker, 100 cm^3
- Pestle and mortar
- Stirring rod
- Spatula
- Filter funnel, small (about 35 mm diameter)
- White tile (optional)
- Burette stand and clamp

Chemicals

- Dilute hydrochloric acid, concentration equal to or below 0.4 mol dm^{-3}, 100 cm^3. The volume of solution needed can be adjusted depending on the results from trial runs for the different indigestion tablets used. The aim is for each tablet tested to require around 20–30 cm^3 of hydrochloric acid to neutralise.
- Two or three different indigestion tablets, ideally the 'chalky' type. It is sensible to select brands of tablets for which a comparison is straightforward, with active ingredients restricted to carbonates, bicarbonates and/or hydroxides, avoiding those containing other active ingredients.
- Original packets from which the tablets are taken, together with price information for each packet.
- Methyl orange indicator solution (or alternative).
- Deionised or distilled water, about 100 cm^3.

Preparation, safety, hazards and additional notes

Chemicals supplied for the practical and hazards	Preparation
Indigestion tablets Not usually classified as hazardous. Check student records for a potential allergy to ingredients in the tablets.	
Hydrochloric acid, 0.4 mol dm^{-3} or under HCl (aq) Currently not classified as hazardous. CLEAPSS Hazcard HC047A.	Dilute* from a solution of higher concentration, ideally 1.0 mol dm^{-3} which can be prepared from: Hydrochloric acid, concentrated HCl (aq), 35–38% (w/w) solution which is about 12 mol dm^{-3} depending on the supplier.  **DANGER** Causes severe skin burns and eye damage. May cause respiratory irritation. Wear splash-proof goggles when using concentrated hydrochloric acid and always add the concentrated acid to the water. Protect the face when opening bottles of the concentrated acid (pressure may have built up) or when transferring or dispensing large volumes. Use a fume cupboard. Avoid contact with skin. The exact concentration of a hydrochloric acid solution prepared can be determined by titrating against a standard solution of sodium carbonate. CLEAPSS recipe sheet RB043.

Methyl orange indicator solution, concentration of about 0.4% weight in 1000 ml of 20% (v/v) IDA in distilled water.  **DANGER** Highly flammable liquid and vapour. Harmful if swallowed. May cause damage to organs. CLEAPSS Hazcards HC032 and HC040A.	Usually purchased as a ready-made solution from an educational supplier but it can also be prepared using methyl orange powder dissolved in IDA and distilled water. Methyl orange indicator (s)  **DANGER** Toxic if swallowed. To prepare 1000 cm^3 of methyl orange indicator: • Wear eye protection and gloves to avoid staining the skin. • Weigh 0.4 g of solid methyl orange in a fume cupboard that is switched off but with the sash down to avoid rising dust. • Dissolve in 200 cm^3 of industrial denatured alcohol (IDA). • Transfer the solution to a 1000 cm^3 measuring cylinder and top up to the 1000 cm^3 mark with distilled water. • Transfer to a bottle with the appropriate hazard warning. CLEAPSS recipe sheet RB000, recipe 46.

***The formula and explanation for dilution are as follows:**
Formula: C1 x V1 = C2 x V2
Explanation:
C1 is the initial concentration of the solution (in mol dm^{-3}) before dilution.
V1 is the initial volume of the solution before dilution (in dm^{-3}).
C2 is the desired final concentration of the solution after dilution (in mol dm^{-3}).
V2 is the final volume of the diluted solution (in dm^{-3}).

Calculate V1 by rearranging the formula: V1 = (C2 x V2)/C1

Dilute the solution: using adequate equipment, measure the volume (V1) of solution of initial concentration and add solvent to achieve the desired final volume (V2).
Reminder: 1 dm^{-3} is equivalent to 1000 cm^{-3}.

Disposal

Add more hydrochloric acid solution to the conical flask until the solution becomes slightly acidic (if not already achieved at the end of the titration) before pouring down a foul-water drain.