Which Anti-acid?

Contents: Survey, practical work and questions on consumer testing of anti-acids.

Time: 2 periods or more, depending on number of parts attempted.

Intended use: GCSE Chemistry and Integrated Science. Links with work on acidity and alkalinity, reactions of acids with carbonates and hydroxides, and titrations.

Aims:

- To complement and revise prior work on acidity and alkalinity
- To develop consumer awareness including the critical evaluation of commercial products
- To develop appreciation of the problems and decisions involved in manufacturing a commercial product
- To develop awareness of the limitations of simple tests in evaluating a commercial product
- To provide an opportunity to practise certain laboratory skills, and skills in data analysis.

Requirements: Students' worksheets No. 709. Packets of three (or more) different commercial anti-acid tablets. See notes in Part 3 for practical requirements.

Part 1 Looking at labels — comparing costs

The work in this part requires a certain amount of mathematical skill. Teachers may prefer to omit this part for some students.

Interpretation of ingredients lists on the labels of anti-acids can be difficult, since the names are frequently abbreviated and non-systematic. If possible, choose anti-acids whose ingredients are listed simply and clearly. The smaller the number of different ingredients the better.

Even so, less able pupils may need help interpreting the ingredients and quantities, and working out the cost of 1 gram of active ingredients.

Students might be interested to know the prices of the pure ingredients if bought from a chemical supplier. These prices can be found from laboratory suppliers' catalogues, though the prices for small quantities will be considerably higher than for bulk supply.

The labels do not always give information about the 'additives' — those materials which, after the anti-acid ingredients, make up the mass of material. These include sugar and flavouring ingredients.

Part 2 Making more comparisons

The intention of this part is to get students to consider the decisions needed in bringing a product such as an anti-acid to market. Encourage students to examine the results of these decisions with the same analytical, critical attention expected in observing and testing materials in 'normal' science.

Apart from costs, manufacturers' decisions have to include:

- The size, shape and taste of the tablets, and the rate at which the ingredients dissolve.
- How the tablets should be packaged — in plastic, metal foil or paper, in boxes or tubes; how many tablets per package. If the tablets contain materials which deteriorate with time (for example, because they are hygroscopic), suitable packaging can increase their shelf-life.
- How easily the tablets may be removed from the packaging — remembering safety aspects, particularly with regard to small children who may think the tablets are sweets.

- How to make the packets convenient for handbag, pocket or cupboard.
- The instructions to customers about the contents and use — how technical is the language, how informative and easy to use?
- The appearance of the package — colours, lettering and advertising.

Part 3 A chemical way of comparing anti-acids

This part is intended for students who have already acquired the skills of titration and the ability to interpret the results. With very able students it could be used as a problem-solving exercise, that is without the help of instructions. Hydrochloric acid is used for the titration: this acid is of course naturally present in the human stomach, at a concentration of about 0.1M.

Requirements

Each group will require:

hydrochloric acid, 1.0M ($50cm^{3}$)
anti-acid tablets (at least three different brands; one tablet of each brand per group)
methyl orange indicator
pestle and mortar
beaker ($100cm^{3}$)
conical flask ($250cm^{3}$)
burette, stand and funnel
eye protection

The merits and demerits of this type of testing should be discussed. It can tell us exactly how much active anti-acid ingredients we are buying and can check the manufacturer's figures, but it cannot tell us if the tablets actually relieve pain without side effects. This could lead to discussion of the feasibility, problems and ethics of testing drugs with animals or human volunteers.

Further activities

1 Investigation of 'sparkling' anti-acid products — for example:
   (a) Testing the gas given off
   (b) Comparing the volume of gas given off by different products
   (c) Making 'sparkling' anti-acid mixture (which should of course *not* be tasted).

2 Cation and anion tests to find the products of neutralization

3 Investigation of rates of reaction of different tablets with acid

4 Designing a poster to advertise an anti-acid product.

WHICH ANTI-ACID?

We are all consumers and we have to make decisions about which products to buy. Scientific tests can help us find out more about these products.

In this unit the products are 'anti-acids'. Anti-acids are taken to relieve pains caused by excess acid in the stomach. They work by neutralizing the acid. Which anti-acid gives the best value?

The unit is in three parts:

Part 1 Looking at labels — comparing costs
Part 2 Making more comparisons
Part 3 A chemical way of comparing anti-acids.

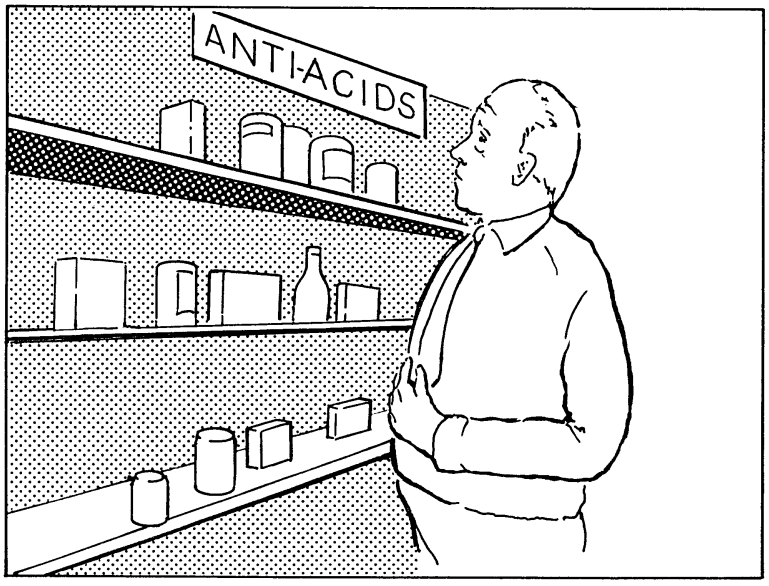


Figure 1

Part 1 Looking at labels — comparing costs

Draw up a table like Table 1 below.

Table 1

A Name of tablet	B Active ingredients	C Mass of active ingredients per tablet/gram	D Mass of one tablet/ gram	E Cost of packet	F Number of tablets per packet	G Cost per tablet	H Cost of 1 gram of active ingredient
TUM-TUM	CALCIUM CARBONATE MAGNESIUM CARBONATE	0·8	1·5	60p	20	3p	3·75p

You are going to fill in the information in the table for several different types of anti-acid tablet. You can use the information given on the label. Figure 2 on the next page gives an imaginary example which has been entered in the table.

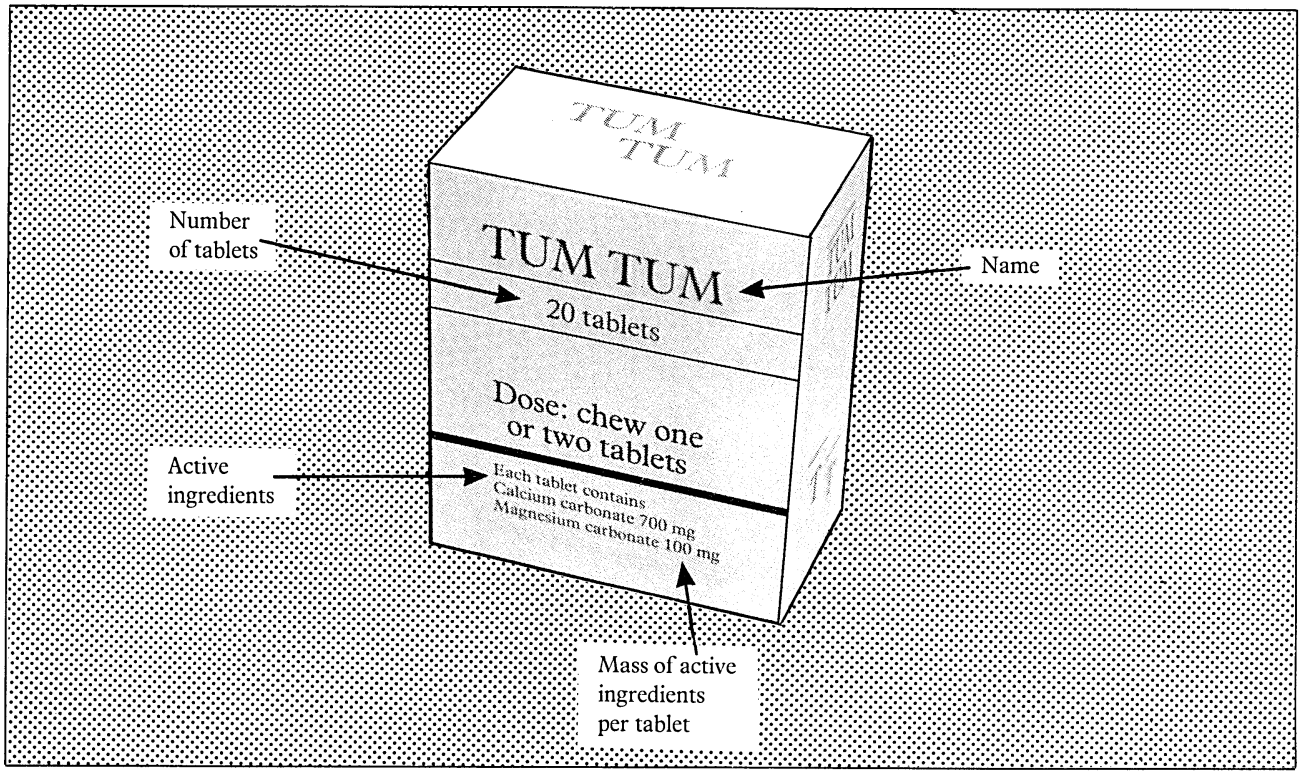


Figure 2

Work through steps **A** to **H** below for each type of tablet.

A Put the brand name of the tablet in column **A** of Table 1.

B Find the active ingredients which can neutralize acids. Put this information in column **B**.

C Find the total mass of all the active ingredients in one tablet. (If there is more than one active ingredient, add their masses together.) The mass may be given in milligrams (mg), which are thousandths of a gram. Convert this to grams and enter it in column **C**.

D Weigh one of the tablets. Write its mass in grams in column **D**.

E Find the cost of the whole packet. Put this in column **E**.

F Find the number of tablets in the full packet. Put this number in column **F**.

G Use the information in **E** and **F** to work out the cost of one tablet. Put this in column **G**.

H Finally, use the information in **C** and **G** to work out the cost of 1 gram of the active ingredient. We will call this the **unit cost**.

When you have done all this for each of the different anti-acids, answers questions 1 to 4.

Questions

1 *For* one *of the tablets, say what products you think would be formed when the active ingredients react with acid.*

2 *Some anti-acids produce carbon dioxide when they react with stomach acid. What happens to this carbon dioxide?*

3 *For* one *of the tablets, compare the mass of active ingredients per tablet with the total mass of the tablet. Is there a difference? If so, what might it be due to?*

4 *Compare the unit costs (the cost of 1 gram of active ingredients) of the different tablets. Which do you think gives the best value for money? (Assume they are all equally effective at relieving indigestion.)*

Part 2 Making more comparisons

Carefully examine two or three different types of anti-acid tablets. Look at their packaging and the shape and size of the tablets. Then answer questions 5 to 7.

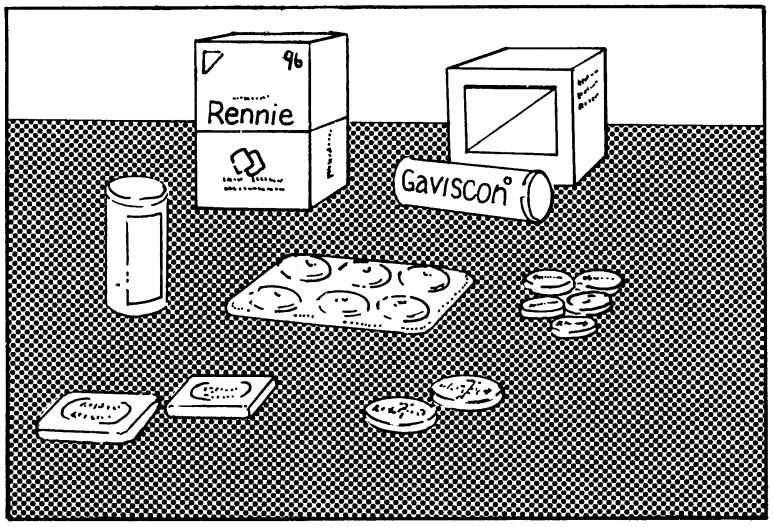


Figure 3

Questions

5 *Manufacturers have to sell products which are as easy to use and as attractive as possible. What have the manufacturers done to make sure of these points?*

6 *Apart from cost, which features of the tablets and packaging influence* you *most in your own choice? What advice would you give to a company which is considering marketing a new anti-acid?*

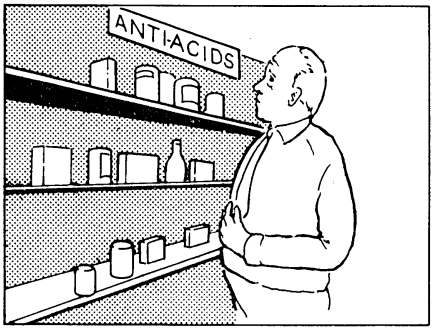
7 *When all the costs to the manufacturers and retailers are taken into account, are consumers generally getting good value? Or are the prices we pay unreasonable?*

Remember that manufacturers' costs will include:

The costs of research and development of new products
Raw materials for the tablets and their packaging
Equipment, factory buildings and transport
Staffing in production, offices, management, distribution and sales
Advertising, taxes and repayment of loans.

Retailers also have costs to cover in running their shops. These costs have to be paid for from sales. Both manufacturers and retailers will also expect to make some profit.

Part 3 A chemical way of comparing anti-acids



We can use titration to compare the amount of active ingredients in different anti-acid tablets. Hydrochloric acid of standard concentration is used. This acid is added to the anti-acid tablet, with an indicator present. The acid will be neutralized until all the anti-acid is used up. At this point the indicator will change colour.

The directions on the packet usually tell you to chew the tablet before swallowing. We can imitate chewing by crushing up the tablet before adding acid.

What you do

CAUTION Wear eye protection, Avoid getting acid in contact with your skin.

A Crush one anti-acid tablet to powder, using a pestle and mortar.

B Transfer *all* the powder to a conical flask.

C Add 5 drops of methyl orange indicator. What colour does the indicator turn?

D Fill a burette with hydrochloric acid. The acid contains 1 mole of HCl per dm^3. Read off the volume of acid in the burette.

E Add acid to the anti-acid powder in the flask. Add it gradually, in small amounts. Swirl the flask vigorously after each addition. What colour does the indicator turn when the acid is added? What happens to the colour on swirling?

Go on adding acid and swirling until no more colour changes occur. When you think the colour has stopped changing, leave the flask to stand for a minute to make sure it does not change again. Finally, read off the new volume in the burette.

F Work out the volume of hydrochloric acid which was neutralized by the tablet. Record your result.

G Repeat for other anti-acids.

Answer questions 8 to 10.

Questions

8 *Why do anti-acid tablets work better if they are chewed before swallowing?*

9 *Using the results of your experiments, decide which anti-acid is the best neutralizer of acid. If you have done Part 2, use information from Table 1 to help you decide which anti-acid is best value.*

10 *Remember that anti-acids are meant to be taken internally by humans. Are chemical tests alone a fair way of measuring their effectiveness? What other kinds of tests might be necessary?*