CREST Bronze Award – typically 10 hours of project work

Make your own toothpaste and compare it with other brands

First things first, you need a recipe for toothpaste. You could find your own by searching on the internet. Try typing things like 'homemade toothpaste' into a search engine. If you can't find your own recipe, you can use this one (you may need some help finding the ingredients):

Making toothpaste

- Mix six tablespoons of baking soda with two tablespoons of salt. Add three teaspoons of glycerol, 10-20 drops of flavouring (peppermint or cinnamon, for example) and one drop of food colouring. Mix the ingredients thoroughly in a bowl and add just enough water to make it toothpaste like.

The comparison

Toothpaste is supposed to clean teeth. But it also matters to people that it tastes nice.

- You could do a taste-test with your toothpaste by asking your classmates to taste a little bit of it (but don't swallow!) and say what they think. They should do the same with other types of toothpaste – don't tell them which is which
- They could comment on the way it looks, and its consistency (how paste like it is)
- They could comment on its abrasiveness (how scratchy it is – rub it between your fingers to work this out)
- Make sure you write down what people say.

Re-writing the recipe

- Look at all the things your classmates said about the different toothpastes
- Decide if you think your recipe needs to be changed slightly. For example, you might want to add a little bit more flavour, or add a different colour
- When you think you've made the perfect paste, re-write the recipe as a standard procedure (standard procedures are really precise recipes or ways of doing things). It will mean that anyone who wants to make your toothpaste will make it exactly the way you want them to make it.

Writing your 'Standard Procedure'

These are the sorts of things you should think about …

- Make sure all the amounts are precise. For example, instead of writing 'six tablespoons' give a precise measurement such as 90 cm^3 (one tablespoon equals 15 cm^3). Otherwise people might use a heaped tablespoon or a flat tablespoon, which are different amounts
- Instead of saying 'add just enough water to make it toothpaste like', write down precisely how much water should be used
- Write down precisely how the mixture should be stirred. For example, should people use a spoon, or a fork? Should they mix it quickly, or slowly?

Finishing touches

- You could give your toothpaste a name
- You could design a logo and packaging for your toothpaste.

CREST Silver Award – typically 30 hours of project work

Investigate the effectiveness of different toothpastes

You should start by writing down the ingredients of numerous different brands of toothpaste and how much they cost. Compare them. Decide which you think gives the best value for money.

How do the compositions of toothpastes vary? Do toothpastes that claim to remove stains from smoking, for example, have any different ingredients? What are they? Try to find out what the various ingredients do.

Choose a few different brands to test. Also make your own toothpaste to see how it compares to shop-bought stuff (see the Bronze project for a toothpaste recipe). How do the ingredients differ between the shop-bought brands and your homemade toothpaste?

Testing toothpaste's cleaning power

You'll need something to clean! Egg shells provide a reasonable alternative to teeth, which might be hard to get hold of. They have similarly high calcium content. Using hard boiled eggs is probably your best option. Use white eggs, as these will show stains better.

You'll then need to think about how you're going to stain the egg shells. One method is to place your egg in a mixture of 120 cm^3 boiling water, one teaspoon of vinegar and 20 drops of food colouring (red or blue is best). Then leave it for half an hour or so. Dry the eggs on a paper towel. You could also try leaving the egg in a cup of tea, coffee or fruit drink. Make sure each egg is stained using the same procedure.

When you've got some stained eggs, you'll need to think how to clean them. Brushing is the obvious way, but there are many things to consider. For example:

- What sort of brush will you use? Make sure you use the same brush for each egg
- How long will you brush each egg for?
- How will you control how hard you brush?
- Make sure you use the same amount of each toothpaste
- How will you decide which egg is the cleanest? Will you just look at them and make a decision, or is there a way you could measure how much stain has been removed?

The results

Put the toothpastes in order of stain-removal (putting the one that removed most of the stain at the top). Now think about these questions:

- Which toothpastes were most abrasive (in other words, which were 'scratchiest')? You can test this simply by rubbing a small amount between your fingers. What are the advantages and disadvantages of abrasives in toothpaste? How could the abrasiveness be measured more accurately?
- Measure the pH of the different toothpastes. What method will you use? How could pH affect the cleaning ability of toothpaste?
- Would your homemade toothpaste help prevent cavities?
- What would you add to your homemade toothpaste to make 'whitening' toothpaste?
- How might your results using eggs differ if you were able to use actual teeth?

CREST Gold Award – typically 70+ hours of project work

Investigate and compare the properties of toothbrushes

To start this project it may be a good idea to look at a range of different toothbrushes available. Look at their different shapes. Look at what they claim to do (for example, certain bends or bristle shapes are supposed to reach areas that other brushes can't reach). Other things to look at include:

- how many 'grades' of hardness there are for the bristles.
- which ones are the most expensive. How does the price of regular toothbrushes compare to electric toothbrushes (indeed, what's the price range of electric toothbrushes)?
- what other products are available for teeth-cleaning purposes?

Testing toothbrushes

You need to select a variety of toothbrushes to test. You then need to think about the properties you want to test. For each property, you will need to devise an experiment. You will need to think about why toothbrushes have to have certain properties, and whether there are certain standards that have to be met in industry when manufacturing them. For example, can bristles be too hard or too soft? Which is best?

If you try to link up with an engineer (or similar) from a toothbrush manufacturer they should be able to tell you what properties are tested in industry, and how. Local universities may also be useful, as they are likely to have more advanced testing equipment for you to use.

When testing the toothbrushes, make sure you try to obtain quantitative data. Some examples of the properties you may wish to test include:

- The shape of the toothbrush head and the area and density of bristles on the head
- Flexibility of the handle – measure how easily and how much they bend before they break
- Strength and wear resistance of the bristles
- Their 'reach' – in other words, do some toothbrushes reach areas that others don't?
- How well they clean
- How abrasive they are. Could they damage teeth and gums?

You could also conduct some tests to determine whether toothbrushes are necessary. Perhaps try to see if a piece of cloth can clean as well as a brush.

Drawing conclusions

When you've conducted tests on a range of toothbrushes, draw some conclusions about the value of different products. Are some toothbrushes significantly better than others?

Designing your own

When you've tested a range of properties you should have some ideas about which features of different toothbrushes were the best. You could try to design the ultimate brush using the results of your research and testing. You would have to think about the materials you would use, and the cost of manufacturing. You would also have to think about how to mass produce your toothbrush. Explain, for example, how you could use computer aided manufacture (CAM) to automate the process.

Health & Safety considerations

When you carry out experiments make sure you:

(a) find out if any of the substances used or made, or any of the equipment or procedures are hazardous

(b) carry out a risk assessment (in other words, think about what could go wrong and how serious it might be)

(c) decide what steps you need to take, if any, to reduce the risks. For example, by wearing personal protective equipment, being aware of how to deal with any emergencies and so on

(d) make sure your teacher checks your plans and risk assessment before practical work starts

(e) if special tools or machines are needed, these should be used in a properly supervised workshop or D&T room.

NOTE: Your teacher will check your risk assessment against that of his/her employer (i.e. your school or LEA). If no risk assessment exists for your activity, your teacher may need to obtain a special risk assessment (e.g. by contacting the CLEAPPS School Science Service.) This may take some time.