



INVESTIGATE - WHICH PAPER HAS THE GREATEST TEARING-STRENGTH?

Equipment:

Strips of different kinds of paper (e.g. kitchen paper, tissue, computer paper, etc.), paper clips, hole-puncher, empty yogurt cartons, string, marbles, hand lens.

Suggested Class Level:

3rd class upwards for the suggested method below.
5th and 6th classes could be asked to devise their own tests.

Preparation:

Cut paper into equal-sized strips e.g. 20 x 5 cm (for younger classes).

Older classes could make their own strips.

Make two holes on opposite sides of the yoghurt carton.



Background information:

The strength of paper is important because we use paper for many different things. For example, you would not use the same strength of paper for blowing your nose and carrying the shopping!

Paper is made from plant fibres, matted together to form a sheet. Paper used to be made from rags and was expensive. Now it is made from wood, especially coniferous trees like pine, spruce and fir, and is much cheaper.

A very important property of paper is its tearing-strength, i.e. how hard it is to tear.

Some kinds of paper tear more easily than others.

There are various ways of carrying out scientific tests to see which paper is the strongest, weakest, etc.

Younger classes could follow the activity suggested below. Older classes could be asked to devise their own tests.



Fibres sticking out from the edge of a sheet of paper



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Trigger questions:

Would you make shopping bags out of tissue paper?! Why not?

How many different types of paper do you know?

Can you think of different ways of describing paper (*coloured, stiff or bendy, rough or smooth, shiny or dull, easy or hard to fold, easy or hard to write on, easy or hard to tear, etc.*)

Predict: Which of the various papers that you are going to test do you think has the greatest tearing-strength? (*i.e. which one is the hardest to tear?*)

Now let's test and see!



Content Strand:

Materials: properties and characteristics

Living things: trees

Environmental Awareness and Care: renewable resource, sustainability

Skills:

Predicting, measuring, investigating, recording, analysing

Cross - curricular links:

Geography – types of forest - location and climate.

History of paper: Made in China 2,000 years ago, Arabs learnt the method from the Chinese in the 8th century, and then they brought it to Spain, from where it spread around Europe.



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Science Activities:

- 1. A.** Take one of the pieces of paper and look at it carefully. Now look at it through a hand lens (or better still if your school has a microscope). Can you see anything special that makes up the paper?
B. Tear the paper in two and look at the torn edge. What do you see sticking out of the torn edge?
C. Repeat with the other papers.
(You will probably see the fibres that make up the paper. It is these fibres that give the paper its strength).

- 2.** Cut strips of the same size from each of the papers (e.g. 20 x 5 cm). Using the hole-puncher, make a hole at both ends of each strip.
(For fair testing try to make sure that the holes are in the middle, and also at the same distance from the end of each strip).

Unwind a paper-clip to form an S-shape and hang it from the hole in the paper.

Push a piece of string through the holes in the yoghurt carton, make a knot at each end to form a handle.

Hang the carton from the paper clip.

Gradually add the marbles one-by-one until the paper tears. Count the number of marbles in the carton.
(Hint: place the marbles very gently into the carton; the shock to the paper of dropping them in might tear the paper with only a small load).

Repeat this using the other end of the strip and count the marbles again. Take the average of the number of marbles.

Repeat this using the other strips of paper, doing each twice and taking the averages.

Now compare the results.





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TYPE OF PAPER	NUMBER OF MARBLES (1)	NUMBER OF MARBLES (2)	AVERAGE NUMBER OF MARBLES	WEIGHT OF MARBLES (g)

Can you put the types of paper in order, with the strongest first?

Older classes:

If each marble weighs about 5 g, can you fill in the last column, saying what weight each piece of paper could take in the carton?

Maths Activity:

Number: ordering (*putting the papers in order according to how many marbles they could take*). Also use of language: “weak, weaker, strongest,” etc.

Measures, Lines and Angles: make sure to draw proper rectangles on the pieces of paper that will be cut out. Accurate lengths and right angles are very important to get a proper rectangle.

Averages

It is very important in science to calculate averages.

This is because an average gives you a single number which summarises the results from a number of tests.

Measures, Number Operations/Equations

If there is a tree in the school grounds the children can estimate its age in the following way:

Use a tape measure, or piece of string, and measure the distance around the trunk (*or girth*) about one metre from the ground. Every 2.5cm of girth corresponds to approximately one year’s growth. So a tree with a girth of 100cm will be about 40 years old (*100 divided by 2.5*). This is true for many, but not all, trees

Operations: Estimate, divide

A packet of a certain computer paper weighs 2.4 kg. It contains 500 sheets of A4 paper.

Can you estimate how much one piece of paper would weigh? Now calculate it. How near was your estimate?





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Safety:

Care with making holes in the cartons.

Follow-up Activities:

1. The same test could be done using wet papers.

Ask the children what they think will happen to the strength of the papers when they are wet. (*Strength is usually reduced*).

For fair testing the papers would need to be soaked for the same time.

(*It is probably easier to punch the holes first*).

2. The test could also be repeated with the strips of paper coated in cooking oil.

3. If the children were asked to compare the strengths of stronger papers, e.g. different newspaper, brown bags, magazine paper, etc. could they think how they might need to modify the equipment (*e.g. use a bucket or Ziploc bag instead of a yogurt carton ...*).

4. Could they find out if leaving newspapers in the sun affects their strength – i.e. if old newspapers are stronger than new ones?

5. Can they do an investigation to answer the question “Does putting a layer of PVA glue on paper and letting it dry strengthen the paper?”