For his forecasts, Chris relies on Met Office information. (Do you know what ‘Met’ is short for?) The Met Office collects data from thousands of weather stations all over Britain – and beyond.

One of the most important measurements is atmospheric (air) pressure. It’s measured with a barometer. Pressure readings from the weather stations are plotted on a map. Lines – isobars – join places which have the same air pressure. The pattern shows the areas of high and low pressure.

The map helps Chris to predict wind speed and direction.

You can do it too. The main rules are:

- Winds blow from high to low pressure and are deflected so that they follow the direction of the isobars and blow clockwise around a high pressure area, anti-clockwise around low pressure.
- The closer together the isobars, the higher the wind speed.

What is the wind direction across Ireland in this example?

Fig 1

Strong winds around a depression
Light winds around an anticyclone
**Procedure: How does a barometer work?**

We are surrounded by air pressure, but we don’t feel it. So how can we measure something we can’t feel?

1. Half fill a U tube with water. The level is the same in both arms because the air pressure pushing on the surface is the same for both.

   ![Fig 2](image)

   Equal air pressure

2. Fit the syringe (with its cork) and carefully pump more air into the tube. What happens to the water?

   The pressure of the air you pumped in supports the weight of a column of water in the other arm. Again, the forces are the same on both sides.

   ![Fig 3](image)

   Extra air pressure
   
   Air pressure + extra water pressure

Continued >
Suppose there was no air pressure on the right side? Try it.

3 Completely fill a test tube with water. Place your thumb over the end. Make sure you don’t trap any air in the tube.

4 Invert the tube. Hold the mouth of the tube under water in a trough or beaker. Remove your thumb. What happens to the water in the tube?

   The air pressure supports a column of water in the tube.

5 Now try with a plastic tube about 1 m long. To fill it, gradually lower the tube into a trough of water. When completely full, close one end with a clip, being careful not to trap any air inside. Hold the open end under water. Lift up the closed end until the tube is vertical. Can air pressure support a 1m column of water?

6 You may be allowed to try with a longer plastic tube. Use coloured water so you can see the level in the tube more easily. You will need to stand on a step ladder (or part way up stairs) to get the top as high as you can. Make sure you keep the bottom end under water.

   How tall a column of water can air pressure support, do you think?

   A mercury barometer works in the same way. It is a column of mercury held up by air pressure. The higher the pressure, the higher the column it can support. Mercury is 13.6 times as dense as water, so the column weighs 13.6 times as much. So, air pressure can only support a short column: about 76cm.
Procedure: Pressure, force and surface area

Pressure is force per unit area. It’s usually measured in newtons per square metre (N/m²). In the case of air pressure it is the weight (= force of gravity) of the atmosphere pressing down.

Does the barometer reading depend on the surface area of the mercury reservoir? If so, how? If not, why not?

You will:

- apply pressure with syringe 1 – like the air pressure on the reservoir
- calculate the resulting pressure in syringe 2 – like the barometer reading.

The aim is to find out what happens when you use syringes (= reservoirs) with different surface areas.

For syringe 2 you may use the one from the U tube experiment, with the bung removed.

1. Measure the internal diameter, \( d \), of each syringe to the nearest 0.1 cm. Calculate the surface area of each piston: surface area, \( A = \frac{1}{4} \pi d^2 \)

   Record the areas in the table.

2. Lubricate the syringe pistons with a little detergent. Check that they move easily inside the barrels.

3. Adjust the syringes so the plunger in syringe 1 is mostly out and the plunger in syringe 2 is mostly pushed in. Join them with a length of rubber or plastic tubing.

4. Clamp both syringes gently, so they are held in place without distorting the barrels. Check that the pistons can still move freely.

5. Clamp a forcemeter above syringe 2, so that it just rests on the piston, but reads zero.

Continued>
6. Apply a force to syringe 1 by pressing down on the piston using a forcemeter. Use a force about one third of the meter’s maximum reading (e.g. about 1.5 N for a 5 N forcemeter).

7. Keep the force steady while you read both forcemeters. Record the applied force and resulting force in the table.

8. Repeat steps 5 and 6 twice more, applying larger forces.

9. Repeat the whole procedure (steps 1 to 7) using a different sized syringe 1. (You do not need to measure d for syringe 2 again.)

10. Calculate the applied pressure and resulting pressure for each applied force

   \[
   \text{pressure, } P = \frac{\text{force, } F}{\text{area, } A}
   \]

<table>
<thead>
<tr>
<th>area of syringe 1, (A_1) (cm(^2))</th>
<th>applied force, (F_a) (N)</th>
<th>applied pressure, (P_a = \frac{F_a}{A_1}) (N/cm(^2))</th>
<th>resulting force, (F_r) (N)</th>
<th>resulting pressure, (P_r = \frac{F_r}{A_2}) (N/cm(^2))</th>
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Comparing the figures

Which of the following do you think are true? Tick them.

- Increasing the applied force, \( F_a \), in syringe 1 increases the resulting pressure, \( P_r \), in syringe 2.
- Increasing the piston area of syringe 1, but using the same applied force, \( F_a \), increases the resulting pressure, \( P_r \), in syringe 2.
- Resulting force, \( F_r = \) applied force, \( F_a \)
- Resulting pressure, \( P_r = \) applied pressure, \( P_a \)
- For a given applied pressure, \( P_a \), the resulting pressure, \( P_r \), is the same whatever the surface area of syringe 1.

Studying science and maths can transform your career options.
Future Morph: become someone.