

Edexcel IAL Biology A Level

Core Practical 17

Investigate the effects of exercise on tidal volume, breathing rate, respiratory minute ventilation, and oxygen consumption using data from spirometer traces.



Independent variable: Whether the test subject is resting or exercising.

Dependent variable: Tidal volume and breathing rate.

Equipment list

- Spirometer
- Soda lime or carbosorb - these absorb the carbon dioxide released during the experiment
- Disinfectant wipes
- Oxygen cylinder
- Human test subject
- Kymograph
- Nose clip

Method

A spirometer is a piece of equipment that can be used to **calculate the air capacity of someone's lungs**. To use it, it must first be calibrated as follows:

- Empty the spirometer so **no air** remains in it, align the pen to the paper so it can record results.
- Now add a set volume of air to the spirometer, such as 1 dm^3 and again let the pen mark on the graph. From this you can use the horizontal scale to calculate how many squares on the graph are equivalent to the volume of air just added to the spirometer.

You can now begin the main part of the experiment with the calibrated spirometer.

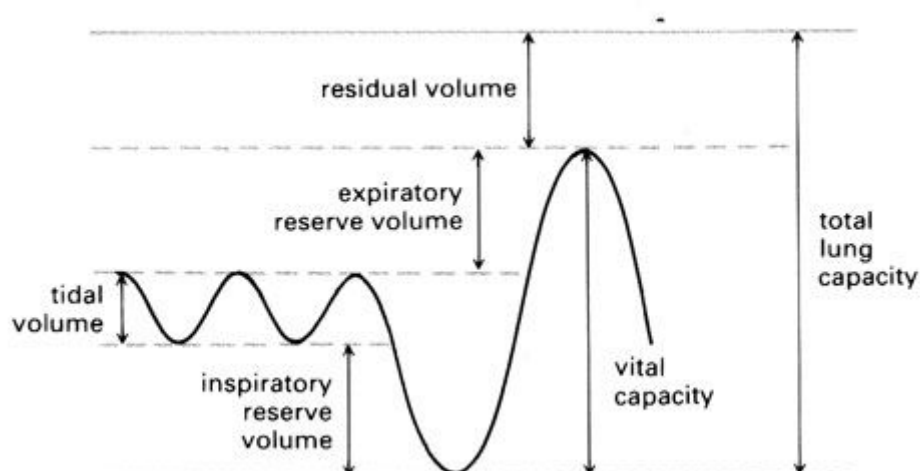
1. Get the test subject to sit down in front of the spirometer and get them to put a nose clip on so they are **only breathing through their mouth**.
2. Insert the disinfected mouthpiece of the spirometer into the student's mouth and allow them to breathe normally until they're accustomed to breathing into the apparatus.
3. Set the kymograph to a rate of 1 mm per second and turn it on so it starts rotating.
4. After an exhalation, adjust the 2-way tap so the subject is now **breathing through the spirometer equipment** instead of the normal atmosphere.
5. Record their normal, resting breathing for a minute and then ask them to breathe deeply for one breath, then returning to normal breathing for another minute.
6. Now ask them to breathe out as deeply as they can, again returning to normal breathing afterwards.
7. The effects of exercise can then be observed by **switching the spirometer to the closed position** and asking the test subject to exercise for 2 minutes - such as running on the spot or star jumps.
8. Then immediately reinsert the mouthpiece, turn the spirometer to the open position and record the results for 1 minute.



Risk assessment

Hazard	Risk	Precaution
Soda lime	Corrosive	Make sure the soda lime is correctly placed in the spirometer so only the air exhaled has contact with it
Test subject	Risk of over-exertion during exercise	Only test subjects without medical conditions that may impair their ability to breath should be used
Mouthpiece	Potentially carries pathogens between users	Needs to be fully disinfected between uses, or use 1-time disposable ones for each subject
Oxygen	Feeds a fire so can cause things to burn much more readily and vigorously	Only teachers should fit the gas canister in the spirometer There should be no naked flames where the experiment is being carried out

Graph and calculations



A graph similar to the one above will be produced.

By using the scale calculated when calibrating the spirometer the tidal volume can be calculated. The breathing rate can be calculated by counting the number of breaths occurring in a set volume of time e.g. in 20 seconds.



From here, the respiratory minute ventilation can be calculate for before and after exercise using the following formula:

Respiratory minute ventilation (dm^3 per minute) = Tidal volume (dm^3) x Breathing rate (breaths per minute)

