Aim: To investigate the effect of exercise on heart rate and breathing rate, and to measure recovery time.

Background Theory

- During exercise, muscles need more oxygen and glucose for aerobic respiration.
- Heart rate increases to deliver more oxygenated blood to muscles and remove CO_2.
- Breathing rate and depth increase to take in more O_2 and remove CO_2 faster.
- Lactic acid builds up if exercise is intense — anaerobic respiration occurs.
- After exercise, heart rate and breathing rate remain elevated to repay the oxygen debt.

★ Cardiac output = heart rate × stroke volume. Fitter individuals have a larger stroke volume and lower resting heart rate.

★ Oxygen debt: extra O_2 needed after exercise to oxidise lactic acid back to glucose in the liver.

Equipment

- Stopwatch
- Students (volunteer participants)
- Step or raised platform (optional)
- Record sheet and pencil
- Pulse oximeter or ability to measure pulse manually

Method

1. Sit quietly for 2 minutes. Measure resting heart rate (count pulse for 1 minute). Record.
2. Measure resting breathing rate (count breaths for 1 minute). Record.
3. Exercise at a set intensity for 3 minutes (e.g. stepping up and down on a step at 1 step per second).
4. Immediately after stopping exercise, measure heart rate for 1 minute. Record.
5. Measure breathing rate for 1 minute. Record.
6. Continue to record heart rate and breathing rate every 1 minute for 5 minutes of recovery.
7. Repeat the experiment with the same participant on a different day for reliability.
8. Compare results between participants of different fitness levels if possible.

Variables

Independent variable	Exercise intensity or duration (e.g. stepping rate or number of steps)
Dependent variable	Heart rate (bpm) and breathing rate (breaths per minute)
Controlled variables	Same participant, same time of day, same step height, same exercise type, temperature of room

Results Table

Time point	Heart rate (bpm)	Breathing rate (breaths/min)	Notes

Analysis

- Plot a line graph of heart rate (y-axis) vs time before, during and after exercise.
- Describe the pattern: increases during exercise, peaks immediately after, decreases during recovery.
- Recovery time = time taken for heart rate to return to resting rate.

★ A fitter individual will recover more quickly — their cardiovascular system is more efficient.

★ Explain why breathing rate stays elevated after exercise has finished (oxygen debt).

Exam Tip: Recovery time is an important variable. Fitter individuals recover more quickly. Always measure both heart rate AND breathing rate — they are separate marks in exam questions.

Common Mistake: Do not say "the heart works harder" — say "heart rate increases". Be precise with measurement units: bpm for heart rate, breaths per minute for breathing rate.