ScienceCube

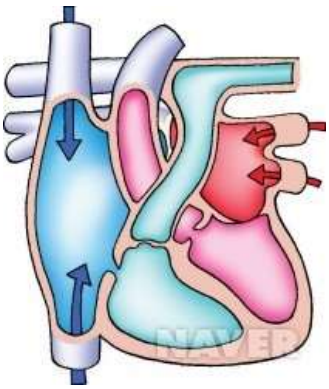
Electrocardiogram (ECG)

Measuring ECG to Compare Heart Rates in Different Situations and Explaining the Principles and Purpose of ECG Waveforms..

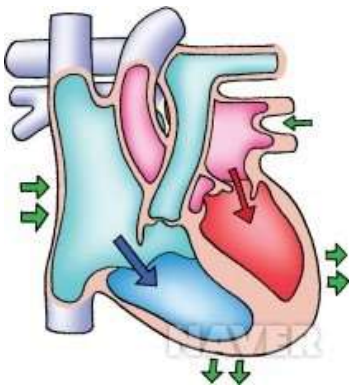
Fundamental Concept

1. Principle of Heartbeat

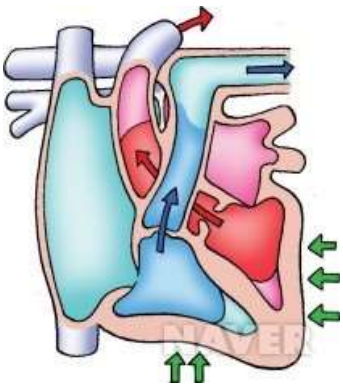
The heart acts as a pump that circulates blood throughout the body, regularly repeating contraction and relaxation. The pumping action of the heart is achieved by the contraction of the myocardium. Each heartbeat generates a small electrical current that flows through the body, creating a potential distribution on the body's surface. An electrocardiogram (ECG) is a recording of these small potential changes induced at specific locations on the body surface in a standard method. The heart beats about 72 times per minute, sending 5 liters of blood throughout the body.



① Blood returning from the body enters the right atrium, while oxygenated blood from the lungs enters the left atrium



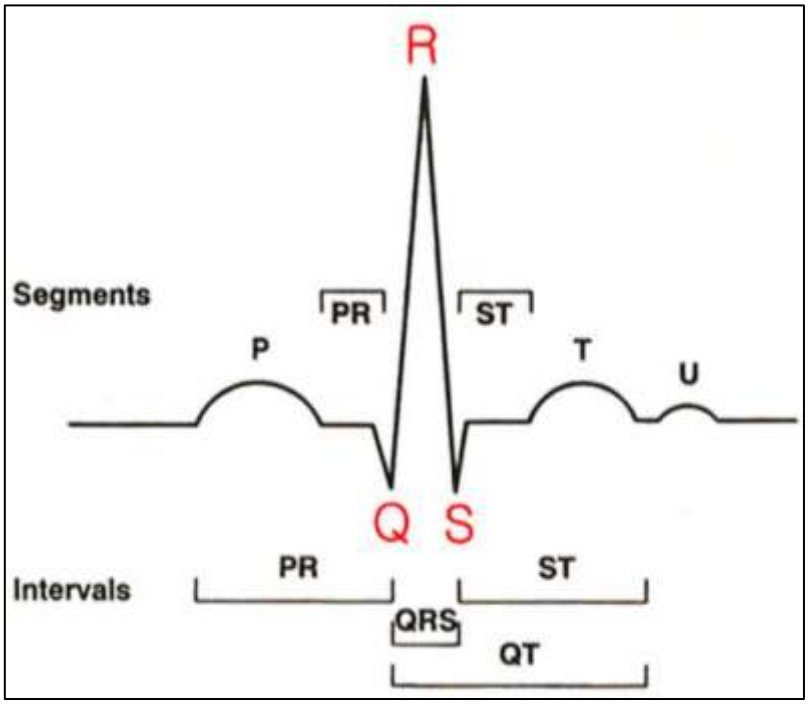
② When the ventricles expand and the atria contract, blood flows into the ventricles through the open valves..



③ When the ventricles contract, blood is sent through the arteries, from the right ventricle to the lungs, and from the left ventricle to the rest of the body.

2. ECG Waveform

The ECG waveform, which reflects the stages of electrical activation of the heart, is composed of the P, Q, R, S, T, and U waves as shown in the diagram below.



- P Wave: Each depolarization originating from the sinoatrial node spreads through both atria, creating the P wave on the ECG. The P wave indicates atrial depolarization and contraction.

- QRS Complex: The depolarization of ventricular myocardial cells forms the QRS complex, leading to ventricular contraction. The QRS complex signifies the start of ventricular depolarization and contraction.

- ST Segment: Represents the beginning of ventricular repolarization. An elevation or depression of the ST segment compared to the baseline may indicate pathological conditions that can cause serious problems.

- T Wave: A normal T wave represents normal ventricular repolarization, starting from the epicardium and progressing towards the endocardium during the last part of ventricular systole.

- U Wave: The exact cause is not clearly understood yet.

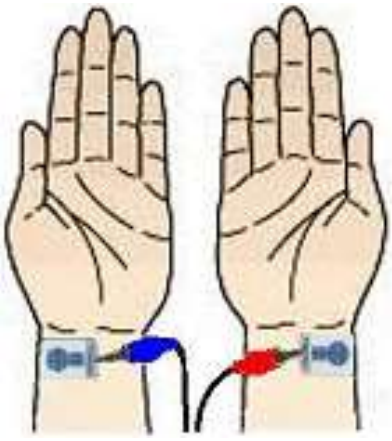
Experiment

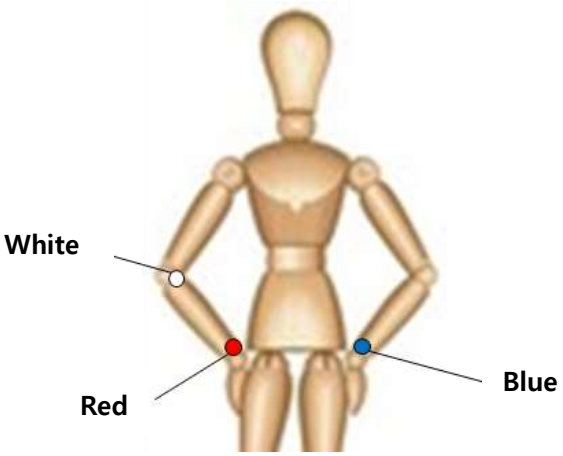
Materials Needed

Interface, Science# program, ECG sensor, ECG patches, Caffeinated drink

Experimental Setup

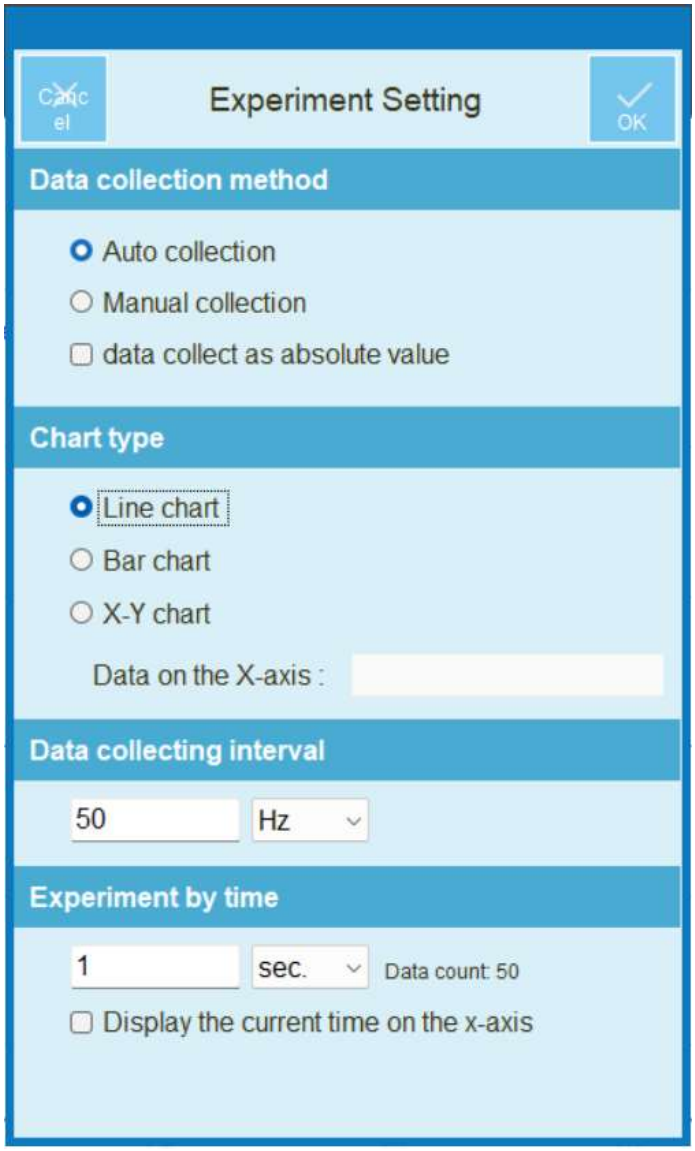
1. Attach ECG patches to both wrists and the front of the right elbow as shown in the diagram.
2. Connect the blue electrode to the left wrist, the red electrode to the right wrist, and the white electrode to the front of the right elbow.





Interface Setup

1. Run Science#.
2. Connect the ECG sensor to the interface.
3. Press the button to set up the experimental environment as shown below or press the button for automatic setup..



 Automatic Setup

Data Collection

1. Sit down and press the button  to collect data for 1 minute..
2. Measure the heart rate for 1 minute in various postures (standing, lying face down, lying down, etc.).
3. Perform various exercises for the same number of times and measure the heart rate (push-ups, sit-ups, pull-ups, etc.).
4. Measure the heart rate after consuming a caffeinated drink (coffee, green tea, etc.).

Data Analysis

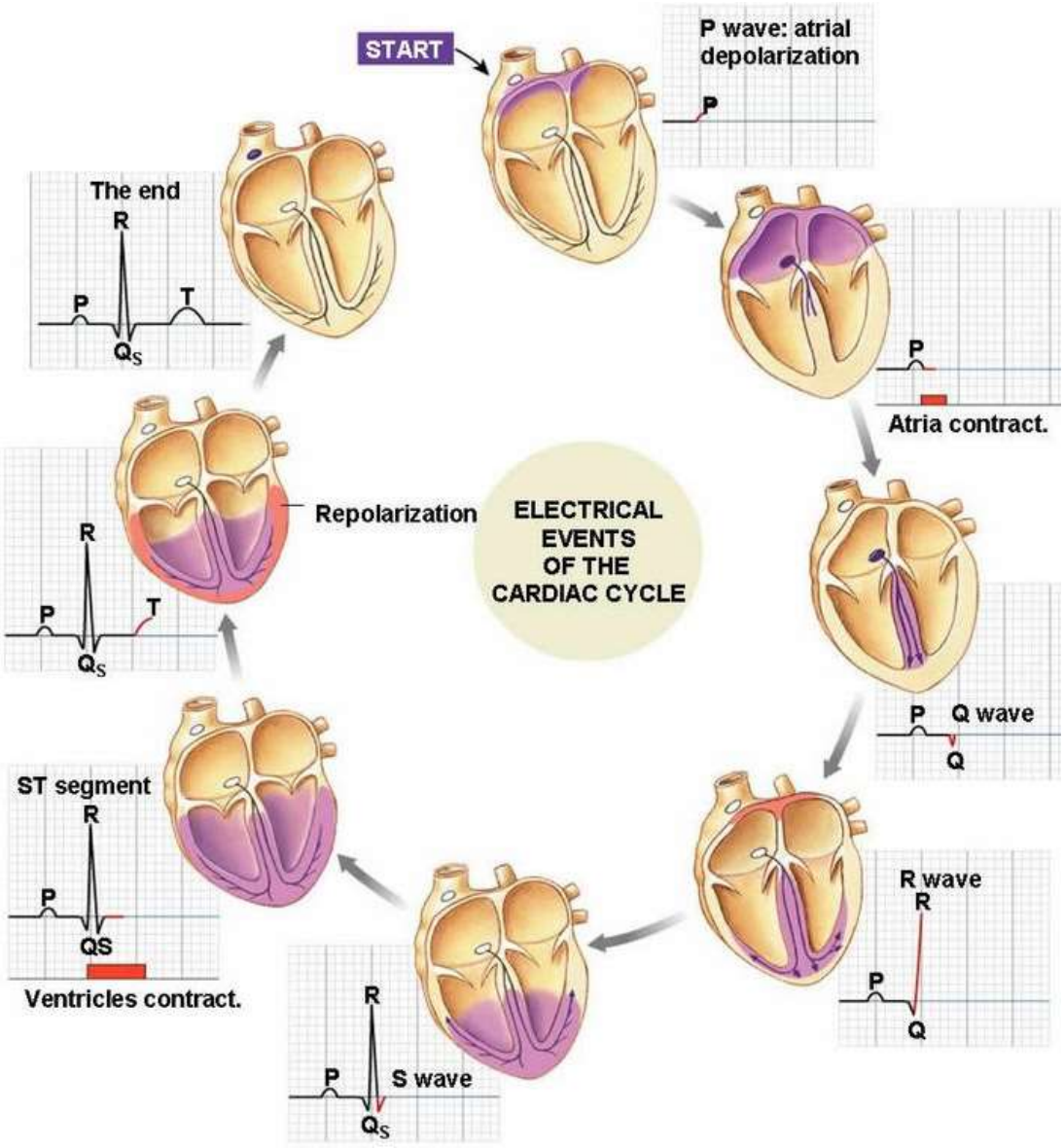
Recording Data

1. Measure your ECG using the ECG sensor. Zoom in on one cycle of the waveform to create a graph.

2. Describe the shape of your ECG waveform as measured with the ECG sensor.

Data Application

1. Explain the principle of the pulse as shown in the following diagram..



2. Confirm that the ECG waveform is measured at regular intervals. Explain what the pulse rate (bpm) means and how it can be calculated.

3. Analyze the measured data to find the pulse rate (bpm) in various situations and complete the table below.

Situation				
Pulse Rate (bpm)				

4. List the three situations in order of the highest pulse rate and explain the reason..

Extension Activities

1. Investigate and describe how ECG is used in daily life.

2. Investigate and describe various tools developed to conveniently measure ECG in daily life.