Electrocardiograms

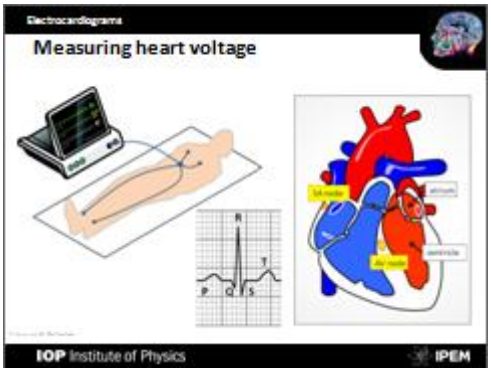
Curriculum links:

- CRO traces
- Frequency/Amplitude

Introduction

Electrocardiograms (ECGs) record the activity of the heart through electrodes placed on the patient's skin. Cardiological contraction is caused by changes in electrical potential in the hearts muscle cells; electrical activity that the body conducts to its surface. Although it is altered by the intervening tissue, the resulting signal at the skin accurately reflects the cardiological cycle and can be used to identify any anatomical and physiological anomalies in a completely non-invasive manner.

Lesson notes



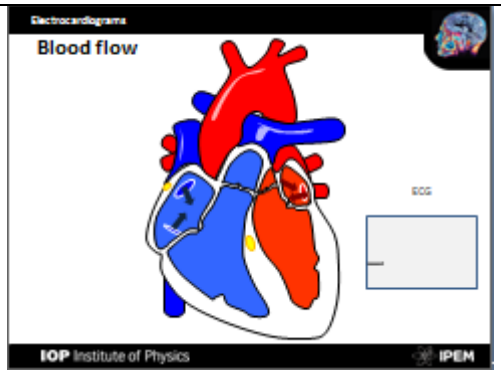
Measuring heart voltage

Non-invasive monitoring of the electrical activity of the heart is possible because the body is an electrical conductor. An ECG machine acts as voltmeter/CRO and voltage-time characteristics are measured by attaching electrodes to the patient's skin.

In a healthy person, the resulting ECG trace has a distinctive shape with sections that are labelled P,Q,R,S and T. Doctors use abnormities in shape of waveform to identify heart problems.

Structure of heart:

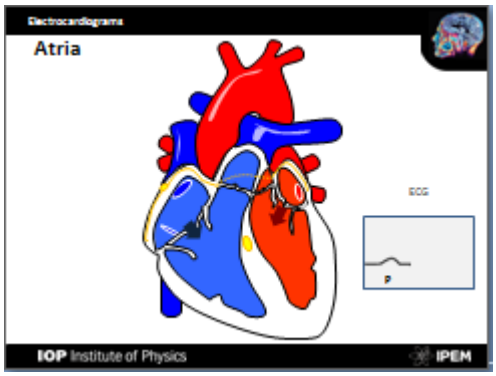
- Pump chambers: atria and ventricles.
- Control: AV and SA electrical nodes.



Blood flow

Oxygenated blood (red) flows into left chambers and deoxygenated (blue) into right chambers.

ECG: zero potential difference across the heart

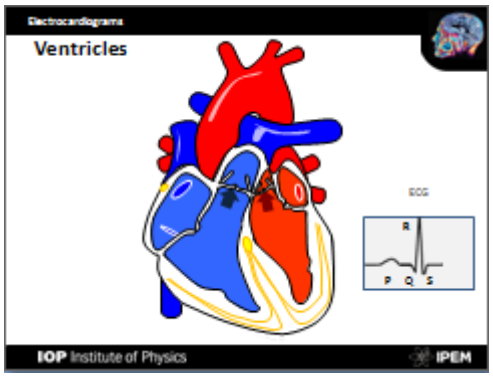


Atria

The SA node is the heart's pacemaker. Electrical activity originating at SA node triggers contraction of atria. Atria pump blood through one-way valves into ventricles.

Other than the pathway through to the AV node, the atria and ventricles are electrically insulted from each other. The AV node momentarily delays electrical activity to allow the ventricles to fill with blood.

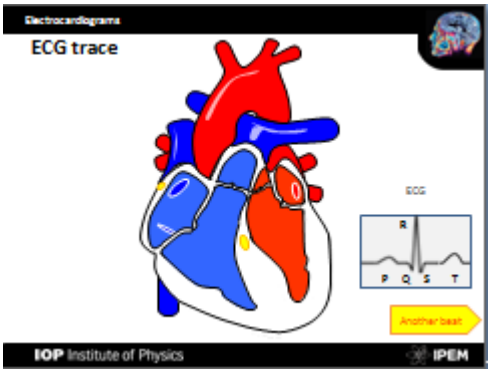
ECG: contraction of atria produces P-wave



Ventricles

Electrical activity spreads from the AV node across ventricles causing them to contract and blood is pumped through one-way valves; oxygenated blood travels to the body and de-oxygenated blood to lungs.

ECG: contraction of ventricles produces QRS complex



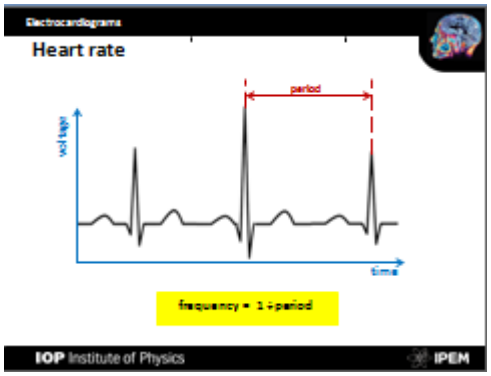
ECG trace

Final section of the ECG trace (T wave) corresponds to the relaxation of ventricles.

Review of waveform sections:

- P wave: contraction of atria
- PQ interval: delay to allow ventricles to fill
- QRS complex: contraction of ventricles
- T wave: relaxation of ventricles

➢ **Another beat:** (If required) repeat slide sequence of heartbeat

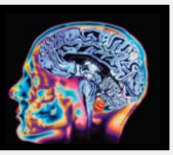


Heart rate

The period (R-R interval) is time between adjacent peaks in the ECG trace. In a healthy person the period varies by up to 10 % between beats. Heart rate is determined by averaging over multiple beats

Heart rate = 1/average period

Heart rate in beats per minute (bpm) is equal to the frequency in hertz (Hz) X 60.



Worksheet mark-scheme

1.

(a) atrium ✓

(b) A ✓

(c) pacemaker/controls heart-rate/causes contraction of atria ✓
[do not accept contraction of heart/ventricles]

2.

(a) Potential difference/voltage ✓

(b) *Evidence of measuring between three peaks* ✓

0.75 seconds [accept 0.6 or 0.8 if no average found] ✓

(c) Evidence of heart rate = 1/period ✓

Answer between 75 and 95 bpm [allow error carried forward from part (a)] ✓

(d) P wave missing/ECG shape abnormal ✓

(waveform indicates) problem with atria ✓