Pulse oximeters

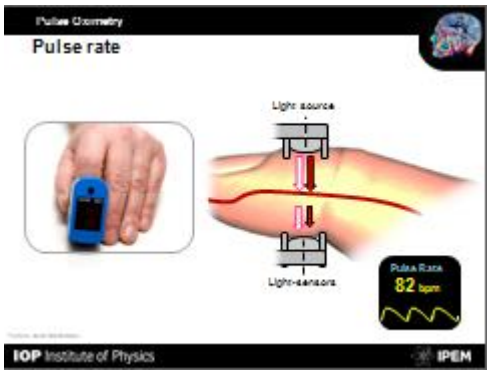
Curriculum links:

- Diodes
- Visible and infra-red light

Introduction

Pulse oximeters use red and infrared light to monitor pulse rate and the oxygenation of a patient's blood. The body scatters and absorbs visible and near infra-red wavelengths significantly so that in order to have a measurable signal thin parts of the body must be used. A typical pulse oximeter consists of light emitting diodes (LEDs) mounted opposite light sensors in a clip that can be attached across a finger or earlobe. As the light produced by the LEDs travels through the body it is absorbed by an amount that is dependent on its wavelength and the average number of oxygen atoms attached to each haemoglobin molecule. The amount absorbed also fluctuates as the arteries expand and contract in response to each heart beat allowing the pulse oximeter to determine the pulse rate as well as blood oxygen saturation from the transmitted signal.

Lesson notes



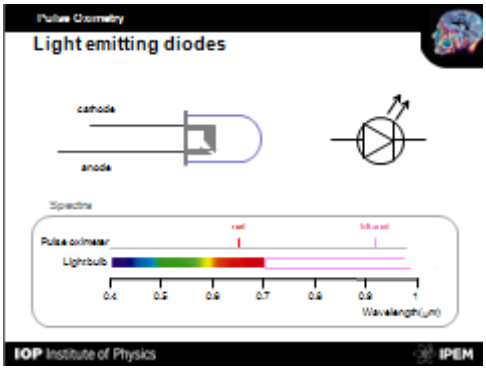
Pulse rate

A pulse oximeter is a device that consists of a light source mounted opposite a sensor in a clip that can be attached across (for example) a finger.

Pulse rate, in beat per minute (bpm), can be worked out by timing how quickly the signal fluctuates.

- **CLICK***: variation of transmitted signal as arteries expand and contract.*

Pulse oximeters

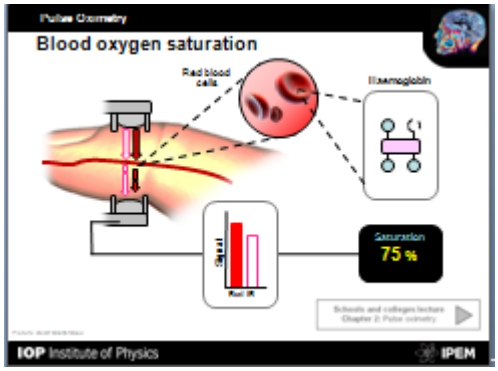


Light emitting diodes

Visible and near infra-red light has wavelengths of a billionth of a metre (a micrometre, μm) or less:

- blue/violet light has wavelengths around 0.4 μm
- red light has wavelengths around 0.7 μm
- wavelengths beyond 0.7 μm are invisible and called infrared

The light source in a pulse oximeter consists of multiple LEDs. Unlike the continuous (white-light) spectrum produced by a light bulb, the spectrum of a pulse oximeter has two distinct lines because the individual LEDs produce light of a single wavelength (either infrared or red).



Blood oxygen saturation

The amount of light absorbed by blood depends on the wavelength of the light. For visible wavelengths blood absorbs blue light more than red; hence blood has a red appearance.

In pulse oximeters the ratio of infrared (IR) to red signals depends on the oxygen saturation (how "full" of oxygen the blood is). Each of the oxygen carrying haemoglobin molecules found in red blood cells can carry up to four oxygen atoms.

Oxygen saturation: for example, 75 % saturation corresponds to each haemoglobin molecule carrying an average of three oxygen atoms.

Worksheet mark-scheme

1.

(a) (One of the wavelengths used is) infra-red/invisible ✓

(b) Light emitting diode ✓

(c) *Correct symbol drawn* ✓

2.

(a) 0.405 (μm) ✓

(b) short-wavelengths/blue/violet (light) absorbed most
OR
Long-wavelengths/red (light) absorbed less ✓

3.

(a) arteries expand (and contract in response to each heart beat) ✓

(b) by taking ratio of/comparing infrared and red (signals) ✓

4.

(a) 1,080 million/1.08×10^8 ✓

(b) *Any attempt to use* multiply by *0.83* ✓

Answer: 896 million/8.96×10^7 ✓

TOTAL: 10 Marks