Physiological Measurement Demo

Equipment

- Oximeters
- 1 glass or red water and 1 glass of blue water (using food dyes)
- Laser pointer and white sheet of paper
- Blood Pressure Monitor
- Table, tablecloth if possible
- "Physiological Measurement" leaflet and poster

Safety / Risk assessment notes

There are no risks attached to the equipment. The main risks would be injuries if any equipment falls off the table. However please do a disclaimer when and if you do the demo that the equipment is not accurate enough to make a diagnosis.

Background

The idea of this demo is to show how engineering based on physics principles is part of all equipment used in medicine – even in small everyday machines.

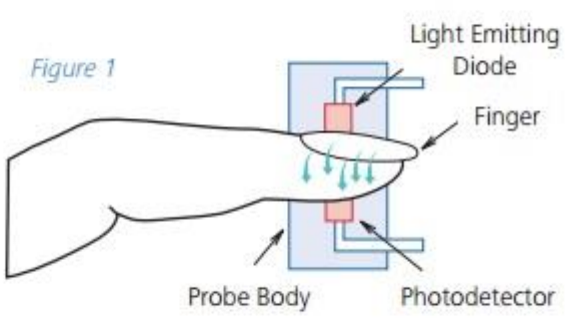
Details

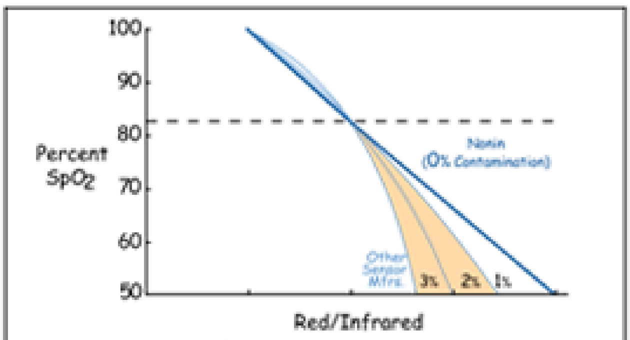
- Start asking whether the kids know what an oximeter and blood pressure monitor are
- Then ask why we need to know oxygen level and blood pressure (Especially pulse oximeters are widely used by paramedics and in hospitals and give a quick and easy reading of two important parameters – pulse rate and blood oxygenation.)
- Then explain how they work (see below) and open one up to look inside
- Do a couple of demonstrations:
  1. One child wears the blood pressure monitor AND the oximeter. What happens to your oxygen levels if you inflate the blood pressure sleeve? And why
  2. Hand out several oximeters and do a little competition and see who has the highest oxygen levels
- Finally, end by saying that in medicine engineering is key – without engineers and physicists most of the equipment used in hospitals would not exist. You can show them the

poster and leaflet.

How does it work – Oximeter:

1. The lungs transfer oxygen from the air into the bloodstream.
2. This oxygenated blood is then pumped by the heart to everywhere in the body.
3. An oximeter, usually attached to the finger, has a red and an infrared LED and the light of both passes through the finger shining two separate light beams into the blood in the finger.
4. How well this light is absorbed depends on the wavelength (red or infrared) and on how many oxygen atoms are attached to each haemoglobin molecule. The amount of oxygen is expressed as a percentage/
5. Well oxygenated blood transmits red light more readily than poorly oxygenated blood (but oxygenated blood transmits less infrared light).
6. 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.
7. To demonstrate how it works you can use two beakers of water, one coloured with blue food dye (and a dash of red) and the other with red food dye. The red water will represent oxygenated blood and the blue water will represent de-oxygenated blood. Shine a red laser pointer through both onto a sheet of white paper and show that more red light passes through the oxygenated 'red blood' than the de-oxygenated 'blue blood'.





b. The ratio of red to infrared light yields the oxygen saturation, or SpO_2.

The differential absorption of the two wavelengths allows the oxygenation to be calculated. (for example, 75 % saturation corresponds to each haemoglobin molecule carrying an average of three oxygen atoms)

How does it work – Blood pressure monitor

1. Blood pressure is a measure of the force that blood applies to the blood vessel walls as it flows through the body.
2. Blood pressure monitors work by detecting the vibrations caused by the blood flowing. These vibrations are measured at two points:
   1. when the heart is at maximal contraction (so the force of blood flow is higher) and
   2. at maximal relaxation (the blood is not forced through as the heart relaxes)
3. The cuff that is inflated over the upper arm produces a pressure greater than the maximal blood pressure in the brachial artery, a major blood vessel located in the upper arm. This stops blood from flowing through the artery.
4. Next, the cuff is deflated, and its pressure begins to fall. As the cuff's pressure falls below blood begins to flow again through the brachial artery, which creates a vibration on the vessel wall.
5. As the cuff deflates further and the pressure eases the blood begins to flow smoothly through the artery without any vibrations.
6. The sound that is caused by these vibrations in your artery while your blood pressure measurements are being taken, is known as K-sound or Korotkoff. It is detected by a piezoelectric crystal and then converted into electrical signals via a transducer.

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