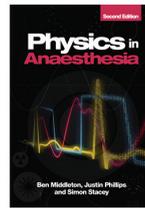


Chapter 11

Measuring gas and vapour concentrations



Self-assessment questions

These questions and answers, in both MTF and SBA formats, accompany *Physics in Anaesthesia 2e* and link back to the book for guidance.

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Multiple true / false questions

For each of the following questions, mark all answers as either true or false

1. Regarding respiratory gas sampling:

- Side-stream sampling minimizes dead space
- Side-stream sampling has a slower response time
- Main-stream sampling is less accurate
- Main-stream sampling allows oxygen and carbon dioxide monitoring
- Side-stream sampling draws off up to 500 mL of gas per minute from the breathing circuit

Pointer

- See Figure 11.1.

2. The following gases are detectable using infrared absorption:

- Water vapour
- Helium
- Nitrogen
- Nitrous oxide
- Isoflurane

Reminder

- Polyatomic gases absorb infrared electromagnetic waves, but elementary gases do not.

3. Measuring the partial pressure of oxygen is possible using:

- Infrared absorption spectroscopy
- Paramagnetic null-deflection
- Raman spectroscopy
- A galvanic fuel cell
- An alkaline battery

Reminder

- Paramagnetic null-deflection oxygen analyses measure the concentration of oxygen, however, this can be converted to partial pressure with use of the universal gas law (Equation 9.9).

Single best answer questions

For each of the following questions, select the single best answer – note that more than one answer may be true but only one option represents the best answer

1. Why is there often a slight upsloping plateau on the S-shaped part of a capnograph in healthy patients?

- This is a sign of bronchospasm
- Because there is continued diffusion of CO_2 across the alveolar membrane during expiration
- This depicts a physiological norm in the respiratory cycle
- This represents the end-tidal CO_2 concentration
- This is part of the expiratory upstroke and is due to air trapping

Did you know?

- Capnography can provide clues about respiratory effort, help diagnose the cause of respiratory distress, provide feedback on how well treatment is working and even detect haemodynamic shock.
- For example, if an expiratory upstroke is more curved, creating a 'shark-fin' appearance, this is a sign of bronchospasm and is due to air trapping in the alveoli.

2. How do fuel cells in anaesthetic machines measure oxygen concentration in the supply gas?

- a. Via a pulsed-field detector measuring pressure changes induced by a magnetic field attracting oxygen molecules
- b. Photons undergo inelastic scattering with gas molecules that are then detected at an angle of 90° to the laser beam in a Raman spectrograph
- c. Hydroxyl ions, generated when oxygen reacts with the gold cathode, react with a lead anode resulting in the release of electrons and thus a current that can be measured
- d. Oxygen reacts with the lead anode and a potassium hydroxide solution to release an electrical current that can be directly measured giving an indication of its concentration
- e. Through the bombardment of high-speed electrons, resulting in positive oxygen ions that are then accelerated through an electric field and then deflected by a magnetic field and measured

Reminder

- Equations 11.2 and 11.3.

3. What is the prime sensor for measuring pH in arterial blood gas analysis called and how does it work?

- a. The Clark electrode allows for the generation of charge-carrying hydroxide ions that carry a current which is a direct reflection of the acidity of the blood
- b. The Sanz electrode has a glass permeable to hydrogen ions separating the blood and a buffer solution; due to a stable buffer solution the potential of the ions across this glass is proportional to their concentration in blood
- c. The Sanz electrode allows for the reaction of hydrogen ions in the blood with a silver/silver chloride electrode resulting in a current which is measured by an ammeter.
- d. The Clark electrode uses a platinum cathode and silver/silver chloride anode with a voltage of 0.6 V applied across them; at the cathode hydroxide ions are produced which produces a current
- e. The Severinghaus electrode mixes carbon dioxide with a dilute bicarbonate buffer forming carbonic acid which dissociates to form hydrogen ions; this change in pH is measured by a glass electrode

Reminder

- The Clark, Sanz and Severinghaus electrodes are the prime sensors in arterial blood gas analysis.
- Learn which gas each electrode measures, and how.

Answers to questions for Chapter 11 – Measuring gas and vapour concentrations

Multiple true / false questions

The following answers are true:

1. a and b
2. a, d and e
3. b and d

Single best answer questions

The options below represent the single best answer, although other options may also be true:

1. b
2. c
3. b