Contents guide and exam preparation notes

The FRCA exam is surprisingly physics-heavy for a postgraduate medical exam. This creates a certain amount of anxiety amongst some candidates, for whom physics and maths may be a long forgotten and unpleasant memory. Throughout *Physics in Anaesthesia* we have tried to clearly explain the concepts and then make them clinically relevant. The guide below provides a quick summary of the chapters with particular emphasis on topics and themes that regularly appear in the exam, because they are either considered core knowledge, or are an easy subject on which to formulate questions.

General advice:

- Nothing gets a viva off to a good start like a well rehearsed and confidently delivered definition. Try to learn the definitions in the boxes, because questions such as 'What is energy' can be difficult to answer when put on the spot.
- Equations are essential for succinctly demonstrating the differing contributions of various components of an observable phenomenon. However, it is sometimes easier to remember the basic principles behind a concept (like the Doppler effect) than to trot out a hard to remember and scary looking equation on demand; and merely remembering the equation does not necessarily demonstrate a deeper understanding of the principle at work.
- There are some equations that it is essential for you to be able to remember and reproduce on demand for the FRCA, and these are annotated throughout the book with "**learn**" beside them.
- One thing the Royal College of Anaesthetists is not short of is paper and it is unlikely you will get through your primary viva without drawing at least one graph. Most of the graphs in the book would be considered reasonable exam fodder, so practise drawing them and remember to label your axes.
- Similarly, a picture paints a thousand words so drawing diagrams (however bad) to help explain concepts will demonstrate understanding, knowledge and preparation; three things found in abundance in a successful candidate.
- Even some die-hard physicists find physics a difficult discipline to talk about. It is imperative to practice discussing topics likely to come up in a viva with colleagues, as this will help iron out weaknesses.

Chapter notes

1. Atoms and matter

- Revision that gives a good base for understanding vapours.
- It is worth spending some time making sure you fully comprehend the phase diagrams.

2. Simple mechanics

- This chapter builds the foundations for understanding concepts later on in the book.
- Make sure you are familiar with Laplace's law and comfortable talking about the principles of surface and wall tension.

3. Energy and power

- Try to develop a clear idea of the difference between work and energy as this will save you from headaches later on.
- Make sure you fully understand compliance and can both draw and explain hysteresis loops and also an annotated cardiac pressure–volume loop.

4. Temperature and heat

- Measurement of temperature and mechanisms of heat loss are core topics that make excellent viva fodder so disregard these at your peril.
- *Section 4.7* onwards is not essential knowledge for the FRCA but a nod to the laws of thermodynamics makes for an impressive viva.

5. Waves

- We spend much of our working lives observing undulating lines on electronic monitors so an

appreciation of the fundamentals of waves is very reasonably considered core.
- Try to develop a clear understanding of the difference between sound and electromagnetic waves and practise explaining resonance and damping with drawn illustrations.
- With the rising application of ultrasound on intensive care units, you need to have a neat explanation of the Doppler effect.
- It is useful to develop an appreciation of flux, intensity and luminance, but they are unlikely to underpin a pass/fail situation.

6. Pressure measurement
- This chapter is highly clinically relevance and a sound knowledge base of the contents is imperative.
- Get to grips with the units of pressure.

7. Humidity
- Whilst not conceptually difficult, humidity is a topic that easily lends itself to viva questions.
- You should be able to explain why appropriate humidification is an important aspect of many of our anaesthetic interventions, how it is measured, and methods to increase or conserve water vapour.

8. Measurement of gas flow
- Manipulation and application of the Hagen–Poiseuille equation is much beloved by the Royal College of Anaesthetists and crops up in all aspects of the FRCA.
- Turbulent and laminar flow and their relationship with resistance are similarly important.
- You should be able to explain the Bernoulli principle with confidence and explain its application in the Venturi effect.
- Recall and understand the internal workings of a couple of the eponymous flow measurement devices, develop a fluent patter explaining how a rotameter measures gas flow and be able to reproduce *Figure 8.14*.

9. The gas laws
- Success in the FRCA is impossible unless you possess a robust knowledge of the concepts in this chapter.
- In addition to having the relevant equations at your fingertips, you should be able to perform simple calculations.

10. Diffusion, osmosis and solubility
- Appreciating diffusion is key to understanding many physical processes in medicine, such as drug delivery.
- Solubility is an important concept that you must understand to allow you to explain common questions concerning diving and the bends.
- Colligative properties require an appreciation rather than an in-depth understanding.

11. Measuring gas and vapour concentrations
- A good rule of thumb is that if you use it every day you should be able to clearly explain how it works; infrared gas analysers fall into this category.
- The physics of null deflection in paramagnetic analysers is neat and regularly comes up in MCQ format.
- Be able to draw the chemical reactions for a fuel cell and Clark electrode.

12. Vaporizers
- Apply the rule of thumb described above.
- Whilst questions about the function of vaporizers at altitude lack any clinically relevant basis, being able to explain the theory demonstrates a thorough understanding of their function.

13. Medical gas supplies
- You need to be confident with the terminology of gas supplies such as vacuum insulated evaporator, filling ratio and cylinder manifold.
- Know which gases are stored as liquids and understand *Figure 13.2*.

14. Breathing systems and ventilation

- Although some anaesthetists will never have seen many of the eponymous circuits that make up the Mapleson classification, its place in anaesthetic history warrants its inclusion.
- Be able to reproduce the chemical equation for the absorption of carbon dioxide by soda lime and understand the simple idea behind gas scavenging.
- Ventilators and modes of ventilation is a complex subject and what is included in this chapter amounts to 'conversational' knowledge only, but aims to resolve some of the confusion surrounding intensive care ventilators.

15. Optics

- Be able to explain the principle behind the piece of monitoring that has made the biggest difference to safety in anaesthesia – the pulse oximeter.
- A general appreciation rather than a detailed knowledge of Snell's law and Beer's law is all that is needed.

16. Blood flow measurement

- A good grasp of dye dilution and washout curves is necessary to understanding many of the different forms of cardiac output monitoring used on intensive care and in theatre.

17. Equipment management

- Infection control is a popular and often overlooked topic so be sure to have read this section to score easy marks.

18. Basis of electricity

- Electricity is conceptually a difficult subject.
- Make sure you know the definitions and uses of materials such as semi-conductors and can explain the theory and application of the Wheatstone bridge.

19. Electromagnetism and alternating current

- Following on from the previous chapter, an appreciation rather than in-depth knowledge is what is required here.
- Be sure to know the particulars of the UK domestic power supply.

20. Electrical shocks and safety

- Electrical safety and electrocution are popular areas for questions, so be familiar with both.
- An appreciation of the concept of earthing is important and also make sure you are conversant with the concept of microshock.

21. Electrocardiography, pacing and defibrillation

- Be able to draw and explain Einthoven's triangle and reproduce *Figure 21.4*.
- Pacemaker modes commonly crop up in the MCQs/SBAs.

22. Processing, storage and display

- The most important concept is that of the ‘Black Box’.
- A general appreciation of each of its components is all that is needed for exam purposes.

23. Ultrasound

- The medical application of ultrasound is rapidly expanding and thorough knowledge of this topic will be of great benefit to your practice in anaesthetics and intensive care.
- Understand how piezo-electric crystals generate ultrasound waves and the use of the Doppler effect to detect flow.
- A general appreciation, rather than in-depth knowledge, is required for the physics behind ultrasound imaging.

24. Lasers

- A rehearsed explanation of how laser light is generated is all that is required to nail this topic in a viva.
- Additionally, know what LASER stands for.

25. Magnetic resonance imaging

- It is an impressive candidate that can accurately describe the principles behind MRI.
- As a minimum you should appreciate the orders of magnitude of the magnetic fields involved and the resulting safety precautions.

26. Nuclear physics and radiation

- The majority of this chapter is not core FRCA knowledge so if pressed for time, focus on the safety aspects.

27. Basic mathematical concepts

- This chapter is included to support the mathematical concepts that occur throughout the book.
- You will not be asked to solve a quadratic equation in your viva. Do, however, be prepared to draw the graph of an exponential function and understand logarithms, particularly if you find yourself on the wrong end of a discussion about pH measurement.

28. Physical quantities and SI units

- Know the SI base units.

29. Statistics

- This chapter aims to provide an introductory explanation to the common basic statistical techniques used in medical research.
- The chapter contains the statistical knowledge an FRCA candidate would be expected to possess at the time of the exam.
- The detail is difficult to retain as many of the core concepts are rarely practically applied, and this chapter is therefore best re-read in the days prior to the exam.