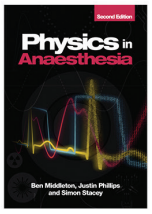
Chapter 2

Simple mechanics



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. When giving an intramuscular injection:

- **a.** The sharper the needle, the smaller the surface area against the skin and thus less pressure is needed to pierce the skin
- **b.** The sharper the needle, the larger the surface area against the skin and thus more pressure is needed to pierce the skin
- **c.** The pressure applied by the thumb onto the plunger of the syringe is smaller than the pressure applied by the needle to the skin
- **d.** The speed and velocity of the plunger of the syringe reduces as the skin is penetrated
- **e.** A greater force would need to be applied to pierce the skin if the syringe and needle had a greater mass

Pointer

- See *Equation 2.1*, Newton's second law and also *Equation 2.3* relating pressure, force and area.

Reminder

- Force (F) is measured in N (Newtons: 1 N = 1 kg·m·s^{-2}), pressure (P) is measured in Pa (Pascals: 1 Pa = 1 N·m^{-2}) and acceleration in m·s^{-2}.
- Clarity with units is so important…

2. Regarding an aortic aneurysm:

- **a.** Wall tension rises as the radius of the artery increases
- **b.** Wall tension of a spherical aneurysm is greater than for a cylindrical vessel of the same radius
- **c.** Wall tension of a spherical aneurysm is less than for a cylindrical vessel of the same radius
- **d.** Wall tension is inversely proportional to radius in a spherical aneurysm
- **e.** Wall tension is proportional to pressure in a cylindrical vessel

Reminder

- Aneurysms tend to evolve from a cylindrical shape towards a more spherical form. This is because the wall tension is less in a sphere (see *Figure 2.4*).

Did you know?

- Endovascular grafts are a treatment option for aneurysms: they narrow the radius, reducing the wall tension and preventing any further bulging.

3. For a gas that travels around a bend in a ventilator circuit at a constant flow rate:

- **a.** The gas has exhibited constant velocity
- **b.** The gas has accelerated
- **c.** A force was needed to change the direction of travel
- **d.** The bend in the circuit has created more resistance to flow
- **e.** If the flow rate were to change, the viscosity of the gas would remain constant

Reminder

- In physics, gases are considered fluids, along with liquids.

Did you know?

- All gases are Newtonian fluids, though some liquids are non-Newtonian, such as blood.
- Newton's laws of motion apply well for our world and its surrounding planetary objects, but they do not apply perfectly to the very small (quantum physics) or to the very fast moving (e.g. those travelling at, or near, the speed of light).

Pointer

- Think like Newton.

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. A 60-year-old man is admitted to ICU with an *E. coli* bacteraemia and a severe AKI (Cr 505, UO 5 ml·hr^{-1}, pH 7.25). A vascular catheter is inserted into the patient's RIJ vein and he is connected to a haemodialysis machine. Regarding preventing thrombosis of the vascular catheter:

a. The blood should be warmed before being returned to the body
b. A patient with polycythaemia may need lower flow rates
c. A patient with a reduced haematocrit won't need as high a flow rate as a patient with polycythaemia
d. A wider catheter will allow for higher flow rates
e. Warming and anticoagulation of the blood before it enters the line, and increasing its rate of flow through the catheter will prevent such thrombosis

Reminder

- The higher the viscosity of blood, the greater the risk of venous stasis and thus, and in keeping with Virchow's triad, the higher the chance of thrombosis.

Pointer

- Factors affecting viscosity can be found in *Section 2.3*.

2. Within any alveolar sac, connected alveoli of differing radii:

a. Have the same pressure when surfactant is present
b. Have the same surface tension when surfactant is present
c. Have the same surface tension when surfactant is not present
d. Have different pressure and different surface tension when surfactant is not present
e. Have different pressure and the same surface tension when surfactant is not present

Pointer

- As alveoli can be treated as sphere-like shapes, consider Laplace's equation for a spherical bubble here (*Equation 2.5*).

Did you know?

- A combination of the substance Colfosceril, cetyl alcohol and Tyloxapol produces a synthetic pulmonary surfactant.
- This can be administered to neonates suffering from a respiratory distress syndrome related to a deficiency in endogenous pulmonary surfactant.

Answers to questions for Chapter 2 – Simple mechanics

Multiple true / false questions

The following answers are true:

1. a, c, d and e

2. a, c, d and e

3. b, c, d and e

Single best answer questions

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

1. e

2. e