

Exercise walk-through

5.4

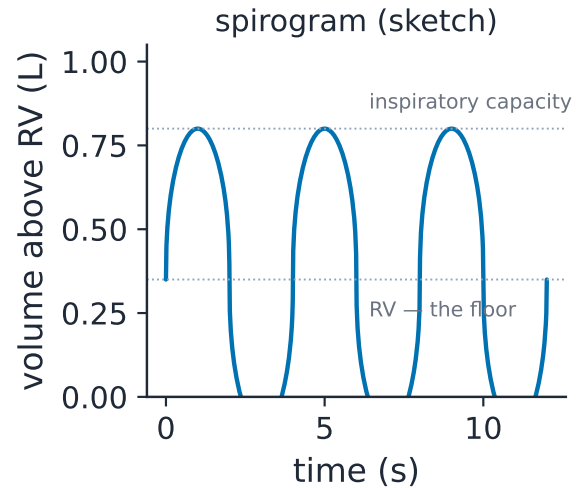
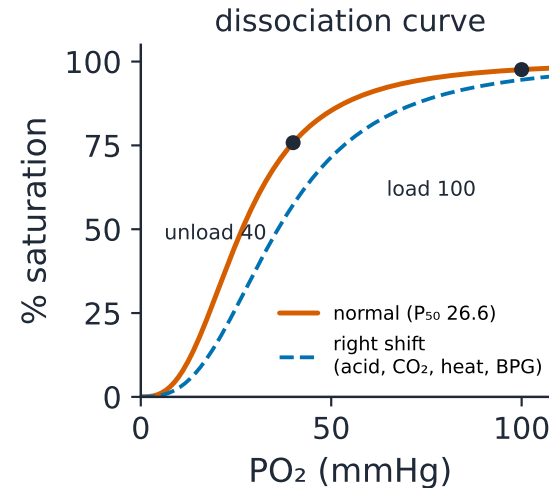
Respiratory physiology

University Medicine

Respiratory physiology: one equation, one curve

- 1 **Equation** Alveolar $PO_2 = 150 - (CO_2 \div 0.8) \rightarrow 100$ mmHg at CO_2 40; **A-a gradient** normal 5–15.
- 2 **Sorting** Shunt and V/Q mismatch **WIDEN** the A-a gradient; hypoventilation and altitude keep it normal.
- 3 **Curve** P50 26.6 mmHg; loads 100 $\rightarrow$ 97%, unloads 40 $\rightarrow$ ~75%; right shift with acid, CO_2 , heat, BPG; saturation is not content.

Respiratory physiology - spirogram and curve



Spirogram sketch; dissociation curve with its right shift.

Exercises 2.1-2.3

2.1 Compute P_{AO_2} at $P_{ACO_2} = 60$, $R = 0.8$. [3]

2.2 Name the four right-shift factors. [3]

2.3 Why does anaemia not desaturate the probe? [3]

Exercises 2.1-2.3

2.1 Compute P_{AO_2} at $P_{ACO_2} = 60$, $R = 0.8$. [3]

2.1

- $150 - 60/0.8 = 150 - 75 = 75$ mmHg ✓.
-

2.2 Name the four right-shift factors. [3]

2.2

- Acidosis, hypercapnia, fever, 2,3-BPG.
-

2.3 Why does anaemia not desaturate the probe? [3]

2.3

- The probe reads saturation (binding); anaemia cuts CONTENT (Hb count) at the same saturation.

Exercise 3.1

3.1 Five hypoxaemic patients (fictional): (a) overdose with P_{ACO_2} 80; (b) pneumonia with wide gradient; (c) at altitude (barometric 460); (d) shunt; (e) anaemia.

For each, state the mechanism and whether the A–a gradient widens. Show the arithmetic for (a) and (c).

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For each, state the mechanism and whether the A-a gradient widens. Show the arithmetic for (a) and (c). [9]

3.1

- (a) Hypoventilation: $150 - 80/0.8 = 50$ mmHg; A-a normal.
- (b) Pneumonia: V/Q mismatch/shunt $\rightarrow$ A-a widens.
- (c) Altitude: $P_{IO_2} = 0.21 \times (460 - 47) \approx 87$; alveolar and arterial fall together $\rightarrow$ A-a normal.
- (d) Shunt: A-a wide (bypassed blood unmixed with ventilated).
- (e) Anaemia: P_{O_2} and saturation normal – content disease, no gradient change.
- Consistent mechanism-to-gradient mapping.

Exercise 3.2

3.2 A patient at P_{AO_2} 100 has saturation 97 %; at tissue P_{O_2} 40 it is ~75 %.

Explain the curve's shape advantage (flat top loads, steep middle unloads). Compute the oxygen delivered per dL (Hb 15, 1.34 mL/g). Predict the content at Hb 7.5. [7]

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3.2

- Flat top (60–100): loading is safe despite small lung swings; steep middle: large unloading for a small tissue drop.
- Content $\approx 1.34 \times 15 \times 0.97 \approx 19.5$ mL/dL loaded; at 75 %: ~ 15 mL $\rightarrow$ ~ 4.5 mL delivered per dL ✓.
- At Hb 7.5: content halves (~ 9.7 mL/dL) – saturation still 97 %.