

5.4 Respiratory physiology

Name: _____ Class: _____ Date: _____

Total: 25 marks

KEY WORDS alveolar gas equation

Objective

Apply the alveolar gas equation and the A-a gradient to sort hypoxaemia, and read the dissociation curve.

1 Key knowledge and worked examples

■ The tools

$P_{AO_2} = 150 - P_{ACO_2}/0.8$; A-a normal 5–15 mmHg; $P_{50} = 26.6$ mmHg, right shift with acid/ CO_2 /heat/BPG.

■ Worked example: the two hypoxaemias

Hypoventilation (P_{ACO_2} 80): $P_{AO_2} = 50$ with NORMAL A-a ✓ (the bellows). Shunt: normal alveolar, low arterial, WIDE gradient ✓ (the lung).

2 Practice

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]

3 Exam-style questions

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). [9]

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]

Solutions

2.1

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

2.2

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

2.3

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

3.1

- (a) Hypoventilation: $150 - 80/0.8 = 50$ mmHg; A-a normal.
- (b) Pneumonia: V/Q mismatch/shunt → A-a widens.
- (c) Altitude: $P_{IO_2} = 0.21 \times (460 - 47) \approx 87$; alveolar and arterial fall together → 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.

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 → ~ 4.5 mL delivered per dL ✓.
- At Hb 7.5: content halves (~ 9.7 mL/dL) – saturation still 97 %.