LESSON MAKER PRO

# Gas Exchange Detective

*Use pressure data to predict which way gases move.*

**HIGH SCHOOL · HS-AP11-3**

**HS-AP11-3** "Analyze data to investigate how percentages and partial pressure gradients of oxygen and carbon dioxide impact net gas exchange."

NAME _____ DATE _____

## FOLLOW THE GRADIENT

To find a gas's partial pressure, divide its percentage by 100 and multiply by the mixture's total pressure. A gas moves across the lung membrane from higher partial pressure to lower partial pressure. Subtract the lower pressure from the higher pressure to find the gradient; a larger gradient means a stronger drive for net movement.

## WORKED EXAMPLE

In a lung model, alveolar air is 40% oxygen at a total pressure of 150 mmHg. Blood oxygen partial pressure is 42 mmHg. Find the oxygen gradient and predict the direction of net movement.

1. Convert the percentage: 40% = 40/100.
2. Find alveolar oxygen pressure: 40/100 × 150 = 60 mmHg.
3. Find the gradient: 60 − 42 = 18 mmHg.
4. Compare pressures: oxygen moves from alveolar air into blood.

**Answer: 18 mmHg; oxygen moves from alveolar air into blood.**

## PRACTICE 6 problems

**1** Use the table to find the partial pressure of oxygen in alveolar air.

**ALVEOLAR AIR SAMPLE**

| Total pressure (mmHg) | Oxygen (%) |
|---|---|
| 700 | 12 |

ANSWER _____

**2** Find the oxygen gradient and predict the direction of net oxygen movement.

**OXYGEN PRESSURES**

| Alveolar total pressure (mmHg) | Alveolar oxygen (%) | Blood oxygen pressure (mmHg) |
|---|---|---|
| 700 | 14 | 68 |

ANSWER _____

**3** Find the carbon dioxide gradient and predict the direction of net carbon dioxide movement.

**CARBON DIOXIDE PRESSURES**

| Alveolar total pressure (mmHg) | Alveolar carbon dioxide (%) | Blood carbon dioxide pressure (mmHg) |
|---|---|---|
| 800 | 4 | 46 |

**ANSWER** _____

**4** Blood oxygen pressure is 80 mmHg for both mixtures. Which mixture has the larger gradient driving oxygen into blood? Give both gradients.

**TWO ALVEOLAR AIR MIXTURES**

| Mixture | Total pressure (mmHg) | Oxygen (%) |
|---|---|---|
| A | 700 | 12 |
| B | 700 | 16 |

**ANSWER** _____

**5** A virtual lung model uses carbon dioxide-rich alveolar air. Find the carbon dioxide gradient and predict its net direction of movement.

**VIRTUAL LUNG MODEL**

| Alveolar total pressure (mmHg) | Alveolar carbon dioxide (%) | Blood carbon dioxide pressure (mmHg) |
|---|---|---|
| 700 | 8 | 48 |

**ANSWER** _____

**6** For each gas, find the gradient and predict its direction of net movement.

**TWO GASES IN ONE LUNG MODEL**

| Gas | Alveolar total pressure (mmHg) | Alveolar gas (%) | Blood gas pressure (mmHg) |
|---|---|---|---|
| Oxygen | 600 | 14 | 72 |
| Carbon dioxide | 600 | 6 | 44 |

**ANSWER** _____

## APPLY IT Show your work

**1** A soccer team compares a low-altitude practice site with a mountain training site. The model uses the same alveolar oxygen percentage at both sites, and blood oxygen pressure is 70 mmHg at both sites. Use the table to find each site's oxygen gradient. At which site is the drive for oxygen to enter blood stronger?

**SOCCER TRAINING SITES**

| Site | Alveolar total pressure (mmHg) | Alveolar oxygen (%) |
|---|---|---|
| Low altitude | 750 | 12 |
| Mountain | 600 | 12 |

**ANSWER** _____

**2** A swim team's breathing simulator compares blood carbon dioxide pressure before and after a lap. At both times, alveolar air is 4% carbon dioxide at a total pressure of 750 mmHg. Blood carbon dioxide pressure is 36 mmHg before the lap and 54 mmHg after it. Find the carbon dioxide gradient at each time. When is the drive for carbon dioxide to enter alveolar air stronger?

WORK SPACE

**ANSWER** _____

## CHALLENGE One step up

In a virtual lung model, alveolar air has a total pressure of 700 mmHg and contains 10% oxygen and 5% carbon dioxide. Blood oxygen pressure is 84 mmHg, and blood carbon dioxide pressure is 46 mmHg. Predict the net direction of each gas. If total pressure and blood pressures stay the same, what is the smallest whole-number alveolar oxygen percentage that makes oxygen enter blood? Explain why the percentage just below it does not work.

WORK SPACE AND ANSWER

# Gas Exchange Detective



## PART 1 · PRACTICE

| # | PROBLEM | ANSWER |
|---|---|---|
| 1 | Use the table to find the partial pressure of oxygen in alveolar air. | **84 mmHg** |
| 2 | Find the oxygen gradient and predict the direction of net oxygen movement. | **30 mmHg; oxygen moves from alveolar air into blood.** |
| 3 | Find the carbon dioxide gradient and predict the direction of net carbon dioxide movement. | **14 mmHg; carbon dioxide moves from blood into alveolar air.** |
| 4 | Blood oxygen pressure is 80 mmHg for both mixtures. Which mixture has the larger gradient driving oxygen into blood? Give both gradients. | **Mixture B; A has a 4 mmHg gradient, and B has a 32 mmHg gradient.** |
| 5 | A virtual lung model uses carbon dioxide-rich alveolar air. Find the carbon dioxide gradient and predict its net direction of movement. | **8 mmHg; carbon dioxide moves from alveolar air into blood.** |
| 6 | For each gas, find the gradient and predict its direction of net movement. | **Oxygen: 12 mmHg, from alveolar air into blood. Carbon dioxide: 8 mmHg, from blood into alveolar air.** |

## PART 2 · APPLY IT

1. **Low altitude: 20 mmHg. Mountain: 2 mmHg. The drive for oxygen to enter blood is stronger at low altitude.** Alveolar oxygen pressures are 90 mmHg and 72 mmHg. Subtract the blood pressure of 70 mmHg from each.
2. **Before: 6 mmHg. After: 24 mmHg. The drive for carbon dioxide to enter alveolar air is stronger after the lap.** Alveolar carbon dioxide pressure is 4/100 × 750 = 30 mmHg. Subtract 30 mmHg from each blood pressure.

## CHALLENGE

**Oxygen moves from blood into alveolar air because its alveolar pressure is 70 mmHg, below 84 mmHg. Carbon dioxide moves from blood into alveolar air because its alveolar pressure is 35 mmHg, below 46 mmHg. The smallest whole-number oxygen percentage is 13%: it gives 91 mmHg. At 12%, alveolar oxygen pressure is 84 mmHg, so there is no gradient and no net oxygen movement.**

Accept equivalent wording for movement between alveolar air and blood. Gradients are positive pressure differences in mmHg, not measured gas transfer rates.