Tracking Original Air in a Model Sensor

Base your answers on the information provided and your knowledge of chemistry. Use the 2025 Chemistry Reference Tables as needed.

A class runs a simulation of gas replacement in a model sensor. The sensor starts with air at 100 kPa, of which oxygen accounts for 21% of the gas particles. In one cycle the simulation removes 60% of the well-mixed particles and adds the same number of pure nitrogen particles. The remaining particles mix again. The sensor’s volume and temperature at the end of each cycle are the same as at the start.

1 Calculate the percent oxygen after one replacement cycle. Show how the removal fraction enters your calculation. [1]

Answer and work

2 What is the oxygen percentage after a second identical cycle?

(1) 3.36%

(2) 5.04%

(3) 8.4%

(4) 12.6%

After each cycle, the simulator reports the same total pressure as it did at the start. A student says that this proves no nitrogen entered.

3 Explain how the total pressure can stay the same even when the composition changes. Use the number of particles, volume, and temperature in the model. [1]

Answer and work

4 The class wants to test whether the final oxygen percentage is below 5%. State the minimum number of complete cycles predicted by the model and the measurement needed to check the prediction. [1]

Answer and work