D1

An ideal gas is kept in a rigid container. When its temperature is 100 ºC, the root-mean-square speed of the gas molecules is v_{rms}. What will be the root-mean-square speed of the molecules at 400 ºC?

D2

Calculate the specific heat capacity at constant volume of water vapor, assuming the nonlinear triatomic molecule has three translational and three rotational degrees of freedom and that vibrational motion does not contribute. The molar mass of water is 18.0 g/mol.

What is the degrees of freedom of CO_2 molecules (ignore the vibrational motion)? Calculate the specific heat capacity at constant volume of CO_2 molecules, assuming that vibrational motion does not contribute. The molar mass of CO_2 is 44.0 g/mol.

D3

Prove that $f(v)$ as given by equation $f(v) = \frac{8\pi}{m}\left(\frac{m}{2\pi kT}\right)^{3/2} \varepsilon e^{-\varepsilon/kT}$ is maximum for $\varepsilon = kT$. Use this result to obtain equation: $v_{mp} = \sqrt{\frac{2kT}{m}}$. Note that ε is the kinetic energy of the molecule.

D4

Part A

Oxygen O_2 has a molar mass of 32.0 g/mol. What is the average translational kinetic energy of an oxygen molecule at a temperature of 295 K ?

Part B

What is the average value of the square of its speed?

Part C

What is the root-mean-square speed?

Part D

What is the momentum of an oxygen molecule traveling at this speed?

Part E

Suppose an oxygen molecule traveling at this speed bounces back and forth between opposite sides of a cubical vessel 0.20 m on a side. What is the average force the molecule exerts on one of the walls of the container? (Assume that the molecule's velocity is perpendicular to the two sides that it strikes.)

Express your answer using two significant figures.

Part F

What is the average force per unit area?

Express your answer using two significant figures.

Part G

How many oxygen molecules traveling at this speed are necessary to produce an average pressure of 1 atm?

Express your answer using two significant figures.

Part H

Compute the number of oxygen molecules that are actually contained in a vessel of this size at 295 K and atmospheric pressure.

Express your answer using two significant figures.