

The JETS Challenge

Provided by Dave Meredith, Associate Professor,
Penn State University-Fayette

Challenge 92 – The Nano Particle Basketball Challenge

Problem:

The new NBA basketball introduced for the 2006-07 season has a thin layer of nano particles to prevent the air from leaking out. The ball will remain inflated for over a year. A regulation NBA basketball must have an outside diameter of 23.9 cm and an inside diameter of 23.2 cm. The ball is inflated with air to 55.158 kPa above the ambient pressure of 101.1 kPa. The ambient temperature is 20°C or 293 K. The molecular weight of air is 29 kg/kmol. The ideal gas law is given by the equation:

$$PV = m(R/M) T \text{ where}$$

P = Pressure in kilo-pascals (kPa)

V = Volume in m³

m = mass in kg

R = ideal gas constant (8.31447 kPa-m/kmol-K)

M = molecular weight (kg/kmol)

T = Absolute temperature in Kelvin (K)

Find the mass (kg) of air inside a regulation NBA basketball.

Solution:

$$PV = m \left(\frac{R}{M} \right) T$$

$$= 8,31447 \frac{\text{kPam}}{\text{kmol-K}}$$

$$T = 293 \text{ K}$$

$$M = 29 \frac{\text{kg}}{\text{kmol}}$$

Need V

$$V = \frac{4}{3} \pi r^3$$

$$= \frac{4}{3} \pi \left(\frac{.232m}{2} \right)^3$$

$$= .0065383m^3$$

Need P

$$P = 101.1 + 55.158 \text{ kPa}$$

$$= 156.258 \text{ kPa}$$

$$PV = m \left(\frac{R}{M} \right) T$$

$$m = \frac{PV}{\left(\frac{R}{M} \right) T}$$

$$m = \frac{(156.258)(.00665383)}{(8.31447/29)(293)}$$

$$m = \frac{1.02166}{84.0048}$$

$$= .012 \text{ kg}$$