Answer on Question #43701, Physics, Other

Problem 12.29

On March 5, 2006, a new college basketball attendance record of 33,633 was set in Syracuse University's Carrier Dome in the last regular-season game against Villanova. The volume of air in the dome is about 1.5×106m3.

Part A

Estimate the temperature change of the air in 2 h, if all the seats in the dome are filled and each person transfers his or her metabolic thermal energy to the air in the dome at a rate of 100 W (100 J/s). Assume that no thermal energy leaves the air through the walls, floor, or ceiling of the dome and specific heat of air is 1000 J/kg·∘C.

Solution.

Due to Law of Conservation of Energy: thermal energy from spectators = thermal energy received by air in Carrier Dome:

$$Q_{spec} = Q_{air}$$

$$Q_{spec} = P\Delta t$$

$$Q_{air} = cm\Delta T = c\rho V\Delta T$$

Where P is 100W; Δt – time, 2h; c - specific heat of air, 1000 J/kg·∘C; ρ – density of air, 1.29 kg/m^3; V - volume of air in the dome, 1.5×10^{6}m^3; ΔT - temperature change of the air.

So:

$$\Delta T = \frac{P\Delta t}{c\rho V}$$

Numerically:

$$\Delta T = \frac{100W \cdot 2 \cdot 60 \cdot 60s}{1000\frac{J}{kg \cdot °C} \cdot 1.29\frac{kg}{m^3} \cdot 1.5 \cdot 10^6 m^3} \approx 3.7 \cdot 10^{-4} °C$$

Answer: $\Delta T \approx 3.7 \cdot 10^{-4} °C$