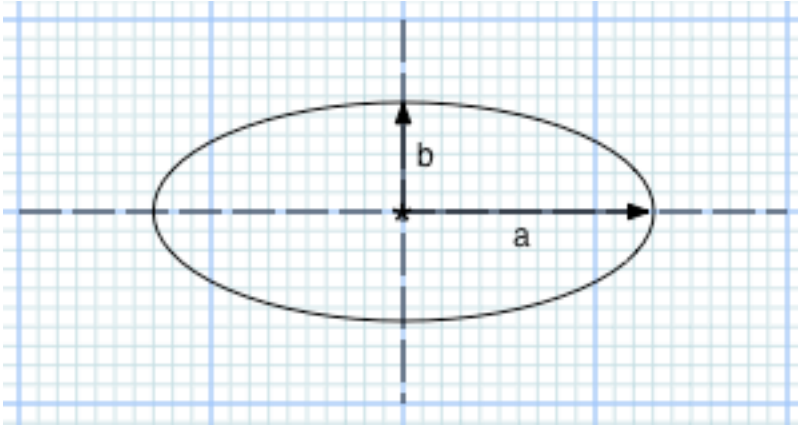


# NFL Football Weight Calculation



**Figure 1. Football axes: a is the polar axis, b is the equatorial axis**

## Physical Measurements (at 20 °C)

Weight of Football without air –  $W_F = 14.5 \text{ Oz} = 411 \text{ g}$

$a = 14.0 \text{ cm}$ ,  $b = 8.50 \text{ cm}$

Guage Pressure --  $P_G = 13 \text{ psi}$  (Pressure above Atmospheric)

Atmospheric Pressure –  $P_A = 14.504 \text{ psi}$

Pressure of Football –  $P_F = P_A + P_G = 27.504 \text{ psi}$

Molecular Weight of Air –  $mW_{\text{Air}} = 28.96 \text{ g/mol}$

Molecular Weight of He –  $mW_{\text{He}} = 4.00 \text{ g/mol}$

Molecular Volume –  $mV = 24506 \text{ cm}^3/\text{mol}$

Volume of Football –  $V_F = (4/3)\pi ab^2 = 4237 \text{ cm}^3$

## Calculation of Weight

$$\text{Weight of Air in Football} = W_{\text{Air}} = mW_{\text{Air}} \left[ \frac{P_F V_F}{(mV)P_A} \right] = 9.67 \text{ g}$$

$$\text{Wight of He in Football} = W_{\text{He}} = mW_{\text{He}} \left[ \frac{P_F V_F}{(mV)P_A} \right] = 1.34 \text{ g}$$

$$\text{Weight of Football with Air} = W_{F(\text{Air})} = W_F + W_{\text{Air}} = 421 \text{ g} = 0.421 \text{ kg}$$

$$\text{Weight of Football with He} = W_{F(\text{He})} = W_F + W_{\text{Air}} = 412 \text{ g} = 0.412 \text{ kg}$$

**Conclusion: The He-filled football is about 2% lighter than the Air-filled football.**