

Problem 81

Consider the equation $s = s_0 + v_0t + a_0t^2/2 + j_0t^3/6 + S_0t^4/24 + ct^5/120$, where s is a length and t is a time. What are the dimensions and SI units of (a) s_0 , (b) v_0 , (c) a_0 , (d) j_0 , (e) S_0 , and (f) c ?

Solution

If s is length, then the six quantities being added, s_0 and v_0t and $a_0t^2/2$ and $j_0t^3/6$ and $S_0t^4/24$ and $ct^5/120$, have to have dimensions of length as well. This means the dimensions are

$$[s_0] = \text{Length}$$

$$[v_0t] = \text{Length} \quad \rightarrow \quad [v_0] \cdot \text{Time} = \text{Length} \quad \rightarrow \quad [v_0] = \frac{\text{Length}}{\text{Time}}$$

$$\left[\frac{a_0t^2}{2}\right] = \text{Length} \quad \rightarrow \quad [a_0] \cdot \text{Time}^2 = \text{Length} \quad \rightarrow \quad [a_0] = \frac{\text{Length}}{\text{Time}^2}$$

$$\left[\frac{j_0t^3}{6}\right] = \text{Length} \quad \rightarrow \quad [j_0] \cdot \text{Time}^3 = \text{Length} \quad \rightarrow \quad [j_0] = \frac{\text{Length}}{\text{Time}^3}$$

$$\left[\frac{S_0t^4}{24}\right] = \text{Length} \quad \rightarrow \quad [S_0] \cdot \text{Time}^4 = \text{Length} \quad \rightarrow \quad [S_0] = \frac{\text{Length}}{\text{Time}^4}$$

$$\left[\frac{ct^5}{120}\right] = \text{Length} \quad \rightarrow \quad [c] \cdot \text{Time}^5 = \text{Length} \quad \rightarrow \quad [c] = \frac{\text{Length}}{\text{Time}^5}.$$

Their SI units are

$$[s_0] = \text{meters}$$

$$[v_0] = \frac{\text{meters}}{\text{second}}$$

$$[a_0] = \frac{\text{meters}}{\text{second}^2}$$

$$[j_0] = \frac{\text{meters}}{\text{second}^3}$$

$$[S_0] = \frac{\text{meters}}{\text{second}^4}$$

$$[c] = \frac{\text{meters}}{\text{second}^5}.$$