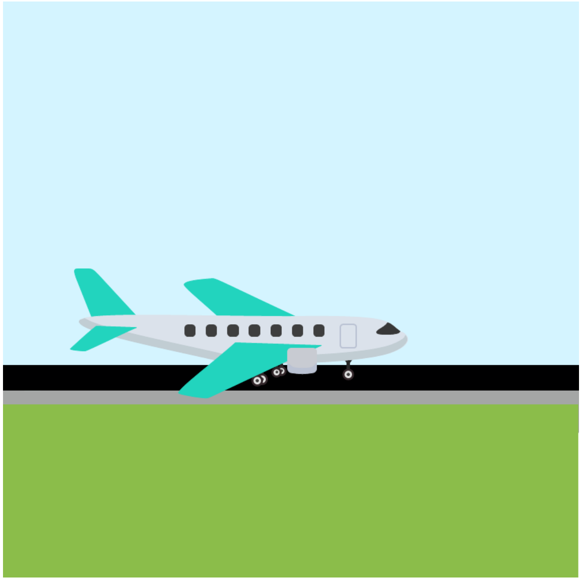
Acceleration Jet Transport



A jet transport with a landing speed of 270 km/h reduces its speed to 90 km/h with a negative thrust from its jet thrust reverses in a distance of $\Delta s = 625$ m along the runway with a constant deceleration. Compute the deceleration in m/s^2 of the jet.

Using known expressions (for arbitrary acceleration):

$$a = \frac{\mathrm{d}v}{\mathrm{d}t} \quad \Rightarrow \quad \mathrm{d}t = \frac{\mathrm{d}v}{a} \tag{1}$$

$$v = \frac{\mathrm{d}s}{\mathrm{d}t} \quad \Rightarrow \quad \mathrm{d}t = \frac{\mathrm{d}s}{v} \tag{2}$$

$$\mathrm{d}t = \frac{\mathrm{d}v}{a} = \frac{\mathrm{d}s}{v} \quad \Rightarrow \quad v\mathrm{d}v = a\mathrm{d}s \tag{3}$$

$$\int_{v_0}^{v_1} v\,\mathrm{d}v = \int_{s_0}^{s_1} a\,\mathrm{d}s \tag{4}$$

Given:

Distance: $\Delta s = 625$ m
Initial velocity: $v_0 = 270$ km/h $= 75$ m/s
End velocity: $v_1 = 90$ km/h $= 25$ m/s

Solution:

Using Equation (5) for a constant acceleration a results in:

$$\int_{v_0}^{v_1} v\,\mathrm{d}v = a\int_{s_0}^{s_1} \mathrm{d}s \tag{5}$$

$$\frac{1}{2}v^2\Big|_{v=v_0}^{v_1} = as|_{s=s_0}^{s_1} \tag{6}$$

$$\frac{1}{2}(v_1^2 - v_0^2) = a(s_1 - s_0) = a\Delta s \tag{7}$$

After substituting $\Delta s = 625$ m, $v_0 = 75$ m/s and $v_1 = 25$ m/s, this results in:

$$\frac{1}{2}(25^2 - 75^2) = a \cdot 625 \quad \Rightarrow \quad a = -4 \text{ m/s}^2 \tag{8}$$

Thus the acceleration is -4 m/s^2. Meaning the deceleration, the final answer, becomes 4 m/s^2.