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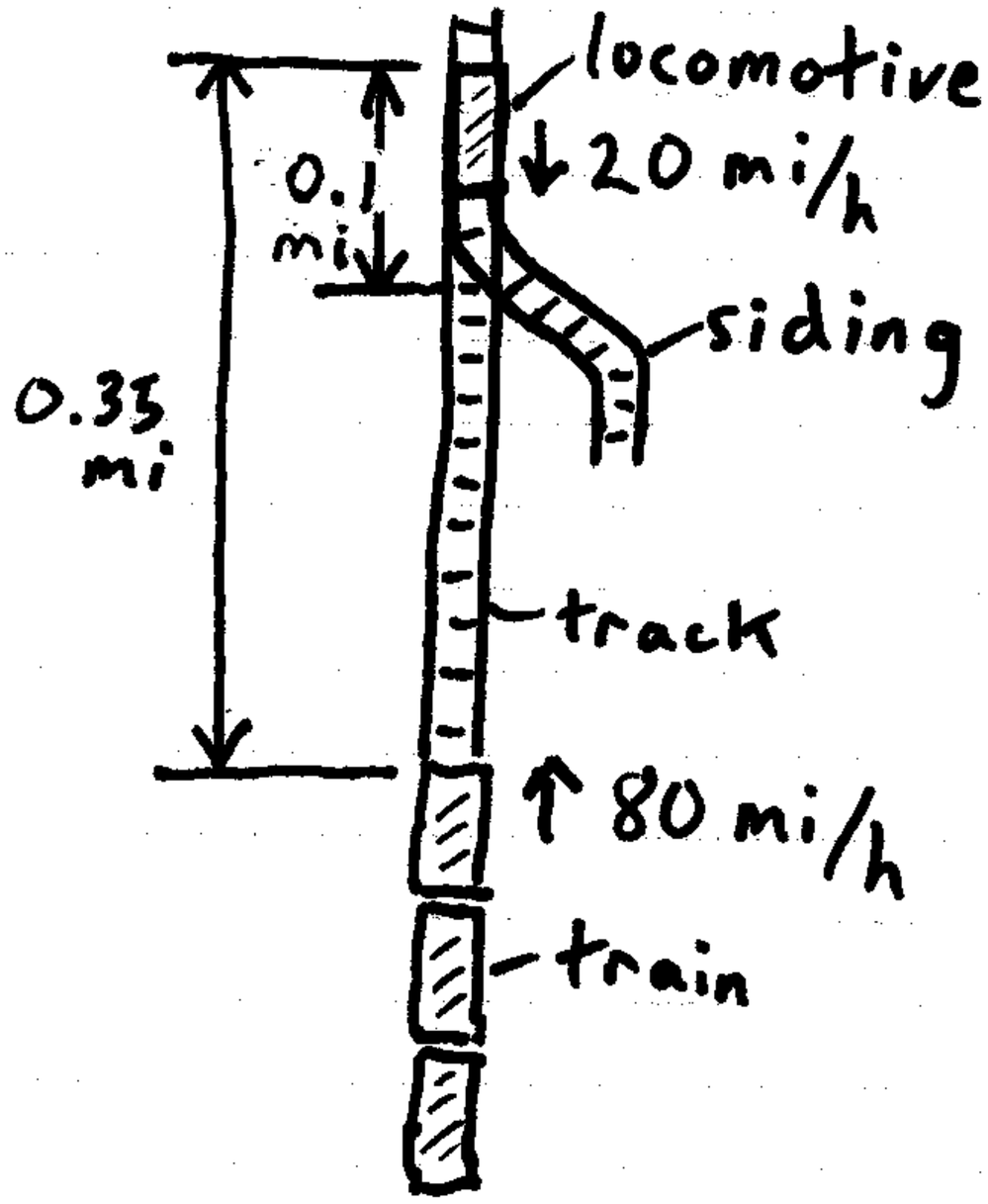
This is a 1-D problem involving constant acceleration.



A train is moving at high speed on a straight track, while at the same time a locomotive is moving in the opposite direction on the same track. In order to avoid a collision, the locomotive must move on to the siding before a collision becomes unavoidable. At the same time, the train must decelerate by putting the brakes on. At the instant shown, the front of the train is 0.35 mi from the back of the locomotive, the back of the locomotive is 0.1 mi from the siding entrance, the speed of the train is 80 mi/h, and the maximum speed of the locomotive is 20 mi/h. What is the minimum deceleration of the train?

Solution:

First, calculate the time it takes the locomotive to move on to the siding.

$$t = \frac{0.1\ mi}{20\ mi/h} = 0.005\ h$$

So, when 0.005 h has passed, the front of the train is precisely at the siding entrance (barely missing the locomotive), which is a result of decelerating at the minimum amount. At the instant shown, the front of the train is at a distance of (0.35 − 0.1) = 0.25 mi from the siding entrance.

Use the kinematic equation to solve for the deceleration of the train:

$$d = v_1 t + \frac{1}{2} a t^2$$

$d = 0.25\ mi$
$v_1 = 80\ mi/h$ (initial speed of train)
$t = 0.005\ h$
$a = ?$ (acceleration of train)

Substitute:

$$0.25 = 80(0.005) + \frac{1}{2} a (0.005)^2$$

$a = -12000\ mi/h^2 = -1.5\ m/s^2$ ∴ The minimum deceleration is $1.5\ m/s^2$ (ans.)