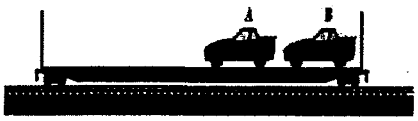
PROBLEM 14.2



Car A of mass 1800 kg and car B of mass 1700 kg are at rest on a flatcar which is also at rest. Cars A and B then accelerate and quickly reach constant speeds relative to the flatcar of 2.55 m/s and 2.50 m/s, respectively, before decelerating to a stop at the opposite end of the flatcar. Knowing that the speed of the flatcar is 0.34 m/s when the cars are moving at constant speeds, determine the mass of the flatcar. Neglect friction and rolling resistance.

SOLUTION

The masses are $m_A = 1800$ kg, $m_B = 1700$ kg, and m_F.

Let the final velocities be v_A, v_B, and $v_F = 0.34$ m/s, positive to the right.

Initial values: $(v_A)_0 = (v_B)_0 = (v_F)_0 = 0$

Initial momentum of system: $m_A(v_A)_0 + m_B(v_B)_0 + m_F(v_F)_0 = 0$

There are no horizontal external forces acting during the time period under consideration. Momentum is conserved.

$$0 = m_A v_A + m_B v_B + m_F v_F$$

Solving for m_F,

$$m_F = -\frac{m_A v_A + m_B v_B}{v_F} \qquad (1)$$

From the given relative velocities,

$V_{A/F} = V_A - V_F$

$$v_A = v_F + v_{A/F} = 0.34 - 2.55 = -2.21 \text{ m/s}$$
$$v_B = v_F + v_{B/F} = 0.34 - 2.50 = -2.16 \text{ m/s}$$

Substituting these values in (1),

$$m_F = -\frac{(1800)(-2.21) + (1700)(-2.16)}{0.34} = 22.5 \times 10^3 \text{ kg}$$

$m_F = 22.5$ Mg ◀

#14.2

+ ←

$m_A = 1800\,kg$ $\quad V_{0,B} = V_{0,A} = V_{0,F} = 0$

$m_B = 1700\,kg$

@ t = t

$V_{A/F} = 2.55\,m/s$

$V_{B/F} = 2.50\,m/s$

$V_F = 0.34\,m/s$ at this point

Find m_F $\quad$ Neglect f, resistance

$V_{A/F} = V_A - V_F$

$V_A = V_{A/F} + V_F$

$L_0 = 0$

$L_t \Rightarrow$ $\quad L_0 = L_t$

$$0 = m_A(\underbrace{2.55 + V_F}_{V_A}) + m_B(\underbrace{2.5 + V_F}_{V_B}) + m_F(\underbrace{0.34}_{V_F})$$

Solve for $m_F = -29{,}500\,kg$