

25. (a) The magnitude of the deceleration of each of the cars is  $a = f/m = \mu_k mg/m = \mu_k g$ . If a car stops in distance  $d$ , then its speed  $v$  just after impact is obtained from Eq. 2-16:

$$v^2 = v_0^2 + 2ad \implies v = \sqrt{2ad} = \sqrt{2\mu_k g d}$$

since  $v_0 = 0$  (this could alternatively have been derived using Eq. 8-31). Thus,

$$v_A = \sqrt{2(0.13)(9.8)(8.2)} = 4.6 \text{ m/s} \quad , \quad \text{and}$$

(b)  $v_B = \sqrt{2(0.13)(9.8)(6.1)} = 3.9 \text{ m/s}$ .

- (c) Let the speed of car  $B$  be  $v$  just before the impact. Conservation of linear momentum gives  $m_B v = m_A v_A + m_B v_B$ , or

$$v = \frac{(m_A v_A + m_B v_B)}{m_B} = \frac{(1100)(4.6) + (1400)(3.9)}{1400} = 7.5 \text{ m/s} .$$

The conservation of linear momentum during the impact depends on the fact that the only significant force (during impact of duration  $\Delta t$ ) is the force of contact between the bodies. In this case, that implies that the force of friction exerted by the road on the cars is neglected during the brief  $\Delta t$ . This neglect would introduce some error in the analysis. Related to this is the assumption we are making that the transfer of momentum occurs at one location – that the cars do not slide appreciably during  $\Delta t$  – which is certainly an approximation (though probably a good one). Another source of error is the application of the friction relation Eq. 6-2 for the sliding portion of the problem (after the impact); friction is a complex force that Eq. 6-2 only partially describes.