CHAPTER SIX SOLUTIONS

6.19 Consider the thrower first, with velocity after the throw of v_t

momentum after = momentum before

$(65.0 \text{ kg})v_t + (0.045 \text{ kg})(30.0 \text{ m/s}) = (65.045 \text{ kg})(2.50 \text{ m/s})$, or

$v_t = 2.48$ m/s.

Now, consider the (catcher + ball), with velocity of v_c after the catch:

$(60.045 \text{ kg})v_c = (0.045 \text{ kg})(30.0 \text{ m/s}) + (60 \text{ kg})(0)$, or $v_c = 2.25 \times 10^{-2}$ m/s.

6.23 (a) $\mathbf{p}_{after} = \mathbf{p}_{before}$ becomes $(3M)v = M(3.00 \text{ m/s}) + (2M)(1.20 \text{ m/s})$, where M is the common mass of the cars, and $\mathbf{v}$ is the velocity of the combination after the collision. This gives $v = 1.80$ m/s.

(b) $KE_{before} = \frac{1}{2}(2.00 \times 10^4 \text{ kg})(3.00 \text{ m/s})^2 + \frac{1}{2}(4.00 \times 10^4 \text{ kg})(1.20 \text{ m/s})^2$

$= 1.19 \times 10^5$ J.

$KE_{after} = \frac{1}{2}(60000 \text{ kg})(1.80 \text{ m/s})^2 = 9.72 \times 10^4$ J.

Thus, the kinetic energy lost $= 2.16 \times 10^4$ J.

6.28 (a) Using conservation of momentum, $(\mathbf{P}_{total})_{before} = (\mathbf{P}_{total})_{after}$, gives

$(4.0 \text{ kg})(5.0 \text{ m/s}) + (10 \text{ kg})(3.0 \text{ m/s}) + (3.0 \text{ kg})(-4.0 \text{ m/s})$
$= [(4.0 + 10 + 3.0)\text{kg}]v$,

where v is the speed of the three mass system after collision. Therefore, $v = +2.2$ m/s, or 2.2 m/s toward the right.

(b) No. For example, if the 10 kg and 3.0 kg mass were to stick together first, they would move with a speed given by solving

$(13 \text{ kg})v_1 = (10 \text{ kg})(3.0 \text{ m/s}) + (3.0 \text{ kg})(-4.0 \text{ m/s})$, so $v_1 = 1.38$ m/s.

Then when this 13 kg combined mass collides with the 4.0 kg mass, we have $(17 \text{ kg})v = (4.0 \text{ kg})(5.0 \text{ m/s}) + (13 \text{ kg})(1.38 \text{ m/s})$, so that

$v = 2.2$ m/s, just like part (a)

6.33 (a) First, we conserve momentum in the x direction (the direction of travel of the fullback):

$(90 \text{ kg})(5.0 \text{ m/s}) + 0 = (185 \text{ kg})V\cos\theta$

where θ is the angle between the direction of the final velocity $\mathbf{V}$ and the x axis. We find: $V\cos\theta = 2.43$ m/s (1)

Now consider conservation of momentum in the y direction (the direction of travel of the opponent.

$(95 \text{ kg})(3.0 \text{ m/s}) + 0 = (185 \text{ kg})(V\sin\theta)$

which gives, $V\sin\theta = 1.54$ m/s (2)

Divide equation (2) by (1):

$\tan\theta = 1.54/2.43 = 0.633$, from which $\theta = 32.3°$.

Then, either (1) or (2) gives: $V = 2.9$ m/s.

(b) $KE(\text{before}) = \frac{1}{2}(90 \text{ kg})(5.0 \text{ m/s})^2 + \frac{1}{2}(95 \text{ kg})(3.0 \text{ m/s})^2 = 1.55 \times 10^3$ J

$KE(\text{after}) = \frac{1}{2}(185 \text{ kg})(2.88 \text{ m/s})^2 = 7.67 \times 10^2$ J

Thus, the kinetic energy lost (to 2 sig. figures) is 780 J.

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6.43 We shall first use conservation of energy to find the speed of the bead just before it strikes the ball. The zero level of potential energy is at the level of point B. We have, $(1/2)mv_i^2 + mgy_i = (1/2)mv_f^2 + mgy_f$, or

$0 + (0.400 \text{ kg})(g)(1.50 \text{ m}) = \frac{1}{2}(0.400 \text{ kg})\, v_{1i}^2 + 0$, giving $v_{1i} = 5.42$ m/s.

We now treat the collision to find the speed of the ball immediately after the collision. Momentum conservation gives:

$$(0.400 \text{ kg})(5.42 \text{ m/s}) + 0 = (0.400 \text{ kg})v_{1f} + (0.600 \text{ kg})v_{2f} \qquad (1)$$

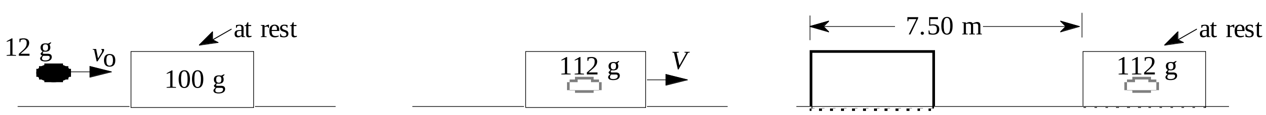
For an elastic collision, $v_{1f} + v_{1i} = v_{2f} + v_{2i}$,

or $v_{1f} + 5.42 = v_{2f} + 0$. (2)

Solve (1) and (2) simultaneously to find, $v_{2f} = 4.34$ m/s.

Apply conservation of energy to the 0.6 kg ball after impact to find:

$$\frac{1}{2}(0.600 \text{ kg})(4.34 \text{ m/s})^2 + 0 = 0 + (0.600 \text{ kg})(g)H, \quad \text{or} \quad H = 0.96 \text{ m}.$$



Immediately Before Impact — Immediately After Impact — At the end

6.45 Using conservation of energy from immediately after to the end gives:

$KE)_{after} = KE)_{end}$ + (work done against friction),

or, $\frac{1}{2}(M + m)V^2 = 0 + fd = (\mu N)d$.

$$\frac{1}{2}(0.112 \text{ kg})\, V^2 = (0.650)\,((0.112 \text{ kg})(9.80 \text{ m/s}^2))(7.50 \text{ m}),$$

from which, $V = 9.77$ m/s.

Then, using conservation of momentum from immediately before to immediately after impact gives:

$$(0.012 \text{ kg})v_o + (0.100 \text{ kg})(0) = (0.112 \text{ kg})(9.77 \text{ m/s}),$$

or $v_o = 91.2$ m/s.

6.49 (a) The initial momentum of the system is zero, which remains constant throughout the motion. Therefore, when m_1 leaves the wedge, we must have

$$m_2 v_{wedge} + m_1 v_{block} = 0, \text{ or}$$

$$(3.00 \text{ kg})v_{wedge} + (0.500 \text{ kg})\left(+4.00 \frac{\text{m}}{\text{s}}\right) = 0, \text{ so}$$

$$v_{wedge} = -0.670 \text{ m/s}.$$

(b) Using conservation of energy as the block slides down the smooth (frictionless) wedge, we have

$$[KE_{block} + PE_{block}]_i + [KE_{wedge}]_i = [KE_{block} + PE_{block}]_f + [KE_{wedge}]_f$$

or $[0 + m_1 gh] + 0 = [\frac{1}{2}m_1(4.00)^2 + 0] + \frac{1}{2}m_2(-0.670)^2$, which gives

$$h = 0.953 \text{ m}.$$

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