Oberlin College Physics 103, Fall 2023

Model Solutions to Assignment 4

Problems from *College Physics* by P.P. Urone and R. Hinrichs.

Chapter 4, problem 5

First:

$$\begin{aligned} \text{net force} &= \text{force due to person} - \text{force due to friction} \\ 51\text{ N} &= \text{force due to person} - 24\text{ N} \\ \text{force due to person} &= 75\text{ N} \end{aligned}$$

Second: If no force due to person, then

$$\begin{aligned} \sum F &= ma \\ -24\text{ N} &= (24\text{ kg})a \\ a &= \frac{-24\text{ N}}{24\text{ kg}} = -1.0\text{ m/s}^2. \end{aligned}$$

Third: How far does it role before stopping?

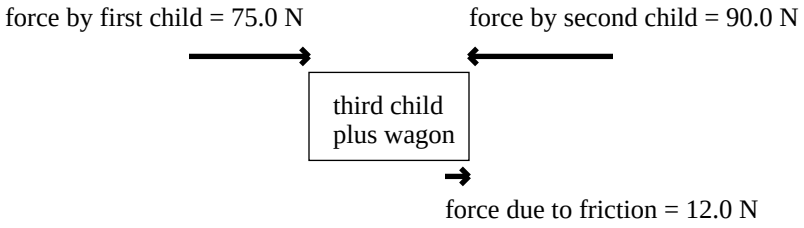
$$\begin{aligned} v^2(x) &= v_0^2 + 2a_0(x - x_0) \\ 0 &= (1.5\text{ m/s})^2 + 2(-1.0\text{ m/s}^2)(\text{distance before stopping}) \\ \text{distance before stopping} &= \frac{(1.5\text{ m/s})^2}{2(-1.0\text{ m/s}^2)} = 1.1\text{ m}. \end{aligned}$$

⟦*Grading:* 1 point for free. Each part (first, second, and third) is worth three points: 1 point for setup; 1 point for execution to get the right number; 1 point for getting two significant figures and proper units.⟧

Chapter 4, problem 9

(a) The system of interest is the third child plus wagon.

(b) Free body diagram:



(c) Acceleration:

$$\begin{aligned} \sum F &= ma \\ (75.0\text{ N}) - (90.0\text{ N}) + (12.0\text{ N}) &= (23.0\text{ kg})a \\ a &= \frac{-3.0\text{ N}}{23.0\text{ kg}} = -0.13\text{ m/s}^2. \end{aligned}$$

(d) If frictional force were instead 15.0 N, acceleration would be zero.
⟦*Grading:* 1 point for each of parts (a) and (d); 4 points for (b): two points for 3 forces, two more points for forces in proper directions; 4 points for (c): one point for setup, one point for correct number, one point for units, one point for two significant digits.⟧

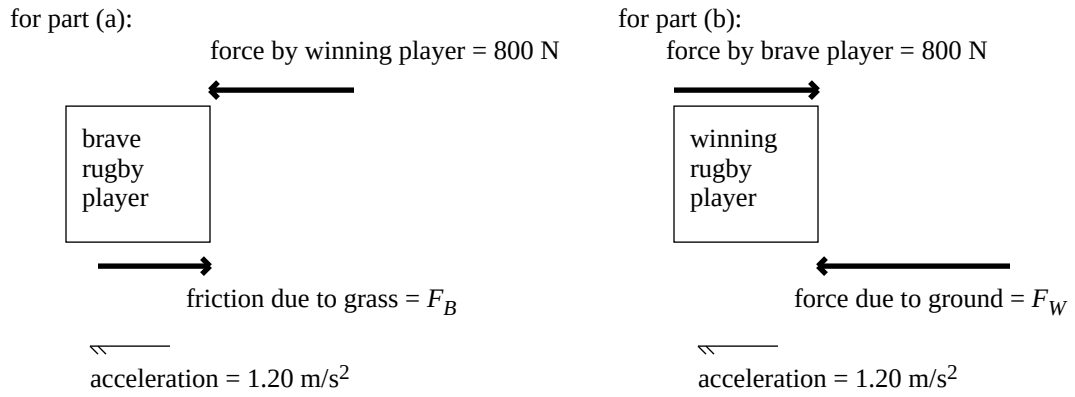
Chapter 4, problem 16
(a) For the brave rugby player:

$$\begin{aligned} \sum F &= ma \\ F_B - (800\text{ N}) &= (90.0\text{ kg})(-1.20\text{ m/s}^2) \\ F_B &= (90.0\text{ kg})(-1.20\text{ m/s}^2) + 800\text{ N} = 692\text{ N}. \end{aligned}$$

(b) For the winning rugby player:

$$\begin{aligned} \sum F &= ma \\ (800\text{ N}) - F_W &= (110\text{ kg})(-1.20\text{ m/s}^2) \\ F_W &= 800\text{ N} + (110\text{ kg})(1.20\text{ m/s}^2) = 932\text{ N}. \end{aligned}$$

(c) Two free body diagrams:



⟦*Grading:* part (a): 1 point for setup, 1 point for answer; part (b): 1 point for setup, 1 point for answer; part (c): 3 points for free-body diagram on left ("brave"), 3 points for free-body diagram on right ("winning").⟧

Chapter 4, problem 22

When the baby is being weighed, it is not accelerating. So for all four systems shown in part (d) [upper cord, scale, lower cord, baby plus basket], the sum of forces must vanish.

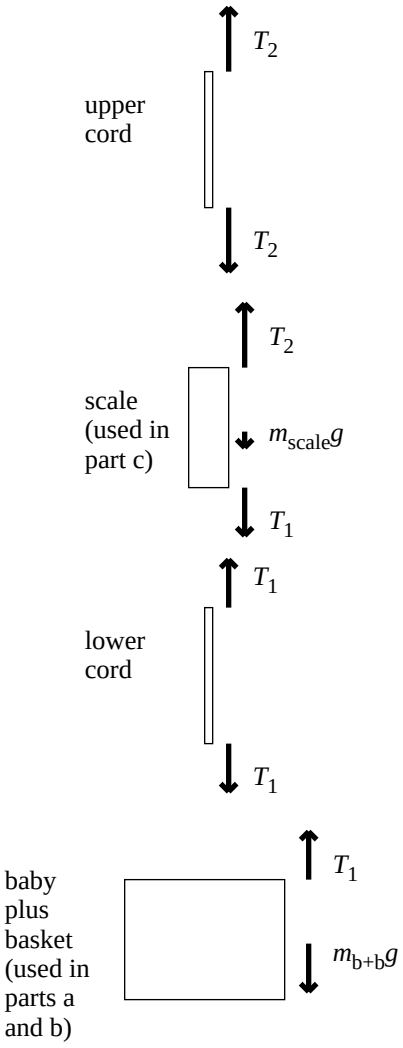
(a) Mass of baby plus basket is

$$m_{\mathrm{b+b}} = \frac{T_1}{g} = \frac{55\ \mathrm{N}}{9.81\ \mathrm{m/s^2}} = 5.6\ \mathrm{kg}.$$

(b) $T_1 = 55$ N

(c) $T_2 = T_1 + m_{\mathrm{scale}}g = 55\ \mathrm{N} + (0.500\ \mathrm{kg})(9.81\ \mathrm{m/s^2}) = 55\ \mathrm{N} + 4.91\ \mathrm{N} = 60\ \mathrm{N}.$

(d)



⟦*Grading:* each of parts (a), (b), and (c): 1 point for setup, 1 point for answer; part (d): 4 points.⟧