1. (Ch07, Q02) The **first force** is larger. Impulse is given by

\[
\text{Impulse} = F \times \Delta t
\]

so if the time is twice as long (second force) the magnitude of the other (first force) must be twice as great.

2. (Ch07, Q08) A padded dash board will **increase the time** over which the force acts to change your velocity in the collision. Since the change in velocity is proportional to the impulse

\[
\text{Impulse} = F \times \Delta t = m \times \Delta v
\]

the force your body experiences will be decreased.

3. (Ch07, Q13) The principle of conservation of momentum is **always valid**. No special conditions apply.

4. (Ch07, Q17)
   
   (a) Both the car and the truck experience the **same force**, by *Newton’s third law*.
   
   (b) The car and the truck are in contact the same amount of time, and they experience the same force. Hence the **impulse** \( F \times \Delta t \) **is the same**.
   
   (c) Impulse equals change in momentum. Since they experience the same impulse, they experience the **same change in momentum**.
   
   (d) The large truck has a larger mass. If the car and truck experience the same change in momentum \( \Delta p = m \Delta v \), the **car must experience a greater \( \Delta v \) hence greater acceleration**.

5. (Ch07, Q20) The **smaller mass shotgun** will recoil with greater velocity. Since the change in momentum \( \Delta p = m \Delta v \) must be the same, if the mass is smaller the change in velocity must be greater.

6. (Ch07, E04)
   
   (a) 
   
   \[
   \text{Impulse} = F \times \Delta t = 45 \times 0.2 = 9.0 \text{ kg} \cdot \text{m/sec}
   \]
   
   (b) 
   
   \[
   \text{Impulse} = \Delta P = 9.0 \text{ kg} \cdot \text{m/sec}
   \]
7. (Ch07, E06)

(a) From the definition of impulse

\[
\text{Impulse} = \Delta P = 24 \text{ kg} \cdot \text{m/sec}
\]

(b)

\[
\text{Impulse} = \Delta P = F\Delta t
\]

so with some algebra

\[
F = \frac{\Delta P}{\Delta t} = \frac{24}{0.15} = 160 \text{ Newtons}
\]

8. (Ch07, E10)

(a) The momentum of the fullback and defensive back (“dback”) are

\[
\begin{align*}
\text{p}_{\text{fullback}} &= mv = 100 \times 3.5 = 350 \text{ kg} \cdot \text{m/s west} \\
\text{p}_{\text{dback}} &= mv = 80 \times 6 = 480 \text{ kg} \cdot \text{m/s east}
\end{align*}
\]

(b) The total momentum before the collision is

\[
350 \text{ kg} \cdot \text{m/s west} + 480 \text{ kg} \cdot \text{m/s east} = 130 \text{ kg} \cdot \text{m/s east}
\]

That is, the difference between the two players’ momenta. Since there is more momentum moving east than west, the total momentum is to the east.

(c) After the collision, they will be moving in the direction of the total momentum, to the east.

9. (Ch07, E12)

(a) The momentum of the bullet is

\[
\text{p}_{\text{bullet}} = mv = 0.006 \times 600 = 3.6 \text{ kg} \cdot \text{m/s}
\]

(b) The rifle will recoil in the opposite direction, with momentum of the same magnitude as the bullet. Solving the momentum definition \( p = mv \) for the velocity, we get

\[
v_{\text{rifle}} = \frac{p}{m} = \frac{3.6}{1.2} = 3 \text{ m/s}
\]
10. (Ch07, E14)

(a) Defining the momentum of the first car as $p_1$, we have

\[ p_1 = mv = 12,000 \times 12 = 144,000 \text{ kg} \cdot \text{m/s} \]

(b) After the collision, if external forces can be ignored, the final momentum $p_f$ of the two coupled cars will be the same as the initial momentum $p_1$ of the system:

\[ p_f = (m_1 + m_2)v_f \]

where $m_1$ and $m_2$ are the masses of the two cars. Solving for $v_f$

\[ v_f = \frac{p_f}{m_1 + m_2} = \frac{144,000}{(12,000 + 18,000)} = 4.8 \text{ m/s} \]