\[ y = 12 \]
\[ g = -9.8 \]
\[ V_i = 0 \]
\[ V_f = \sqrt{V_i^2 + 2gy} \]
\[ V = \sqrt{2gy} \]
\[ \text{m/s} \]

bullet block

\[ M_1V_{i1} + M_2V_{i2} = (M_1 + M_2)V_f \]
\[ 0.002(700) = (0.002 + 5)V_f \]

\[ J = \text{impulse} \]

\[ F_{at} = m\Delta v \]
\[ J = m\Delta v \]
\[ \overrightarrow{\Delta p} = \overrightarrow{F} \Delta t \]

\[ \overrightarrow{p} = m \overrightarrow{v} \]

\[ \text{not on chart} \]

\[ F_{\text{tot}} = m a v \]

\[ m (v_f - v_i) \]

\[ \text{elastic} \]

\[ m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2} \]

\[ \text{inelastic} \]

\[ m_1 v_{i1} + m_2 v_{i2} = \left( \frac{m_1 + m_2}{m_1} \right) v_f \]

\[ \text{explosion} \]

\[ (m_1 + m_2) v = m_1 v_{f1} + m_2 v_{f2} \]

\[ m = .475 \]

\[ v_i = -12 \]

\[ v_f = 8.5 \]

\[ \overrightarrow{F} = 1275 \]

\[ \Delta t \]

\[ F_{\text{tot}} = m a v \]

\[ (8.5 + -12) \]
17) An empty train car of mass $2.0 \times 10^4$ kg coasts along at 10 m/s. A 3000-kg boulder is suddenly dropped vertically into the car. Find the speed of the car immediately after the boulder is dropped in.

\[ m_1 v_1 + m_2 v_2 = (m_1 + m_2) v \]

19) A 1200-kg cannon suddenly fires a 100-kg cannonball at 35 m/s. What is the recoil speed of the cannon? Assume that frictional forces are negligible and the cannon is fired horizontally.

A) 2.9 m/s  
B) 35 m/s  
C) 3.5 m/s  
D) 3.2 m/s
18) A small car meshes with a large truck in a head-on collision. Which of the following statements concerning the magnitude of the average force during the collision is correct? 
A) The truck experiences the greater average force. 
B) The small car experiences the greater average force. 
C) The small car and the truck experience the same average force. 
D) The force experienced by each one is inversely proportional to its mass. 
E) The force experienced by each one is directly proportional to its mass. 

2) A 0.14-kg baseball is dropped from rest from a height of 2.0 m above the ground. What is the magnitude of its momentum just before it hits the ground if we neglect air resistance? 
A) 0.28 kg \cdot m/s 
B) 0.88 kg \cdot m/s 
C) 0.44 kg \cdot m/s 
D) 0.62 kg \cdot m/s 
E) 1.4 kg \cdot m/s 

\[ g = 9.8 \quad \sqrt{v_f^2} = \sqrt{v_i^2 + 2gy} \]
\[ y = -2 \quad \sqrt{v_f} = \sqrt{2gy} \]
\[ v_i = 0 \quad \sqrt{v_f} \]
\[ p = m \cdot v \]

1) What is the magnitude of the momentum of a 0.140 kg baseball traveling at 45.0 m/s?
7) A 0.140-kg baseball is dropped and reaches a speed of 1.20 m/s just before it hits the ground and bounces. It rebounds with an upward velocity of 1.00 m/s. What is the change of the ball's momentum during the bounce?
A) 0.0280 kg \cdot m/s upwards
B) 0.0280 kg \cdot m/s downwards
C) 0.308 kg \cdot m/s upwards
D) 0.308 kg \cdot m/s downwards
E) 0.000 kg \cdot m/s

\[ \Delta p = m(v_f - v_i) \]
\[ \Delta p = 0.14 \cdot 1 \cdot (1 - 1.2) \]

14) In a police ballistics test, a 2.00-g bullet traveling at 700 m/s suddenly hits and becomes embedded in a stationary 5.00-kg wood block. What is the speed of the block immediately after the bullet has stopped moving relative to the block?
28) A forklift pushes a 100-kg crate, starting from rest, with a horizontal force of magnitude $F$. The graph in the figure shows the $x$ component of this force as a function of time. What is the instantaneous velocity of the crate at time $t = 10$ s?

\[ J = -75 \text{ Ns} \]

\[ F \Delta t = m \Delta v \]

\[-75 = 100(\Delta v) \]

\[ \Delta v = -0.75 \text{ m/s} \]
32) A 0.17-kg baseball is thrown with a speed of 38 m/s and it is hit straight back toward the pitcher with a speed of 62 m/s. What is the magnitude of the impulse exerted upon the ball by the bat?

\[ \frac{F \Delta t}{m} = m \Delta v \]

35) A 0.140-kg baseball is thrown with a velocity of 27.1 m/s. It is struck by the bat with an average force of 5000 N, which results in a velocity of 37.0 m/s in the opposite direction from the original velocity. How long were the bat and ball in contact?

A) \(1.79 \times 10^{-3}\) s
B) \(1.28 \times 10^{-2}\) s
C) \(3.07 \times 10^{-2}\) s
D) \(4.30 \times 10^{-3}\) s

\[ \frac{F \Delta t}{m} = m \Delta v \]

\[ 5000 \Delta t = 0.14(-37 - 27.1) \]

38) A 475-gram ball is traveling horizontally at 12.0 m/s to the left when it is suddenly struck horizontally by a bat, causing it to reverse direction and initially travel at 8.50 m/s to the right. If the bat produced an average force of 1275 N on the ball, for how long (in milliseconds) was it in contact with the ball?
17) An empty train car of mass $2.0 \times 10^4$ kg coasts along at 10 m/s. A 3000-kg boulder is suddenly dropped vertically into the car. Find the speed of the car immediately after the boulder is dropped in.

19) A 1200-kg cannon suddenly fires a 100-kg cannonball at 35 m/s. What is the recoil speed of the cannon? Assume that frictional forces are negligible and the cannon is fired horizontally.
A) 2.9 m/s
B) 35 m/s
C) 3.5 m/s
D) 3.2 m/s

\[ (m_1 + m_2) \vec{v} = m_1 \vec{v_1} + m_2 \vec{v_2} \]
D) 0.308 kg \cdot m/s downwards
E) 0.000 kg \cdot m/s

14) In a police ballistics test, a 2.00-g bullet traveling at 700 m/s suddenly hits and becomes embedded in a stationary 5.00-kg wood block. What is the speed of the block immediately after the bullet has stopped moving relative to the block?

\[ m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f \]

bullet block

17) An empty train car of mass 2.0 \times 10^4 \text{ kg} coasts along at 10 m/s. A 3000-kg boulder is suddenly dropped vertically into the car. Find the speed of the car immediately after the boulder is dropped in.

19) A 1200-kg cannon suddenly fires a 100-kg cannonball at 35 m/s. What is the recoil speed of the cannon? Assume that frictional forces are negligible and the cannon is fired horizontally.
A) 2.9 m/s
B) 35 m/s
C) 3.5 m/s
D) 3.2 m/s
\[ V_i = -1.2 \]
\[ V_f = 1 \]
\[ m = 0.14 \]
\[ \Delta P = m(V_f - V_i) \]
\[ 0.14 \times (1 + 1.2) \]
\[ 0.308 \]