Physics 4A
Fall 2025

Name Answer Key

Lab: 8:00 am 11:20 am 2:40 pm (circle one)

Quiz #9: Impulse and Momentum

Problem 1 (2 points)
A rifle of mass M is initially at rest but free to recoil. It fires a bullet of mass m and velocity v (relative to the ground). After firing, the velocity of the rifle (relative to the ground) is:

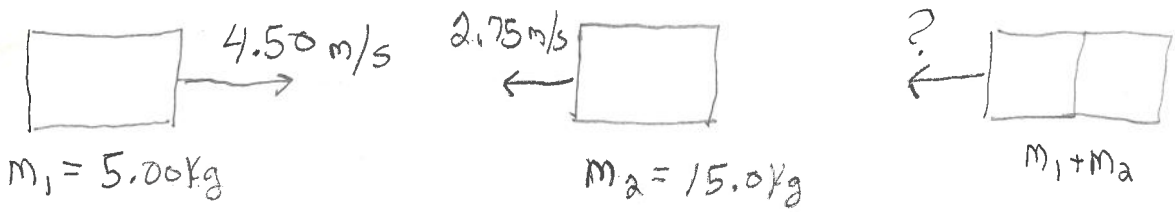
a) $-mv$
b) $-Mv/m$
c) $-mv/M$
d) $-v$
e) mv/M

C

$\vec{P}_i = \vec{P}_f$

$0 = mv + MV_{rifle} \rightarrow$ $\boxed{V_{rifle} = -\frac{mv}{M}}$

Problem 2 (4 points)
A 5.00 kg object is traveling at 4.50 m/s to the right and collides with a 15.0 kg object traveling at 2.75 m/s to the left. If the two objects stick together after the collision, what is their combined velocity after the collision?



system → both objects

$\sum F_{ext,x} = 0 \rightarrow P_{f,x} = P_{i,x}$

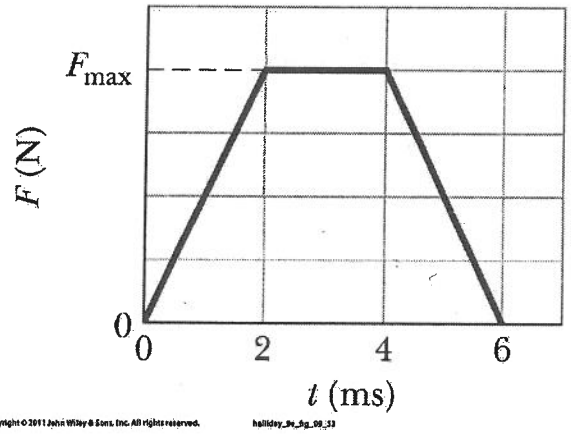
$(m_1 + m_2) V_{f,x} = m_1 V_{1i,x} + m_2 V_{2i,x}$

$V_{fx} = \frac{m_1 V_{1i,x} + m_2 V_{2i,x}}{(m_1 + m_2)}$

$V_{f,x} = \frac{(5.00kg)(4.50m/s) + (15.0kg)(-2.75m/s)}{(5.0kg + 15.0kg)}$

$\boxed{V_{f,x} = -0.938\ m/s}$

Problem 3 (4 points)
The figure below shows the magnitude of the force F versus time t during the collision of a 75 g superball with a wall. The initial velocity of the ball is 32 m/s perpendicular to the wall. The ball rebounds directly back with a speed of 28 m/s, also perpendicular to the wall. What is F_{max}, the maximum magnitude of the force on the ball from the wall during the collision? (Note: time is in milliseconds)



$\leftarrow$ ○ $v_{ix} = -32$ m/s

○ $\rightarrow$ $v_{fx} = +28$ m/s

$\Delta p_x = m(v_{fx} - v_{ix})$

$= (0.075\,kg)[28\,m/s - (-32\,m/s)]$

$\Delta p_x = 4.5\,kg\,m/s$

J_x = area under curve of F_x vs. t = Δp_x

$J_x = \frac{1}{2} F_{max}(2ms) + F_{max}(2ms) + \frac{1}{2} F_{max}(2ms) = \Delta p_x$

$F_{max}(4ms) = \Delta p_x \rightarrow F_{max} = \frac{\Delta p_x}{(4ms)}$

$F_{max} = \frac{4.5\,kg\,m/s}{(4.0 \times 10^{-3}\,s)} \rightarrow$ $F_{max} = 1125\,N$

$= 1 \times 10^3\,N$