Name:_____Class:_____ Date:_____

Momentum and Collisions

Problem B

FORCE AND IMPULSE

PROBLEM

A student with a mass of 55 kg rides a bicycle with a mass of 11 kg. A net force of 125 N to the east accelerates the bicycle and student during a time interval of 3.0 s. What is the final velocity of the bicycle and student? Assume the student and bicycle are initially at rest.

SOLUTION

Given: $m_s = 55$ kg

$m_b = 11$ kg

$\mathbf{F} = 125$ N to the east

$\Delta t = 3.0$ s

$\mathbf{v_i} = 0$ m/s

Unknown: $\mathbf{v_f} = ?$

Use the impulse-momentum theorem to solve for $\mathbf{v_f}$.

$$\mathbf{F}\Delta t = \Delta \mathbf{p} = m\mathbf{v_f} - m\mathbf{v_i}$$

$$\mathbf{v_f} = \frac{\mathbf{F}\Delta t + m\mathbf{v_i}}{m}$$

$$m = m_s + m_b = 55 \text{ kg} + 11 \text{ kg} = 66 \text{ kg}$$

$$\mathbf{v_f} = \frac{(125 \text{ N})(3.0 \text{ s}) - (66 \text{ kg})(0 \text{ m/s})}{66 \text{ kg}}$$

$$\mathbf{v_f} = \frac{(125 \text{ N})(3.0 \text{ s})}{66 \text{ kg}}$$

$$\mathbf{v_f} = \boxed{5.7 \text{ m/s to the east}}$$

ADDITIONAL PRACTICE

1. A net force of 10.0 N to the right pushes a 3.0 kg book across a table. If the force acts on the book for 5.0 s, what is the book's final velocity? Assume the book to be initially at rest.
2. A 60.0 g egg dropped from a window is caught by a student. If the student exerts a net force of −1.5 N over a period of 0.25 s to bring the egg to a stop, what is the egg's initial speed?
3. A child riding a sled is pulled down a snowy hill by a force of 75 N. If the child and sled have a combined mass of 55 kg, what is their speed after 7.5 s? Assume the child and sled are initially at rest.

4. A billiard ball with a mass of 0.195 kg and a velocity of 0.850 m/s to the right is deflected by the cushioned edge of the billiard table. The cushion exerts a force of 3.50 N to the left for 0.0750 s. What is the ball's final velocity?
5. A 5.00 g projectile has a velocity of 255 m/s to the right. What force is required to stop this projectile in 1.45 s?
6. The Pacific walrus has an average mass of 1.1×10^3 kg and can swim with a speed of about 9.7 m/s. Suppose a walrus starting from rest takes 19 s to reach a velocity of 9.7 m/s to the east. What net force acts upon the walrus?
7. With a mass of 3.000×10^3 kg, the Russian-made Zil-41047 is the most massive automobile to have been manufactured on a regular basis. Suppose one of these cars accelerates from rest to a velocity of 8.9 m/s to the right in 5.5 s. Calculate the net force acting on the Zil-41047.
8. How much time would it take for a 0.17 kg ice hockey puck to decrease its speed by 9.0 m/s if the coefficient of kinetic friction between the ice and the puck is 0.050?
9. A girl pulls a 12.0 kg wagon along by exerting a force of 15.0 N on the wagon's handle, which makes an angle of 20.0° with the horizontal. Friction provides a force of 11.0 N in the opposite direction. How long does it take for the wagon, which is initially at rest, to reach a speed of 4.50 m/s?
10. The compressed air device at Sandia Laboratories in Albuquerque, New Mexico, accelerates small metal disks to a speed of 15.8 km/s. Suppose the compressed air exerts a force of 12.0 N on a 0.20 g disk that is initially at rest. How long will it take the disk to reach its maximum speed?