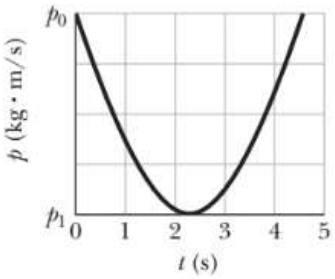
**Linear Momentum Problems**

1. A 0.70 kg ball moving horizontally at 5.0 m/s strikes a vertical wall and rebounds with speed 2.0 m/s. What is the magnitude of the change in its linear momentum?

2. A 0.300 kg softball has a velocity of 15.0 m/s at an angle of 35.0° be- low the horizontal just before making contact with the bat. What is the magnitude of the change in momentum of the ball while in contact with the bat if the ball leaves with a velocity of (a) 20.0 m/s, vertically downward, and (b) 20.0 m/s, horizontally back toward the pitcher?

3. At time $t = 0$, a ball is struck at ground level and sent over level ground. The momentum $p$ versus $t$ during the flight is given by the figure shown below (with $p_0 = 6.0\ \text{kg} \cdot \text{m/s}$ and $p_1 = 4.0\ \text{kg} \cdot \text{m/s}$). At what initial angle is the ball launched? (Hint: Find a solution that does not require you to read the time of the low point of the plot.)




4. An object is tracked by a radar station and determined to have a position vector given by

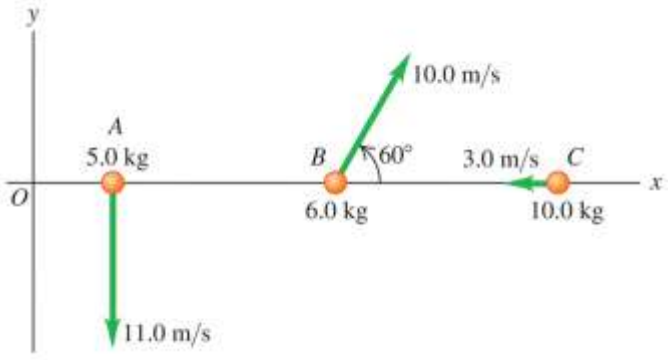
$$\vec{r}(t) = (3500 - 160t)\hat{\imath} + 2700\hat{\jmath} + 300\hat{k}$$

with $\vec{r}$ in meters and $t$ in seconds. The radar station's $x$ axis points east, its $y$ axis north, and its $z$ axis vertically up. If the object is a 250 kg meteorological missile, what are (a) its linear momentum, (b) its direction of motion, and (c) the net force on it?

5. Starting at $t = 0$, a horizontal net external force $\vec{\boldsymbol{F}}(t) = (0.280\ \text{N/s})t\hat{\imath} + (-0.450\ \text{N/s}^2)t^2\hat{\jmath}$ is applied to a box that has an initial momentum $\vec{\boldsymbol{p}} = (-3.00\ \text{kg} \cdot \text{m/s})\hat{\imath} + (4.00\ \text{kg} \cdot \text{m/s})\hat{\jmath}$. What is the momentum of the box at $t = 2.00$ s?

6. A young ice skater with mass 40.0 kg has fallen and is sliding on the frictionless ice of a skating rink with a speed of 20.0 m/s. (a) What is the magnitude of her linear momentum when she has this speed? (b) What is her kinetic energy? (c) What constant net horizontal force must be applied to the skater to bring her to rest in 5.00 s?

7. Objects $A$, $B$, and $C$ are moving as shown in the figure below. Find the $x$- and $y$-components of the net momentum of the particles if we define the system to consist of (a) $A$ and $C$, (b) $B$ and $C$, and (c) all three objects.




8. One 110 kg football lineman is running to the right at 2.75 m/s while another 125 kg lineman is running directly toward him at 2.60 m/s. What are (a) the magnitude and direction of the net momentum of these two athletes, and (b) their total kinetic energy?