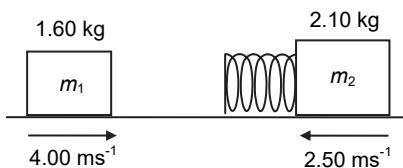




- 23.** A block of mass  $m_1 = 1.60 \text{ kg}$  initially moving to the right with a speed of  $4.00 \text{ ms}^{-1}$  on a frictionless horizontal track collides with a spring attached to a second block of mass  $m_2 = 2.10 \text{ kg}$  initially moving to the left with a speed of  $2.50 \text{ ms}^{-1}$ . The spring constant is  $600 \text{ Nm}^{-1}$ .



Find the velocities of the two blocks after the collision.

- During the collision, at the instant mass 1 is moving to the right with a velocity of  $3.00 \text{ ms}^{-1}$ , determine the velocity of mass 2.
- Determine the distance the spring is compressed at that instant.
- What is the maximum compression of the spring during the collision?



- 24.** An aeroplane is flying horizontally at a steady speed of  $67 \text{ ms}^{-1}$ . A parachutist falls from the aeroplane freely for  $80 \text{ m}$  (vertical height) before the parachute opens. Assume that air resistance is negligible before the parachute opens.

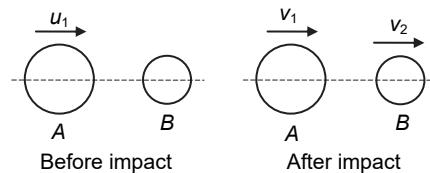
- Determine the magnitude and direction of the resultant velocity of the parachutist when he has fallen  $80 \text{ m}$ .
- Sketch a simple diagram and draw two labeled paths, P and Q, of the parachutist during the free-fall, assuming that
  - for path P, air resistance is negligible,
  - for path Q, air resistance cannot be neglected.
- Suggest an explanation for any differences between paths P and Q.
- After the parachute opens, the parachutist, of mass  $85 \text{ kg}$ , slows down and reaches a terminal velocity of  $7.0 \text{ ms}^{-1}$ . At this point, there is no horizontal velocity.
  - State the condition for the parachutist to reach terminal velocity.
  - Explain why the loss in gravitational energy does not result in an increase in the kinetic energy of the parachutist.

- (e) The parachutist lands with the terminal velocity, taking  $0.25 \text{ s}$  to come to rest after touching the ground.

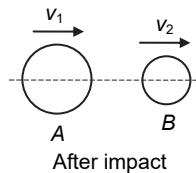
- Calculate the average retarding force on the parachutist during the landing.
- Explain how the parachutist's loss of momentum on landing is consistent with the principle of conservation of momentum.



- 25.** (a) A ball A of mass  $M$ , moving with velocity  $u_1$ , makes a head-on and perfectly elastic collision with a ball B of mass  $m$ , which is initially at rest.



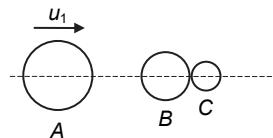
Before impact



After impact

- Write down equations expressing, for this system, the principle of conservation of momentum and the principle of conservation of kinetic energy.
- In the special case in which  $M = m$ , describe in words what happens after the collision.
- Consider the general case that  $M \neq m$ , find an expression, in terms of  $M$  and  $m$ , for the fraction of the initial kinetic energy of ball A which is transferred to ball B.

- (b) In another experiment, a third ball C, of mass  $\mu$ , is placed in contact with ball B, as shown in the figure below. Ball A is again projected with velocity  $u_1$  towards the stationary ball B.



Ball A strikes ball B, which then knocks forward ball C. All collisions are perfectly elastic. Using your answer to (a)(iii), obtain an expression for the fraction of the initial kinetic energy of ball A which is transferred to ball C.

