7. A 4.0 kg mass on a horizontal frictionless surface is pushed against a horizontal spring, compressing the spring a distance of 0.20 m from its equilibrium length. If the block is now released from rest, its final velocity after it leaves the spring is 2.3 m/s. What is the spring constant of the spring?

\[ K_i = 0 \quad K_f = \frac{1}{2} m v_i^2 \quad U_i = \frac{1}{2} k x_i^2 \quad U_f = 0 \]
\[ \Delta K = -\Delta U \quad \text{no non-conservative forces} \]
\[ K_f = U_i \quad \frac{1}{2} k x_i^2 = \frac{1}{2} m v_i^2 \quad k = \frac{m v_i^2}{x_i^2} = 580 \text{ N/m} \]

8. A farmer raises 35 kg of water from a well, lifting it a distance of 8.7 m at a constant speed of 0.25 m/s. What is his power output to perform this task?

\[ P = \frac{\Delta W}{\Delta t} \quad \text{or} \quad P = Fv \quad \text{a constant force} \]
\[ F = mg \quad \text{since} \quad F_{net} = ma = 0 \]
\[ P = mgv = (35 \text{kg})(9.8 \text{ m/s}^2)(0.25 \text{ m/s}) = 86 \text{ Watts} \]

9. A 3.0 kg block slides down a frictionless ramp a vertical distance of 2.2 m, then slides across a horizontal, rough surface with a coefficient of sliding friction of 0.35. How far along the horizontal surface does it travel before stopping? Do not use Newton’s laws.

- Initial: block at top of ramp
- Final: block at rest.

\[ E_i = mgh = (3 \text{kg})(9.8 \text{ m/s}^2)(2.2 \text{ m}) = 65J \]
\[ E_f = 0 \]
\[ \Delta E = E_f - E_i = -65J \quad \Rightarrow F_{fr} \Delta \ell = -\frac{\mu mg \Delta \ell}{m} \]
\[ \Delta \ell = \frac{65J}{\mu mg} = 6.3 \text{ m} \]

10. A wooden block which is stationary is shot with a bullet. After the collision, the bullet passes through the block and emerges with a lessened velocity, and the block slides in the same direction with some velocity. Which of the following is true of the collision?

a) Energy and momentum are conserved
b) Only momentum is conserved
c) Only energy is conserved
d) The greatest possible amount of mechanical energy is lost

11. A stationary object with a mass of 12.0 kg explodes into two parts. Part 1 has a mass of 10.0 kg and moves in the negative x direction at a speed of 45 m/s. If no mass is lost in the explosion, what is the velocity of Part 2 (magnitude and direction)?

\[ P_i = 0 \quad P_f, x = 0 \]
\[ m_1 v_2 + m_2 v_2 = m_1 v_1 + (10 \text{ kg})(-45 \text{ m/s}) \]
\[ m_1 v_2 = 450 \text{ kg-m/s} \]
\[ m_2 v_2 = 12 \text{ kg} - 10 \text{ kg} = 2 \text{ kg} \]
\[ v_2 = 22.5 \text{ m/s} + x \]

12. A 6.0 kg mass moving at 3.5 m/s in the positive x direction collides elastically with a 1.5 kg mass which is initially at rest. Find the final velocities of each (magnitude and direction).

\[ V_1 = 3.5 \text{ m/s} \quad m_1 = 6.0 \text{ kg} \]
\[ V_2 = 0 \]
\[ v_1 - v_2 = v_1' - v_2' \]
\[ m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2' \]
\[ m_1v_1 = m_1v_1' + m_2v_2' \]
\[ m_1v_1 - m_2v_2' = (m_1 + m_2)v_1' \]
\[ v_1 = \frac{m_1 - m_2}{m_1 + m_2} v_1' = \frac{6.0 - 1.5}{6.0 + 1.5} (3.5 \text{ m/s}) = 2.1 \text{ m/s} + x \]

13. A 0.045 kg ball is thrown downwards and hits the floor at a speed of 7.0 m/s. It rebounds upwards at 5.0 m/s. If it is in contact with the floor for 0.0025 s, what is the average force exerted by the floor on the ball?

\[ F_{avg} = \frac{m v_f - m v_i}{\Delta t} \]
\[ F_{avg} = \frac{0.045 \text{ kg} (5.0 \text{ m/s} - (-7.0 \text{ m/s}))}{2.5 \times 10^{-3} \text{ s}} = 216 \text{ N} \]