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?

$K_i = 0 \quad K_f = \frac{1}{2} m v_f^2 \quad U_i = \frac{1}{2} k x_0^2 \quad U_f = 0$

$\Delta K = -\Delta U$ no non-conservative forces

$K_f = U_i \quad \frac{1}{2} k x_0^2 = \frac{1}{2} m v_f^2 \quad k = m \frac{v_f^2}{x_0^2} = 530\ N/m$

I will take this – I should have said mechanical energy

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?

$P = \frac{\Delta W}{\Delta t}$ (work/time) or $P = Fv$ for a constant force; here $F = mg$ since $F_{net} = ma = 0$

$P = mgv = (35 kg)(9.8 m/s^2)(0.25 m/s) = 86$ 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.

$E_i = mgh = (3 kg)(g)(2.2 m) = 65 J \qquad E_f = 0$

$W_{fric} = \Delta E = E_f - E_i = -65 J = -F_{fr} d = -\mu_k m g d$

$d = \frac{65 J}{\mu_k m g} = 6.3 m$

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
2 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)?

$P_{i,tot} = 0 = P_{f,tot} = m_2 v_2 + m_1 v_1 = m_2 v_2 + (10 kg)(-45 m/s)$

so $m_2 v_2 = 450 \frac{kg \cdot m}{s} \quad m_2 = 12 kg - 10 kg = 2.0 kg$

so $v_2 = 225 m/s \ +x$

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).

$v_1 = 3.5 m/s \quad m_1 = 6.0 kg \quad v_2 = 0 \quad m_2 = 1.5 kg$

$v_1 - v_2 = v_2' - v_1'$ ① $v_1 = v_2' - v_1'$ and $m_1 v_1 = m_1 v_1' + m_2 v_2'$ ②

Eliminate v_2' ① $v_2' = v_1 + v_1' \rightarrow$ ② $m_1 v_1 = m_1 v_1' + m_2 v_1 + m_2 v_1'$

$(m_1 - m_2) v_1 = (m_1 + m_2) v_1'$ so $v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 = \frac{6.0 - 1.5}{6.0 + 1.5}(3.5 m/s) = 2.1 m/s\ +x$

Then $v_2' = v_1 + v_1' = 5.6 m/s$

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 wit the floor for 0.0025 s, what is the average force extented by the floor on the ball?

$F_{AV} \Delta t = p_f - p_i$ so $F_{AV} = \frac{m v_f - m v_i}{\Delta t}$

$F_{AV} = \frac{0.045 kg (7.0 m/s - (-5.0 m/s))}{2.5 \times 10^{-3} s} = 216 N$ opposite direction!