UNIVERSITY OF OTTAWA
Principles of Physics
PHY1321/1331 FALL 2011
Dr. A. Czajkowski

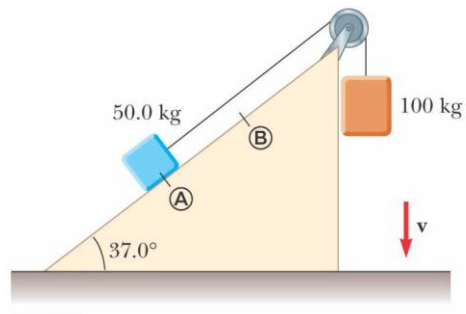
CLASS: PHY_____
STUDENT #: _______________
NAME: ___________________

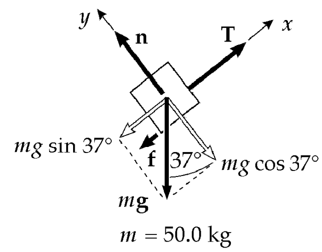
Brooke Lee Adams

Assignment 6: Energy, Linear Momentum

Assigned: Oct 14 14:30 Due: Oct21 18:00

11 A 50.0-kg block and 100-kg block are connected by a string as in Figure P8.36. The pulley is frictionless and of negligible mass. The coefficient of kinetic friction between the 50-kg block and incline is 0.250. Determine the change in the kinetic energy of the 50-kg block as it moves from A to B, a distance of 20.0 m





$$\sum F_y = n - mg\cos 37.0° = 0$$

$$\therefore n = mg\cos 37.0° = 400\ \text{N}$$

$$f = \mu n = 0.250(400\ \text{N}) = 100\ \text{N}$$

$$-f\Delta x = \Delta E_{mech}$$

$$(-100)(20.0) = \Delta U_A + \Delta U_B + \Delta K_A + \Delta K_B$$

$$\Delta U_A = m_A g(h_f - h_i) = (50.0)(9.80)(20.0\sin 37.0°) = 5.90\times 10^3$$

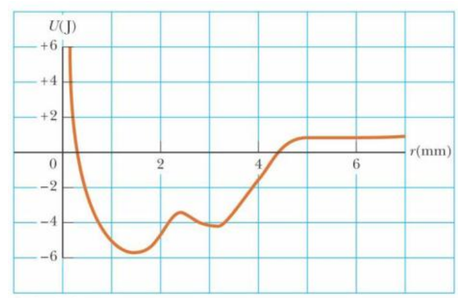
$$\Delta U_B = m_B g(h_f - h_i) = (100)(9.80)(-20.0) = -1.96\times 10^4$$

$$\Delta K_A = \frac{1}{2} m_A\left(v_f^2 - v_i^2\right)$$

$$\Delta K_B = \frac{1}{2} m_B\left(v_f^2 - v_i^2\right) = \frac{m_B}{m_A}\Delta K_A = 2\Delta K_A$$

Adding and solving, $\Delta K_A = \boxed{3.92\ \text{kJ}}$.

2. A particle moves along a line where the potential energy of its system depends on its position *r* as graphed in Figure P8.46. In the limit as *r* increases without bound, *U(r)* approaches +1 J. (a) Identify each equilibrium position for this particle. Indicate whether each is a point of stable, unstable or neutral equilibrium. (b) The particle will be bound if the total energy of the system is in what range? Now suppose that the system has energy −3 J. Determine (c) the range of positions where the particle can be found, (d) its maximum kinetic energy, (e) the location where it has maximum kinetic energy, and (f) the *binding energy* of the system—that is, the additional energy that it would have to be given in order for the particle to move out to $r\to\infty$.



(a) There is an equilibrium point wherever the graph of potential energy is horizontal:
At $r = 1.5\ \text{mm}$ and 3.2 mm, the equilibrium is stable.
At $r = 2.3\ \text{mm}$, the equilibrium is unstable.
A particle moving out toward $r\to\infty$ approaches neutral equilibrium.

(b) The system energy *E* cannot be less than –5.6 J. The particle is bound if $\boxed{-5.6\ \text{J} \le E < 1\ \text{J}}$.

(c) If the system energy is –3 J, its potential energy must be less than or equal to –3 J. Thus, the particle's position is limited to $\boxed{0.6\ \text{mm} \le r \le 3.6\ \text{mm}}$.

(d) $K + U = E$. Thus, $K_{max} = E - U_{min} = -3.0\ \text{J} - (-5.6\ \text{J}) = \boxed{2.6\ \text{J}}$.

(e) Kinetic energy is a maximum when the potential energy is a minimum, at $\boxed{r = 1.5\ \text{mm}}$.

(f) $-3\ \text{J} + W = 1\ \text{J}$. Hence, the binding energy is $W = \boxed{4\ \text{J}}$.

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Assignment 6: Work and Energy Cont.

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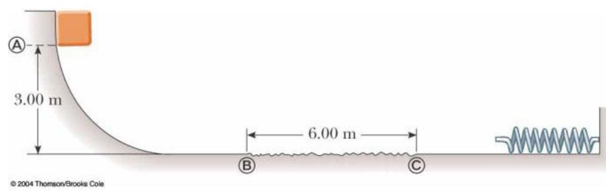
3. A potential energy function for a two-dimensional force is of the form $U = 3x^3y - 7x$. Find the force that acts at the point (x, y).

$$F_x = -\frac{\partial U}{\partial x} = -\frac{\partial\left(3x^3y - 7x\right)}{\partial x} = -\left(9x^2y - 7\right) = 7 - 9x^2y \qquad F_y = -\frac{\partial U}{\partial y} = -\frac{\partial\left(3x^3y - 7x\right)}{\partial y} = -\left(3x^3 - 0\right) = -3x^3$$

Thus, the force acting at the point (x, y) is $\mathbf{F} = F_x\hat{\mathbf{i}} + F_y\hat{\mathbf{j}} = \boxed{\left(7 - 9x^2y\right)\hat{\mathbf{i}} - 3x^3\hat{\mathbf{j}}}$.

4 A 10.0-kg block is released from point *A* in Figure P8.57. The track is frictionless except for the portion between points B and *C* , which has a length of
6.00 m. The block travels down the track, hits a spring of force constant 2 250 N/m, and compresses the spring 0.300 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of kinetic friction between the block and the rough surface between B and *C*.

$$\Delta E_{mech} = -f\Delta x$$
$$E_f - E_i = -f \cdot d_{BC}$$
$$\frac{1}{2}kx^2 - mgh = -\mu mg d_{BC}$$
$$\mu = \frac{mgh - \frac{1}{2}kx^2}{mgd_{BC}} = \boxed{0.328}$$



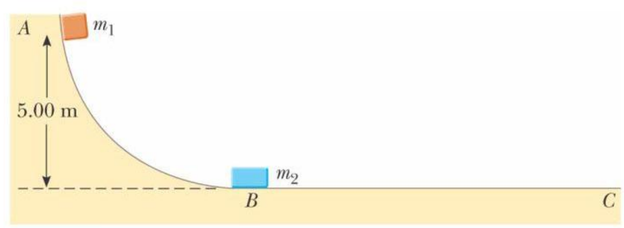
5. Two blocks are free to slide along the frictionless wooden track *ABC* shown in Figure P9.20. A block of mass m_1 = 5.00 kg is released from *A*. Protruding from its front end is the north pole of a strong magnet, repelling the north pole of an identical magnet embedded in the back end of the block of mass m_2 = 10.0 kg, initially at rest. The two blocks never touch. Calculate the maximum height to which m_1 rises after the elastic collision.

v_1, speed of m_1 at B before collision.

$$\frac{1}{2}m_1v_1^2 = m_1gh$$
$$v_1 = \sqrt{2(9.80)(5.00)} = 9.90 \text{ m/s}$$

v_{1f}, speed of m_1 at B just after collision.

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_1 = -\frac{1}{3}(9.90) \text{ m/s} = -3.30 \text{ m/s}$$



At the highest point (after collision)

$$m_1gh_{max} = \frac{1}{2}m_1(-3.30)^2 \qquad h_{max} = \frac{(-3.30 \text{ m/s})^2}{2\left(9.80 \text{ m/s}^2\right)} = \boxed{0.556 \text{ m}}$$