Answer on Question #39588, Physics, Other

a) A force F=A[(x/a)-1] is acting on a particle along the x-axis. Determine the work done by the force in moving the particle from x = 0 to x = 2a.

b) A block of mass 6.0 kg slides from rest at a height of 2.0 m down to a horizontal surface where it passes over a 1.5 m rough patch. After crossing this patch it climbs up another incline which is at an angle of 30° to the ground. The rough patch has a coefficient of kinetic friction μk = 0.25. What height does the block reach on the incline before it comes to rest?

Solution:

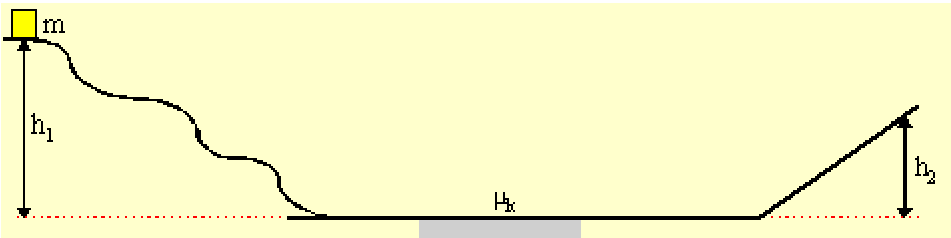
a)

The basic work relationship W=Fx is a special case which applies only to constant force along a straight line. In the more general case of a force which changes with distance the work may be calculated by performing the integral

$$W = \int_{x_1}^{x_2} F(x)dx = \int_0^{2a} F(x)dx = \int_0^{2a} A[(x/a) - 1]\,dx$$

$$W = A\int_0^{2a} \left(\frac{x}{a} - 1\right)dx = A\left[\frac{x^2}{2a} - x\right]\Bigg|_0^{2a} = A\left[\frac{(2a)^2}{2a} - 2a - 0\right] = A[2a - 2a] = 0$$

b)



Given:

h_1 = 2.0 m

m = 6.0 kg

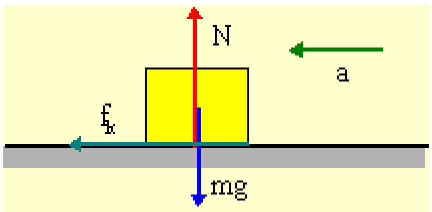
d = 1.5 m

μ_k = 0.25

h_1 - ?

Since the problem involves a change of height and speed, we make use of the Generalized Work-Energy Theorem. Since the block's initial and final speeds are zero, we have

$$W_{NC} = \Delta E = U_f - U_i = mgh_2 - mgh_1 \qquad (1)$$



The nonconservative force in this problem is friction. To find the work done by friction, we need to know the friction. To find friction, a force, we draw a Free–Body Diagram at the rough surface and use Newton's Second Law.

Along x-axis: $\Sigma F_x = ma_x$, $-f_k = -ma$

Along y-axis: $\Sigma F_y = ma_y$, $N - mg = 0$

The second equation gives $N = mg$ and we know $f_k = \mu_k N$, so $f_k = \mu_k mg$. Therefore, the work done by friction is $W_{friction} = -f_k d = -\mu_k mgd$. Putting this into equation (1) yields

$$-\mu_k mgd = mgh_2 - mgh_1 .$$

Solving for h_2, we find

$$h_2 = h_1 - \mu_k d = 2.0 - 0.25 \cdot 1.5 = 1.625 \text{ m} .$$

Answer. a) work = 0,

b) h = 1.625 m .