21-R-WE-ZA-44 Solution

Question: A block of mass m kg is moved x m to the left by motor M. If motor applies a force of F N, the coefficient of kinetic friction is μ_k, and the spring constant is k N/m, find the power supplied to the motor that has an efficiency of ϵ. The system starts from rest.

Solution:

We can solve for the acceleration of the block by taking the sum of forces.

$\Sigma F_x = F - k\Delta x - N\mu_k = ma_x$

$\Sigma F_y = -mg + N = 0 \Rightarrow N = mg$

$a_x = (F - k\Delta x - N\mu_k)/m$

Using kinematic equations and the fact that the system starts from rest, we can find the final velocity.

$v_f^2 = v_i^2 + 2ad \Rightarrow v_f = (2ax)^{1/2}$

$P_{out} = Fv_f = P_{in}\epsilon \Rightarrow P_{in} = Fv_f/\epsilon$