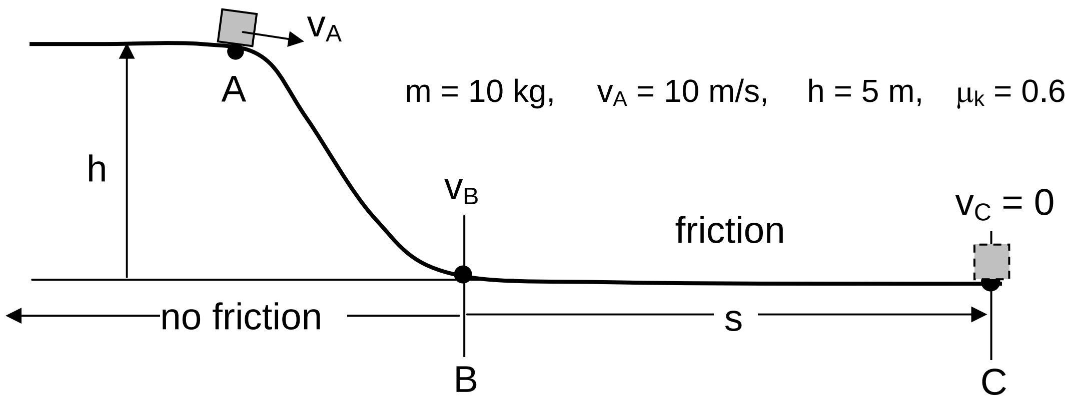
29:011 – Example problem on conservation of mechanical energy



- A crate of mass m is carried on a conveyor belt to point A where it falls down a frictionless incline to point B and slides along a rough horizontal path and comes to rest at point C. Find s.

From point A to point B there is no friction, so mechanical energy is conserved $\rightarrow \Delta E = W_{NC} = 0$

$$\Delta E = E_B - E_A = \left(KE_B + PE_B\right) - \left(KE_A + PE_A\right) = 0$$ Take PE = 0 at the bottom of the incline.

$$\therefore \frac{1}{2}mv_B^2 + 0 - \left(\frac{1}{2}mv_A^2 + mgh\right) = 0 \Rightarrow \boxed{v_B = 14.1\ m/s}$$

From point B to point C there is friction, so $\rightarrow \Delta E = E_C - E_B = W_{NC} = W_f$ (W_{NC} is the work done by the non-conservative friction force.)

$$\Delta E = E_C - E_B = \left(KE_C + PE_C\right) - \left(KE_B + PE_B\right) = W_f$$

$$\left(0+0\right) - \left(\frac{1}{2}mv_B^2\right) = -f_k s = -\left(\mu_k F_N\right)s = -\mu_k\left(mg\right)s \Rightarrow \boxed{s = 16.8\ m}$$

- The energy conservation principle can be applied between any two points along the path. We can apply it directly between points A and B; there is no need to consider the intermediate position B.

$\rightarrow \Delta E = E_C - E_A = W_{NC} = W_f$. The work done by friction is only present between B and C.

$$E_C - E_A = W_f$$

$$\left(KE_C + PE_C\right) - \left(KE_A + PE_A\right) = -f_k s = -\left(\mu_k F_N\right)s = -\mu_k\left(mg\right)s$$

$$\left(0+0\right) - \underbrace{\left(\frac{1}{2}mv_A^2 + mgh\right)}_{\frac{1}{2}mv_B^2} = -\mu_k mgs \Rightarrow \boxed{s = 16.8\ m}$$