A 13.7-kg box is being pushed from the bottom to the top of a frictionless ramp. When the box is pushed at a constant velocity, the nonconservative pushing force does 58.0 J of work. How much work is done by the pushing force when the box starts from rest at the bottom and reaches the top of the same ramp with a speed of 1.50 m/s?

Solution:

The system will be the box and the earth. Then the only external force is the pushing force. We have:

$$\text{work done by external force} = \text{change of energy of the system}$$

That is:

$$\text{work done by pushing force} = \Delta U_k + \Delta U_g$$

$$(U_k\text{: kinetic energy}, U_g\text{: potential energy of gravity})$$

$$A = \Delta U_k + \Delta U_g$$

$$\Delta U_g = A - \Delta U_k$$

in the first part, the box moves with a constant velocity, so there is no change in kinetic energy. Hence, $\Delta U_k = 0$

$$\Delta U_g = A - 0 = A = 58\ \text{J}$$

Next, we can rewrite the equation ($U_{k_{initial}}$ is zero since the box starts from rest):

$$\text{work done by pushing force} = \Delta U_k + \Delta U_g$$

$$A_{push} = \Delta U_k + \Delta U_g$$

$$A_{push} = U_{k_{final}} - U_{k_{initial}} + A = \frac{mV^2}{2} - 0 + A =$$

$$= \frac{13.7\text{kg} \cdot \left(1.5\frac{\text{m}}{\text{s}}\right)^2}{2} + 58\ \text{J} = 73.4\ \text{J}$$

Answer: work is done by the pushing force is 73.4 J.