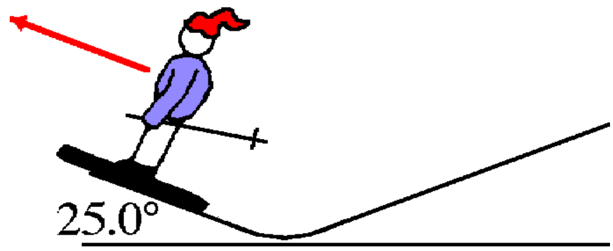
PHYS1002 Fundamentals Mechanics
Lecture 11 : Solution to Skier Problem

Problem



A 60 kg skier leaves the end of a ski jump ramp with a velocity of 24 ms^{-1} directed 25° above the horizontal. Suppose that as a result of air resistance the skier returns to the ground with a speed of 22 ms^{-1} and lands at a point down the hill that is 14 m below the ramp.

How much energy is dissipated by air resistance during the jump?

Solution

This problem is much easier if solved using energy principles. Take the potential energy to be measured with respect to the ground at the level at which the skier lands (remember we can choose the reference level for potential energy wherever we like, as only differences in potential energy affect the situation).

$$
\begin{aligned}
K_{top} &= \frac{1}{2}mv_i^2 = \frac{1}{2} \times 60 \text{ kg} \times \left(24 \text{ ms}^{-1}\right)^2 = 1.7 \times 10^4 \text{J} = 17 \text{ kJ} \\
U_{top} &= mgh = 60 \text{ kg} \times 9.8 \text{ ms}^{-2} \times 14 \text{ m} = 0.8 \times 10^4 \text{J} = 8 \text{ kJ} \\
K_{bottom} &= \frac{1}{2}mv_f^2 = \frac{1}{2} \times 60 \text{ kg} \times \left(22 \text{ ms}^{-1}\right)^2 = 1.4 \times 10^4 \text{J} = 14 \text{ kJ} \\
U_{bottom} &= 0 \text{ kJ}
\end{aligned}
$$

Mechanical energy (sum of kinetic and potential energy) is not conserved in this situation, since there is a non-conservative, dissipative force acting, air resistance. But we can write

$$K_{top} + U_{top} = K_{bottom} + U_{bottom} + \Delta E_{drag}$$

So

$$\Delta E_{drag} = K_{top} + U_{top} - K_{bottom} - U_{bottom} = 17 \text{ kJ} + 8 \text{ kJ} - 14 \text{ kJ} - 0 \text{ kJ} = 11 \text{ kJ}$$

This is the energy lost to air resistance (drag).