

- 7.26.** A 75-kg roofer climbs a vertical 7.0-m ladder to the flat roof of a house. He then walks 12 m on the roof, climbs down another vertical 7.0-m ladder, and finally walks on the ground back to his starting point. How much work is done on him by gravity (a) as he climbs up; (b) as he climbs down; (c) as he walks on the roof and on the ground? (d) What is the total work done on him by gravity during this round trip? (e) On the basis of your answer to part (d), would you say that gravity is a conservative or nonconservative force? Explain.

Identify: $W_G = mgh \cos \phi$.

Set up: When he moves upward, $\phi = 180^\circ$ and when he moves downward, $\phi = 0^\circ$. When he moves parallel to the ground, $\phi = 90^\circ$.

Execute:

(a) $W_{\text{grav}} = (75 \text{ kg})(9.80 \text{ m/s}^2)(7.0 \text{ m})\cos 180^\circ = -5100 \text{ J}$.

(b) $W_{\text{grav}} = (75 \text{ kg})(9.80 \text{ m/s}^2)(7.0 \text{ m})\cos 0^\circ = +5100 \text{ J}$.

(c) $\phi = 90^\circ$ in each case and $W_{\text{grav}} = 0$ in each case.

(d) The total work done on him by gravity during the round trip is $-5100 \text{ J} + 5100 \text{ J} = 0$.

(e) Gravity is a conservative force since the total work done for a round trip is zero. Technically, to prove this you must show that it is true for all possible round trips.

Evaluate: The gravity force is independent of the position and motion of the object. When the object moves upward gravity does negative work and when the object moves downward gravity does positive work.