Question #56933, Physics / Mechanics | Relativity

A man whose mass is m kg jumps vertically into air from a sitting position in which his center of mass is at a height h1 from the ground. When his feet are just about to leave the ground, his center of mass is h2 from the ground and finally rises to h3 when he is at the top of the jump. (a) What is the upward force exerted by the ground on him treating it as a constant? (b) Find work done by normal reaction from ground.

Solution:

The work of upward force changes the man's potential energy so that his center of mass moves from h1 to h2, and provides him kinetic energy, which allows him to reach the height h3. At the same time, the man's kinetic energy at the height h3 is zero. Thus, according to the conservation of energy, all the work is spent to change the man's potential energy:

$$W = mg\Delta h_{13} = mg(h_3 - h_1)\,\text{J} \qquad (1)$$

The work is performed while the center of man's mass moves from h1 to h2, thus:

$$F = \frac{W}{\Delta h_{12}} = \frac{mg(h_3 - h_1)}{h_2 - h_1}\,\text{N} \qquad (2)$$

Answer: the force $F = \frac{mg(h_3 - h_1)}{h_2 - h_1}$ N; work $W = mg(h_3 - h_1)$ J