

A person whose mass is $m = 70.0 \text{ kg}$ steps on a mechanical bathroom scale placed on an inclined plane that makes the angle $\alpha = 12.9^\circ$ with the horizontal. What is the reading on the scale?

Solution:

$m = 70.0 \text{ kg}$ - mass of the person;

$\alpha = 12.9^\circ$ - angle which plane makes with the horizontal;

N - reaction force;

M - mass of the person which shows the scales.

Newton's second law for person (the first law of equilibrium):

$$\overrightarrow{mg} + \overrightarrow{N} + \overrightarrow{F}_{\text{friction}} = \overrightarrow{0}$$

$$y: N - mg_y = 0 \quad (1)$$

From the a right triangle:

$$\cos \alpha = \frac{mg}{mg_y}$$

$$mg_y = mg \cdot \cos \alpha \quad (2)$$

(2)in(1):

$$N = mg_y = mg \cdot \cos \alpha \quad (3)$$

Newton's third law: When person exerts a force on a plane, the plane simultaneously exerts a force equal in magnitude and opposite in direction to that of the person:

$$\overrightarrow{N} = -\overrightarrow{P}$$

$$N = P \quad (4)$$

$$P = Mg \quad (5)$$

(5)and(3)in(4):

$$mg \cdot \cos \alpha = Mg$$

$$M = m \cdot \cos \alpha = 70 \text{ kg} \cdot \cos 12.9^\circ = 68.23 \text{ kg}$$

Answer: the reading on the scale is 68.23 kg

