Answer of question #78272-Physics- Mechanics - Relativity

box of mass 40 kg is pulled on the floor by a light rope with a force 200 N. The rope makes an angle of 30° with the horizontal. Determine the acceleration of the box, if the coefficient of the kinetic friction between the floor and the box is 0.20. Draw the free body diagram. Identify the no-work forces from amongst the forces exerted on the box.
Take g = 10 ms-2.

Input Data:

$Mass$: m=40kg;

$Force$: F = 200N;

$Angle$: $\alpha = 30°$

$Coefficient\ of\ the\ kinetic\ friction$: $\mu = 0.2$

$Acceleration\ of\ gravity$: $g = 10\frac{m}{s^2}$

Solution:

According to Newton's second law:
$ma = F_x - F_{fr}$;

Where $\boldsymbol{F_x}$ is the projection of the applied tractive force on the horizontal axis x:

$F_x = Fcos(\alpha)$;
$F_x = 200cos(30°) = 173.2N$;

$\boldsymbol{F_{fr}}$ – friction force;
$F_{fr} = R\mu$;

$\boldsymbol{R}$ – surface reaction force;
$R = (mg - F_y)$;

$\boldsymbol{F_y}$ - is the projection of the applied tractive force on the vertical axis y:

$F_y = Fsin(\alpha)$;

$F_y = 200sin(30°) = 100N$;

$R = (40 * 10 - 100) = 300N$;

$F_{fr} = 300 * 0.2 = 60N$;

$ma = 173.2 - 60 = 113.2N$

Acceleration is:

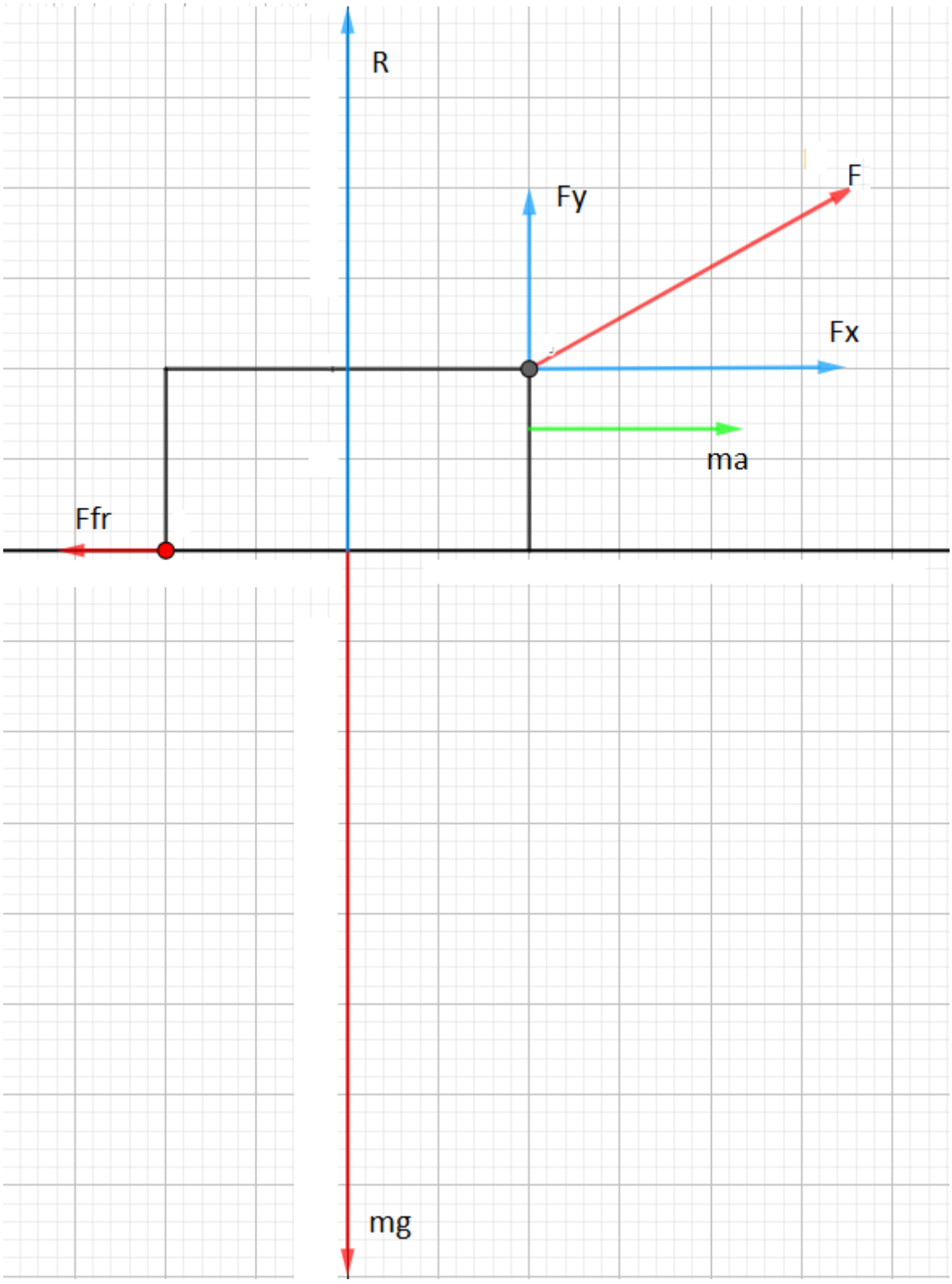
$$a = \frac{(F_x - F_{fr})}{m}$$

Or full formula:

$$a = \frac{F\left(cos(\alpha) + \mu sin(\alpha)\right)}{m} - g\,\mu$$

$$a = \frac{173.2 - 60}{40} = 2.83\,\frac{m}{s^2}$$

Force diagram:



Answer:

Acceleration of the box is: $2.83\,\frac{m}{s^2}$