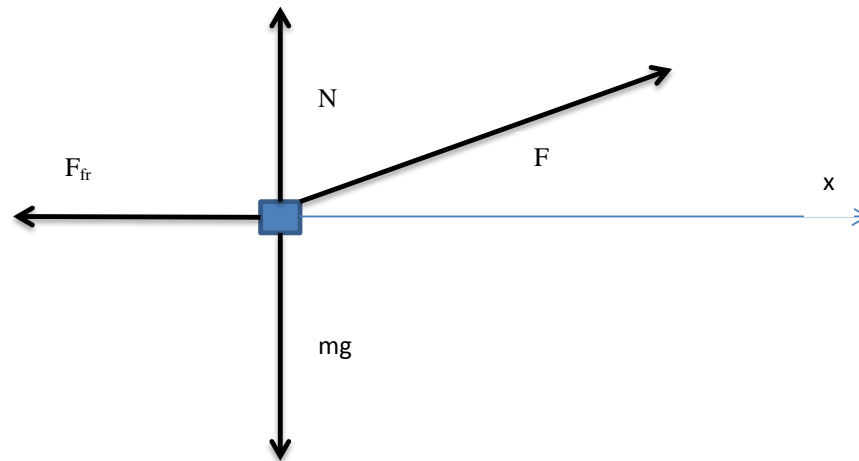


a 20kg wagon is pulled along the level ground by a rope inclined at 30 degree above the horizontal. A friction force of 30N opposes the motion. How large is the pulling force if the wagon is moving with (a) constant speed and (b) an acceleration of 0.40 m/s.



F_{fr} – friction force

F – pulling force

- a) Constant speed => acceleration equals 0.
 Newton's first law of motion on x-axis:

$$F \cos(30) = F_{fr}$$

$$F = \frac{F_{fr}}{\cos(30)} = \frac{30}{\frac{\sqrt{3}}{2}} = 20\sqrt{3} \text{ N}$$

Answer: $F = 20\sqrt{3} \text{ N}$

- b) Newton's second law of motion:

$$ma = F \cos(30) - F_{fr}$$

$$F = \frac{(ma + F_{fr})}{\cos(30)} = \frac{20 \cdot 0.4 + 30}{\frac{\sqrt{3}}{2}} = \frac{76}{\sqrt{3}} \text{ N}$$

Answer: $F = \frac{76}{\sqrt{3}} \text{ N}$