Newton's Second Law

Honors Physics

N.S.L.

"The acceleration of an object is directly proportional to the NET FORCE AND inversely proportional to the mass."

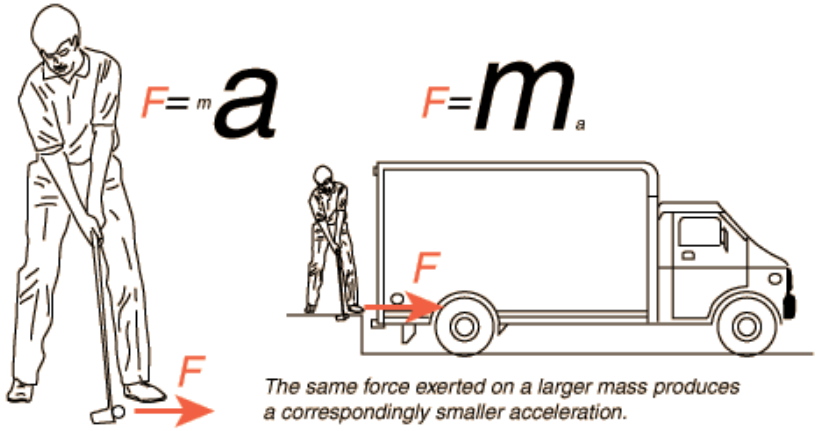
$$a \propto F_{NET}$$

$$a \propto \frac{1}{m}$$

Acceleration is directly proportional to the NET Force.
DIRECTLY = They do the same thing. If the force increases, the acceleration increases. If the force decreases, the acceleration decreases.

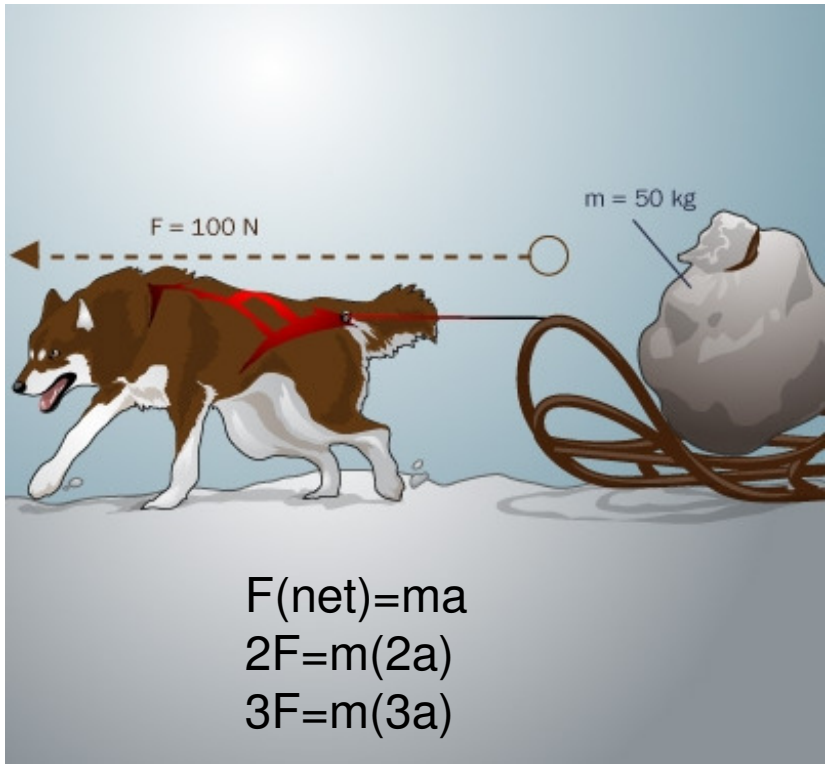
Acceleration is inversely proportional to the mass.
INVERSELY = They do the opposite.
If the mass decreases, the acceleration will increase. If the mass increases, the acceleration will decrease.

N.S.L.



N.S.L. works based on these direct and inverse relationships. As 2 of the variable change, ONE of them must remain constant.

If the force is constant, the acceleration and mass change as shown above.



If we add a second dog pulling with 100N just like the first dog, we could pull the sled with twice the acceleration, provided the mass of the sled was constant.

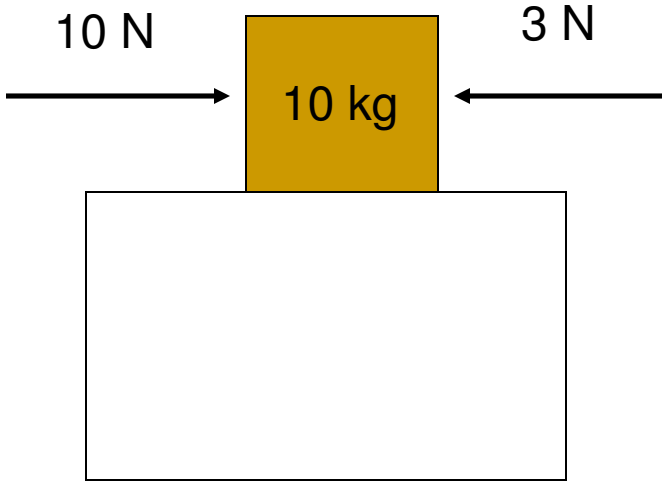
Putting it all together

$$a \propto F_{NET} \qquad a \propto \frac{1}{m}$$

$$a = \frac{F_{NET}}{m} \rightarrow F_{NET} = ma$$

$$F_{NET} = \text{Total Force} = \sum F$$

$$F_{NET} \neq 0$$



Magnitude of F_{NET}= **7 N**

Direction = **RIGHT**

Acceleration = **0.70 m/s/s**

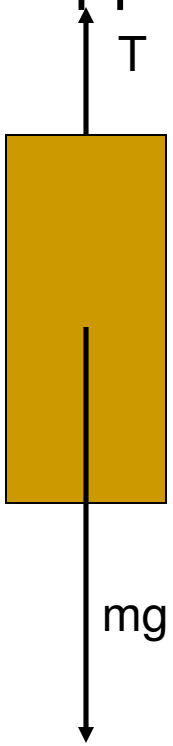
N.S.L Tips

1. **Draw a free body diagram**
2. **Break vectors into components if needed**
3. **Find the NET force by adding and subtracting forces that are on the same axis as the acceleration.**
4. **Set net force equal to "ma" this is called writing an EQUATION OF MOTION.**

NOTE: To avoid negative numbers, always subtract the smaller forces from the larger one.

Example

An elevator with a mass of 2000 kg rises with an acceleration of 1.0 m/s/s. What is the tension in the supporting cable?



Equation of Motion

$$F_{NET} = ma$$

$$T - mg = ma$$

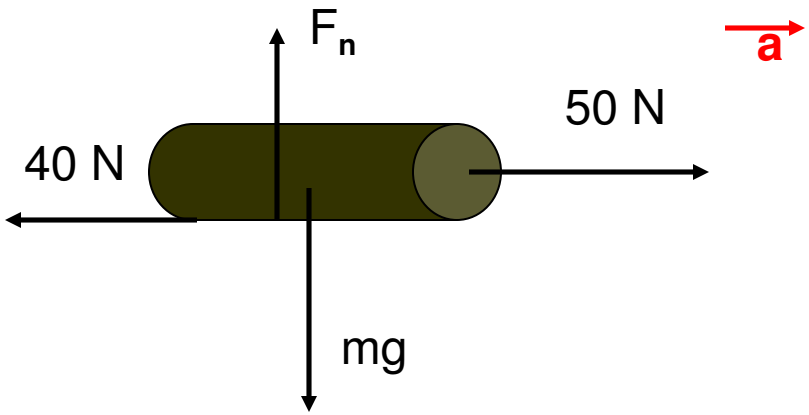
$$T = ma + mg$$

$$T = (2000)(1) + (2000)(9.8)$$

$$T = \text{21,600 N}$$

Example

A 50 N applied force drags an 8.16 kg log to the right across a horizontal surface. What is the acceleration of the log if the force of friction is 40.0 N?



$$F_{NET} = ma$$

$$F_a - F_f = ma$$

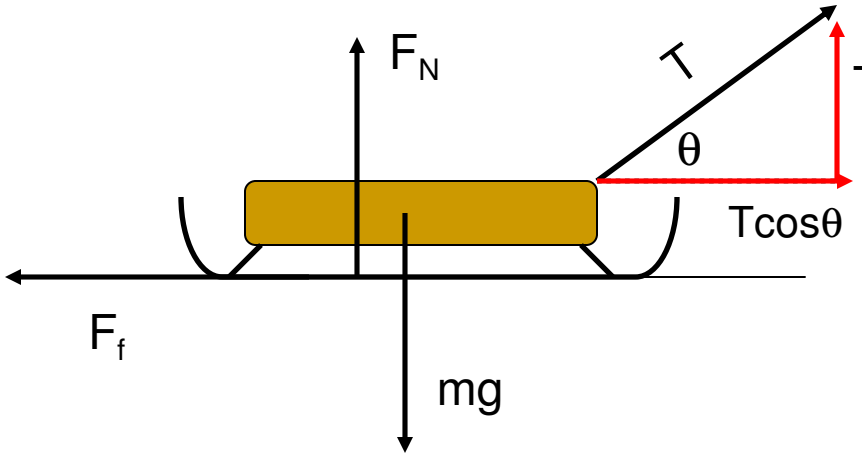
$$50 - 40 = 8.16a$$

$$10 = 8.16a$$

$$a = \text{1.23 m/s/s}$$

Example

A sled is being accelerated to the right at a rate of 1.5 m/s/s by a rope at a 33 degree angle above the + x . Calculate the Frictional Force if the mass of the sled is 66 kg and the tension in the rope is 150 N.



$$F_{NET} = ma$$

$$T\cos\theta - F_f = ma$$

$$T\cos\theta - ma = F_f$$

$$150\cos 33 - (66)(1.5) = F_f$$

$$F_f = \textbf{26.8 N}$$