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# Newton's Second Law

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Honors Physics

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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.

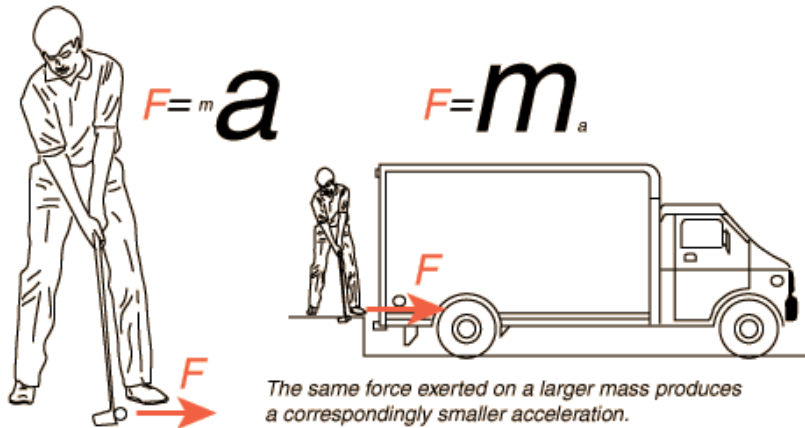
*Acceleration is inversely proportional to the mass.*

**INVERSELY** = They do the opposite.

If the mass decreases, the acceleration will increase. If the mass increases, the acceleration will decrease.

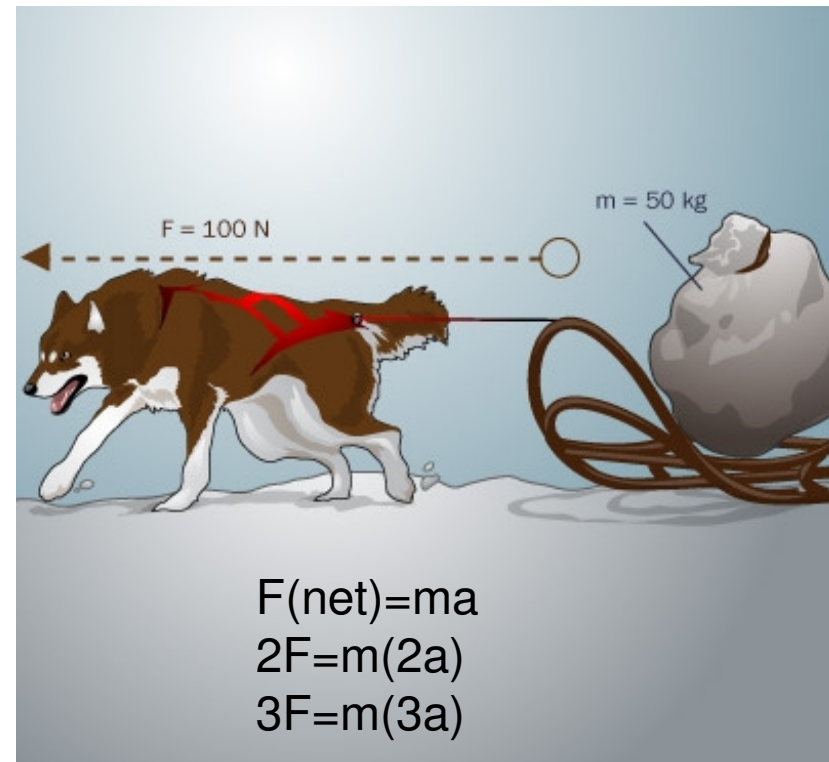
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# N.S.L.



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.

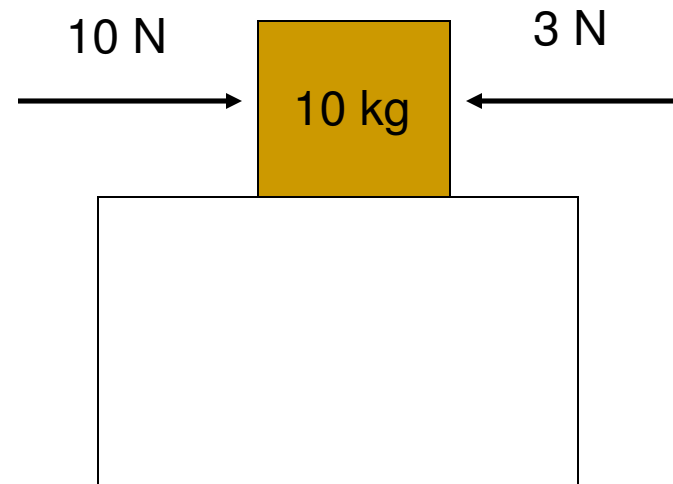
# Putting it all together

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

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

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

$$F_{NET} \neq 0$$



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

Direction = **RIGHT**

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

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## N.S.L Tips

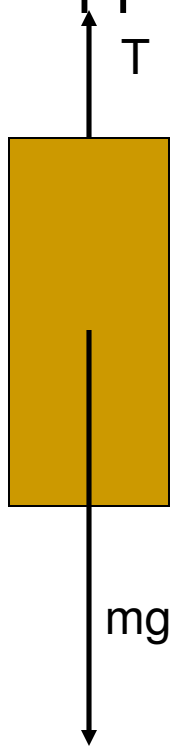
1. **Draw a free body diagram**
2. **Break vectors into components if needed**
3. **Find the NET force by adding and subtracting forces that are on the same axis as the acceleration.**
4. **Set net force equal to “ma” this is called writing an EQUATION OF MOTION.**

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

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## 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?



$$F_{NET} = ma$$

$$T - mg = ma$$

$$T = ma + mg$$

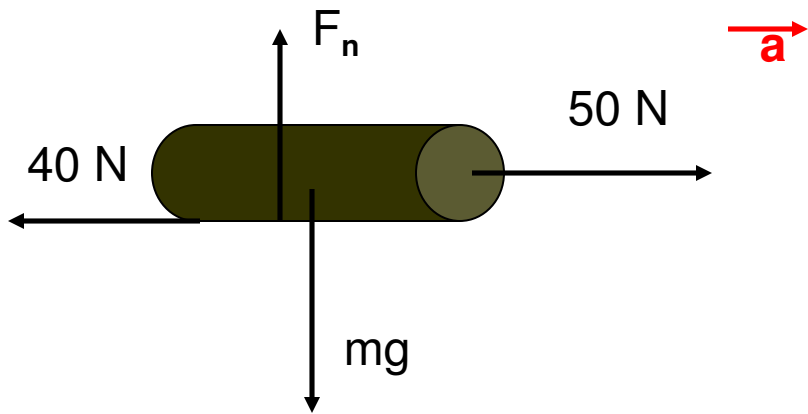
$$T = (2000)(1) + (2000)(9.8)$$

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

Equation of Motion

## 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?



$$F_{NET} = ma$$

$$F_a - F_f = ma$$

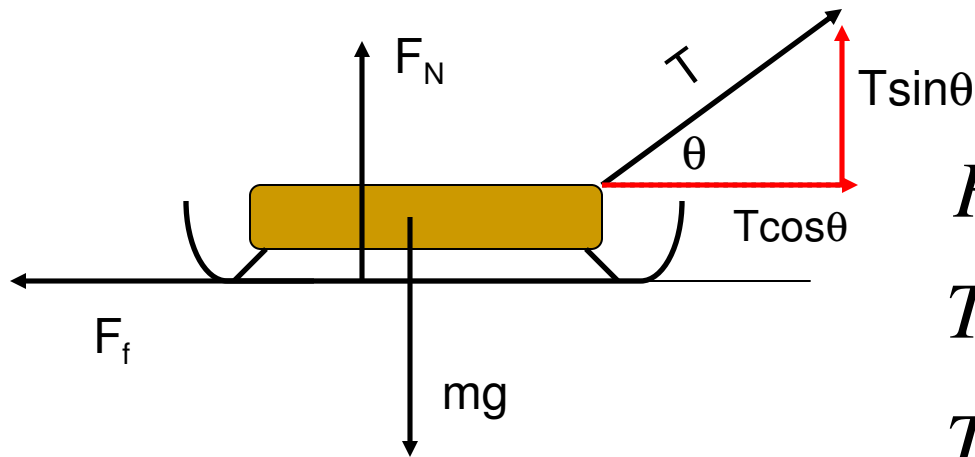
$$50 - 40 = 8.16a$$

$$10 = 8.16a$$

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

# 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.



$$F_{NET} = ma$$

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

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

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

$$F_f = \mathbf{26.8 \text{ N}}$$