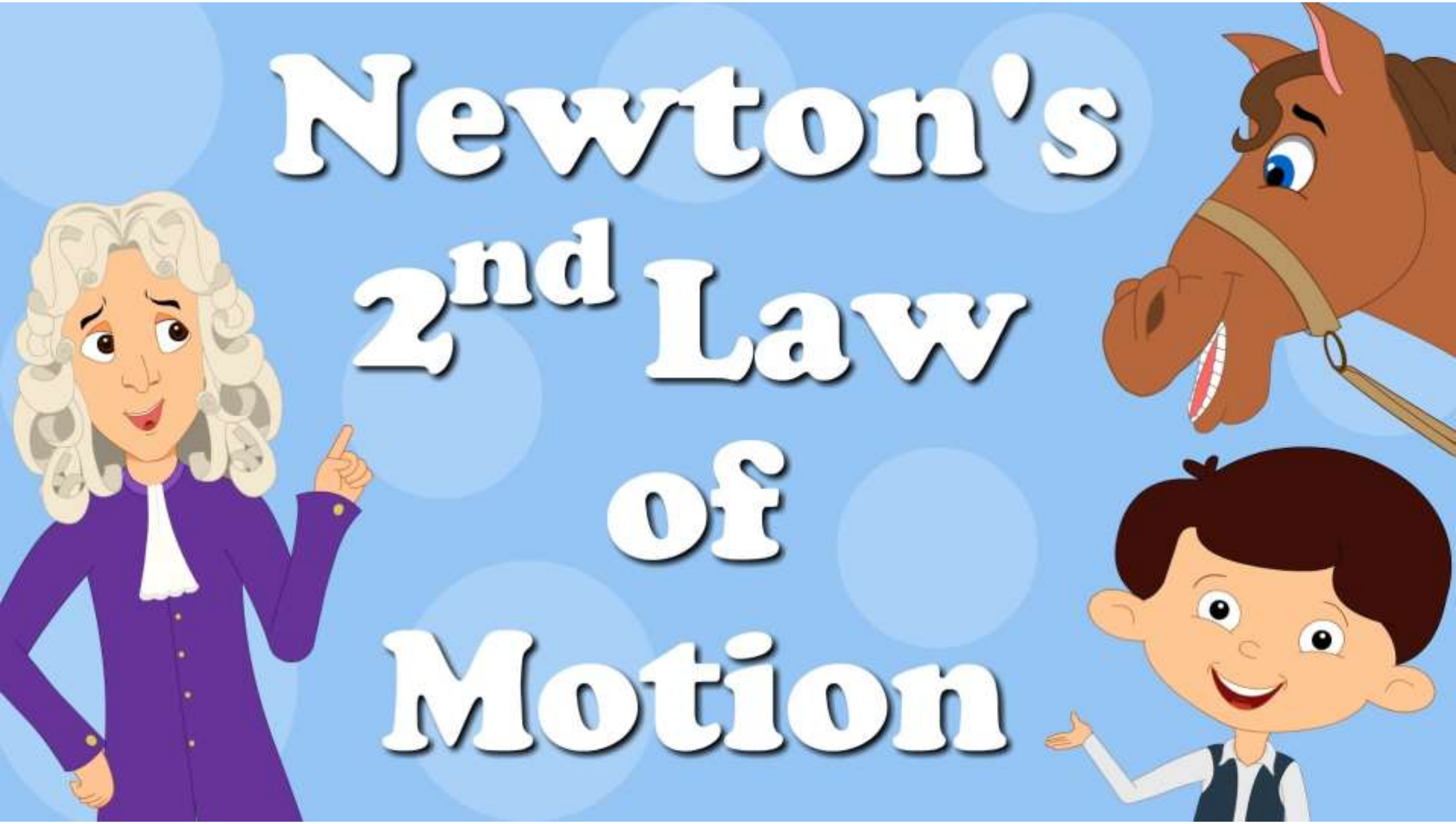
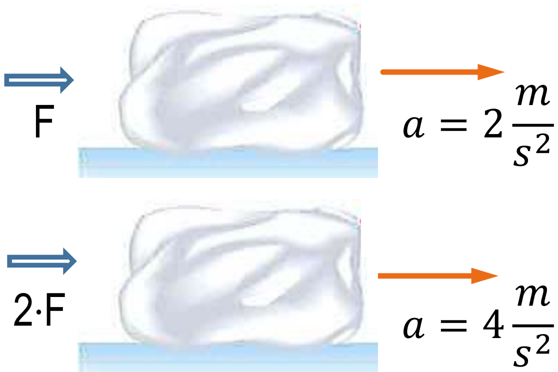

Newton's
2nd Law
of
Motion

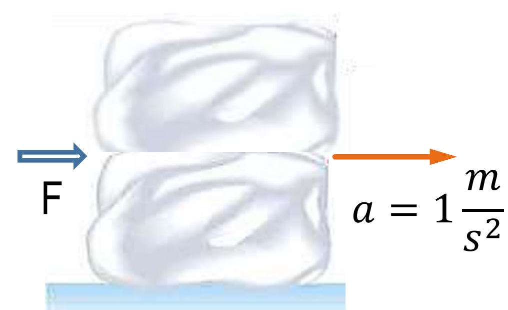
NEWTON'S SECOND LAW

Newton's first law explains what happens to an object that has no resultant force acting on it: The object either remains at rest or continues moving in a straight line with constant speed. Newton's second law answers the question of what happens to an object that *does* have a resultant force acting on it.



Imagine pushing a block of ice across a frictionless horizontal surface. When you exert some horizontal force on the block, it moves with an acceleration of, say,2 $\frac{m}{s^2}$. If you apply a force twice as large, the acceleration doubles to $4\,\frac{m}{s^2}$. Pushing three times as hard triples the acceleration, and so on. From such observations, we conclude that **the acceleration of an object is directly proportional to the resultant force acting on it**.

Mass also affects acceleration. Suppose you stack identical blocks of ice on top of each other while pushing the stack with constant force. If the force applied to one block produces an acceleration of 2 m/s2, then the acceleration drops to half that value, 1 m/s2, when two blocks are pushed, to one-third the initial value when three blocks are pushed, and so on. We conclude that **the acceleration of an object is inversely proportional to its mass**.



These observations are summarized in **Newton's second law**:

The acceleration $\vec{a}$ of an object is directly proportional to the resultant force acting on it and inversely proportional to its mass.

$$\vec{a} = \frac{\vec{F}}{m}$$

- $\vec{a}$-is the acceleration of the object,
- m is its mass,
- $\vec{F}$ −resultant force (is the vector sum of all forces acting on it)

Multiplying through by *m*, we have

$$\vec{F} = m \cdot \vec{a}$$

When there is no resultant force on an object, its acceleration is zero, which means the velocity is constant.

The SI unit of force is the **newton**. When 1 newton of force acts on an object that has a mass of 1 kg, it produces an acceleration of 1 $\frac{m}{s^2}$ in the object. From this definition and Newton's second law, we see that the newton can be expressed in terms of the fundamental units of mass, length, and time as

$$1N = kg \cdot \frac{m}{s^2}$$

When a pitcher throws a baseball, the harder he throws the more the ball accelerates. The mass of the ball stays the same but the force increases.