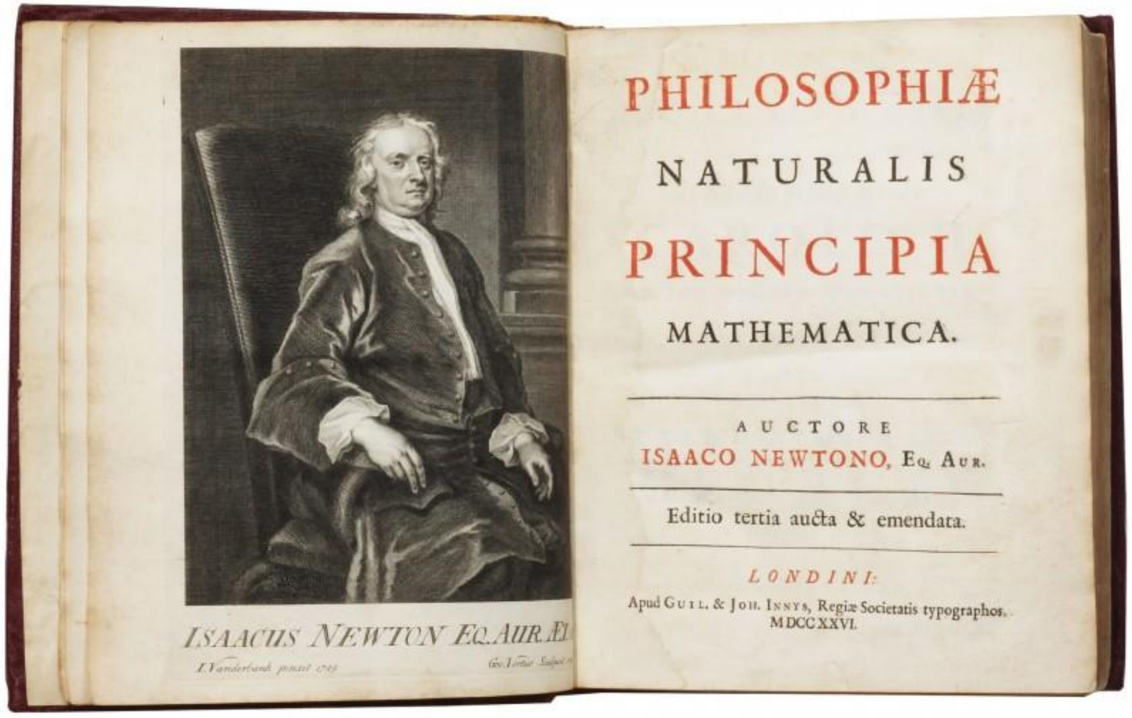
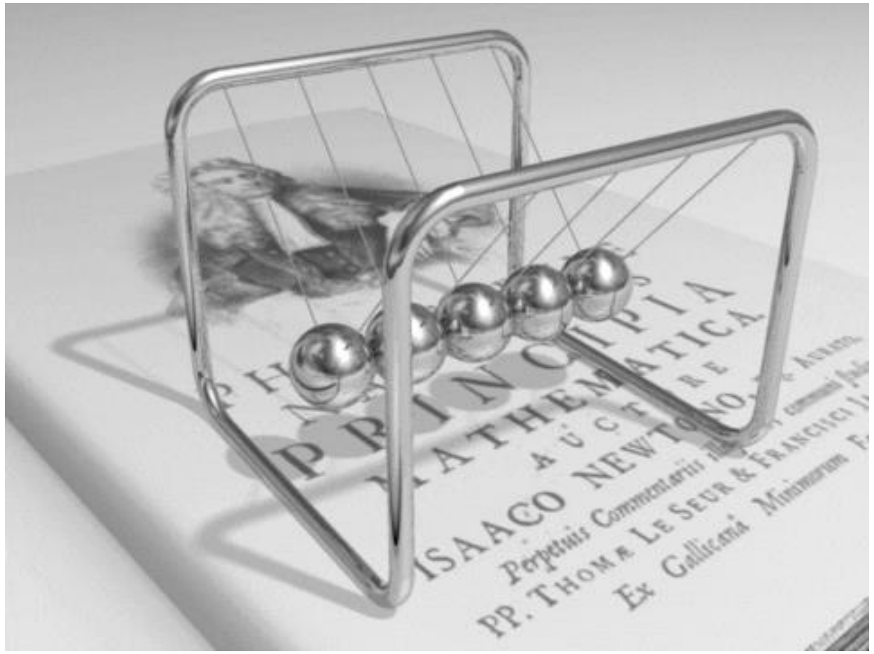
Newton's Laws RECAP ONLY

This is a **recap** of the self study program that you have done on Newtons laws.





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Newtons laws **self-study program.**
Do the following

- Watch the two videos on Newtons laws (chapters 4 & 5) and make notes on these.
- Study the two PowerPoints on Newtons laws (chapters 4 & 5)
- Study Mastering physics (if available)
- Test yourself on some of the 723 questions on Newtons laws.

Newton's first law

Every object continues either at rest or in constant motion in a straight line, unless it is forced to change that state by forces acting on it.

Newton's First Law: Vector form

$$\sum \vec{F} = 0 \qquad \vec{a} = 0$$

$$\Delta \vec{v} = 0$$

$$\vec{v} = \text{constant}$$

Newton's Second Law

- **The net force acting on an object is equal to its mass times its acceleration**

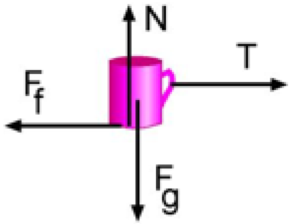
Vector form

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

Component form

$$\Sigma F_x = ma_x \qquad \Sigma F_y = ma_y$$

1. $\Sigma \vec{F} = 0$
2 $\Sigma \vec{F} = m\vec{a}$
3 $\vec{F}_{AB} = -\vec{F}_{BA}$



Newton's third law

- **For every action (force) there is a reaction (force) equal in magnitude and opposite in direction.**

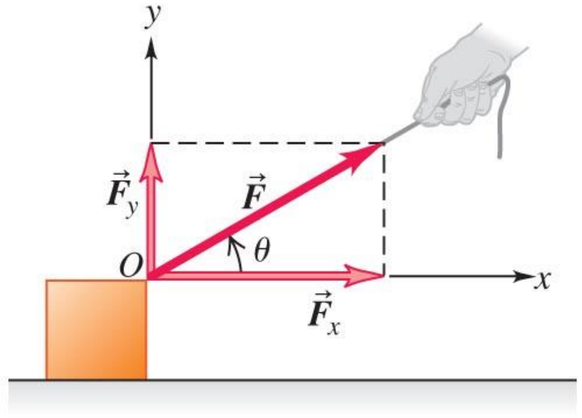
$$\vec{F}_{AonB} = -\vec{F}_{BonA}$$
$$\vec{F}_{AB} = -\vec{F}_{BA}$$

- Forces always act in pairs (of action and reaction)

A Force May Be Resolved Into Components

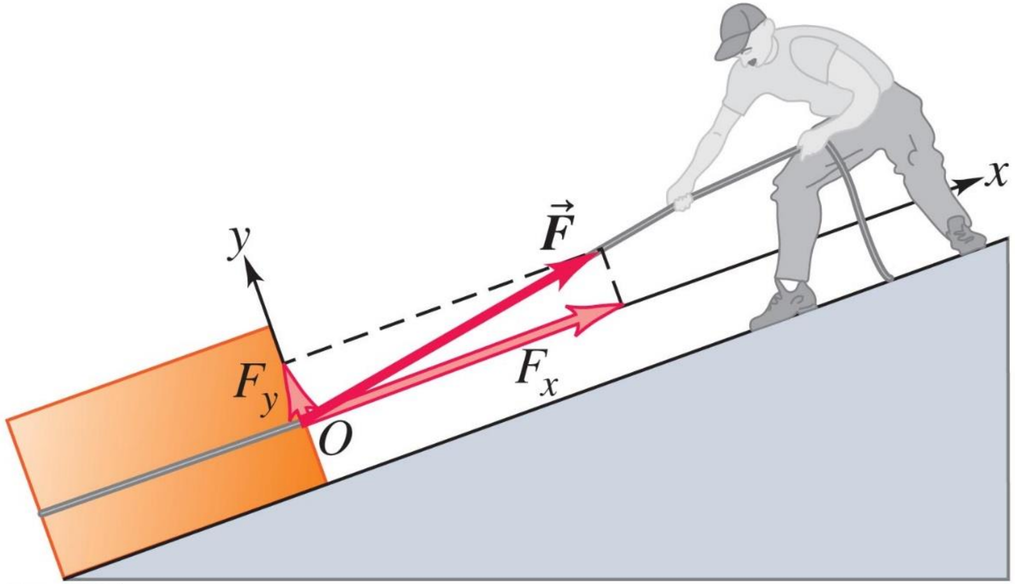
$$F_x = F\cos\theta$$

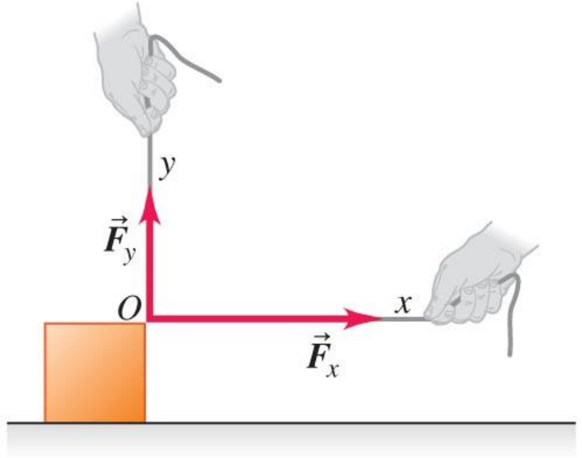
$$F_y = F\sin\theta$$



(a) Component vectors: $\vec{F}_x$ and $\vec{F}_y$
Components: $F_x = F\cos\theta$ and $F_y = F\sin\theta$

- The *x*- and *y*-coordinate axes don't have to be vertical and horizo





(b) Component vectors $\vec{F}_x$ and $\vec{F}_y$ together have the same effect as original force $\vec{F}$.

Inertia

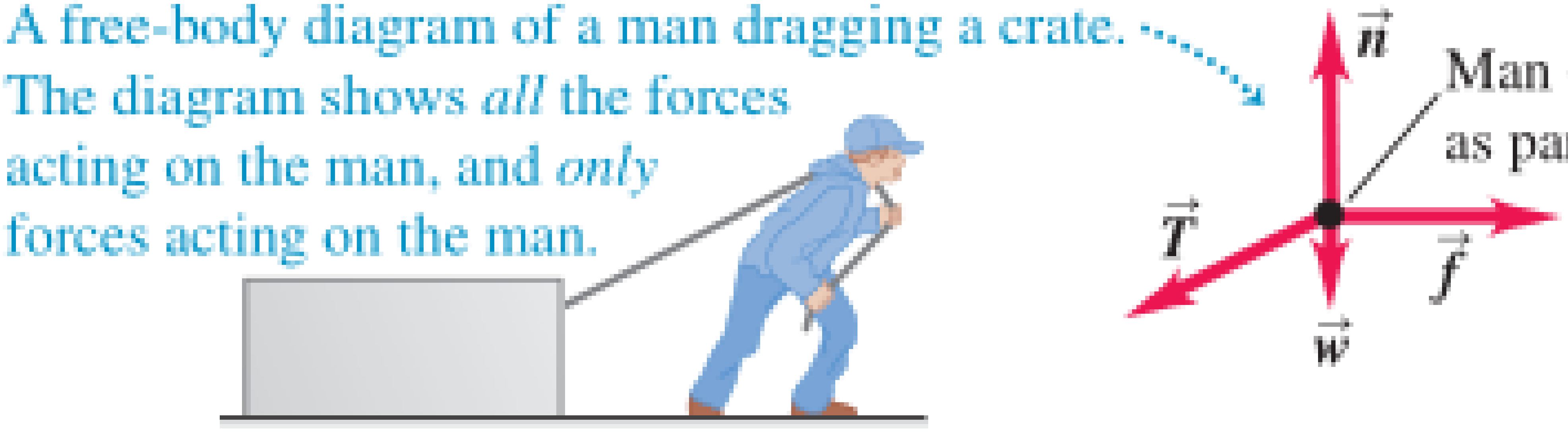
- Every object has **inertia**; the tendency of a body to resist change in motion.
- The **mass** of the body is a measure of its inertia.
- Newton's 1st law is also known as the law of inertia.

Most large tankers turn off their engines about 15 miles (25 km) away from their stop point

Mass and Weight

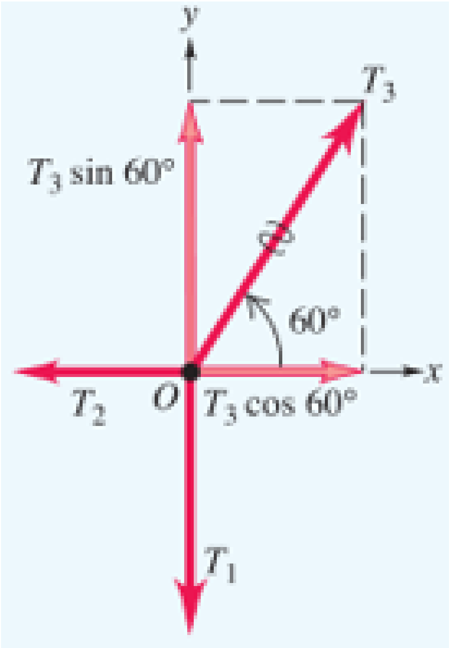
- Weight is the gravitational force acting on a mass.
- The gravitational acceleration ***g*** is assumed constant near the surface of the Earth (unless otherwise is stated)
- ***g*** varies from a planet to another, so weight changes, but mass does not change.

$$W = mg$$



ONLY SHOW FORCES ACTING ON THE OBJECT

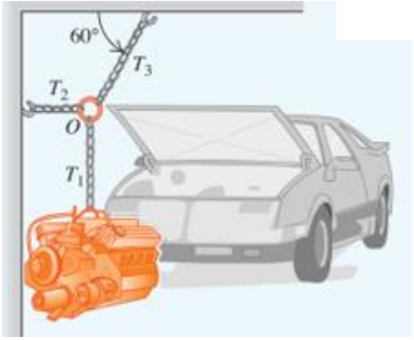
$$\Sigma\vec{F} = 0$$



(c) Free-body diagram of ring O

$$\sum F_x = 0 = T_3 \cos(60) - T_2$$

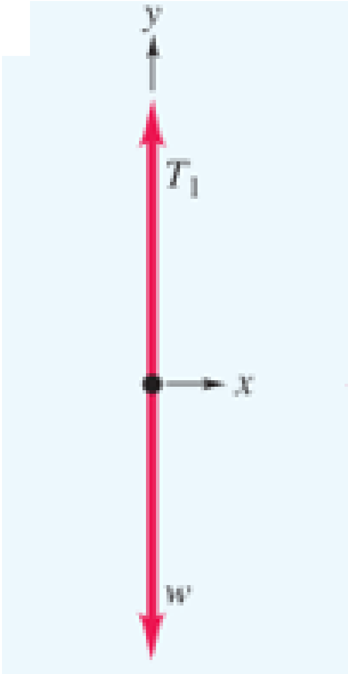
$$\sum F_y = 0 = T_3 \sin(60) - T_1$$



No net force acting on the object.
Draw a free body diagram for the O ring. Since the net force is zero write two equations.

Realize you have 3 unknowns.
You need another equation from the free body diagram of the engine.

Solve the equations.



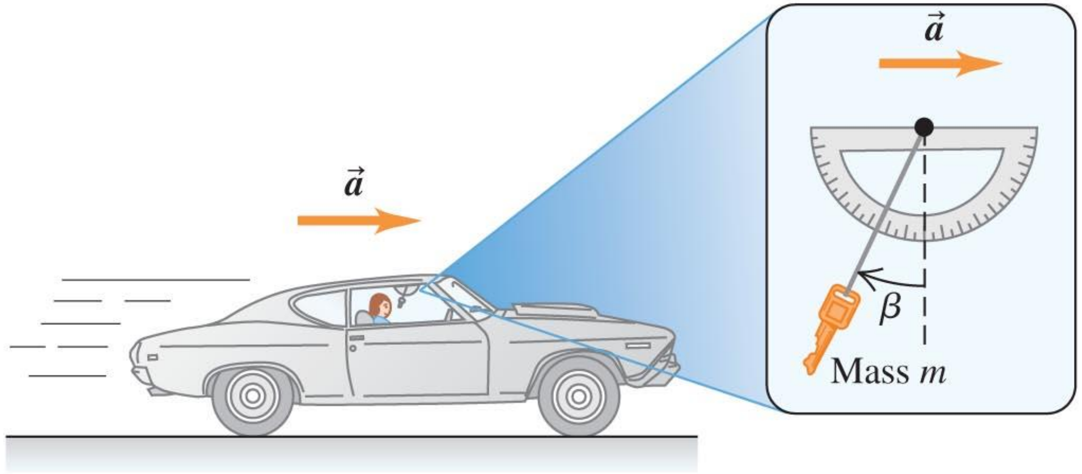
(b) Free-body diagram of engine

$$\sum F = 0 = T_1 - 224\ x\ 9.8$$

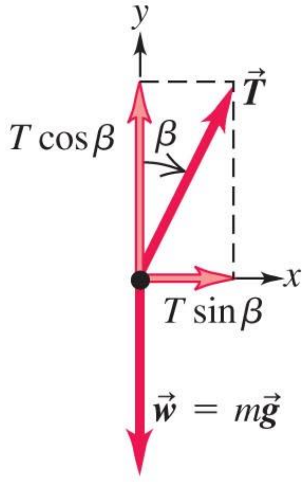
Ans = T1 = 2,195 N , T2 = 1,268 N , T3 = 2,535 N

- This experiment works in your car, a bus, or even an amusement park ride!

VTS Ex 5.5



(a) Low-tech accelerometer

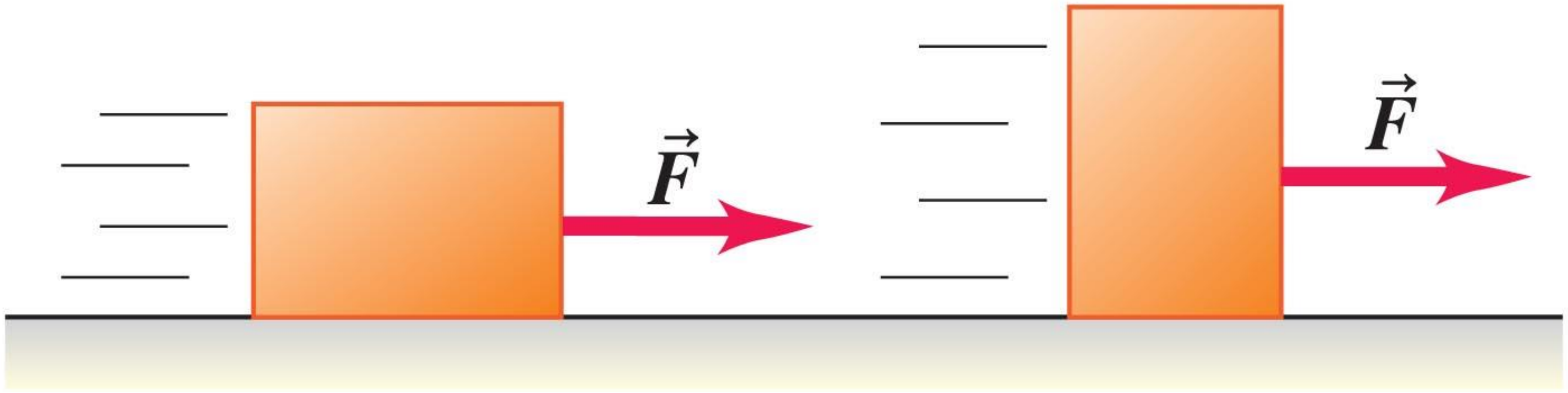


(b) Free-body diagram for the key

$$\left.\begin{aligned} \sum F_x &= ma_x, \quad T \sin\beta = ma_x \\ \sum F_y &= 0, \quad T\cos\beta + (-mg) = 0 \end{aligned}\right\} \quad a_x = g\tan\beta$$

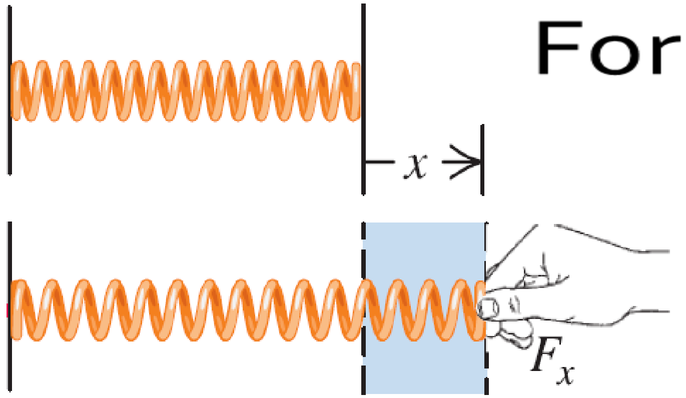
No Dependence on Surface Area

- The normal force determines friction.



$$\left.\begin{array}{ll} f_s \le \mu_s n & \rightarrow \text{no relative movement} \\ f_{s,\max} = \mu_s n & \rightarrow \text{interface "breaks loose"} \\ f_k = \mu_k n & \rightarrow \text{sliding with friction} \end{array}\right\} \mu_k \le \mu_s$$

Hooke's Law 5.4 Elastic forces

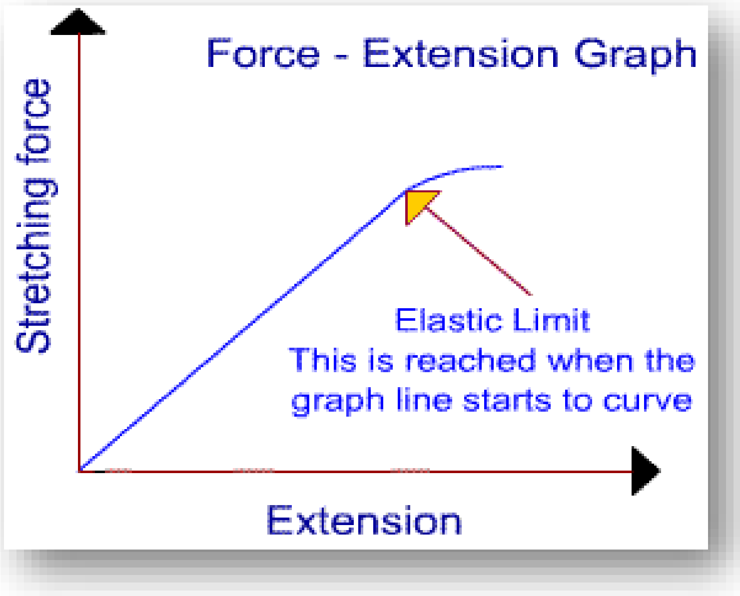


For an elastic spring, the applied force F is proportional to the extension/compression x.

$$\boldsymbol{F} \propto \boldsymbol{x}$$

$$\boldsymbol{F} = \boldsymbol{kx}$$

Where $\boldsymbol{k}$ is the *spring constant*



k is also sometimes called the force constant

Tutorial now.

Try questions