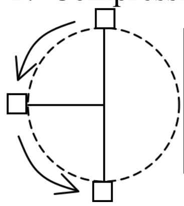
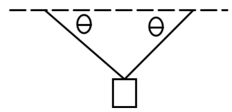
Tension is the force trying to pull an object (usually a string) apart. Newton's 3rd Law says the string pulls back with an equal force. Both ends and middle parts of string <u>all</u> have the same T. Compression is Tension, but for pushing.



$T_{top} = F_c - mg$
$T_{mid} = F_c$
$T_{bot} = F_c + mg$

T changes with position

$2\,T\sin\theta = mg$



Multiple ropes share mg

1st – Inertia – For constant (possibly 0) v, all forces add to zero (even as components). If there is acceleration, F_{net} must not = 0 in that direction.

2nd – $ma = F = \dfrac{\Delta\rho}{\Delta t}$ – most problems that talk about something causing a change in an objects position/movement will use this law.

3rd – Reciprocal Force – No matter what, an object pushes back with the same force that pushes on it. NOTE: forces pushing on the object cause its movement, **<u>not</u>** the object pushing back.

$$P_{avg} = \frac{W}{\Delta t} = \frac{F\Delta x}{\Delta t}\cos\theta;\ P = IV = \frac{\Delta Q}{\Delta t}V;\ \frac{joules}{second}$$

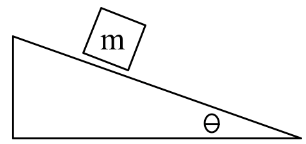
Power (Watts) measures how much energy is used in a given time. Note, since energy = force * displacement, power = force * velocity (the cosθ tells that only the parallel parts count).

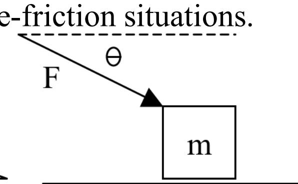
Also, since voltage measures how much energy a charge will pick up crossing a gap, P=IV.

Note, a task can be done quickly with a high power device or slowly with a low power device. Regardless, the same total energy is used.

$F_f \le \mu N = \mu F\sin\theta$

Two common net force-friction situations.





$F_{net} = mg\sin\theta - \mu mg\cos\theta$ $\quad F_{net} = mg\cos\theta - \mu mg\sin\theta$

Also, note work/energy done by friction is lost, friction can on slow (never reverse) motion, and static (stationary) friction is > kinetic friction.

$T = \dfrac{1}{f} \qquad T_{Circle} = \dfrac{2\pi r}{v}$

Period is the time (in seconds typically) for an oscillator (a moon in orbit, a mass on a spring) to return to its starting condition. Frequency is the number of periods per time unit (typically, periods per second – Hz).

$T_{spring} = 2\pi\sqrt{\dfrac{m}{k}} \qquad T_{pendulum} = 2\pi\sqrt{\dfrac{l}{g}}$

Note: Pendulum period doesn't depend on mass.

$F_s = -kx \qquad U_s = \dfrac{1}{2}kx^2$

Spring is the physics code word for harmonic oscillator. Anything that creates a sin wave graph (pendulum, guitar string, water ripple, etc.) for displacement follows the spring equations. The important part of this is that the magnitude of the force, acceleration, and potential energy are all greatest when displacement is great and equal to zero when x=0. Velocity and kinetic energy, however, are the reverse of this.

$\tau = rF\sin\theta$ All of kinematics can be re-derived with torque for **F**, angular acceleration for **a**, etc., but Newton's 1st law is the most important part. An object moving at a constant angular velocity (or stationary) has balanced (or no) torque. On a teeter-totter, a man near the center balances a boy at the end.

The sinθ part means only the part of F tangent to the circle causes angular acceleration. Tension may cause the circular path, but torque is what gets the object moving or stopping.

$J = F\Delta t = \Delta\rho \qquad N \cdot s = kg\dfrac{m}{s}$

Impulse is the change in momentum. It shows that a small force pushing for a long time will have the same effect as a large force for a short time. Also, all changes in momentum do require some time, even a bat hitting a baseball.

It is mostly important for the AP exam, because Newton's 2nd Law can be re-written with impulse $ma = F = \dfrac{\Delta\rho}{\Delta t}$.

Torque

Impulse

Period

Springs

Power

Friction

Tension

Newton’s Laws