After this you can

- calculate the new quantities of stress and strain
- apply Hooke's Law to solids

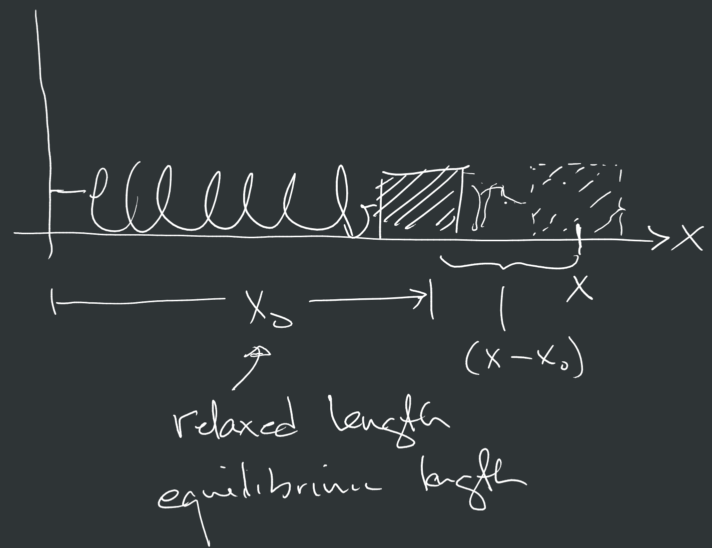
force from a spring is directly proportional to the distortion

stretch/compress distance

$$F = k\,\Delta x$$

spring constant

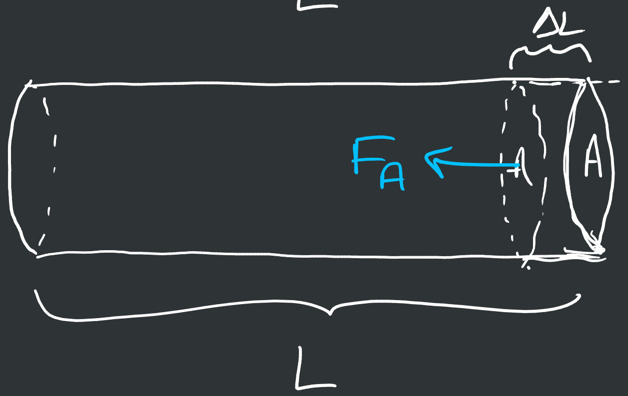
$$F(x) = k(x - x_0)$$



tensile and compressive deformation

strain $= \dfrac{\Delta L}{L}$ — fractional length change $\}$ % change

$\dfrac{\Delta L}{L} > 0$ $\}$ tensile strain



$\dfrac{\Delta L}{L} < 0$ $\}$ compressive strain

Hooke's Law for solids

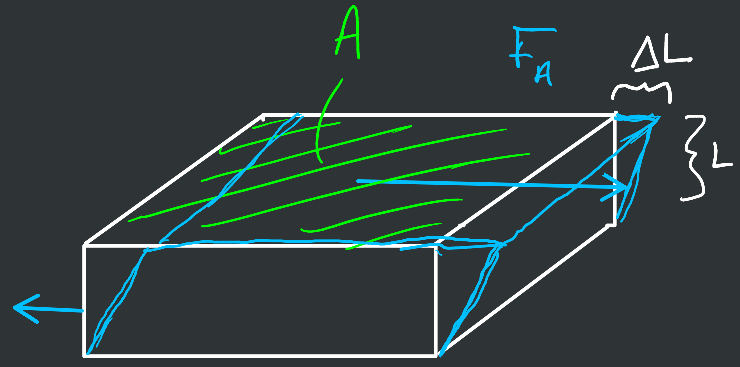
- stress is directly proportional to strain

$$\boxed{\underbrace{\frac{F}{A} = Y}_{} \frac{\Delta L}{L}}$$

intrinsic material property $\{$ Young's Modulus or elastic modulus

What causes strain?

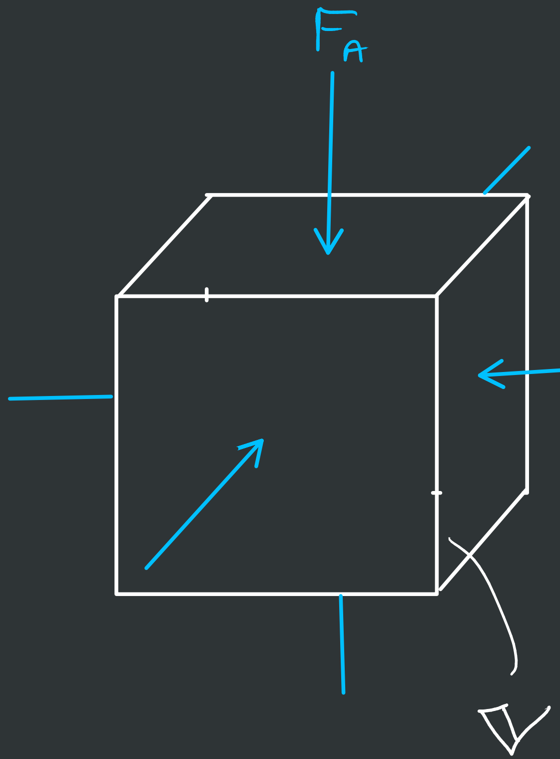
stress $= \dfrac{F}{A}$ ← pressure
↳ units of pascals



$$\underbrace{\frac{F}{A}}_{\text{sheer stress}} = S \underbrace{\frac{\Delta L}{L}}_{\text{shear strain}}$$

sheer deformation

sheer modulus



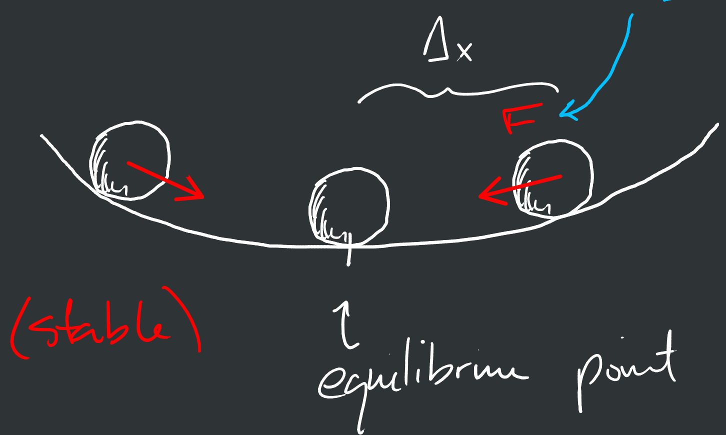
$$\frac{F}{A} = B \frac{\Delta V}{V}$$

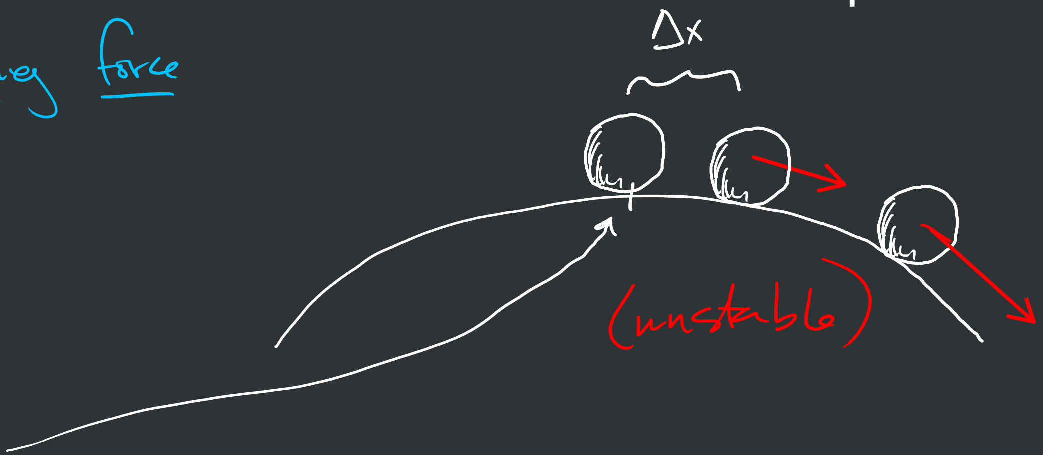
entire surface area

bulk modulus

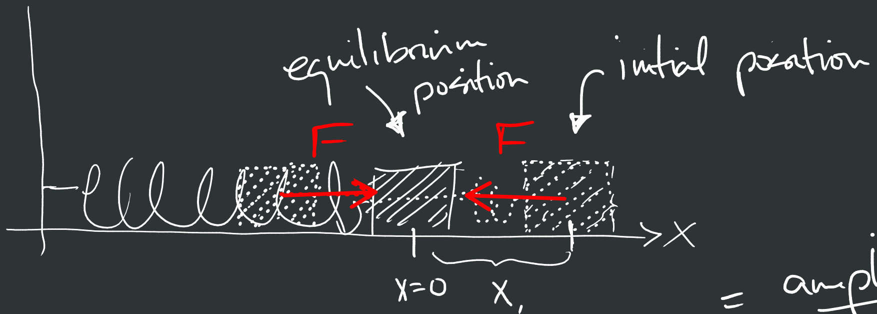
After this you can
- discuss oscillatory motion and what produces it
- discuss the conditions of **stable** equilibrium $F_{NET}=0$ $\tau_{NET}=0$
- discuss simple harmonic motion as the kind of motion
    near a point of stable equilibrium
- identify key quantities for describing simple harmonic motion

oscillation - motion occuring about a point of stable equilibrium
equilibrium - Fnet=0
stable - a small displacement results in a force that points back towar
    the stable point. restoring force

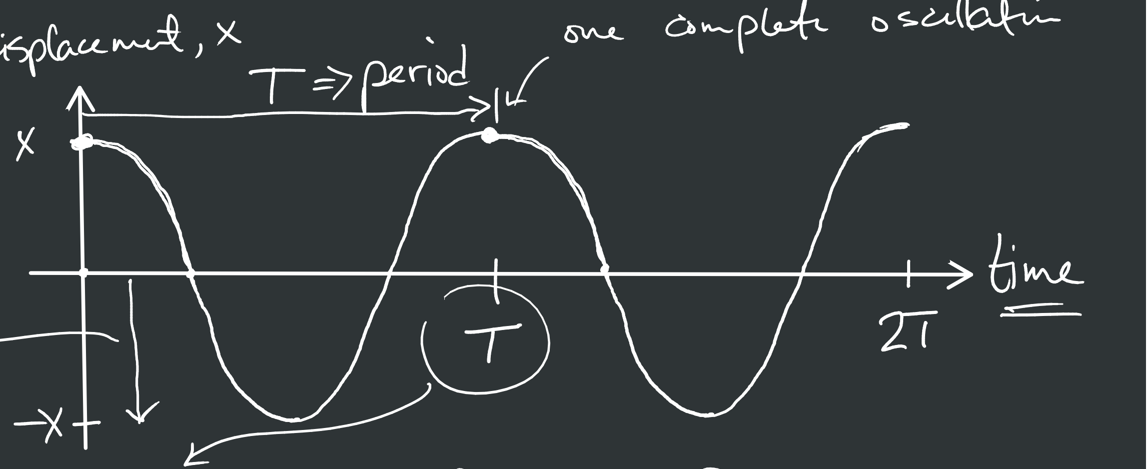




simple harmonic motion - type of oscillatory motion that results when the
    restoring force is directly proportional to the displacement
    → Hooke's Law (like spring)



X_{max} = amplitude



<u>period</u> - amount of time for <u>one</u> oscillation

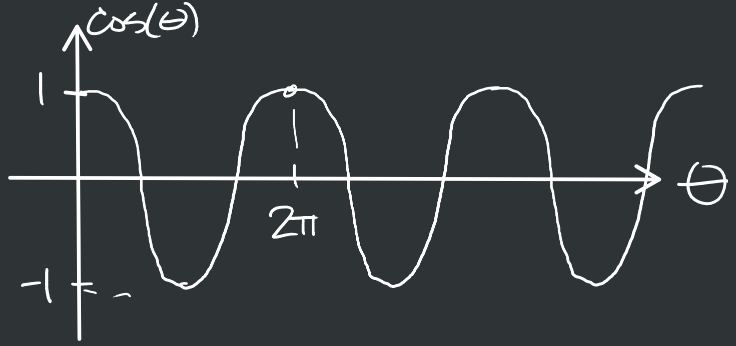
[s] $\qquad \dfrac{\text{time}}{1 \text{ oscillation}}$

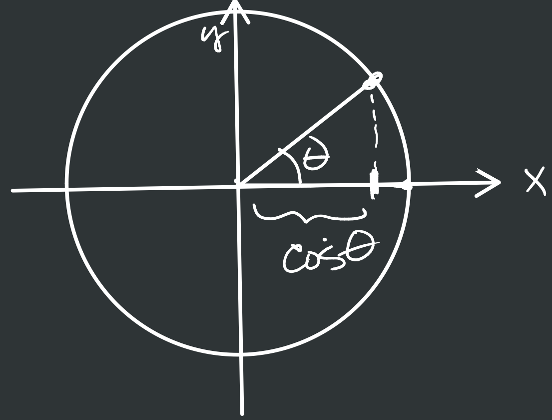
↓ invert

$\dfrac{\#\text{ of oscillations}}{1 \text{ unit of time}}$

$f = \dfrac{1}{T}$ ← <u>frequency</u> - number of oscillations that happen in a unit time

$\left[\frac{1}{s}\right] = \left[s^{-1}\right] = [\text{Hertz}] = [\text{Hz}]$





$$2\pi\,\text{rad} \rightarrow T$$

$$\theta = \left[\frac{\text{rad}}{s}\right] \cdot t$$

$$\frac{2\pi}{T} = \omega$$

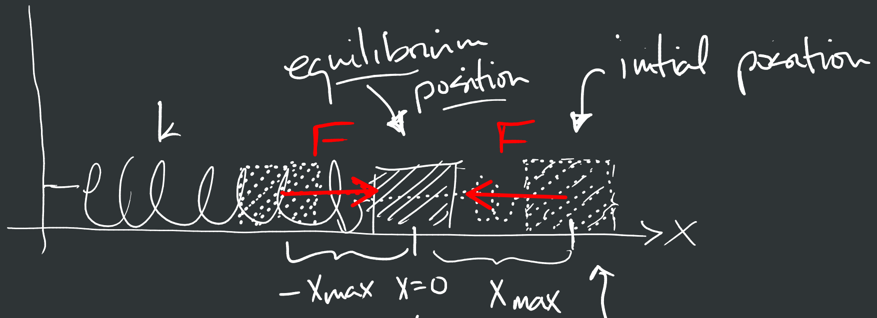
~~angular velocity~~

angular frequency

$$\omega = \frac{2\pi}{T} = 2\pi f$$

$$\boxed{x(t) = X_{max} \cdot \cos(\omega t)}$$

amplitude



How much energy?

$\rightarrow U_s = \frac{1}{2} k x_{max}^2$

if I let go it speeds up.

how fast? $\rightarrow v_{max}$

$$K_f = U_{s_i}$$

at equi. point $\rightarrow$ $\cancel{\frac{1}{2}} m v_{max}^2 = \cancel{\frac{1}{2}} k x_{max}^2$

$$v_{max}^2 = \frac{k}{m} x_{max}^2$$

$$\boxed{v_{max} = \sqrt{\frac{k}{m}} \cdot x_{max}}$$

what about max acceleration?

$$F_{max} = k x_{max} = F_{NET} = m a_{max}$$

$$k x_{max} = m a_{max}$$

$$\boxed{a_{max} = \frac{k}{m} x_{max}}$$

$$\left[\frac{k}{m}\right] = \left[\frac{\frac{N}{m}}{kg}\right] = \left[\frac{N}{m \cdot kg}\right]$$

$$= \left[\frac{\frac{\cancel{kg\,m}}{s^2}}{\cancel{m} \cdot \cancel{kg}}\right] = \frac{1}{s^2}$$

$$\left[\sqrt{\frac{k}{m}}\right] \Rightarrow \frac{1}{s}$$

$$\boxed{\begin{aligned} x(t) &= X_{max}\cos(\omega t) \\ v(t) &= -V_{max}\sin(\omega t) \\ a(t) &= -a_{max}\cos(\omega t) \end{aligned}}$$

$$\boxed{\omega = \sqrt{\frac{k}{m}}}$$

$$2\pi f = \sqrt{\frac{k}{m}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$\frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$\boxed{T = 2\pi\sqrt{\frac{m}{k}}}$$

$$\boxed{\begin{aligned} &X_{max} \rightarrow \text{amplitude} \\ &V_{max} = \omega \cdot X_{max} \\ &a_{max} = \omega^2 \cdot X_{max} \end{aligned}}$$