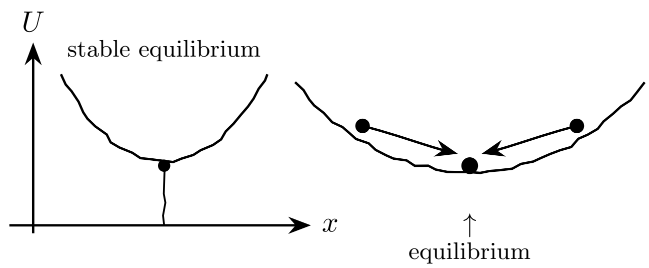
# 14. Oscillation (Class Notes)

## Equilibrium

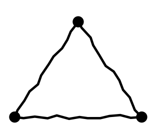
- **Equilibrium:** $\sum \vec{F} = 0$.
- This does *not* mean "not moving." You can have $\sum \vec{F} = 0$ and still move at constant velocity.
- **Stable equilibrium:** if displaced, the system experiences a restoring tendency back toward the equilibrium point.




## Period, Frequency, and "Cycle"

- **Period** $T$: time for *one full cycle* (seconds).
- **Frequency** $f$: number of cycles per second (Hz).

$$f = \frac{1}{T}, \qquad T = \frac{1}{f}, \qquad 1\ \text{Hz} = 1\,\text{s}^{-1}.$$



→ 1 full cycle

how many cycles
per sec

$$f = \frac{\text{cycles}}{\text{sec}}$$

### Quick unit check (like your line)

If you complete $N$ cycles in 1 second, then

$$f = \frac{N\ \text{cycles}}{1\ \text{s}}.$$

If one cycle takes $T$ seconds, then

$$f = \frac{1\ \text{cycle}}{T\ \text{s}} = \frac{1}{T}\ \text{Hz}.$$

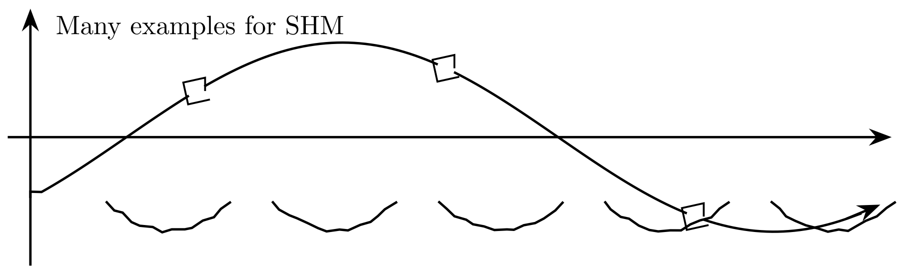
**Radio station meaning**

A radio station at 100 MHz means the electromagnetic field oscillates

$$100 \times 10^6 \text{ times per second.}$$

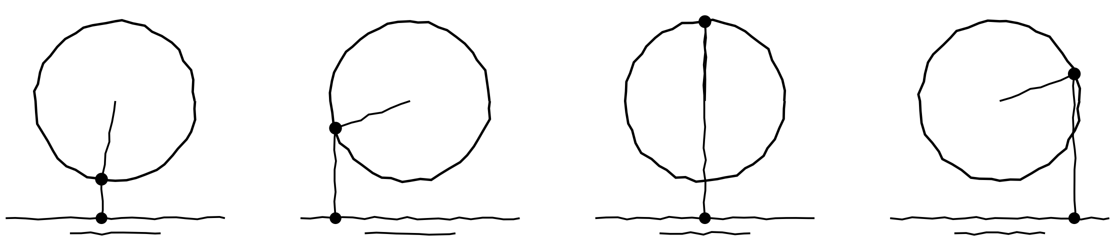
## Many Examples of SHM

SHM (simple harmonic motion) is the kind of oscillation produced by a **restoring influence** that is proportional to displacement (for small displacements). The result is sinusoidal motion.




## Why are sine waves and SHM related?

One clean way to see the connection: **uniform circular motion projected onto a line gives sinusoidal motion.** That's the idea behind your small circle doodles.



projection of circular motion ⇒ sine wave (SHM)

## Summary (matches your page)

- Equilibrium: $\sum \vec{F} = 0$ (can still be moving).
- Stable equilibrium gives a restoring tendency ⇒ oscillation.
- Period $T$ = seconds per cycle; frequency $f$ = cycles per second; $f = 1/T$.
- Many physical systems (near stable equilibrium) approximate SHM ⇒ sinusoidal motion.
- A geometric reason for sine: projection of uniform circular motion.