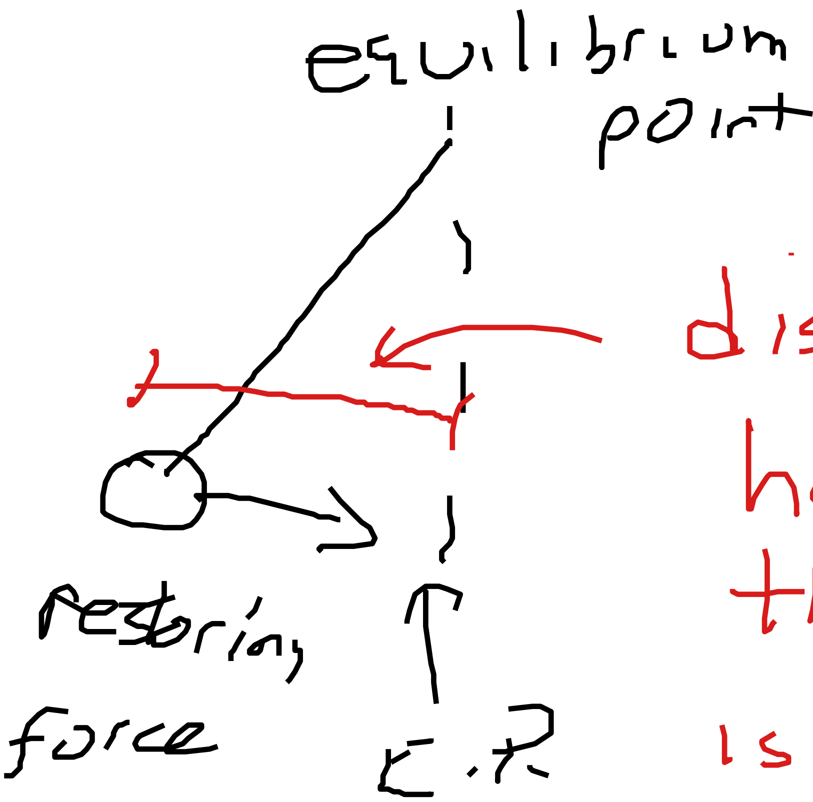
Oscillations

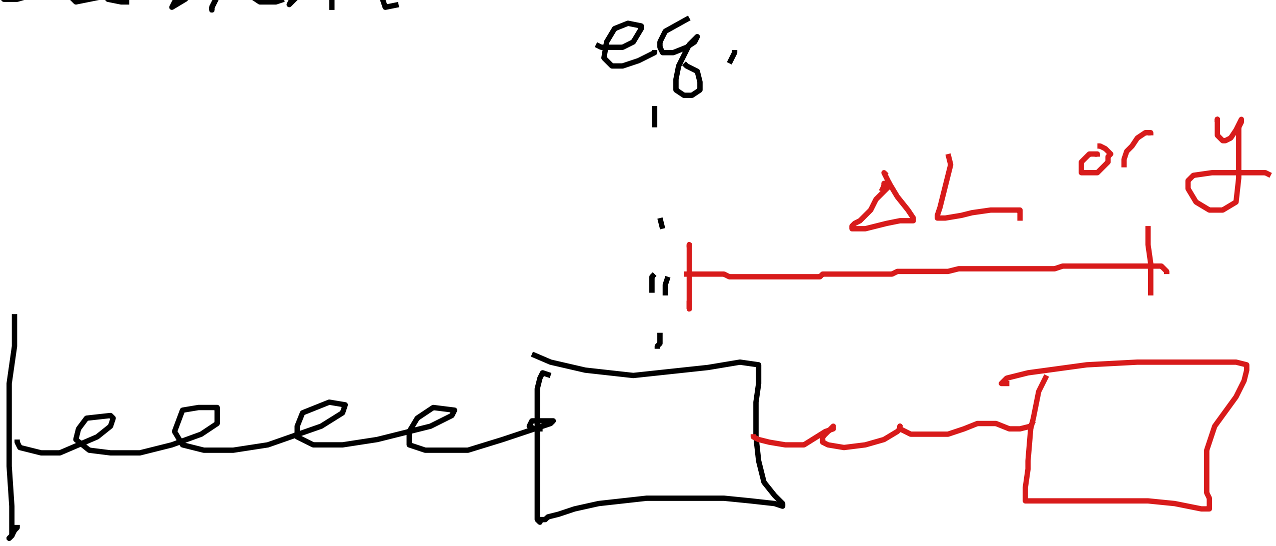


displacement: how far the system is from equilibrium at any time

$$y(t)$$

At equilibrium: $y = 0$

If restoring force is linearly proportional to the displacement



$$F = k(L - L_0)$$

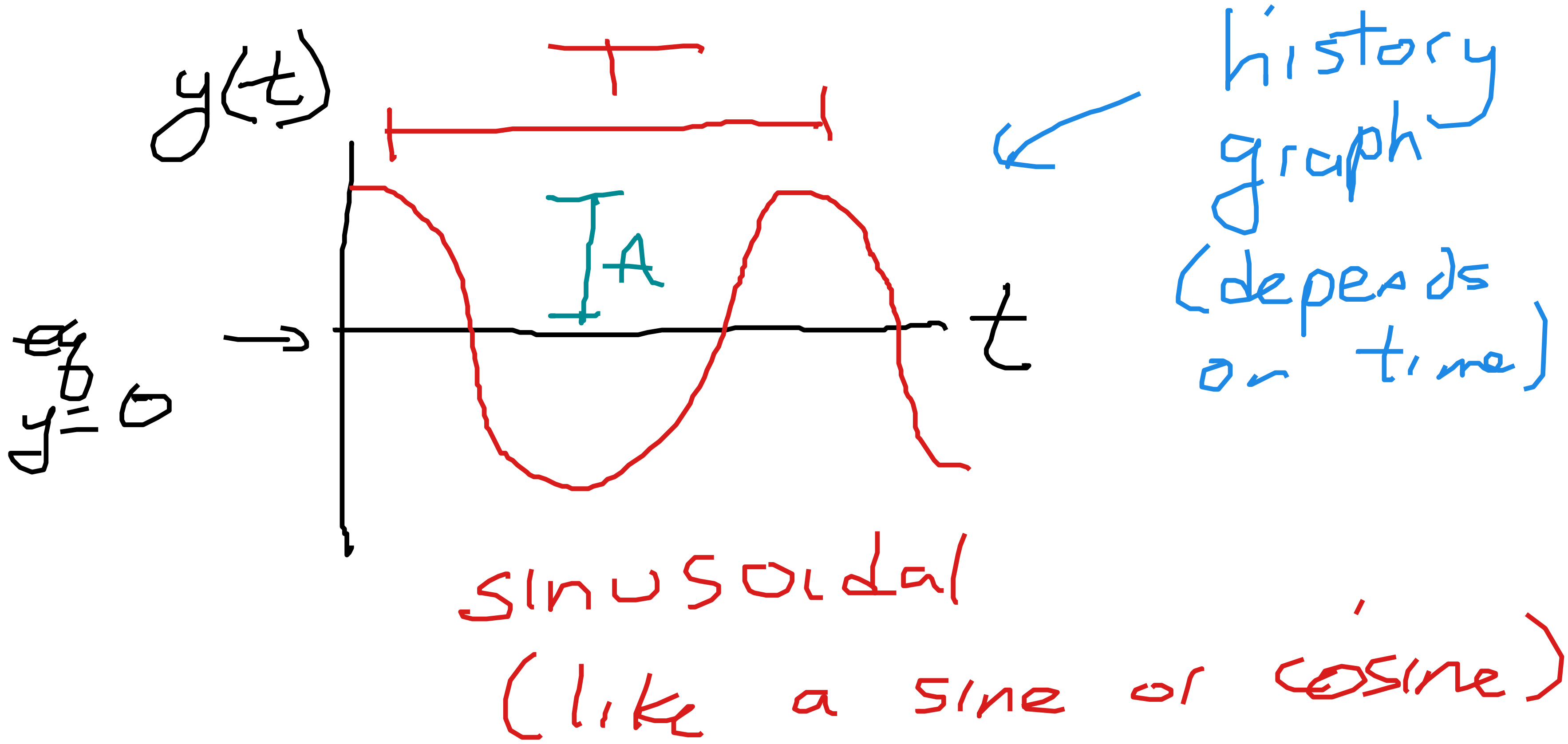
$$= k\Delta L$$

$$F = ky$$

$$F \propto y$$

.. then oscillation is

simple harmonic motion
(SHM)



phi

$$y(t) = A\cos\left(2\pi \frac{t}{T} + \phi_0\right)$$

in radians

- t : time (s)
- T : period of oscillation (s)

$$\cos\theta = \cos(\theta + 2\pi)$$

$$y(t=0) = A\cos(0 + \phi_0)$$
$$= A\cos\phi_0$$

$$y(t=T) = A\cos\left(2\pi\frac{T}{T} + \phi_0\right)$$
$$= A\cos(2\pi + \phi_0)$$
$$= A\cos\phi_0 = y(t=0)$$

$$f = \frac{1}{T}$$

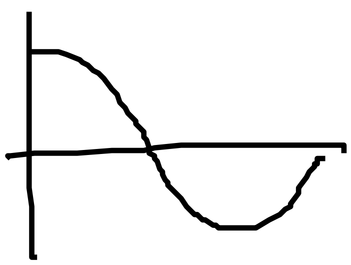
$$\boxed{y(t) = A\cos(2\pi f t + \phi_0)}$$

- A : amplitude of oscillation

  farthest distance the object gets from equilibrium

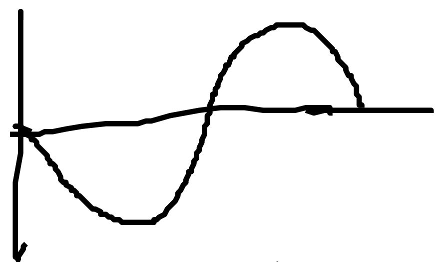
- ϕ_0 : initial phase

  - where the graph starts



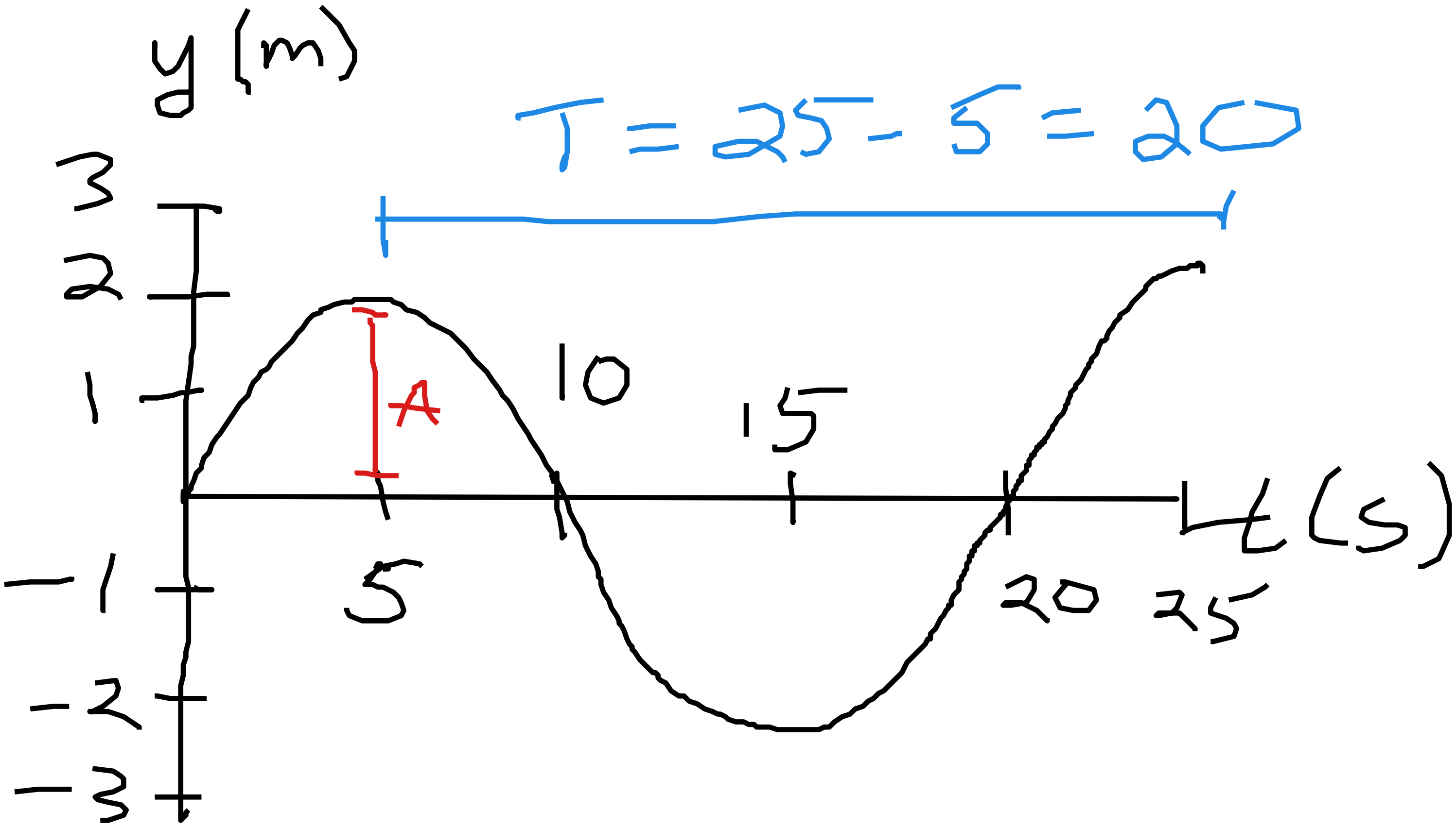
$A\cos(2\pi f t)$

$\phi_0 = 0$



$A\cos(2\pi f t + \frac{\pi}{2})$

$\phi_0 = \frac{\pi}{2}$

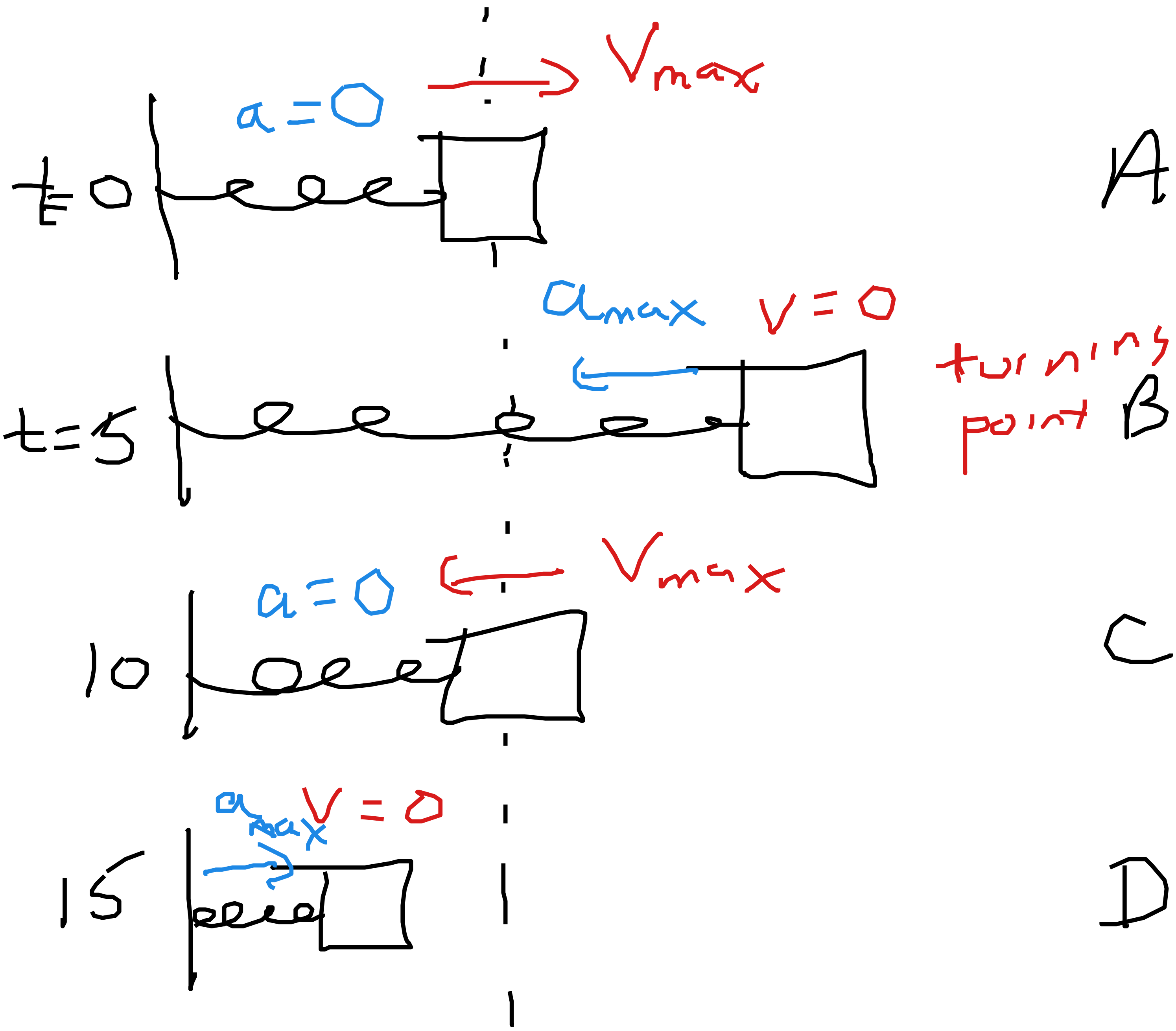


Amplitude? 2m

Period? 20s

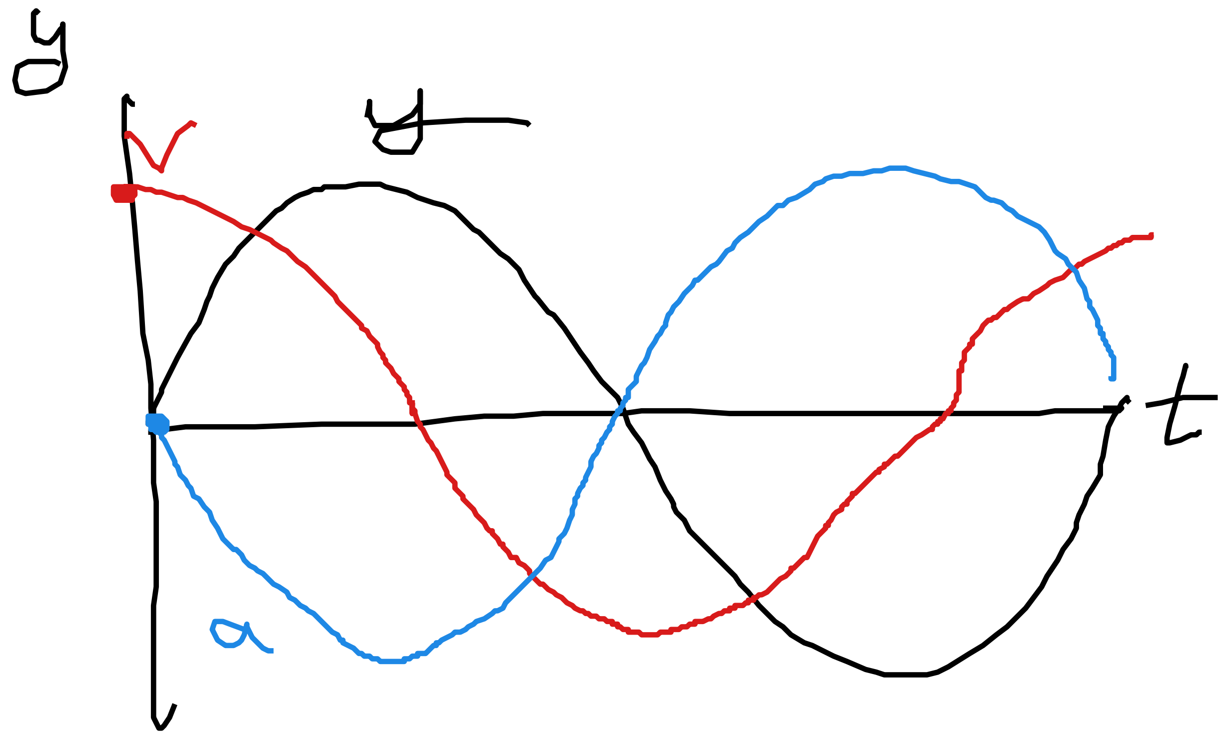
Frequency? Find T first

$$f = \frac{1}{T} = \frac{1}{20}\ Hz$$



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

At turning point, $v = 0$
but $a \neq 0$
(turning → changing velocity)


y
v
y
t
a