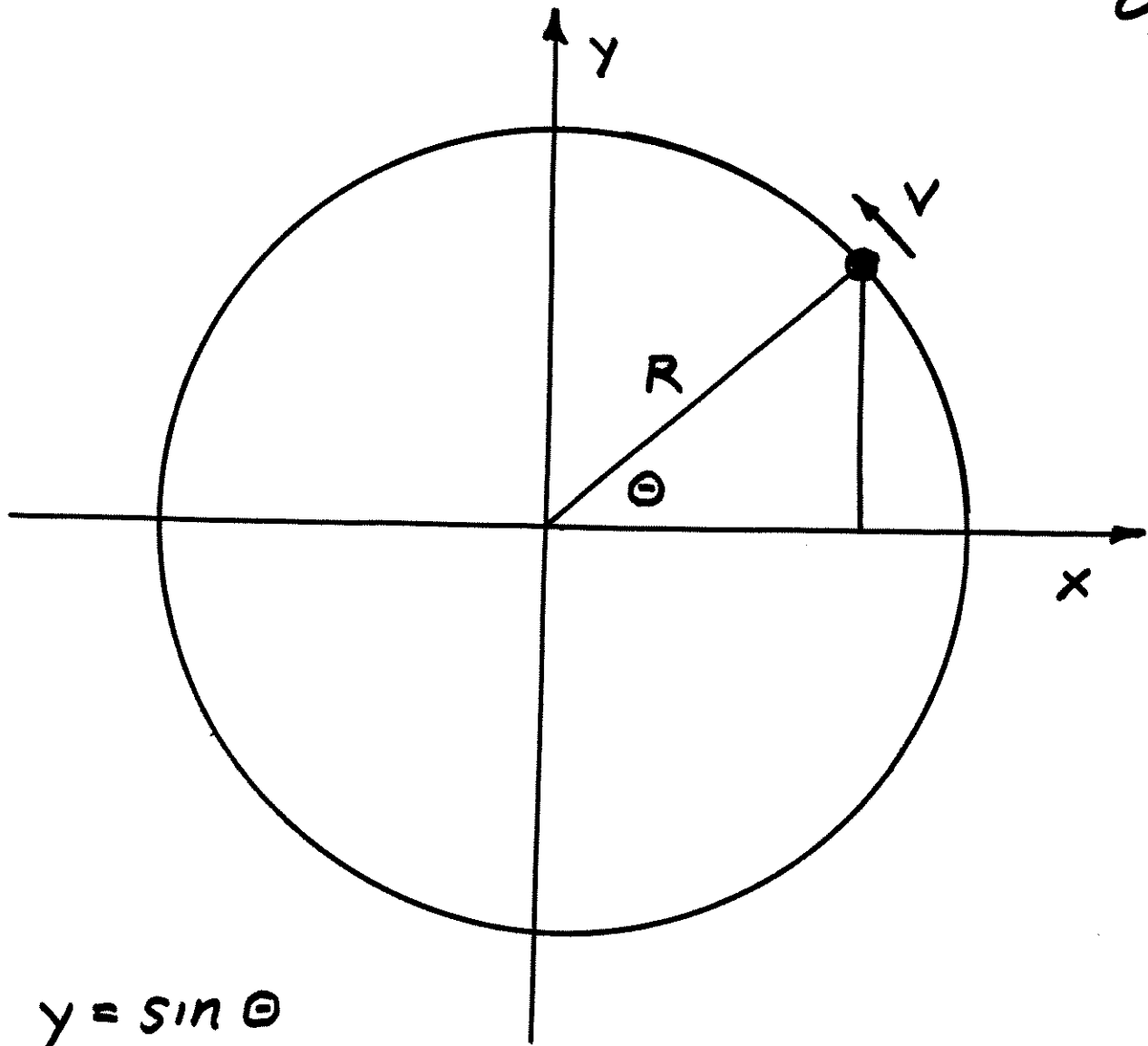


OH 1



$$y = \sin \theta$$

$$\theta = \frac{vt}{R}$$

When $\theta = 2\pi$, $2\pi R = vT$

where $T =$ the period

So, in general, $\theta = \frac{2\pi t}{T}$

and $y = \sin \frac{2\pi t}{T}$

or $y = \sin 2\pi f t$, where $f = \frac{1}{T} =$ frequency

or $y = \sin \omega t$, where $\omega = 2\pi f =$ angular frequency

What does Newton say about a mass on a spring?

$$F_{\text{net}} = -kx \quad (\text{Hooke's Law})$$

$$a = \frac{F_{\text{net}}}{m} \quad (\text{N2})$$

$$\boxed{\frac{d^2x}{dt^2} = -\frac{kx}{m}}$$

EQUATION
OF
MOTION

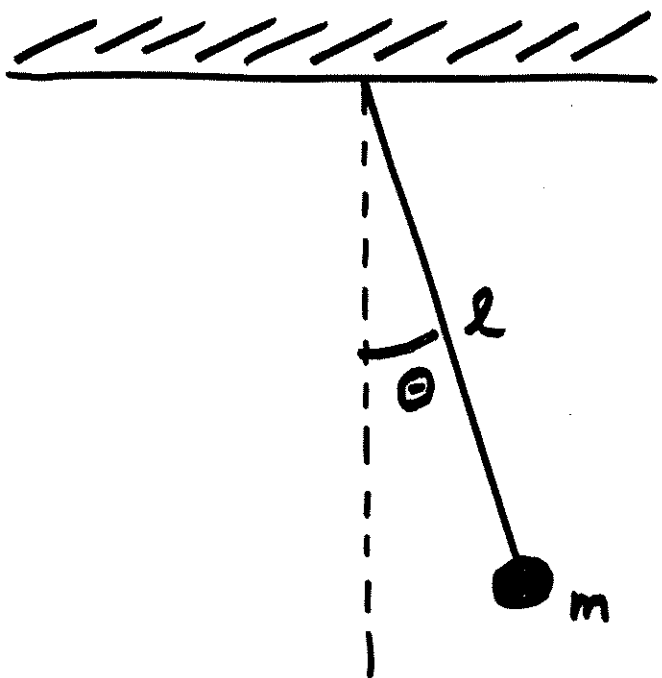
Let's check dimensions:

$$\left[\frac{d^2x}{dt^2} \right] = \frac{L}{T^2}$$

$$\therefore \left[\frac{kx}{m} \right] = \frac{L}{T^2} \Rightarrow \left[\frac{k}{m} \right] = \left[\frac{1}{T^2} \right]$$

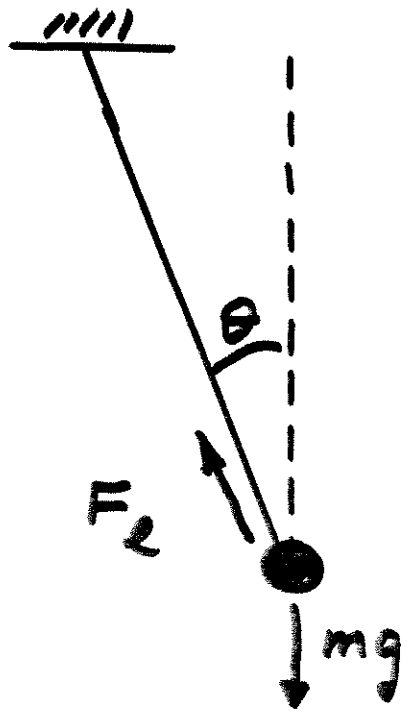
i.e. $\frac{k}{m}$ looks like a frequency squared

How about a simple pendulum?



Is this an example of linear motion or circular motion?

Let's look at the free-body diagram



It's circular motion!

$$\tau = I\alpha \quad (\text{circular NZ})$$

$$-mg\ell \sin\theta = I^2 m \frac{d^2\theta}{dt^2}$$

\Downarrow

$$\frac{d^2\theta}{dt^2} = -\left(\frac{g}{\ell}\right) \sin\theta$$

For small θ (Do a calculator experiment.)

$$\sin\theta \approx \theta$$

$$\therefore \boxed{\frac{d^2\theta}{dt^2} = -\left(\frac{g}{\ell}\right)\theta}$$

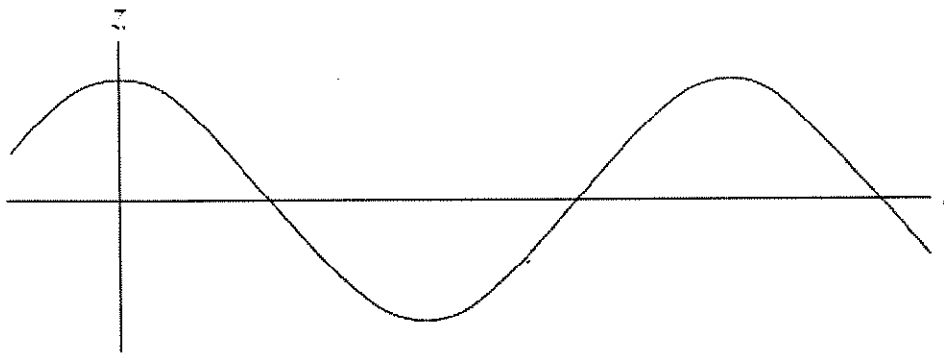
It's the same EQUATION OF MOTION!

A mass suspended from a spring is oscillating up and down as indicated.

Consider two possibilities:

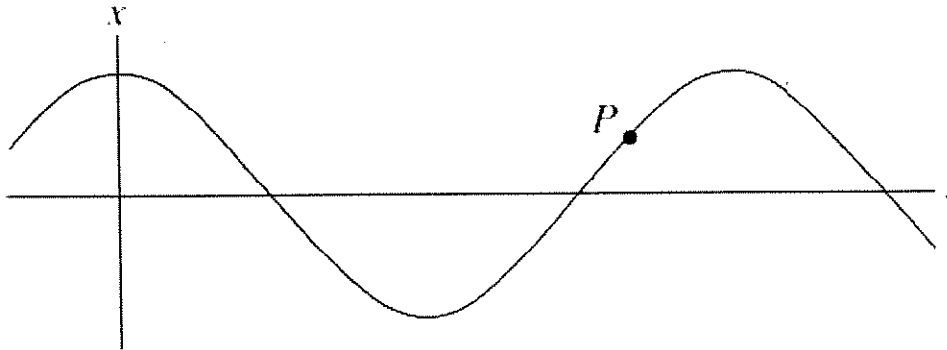
(i) at some point during the oscillation the mass has zero velocity but is accelerating (positively or negatively);

(ii) at some point during the oscillation the mass has zero velocity and zero acceleration.



1. Both occur sometime during the oscillation.
2. Neither occurs during the oscillation.
3. Only (i) occurs.
4. Only (ii) occurs.

A mass attached to a spring oscillates back and forth as indicated in the position vs. time plot below.



At point P , the mass has

1. positive velocity and positive acceleration.
2. positive velocity and negative acceleration.
3. positive velocity and zero acceleration.
4. negative velocity and positive acceleration.
5. negative velocity and negative acceleration.
6. negative velocity and zero acceleration.
7. zero velocity but is accelerating (positively or negatively).
8. zero velocity and zero acceleration.