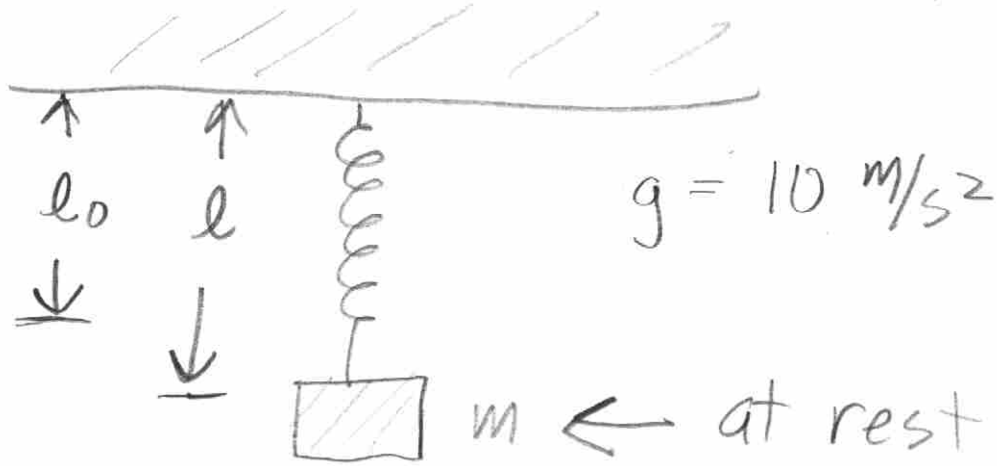


$l - l_0 = 0.4$ meters

Period for small oscillations is:

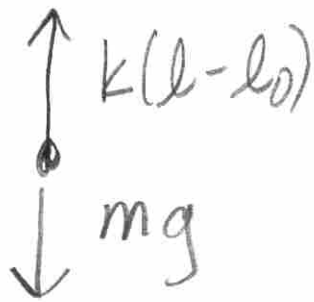
(A) Not enough information

(B) 5 s

(C) 2π s

(D) $\frac{2\pi}{5}$ s

(E) $\frac{\pi}{5}$ s



$$k(l-l_0) = mg$$

$$k = \frac{mg}{l-l_0}$$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{\cancel{m}g}{\cancel{m}(l-l_0)}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{(l-l_0)}{g}}$$

$$= 2\pi\sqrt{\frac{0.4}{10}}$$

$$= 2\pi\sqrt{0.04} = 0.2 \cdot 2\pi$$

$$\boxed{T = 0.4\pi = \frac{2\pi}{5}\ s}$$

$y(0) = 0$

$\dot{y}(0) = -2 \text{ m/s}$

$y(t) = A\sin(\omega t) + B\cos(\omega t)$

$y(0) = B = 0$

$\dot{y}(t) = \omega A\cos(\omega t) - \omega B\sin(\omega t)$

$\dot{y}(0) = \omega A = -2 \text{ m/s}$

$A = -\frac{2}{\omega} = -\frac{2 \text{ m/s}}{5 \text{ 1/s}}$

$A = -0.4 \text{ m}$

$$y(t) = -0.4\sin(5t)$$

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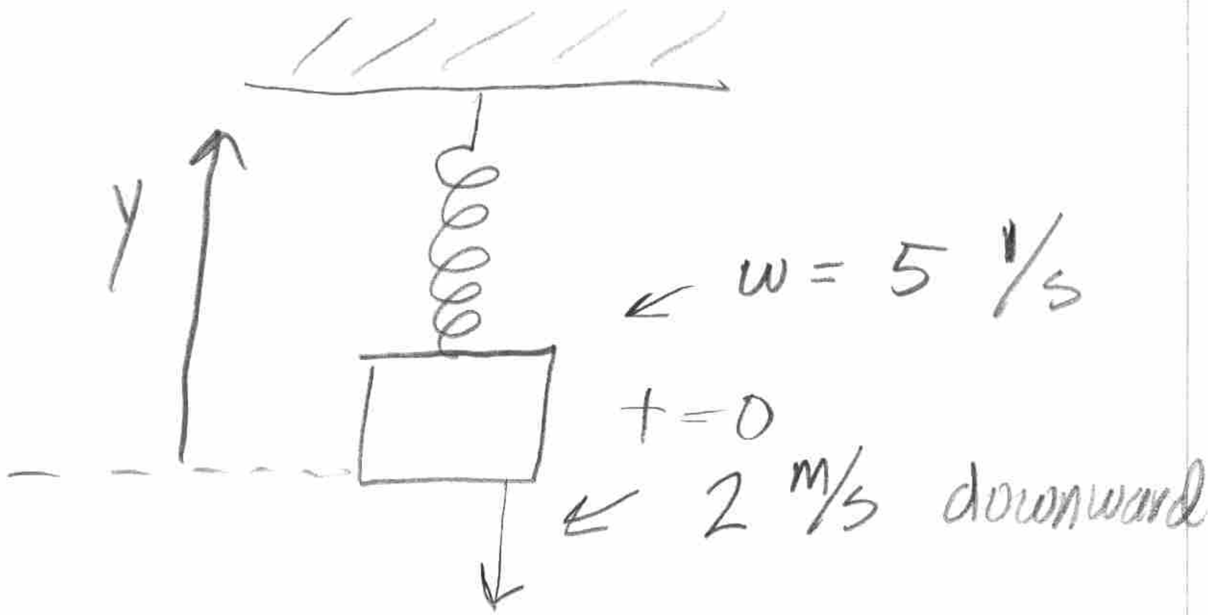


$y(t) =$

(A) $2\cos(5t)$ meters

(B) $-2\cos(5t)$ "

(C) $-0.4\sin(5t)$ "

(D) $-2\sin(5t)$ "

(E) $-0.4\cos(5t)$.

Momentum

Chapter 3 K+K
9 RHK4
(no energy)

$$\vec{F}_{Net} = m\vec{a} = m\dot{\vec{v}}$$

hidden assumption: m = constant

more generally, (relativity, the kilogram)

$$\vec{F}_{Net} = \frac{d}{dt}(m\vec{v})$$

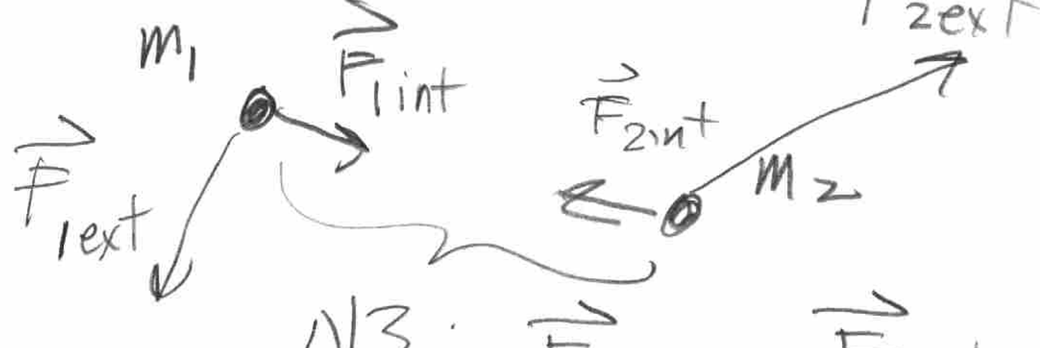
↑ the momentum

$$\vec{p} = m\vec{v}$$

Curious situation: system of particles...

Every ball, block, etc. $\approx 10^{24}$ atoms!

Start with 2



N3: $\vec{F}_{1int} = -\vec{F}_{2int}$.

$$\vec{F}_{1Net} = \vec{F}_{1ext} + \vec{F}_{1int} = \frac{d}{dt}(\vec{p}_1)$$

$$\vec{F}_{2Net} = \vec{F}_{2ext} + \vec{F}_{2int} = \frac{d}{dt}(\vec{p}_2)$$

cancel

$$\vec{F}_{1ext} + \vec{F}_{2ext} = \frac{d}{dt}(\vec{p}_1 + \vec{p}_2)$$

total momentum

independent of: internal forces

$$M\ddot{\vec{R}} = \frac{d}{dt}(\vec{p}_1 + \vec{p}_2)$$

$(m_1 + m_2)$ (to be found) $\frac{dm_1}{dt} = 0$, $\frac{dm_2}{dt} = 0$

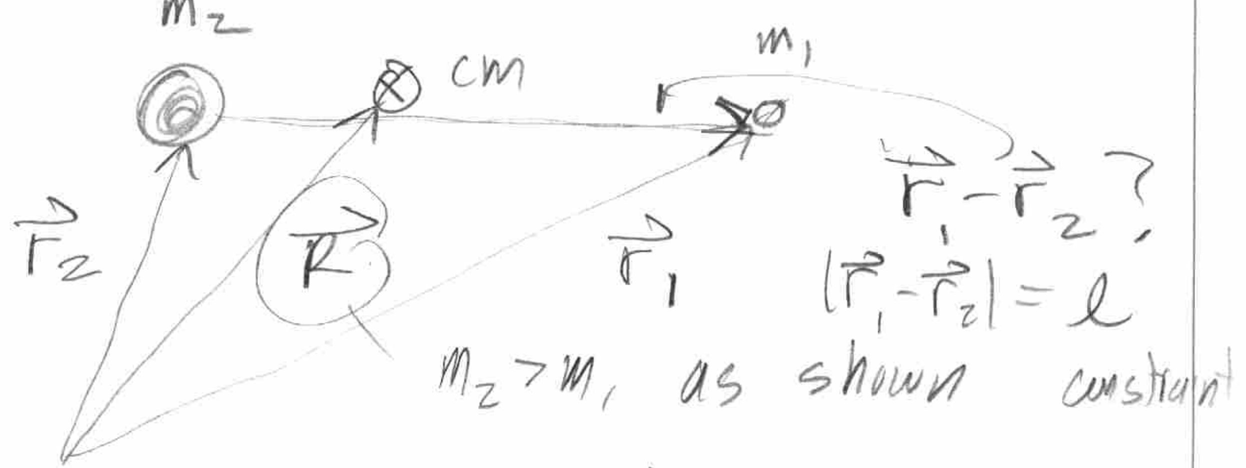
$$= m_1\ddot{\vec{r}}_1 + m_2\ddot{\vec{r}}_2$$

$$\ddot{\vec{R}} = \frac{m_1\ddot{\vec{r}}_1 + m_2\ddot{\vec{r}}_2}{m_1 + m_2}$$

$$\vec{R} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2}$$

$\vec{R}$ is called .. <u>center of mass</u>

Dumb-bell: balance point.



$$\vec{R} = \frac{m_1 \vec{r}_1 + m_2 \vec{r}_2}{m_1 + m_2}$$

$$f_1 = \frac{m_1}{m_1 + m_2} \qquad f_2 = \frac{m_2}{m_1 + m_2}$$

$$\vec{R} = f_1 \vec{r}_1 + f_2 \vec{r}_2 \qquad 0 \le f \le 1$$

$m_2 = 0$, $f_1 = 1$, $f_2 = 0$

$$\vec{R} = \vec{r}_1$$

$m_1 = 0$, $f_1 = 0$, $f_2 = 1$

$$\vec{R} = \vec{r}_2$$

<u>LINEAR</u> between these two limits.