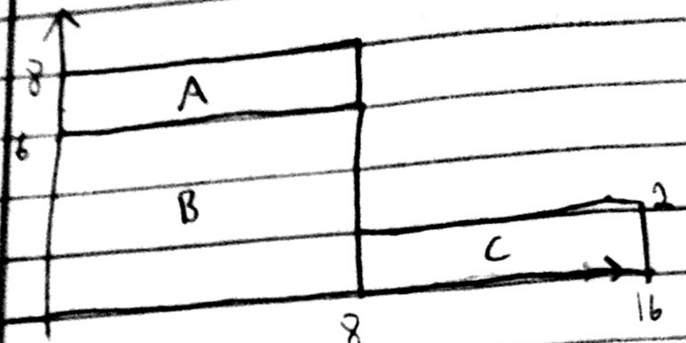
1.



$M_A = 50\ kg$
$M_B = 12\ kg$
$M_C = 90\ kg$

$COM_A = (4, 7)$
$COM_B = (4, 3)$
$COM_C = (12, 1)$

$$COM = \frac{(m_1 x_1 + m_2 x_2)}{m_1 + m_2}$$

$$COM_x = \frac{(M_A X_A + M_B X_B + M_C X_C)}{M_A + M_B + M_C} = \frac{((50kg)(4) + (12kg)(4) + (90kg)(12))}{50kg + 12kg + 90kg}$$

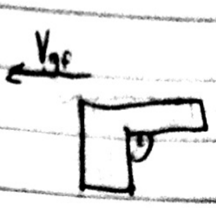
$$= \frac{(200 + 48 + 1080)}{152} = \boxed{8.74 \text{ x-coordinate}}$$

$$COM_y = \frac{(M_A Y_A + M_B Y_B + M_C Y_C)}{M_A + M_B + M_C} = \frac{((50kg)(7) + (12kg)(3) + (90kg)(1))}{50kg + 12kg + 90kg}$$

$$= \frac{(350 + 36 + 90)}{152} = \boxed{3.13 \text{ y-coordinate}}$$

$\boxed{(8.74, 3.13)}$

2.



V_{bf} $800\,\frac{m}{s}$ → $= 0$

$m_g = 80 m_b$

$P_o = P_f$

$P_o = m_b(0\,\frac{m}{s}) + 80 m_b(0\,\frac{m}{s})$

$P_o = 0\,\frac{kgm}{s}$

$P_f = 0\,\frac{kgm}{s}$

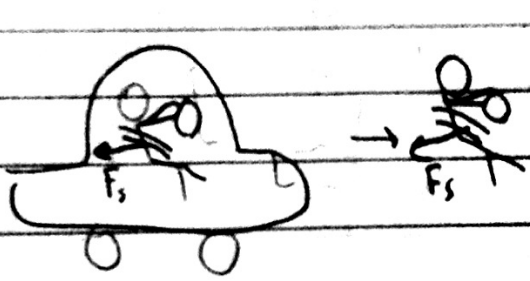
$P_f = m_b(800\,\frac{m}{s}) + 80 m_b(V_f) = 0$

$\cancel{m_b}(800\,\frac{m}{s}) = -80\,\cancel{m_b}(V_f)$

$800\,\frac{m}{s} = -80 V_f$

$\boxed{V_f = -10\,\frac{m}{s}}$

3.



$V_o = 4.5\,\frac{m}{s}$

$m_i = 75\,kg$

$t = 0.09s$

$P_o = m_o V_o$

$P_o = (75kg)(45\,\frac{m}{s}) = 3375\,\frac{kgm}{s}$

$P_f = M_f V_f$

$P_f = 75kg \cdot 0\,\frac{m}{s}$

$P_f = 0$

Impulse is defined as the product of the average force acting on the object and the time the force acts. It is also equivalent to the change in momentum

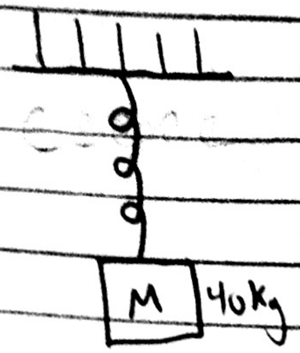
$I = F(t) = \nabla P$ $\quad \nabla P = P_f - P_o$ $\quad \nabla P = -3375\,\frac{kgm}{s}$

$F(t) = -3{,}375\,\frac{kgm}{s}$

$F = -\frac{3375\,\frac{kgm}{s}}{0.09s}$

$\boxed{F = 37500\,N\ (-x)}$

4.



$K = 10\,N/m$

$M = 40\,kg$

$\omega = \sqrt{K/M} = \frac{2\pi}{T}$

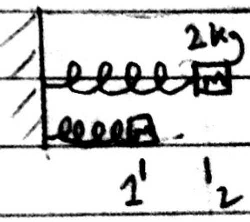
$T = \frac{2\pi}{\sqrt{K/m}}$ $\quad T = 2\pi\sqrt{\frac{40\,kg}{10\,N/m}}$

$T = 2\pi\sqrt{4\,s^2}$

$\boxed{T = 4\pi\,s}$

$\omega = \frac{2\pi\,rad}{4\pi\,s}$ $\quad \boxed{\omega = 2\,rad/s}$

5.



$K = 18\,N/m$ $\quad X = 1$

$M = 2\,kg$

$X_{max} = 2$

$A = X_{max}$

(delta)

$X(t) = A\cos(\omega t + \delta)$

Phase angle related to initial position.

If the motion starts out with max displacem

$\delta = 0.$

$\omega = \sqrt{K/M}$

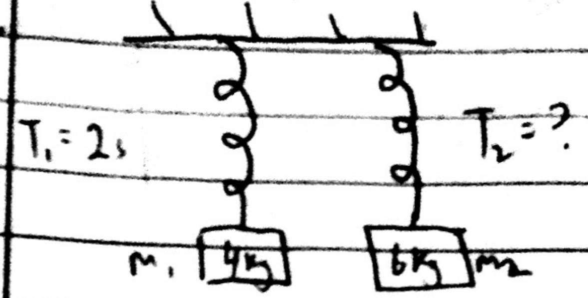
$\omega = \sqrt{\frac{18\,N/m}{2\,kg}}$ $\quad \omega = 3\,rad/s$

$1 = 2\cos(3t)$ $\quad t = \pi/9 = \boxed{0.35\,s}$

$\cos(3t) = 1/2$

$\cos^{-1}(1/2) = 3t$

6.



We need k because springs are the same

$$\sqrt{k/m_1} = \frac{2\pi}{T_1}$$

$$k/m_1 = \left(\frac{2\pi}{T_1}\right)^2$$

$$K = m_1\left(2\pi/T_1\right)^2$$

$$K = 4\,kg\left(2\pi/2s\right)^2$$

$$K = 4\,kg\,(\pi s)^2$$

$$\boxed{k = 4\pi^2\,N/m}$$

$$\sqrt{k/m_2} = \frac{2\pi}{T_2}$$

$$T_2 = 2\pi/\sqrt{k/m_2}$$

$$T_2 = 2\pi\sqrt{\frac{m_2}{K}}$$

$$T_2 = 2\pi\sqrt{\frac{6\,kg}{4\pi^2\,N/m}} = 2\pi\cdot\frac{\sqrt{6\,kg}}{2\pi} = \sqrt{6}\ s = \boxed{2.45\,s}$$