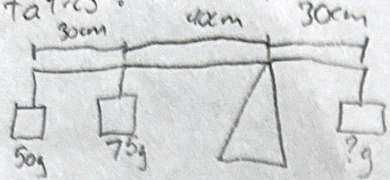
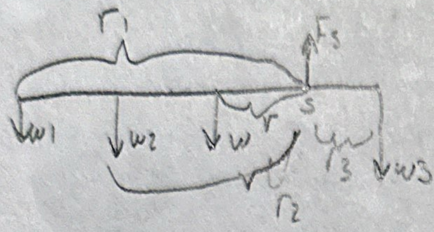
Statics:



W=mg

Fs is normal force on support

FBD:



$r_1 = 30cm + 40cm = 70cm$

$r_2 = 40cm$

$r = 50cm - 30cm = 20cm$

$r_s = 0$ since f_s is at pivot

$r_3 = 30cm$

Find torques $\tau = rw\sin\theta$

$\tau_1 = +r_1 w_1 \sin 90° = +r_1 m_1 g$ (+, CCW) ← counter clockwise

$\tau_2 = +r_2 w_2 \sin 90° = +r_2 m_2 g$ (+, CCW)

$\tau = +rw\sin 90° = +rmg$ (gravitational torque)

$\tau_s = r_s F_s \sin\theta_s = 0$ (since $r_s = 0$)

$\tau_3 = -r_3 w_3 \sin 90° = -r_3 m_3 g$ (−, CW)

Find equilibrium

$r_1 m_1 g + r_2 m_2 g + rmg - r_3 m_3 g = 0$

Since F_s is parallel to g: All $-y$ forces = F_s

$-w_1 - w_2 - w + f_s - w_3 = 0 \rightarrow -m_1 g - m_2 g - mg + f_s - m_3 g = 0$

solve each one → cancel g

$r_1 m_1 + r_2 m_2 + rm - r_3 m_3 = 0$

$m_3 = \frac{r_1}{r_3} m_1 + \frac{r_2}{r_3} m_2 + \frac{r}{r_3} m = m_3$

↳ 317g

$F_s = m_3 g + mg + m_2 g + m_1 g$

↳ 5.8N

Angular momentum:

$a_x = 0$ $a_y = -2\,m/s^2$

$v_x = 0$ $v_y = -2E3\,m/s - 2\,m/s^2 t$

$2.5\hat{i} \times 15 v_y \hat{j} = 15(25k \cdot v_y)$

a) $\vec{l} = \vec{r} \times \vec{p} = (25\,km\,\hat{i} + 25\,km\,\hat{j}) \times 15\,kg\,(0\hat{i} + v_y\hat{j})$ ($\vec{p} = m \cdot v$)

$= 15\,kg\,(2.5E4(-2E3 - 2t))$

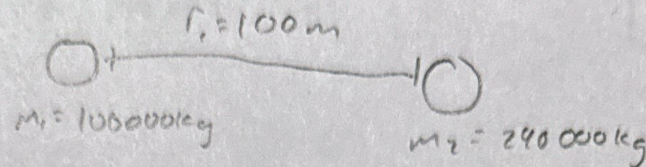
at $t = 0$

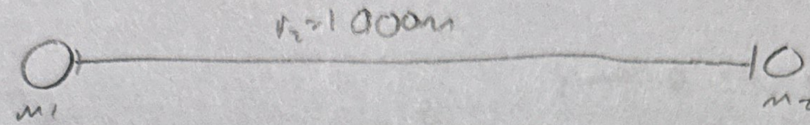
$\vec{l}_0 = 15\,kg\,(2.5E4\,m(-2E3\,m/s)\hat{k}) = 7.5E8\,kg \cdot m^2/s\,(-\hat{k})$

b) $\Sigma\vec{\tau} = \frac{d\vec{l}}{dt} = -15\,kg\,(2.5E4(m))(2\,m/s^2)\hat{k} = -7.5E5\,N \cdot m\,\hat{k}$

Gravitation:

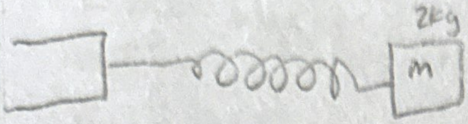
*Not to scale





$$\Delta U = U_f - U_i = \frac{Gm_1m_2}{r_2} - \frac{Gm_1m_2}{r_2} = -0.0144$$

Harmonic Motion:



$\phi = 0$ rad because block is released from rest

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{1.57} = 4 (1/s)$$

$$v_{max} = A\omega = 0.02m(4(1/s)) = 0.08 m/s$$

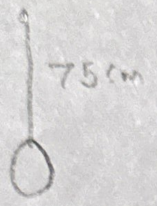
$$a_{max} = A\omega^2 = 0.02(4(1/s))^2 = 0.32 m/s^2$$

$$x(t) = A\cos(\omega t + \phi) = (0.02m)\cos(4(1/s)t)$$

$$v(t) = -v_{max}\sin(\omega t + \phi) = (-0.08 m/s)\sin(4(1/s)t)$$

$$a(t) = -a_{max}\cos(\omega t + \phi) = (-0.32 m/s^2)\cos(4(1/s)t)$$

Pendulums:

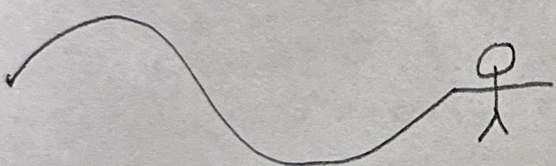


$T = 1.7357s$

$T = 2\pi\sqrt{L/g}$ $\quad$ $g = 4\pi^2 \frac{L}{T^2}$

$$g = 4\pi^2 \frac{.75m}{1.7357s^2} = 9.8281 m/s^2$$

Waves:



a) First wave went 30m in 6sec

$v = 30m/6s = 5m/s$

b) Period = 1/f

$T = 1/f = \frac{1}{2s^{-1}} = 0.5s$

c) $\lambda = vT = 5m/s(.5s) = 2.5m$

Fluids:

Depth is not constant → Bernoulli

$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$

1 → ground ($h_1 = 0$)
2 → nozzle

$Q = A_1 v_1$

$v_1 = \frac{Q}{A_1} = \frac{40\,E\text{-}3\ m^3/s}{\pi(3.2E\text{-}2\,m)^2} = 12.4\,m/s$

↖ same way
$v_2 = 56.6\,m/s$

$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) - \rho g h_2$

$P_2 = 1.62\,E6\ N/m^2 + \frac{1}{2}(1000\,kg/m^3)((12.4\,m/s)^2 - (56.6\,m/s)^2) - (1000\,kg/m^3)(9.8\,m/s^2)(1\,cm)$

$= -2.9\,kPa$

Air pressure is 101.kPa