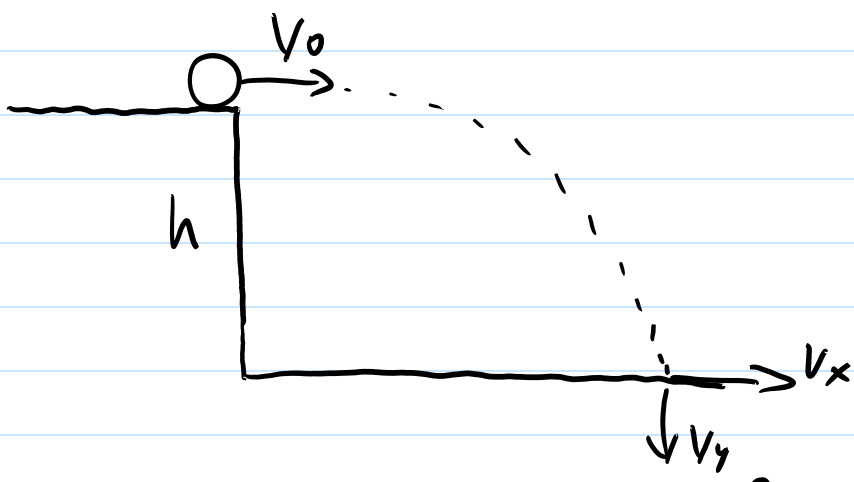
Final Exam

(1) $x(t) = 30 + 11t - 0.041t^3$

$v(t) = 11 - 0.041(3t^2)$

$v(8) = 11 - 0.041(3)(8)^2 = \boxed{3.128 \text{ m/s}}$

(2)



$h = \frac{gt^2}{2} = \frac{(9.8)(0.490\,s)^2}{2} = \boxed{1.176 \text{ m}}$

$\Delta x = V_0 t = (1.70 \frac{m}{s})(0.490\,s) = \boxed{0.833 \text{ m}}$

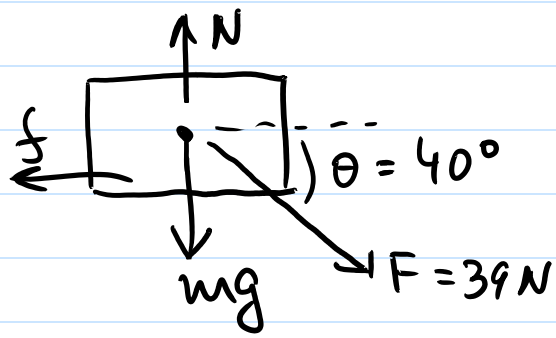
$V_x = V_{x0} = \boxed{1.70 \text{ m/s}}$

$V_y = gt = (9.8)(0.490\,s) = \boxed{4.802 \text{ m/s}}$ down

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{(1.70)^2 + (4.802)^2} = \boxed{5.094 \text{ m/s}}$

$$\theta = \arctan\left(\frac{V_y}{V_x}\right) = \arctan\left(\frac{4.802}{1.70}\right) = 70.51^\circ$$

3



$$N = mg + F\sin\theta = 125 + 39\sin(40^\circ) = \boxed{150\ N}$$

4

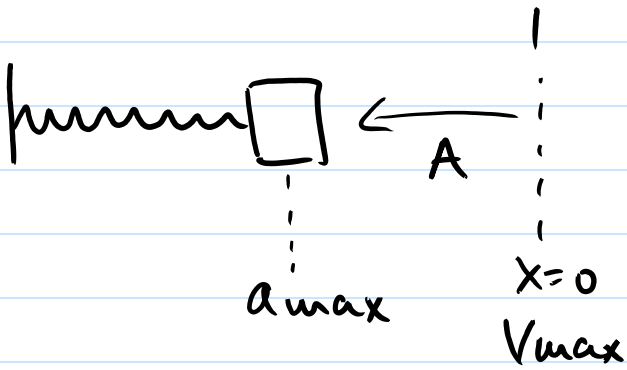
$$x = A\cos(\omega t + \varphi)$$
$$a = -\omega^2 A\cos(\omega t + \varphi) = -\omega^2 x$$

$$\omega^2 = -\frac{a}{x}$$

$$\omega = \sqrt{\frac{-a}{x}} = 2\pi f$$

$$f = \frac{1}{2\pi}\sqrt{\frac{-a}{x}} = \frac{1}{2\pi}\sqrt{\frac{-(-5.77\ m/s^2)}{0.340\ m}}$$

5



$$K = \frac{28\,N}{cm} = \frac{28\,N}{0.01\,m} = 2800\ \frac{N}{m}$$

$$m = 2.30\ kg$$

$$E = 14\ J$$

$$E = \frac{m V_{max}^2}{2}$$

$$V_{max} = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2(14)}{2.30}} = \boxed{3.49\ m/s}$$

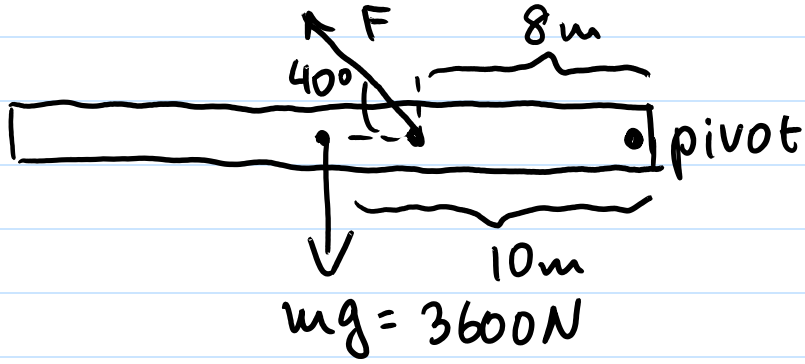
$$E = \frac{K\,A}{2}$$

$$A = \sqrt{\frac{2E}{K}}$$

$$a_{max} = \frac{K\,A}{m} = \frac{K}{m}\sqrt{\frac{2E}{K}} =$$

$$= \frac{(2800\ N/m)}{2.30\,kg}\sqrt{\frac{2(14\,J)}{2800\ N/m}} = \boxed{121.74\ m/s^2}$$

(6)

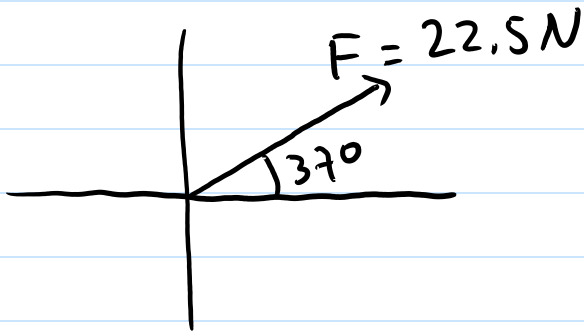


$$\underset{\text{pivot}}{\tau = 0} = +\underbrace{mg}_{3600N}(10\,m) - F(8\,m)\sin(40°)$$

$$F = \frac{(3600N)(10\,m)}{(8\,m)\sin(40°)} = \boxed{7001\ N}$$

The forces at the pivot have 0 torque.

(7)



$$F = 22.5\cos 37°\,\hat{i} + 22.5\sin 37°\,\hat{j} =$$

$$= 17.97\,\hat{i} + 13.54\,\hat{j}$$

a) $\text{Work} = \vec{F} \cdot \vec{S} = (17.97, 13.54) \cdot (5, 0)$

$= (17.97)(5) = \boxed{89.85\ J}$

b) $\text{Work} = \vec{F} \cdot \vec{S} = (17.97, 13.54) \cdot (0, -6)$

$= (13.54) \cdot (-6) = \boxed{-81.24\ J}$

c) $\text{Work} = \vec{F} \cdot \vec{S} = (17.97, 13.54) \cdot (-2, 4) =$

$= (17.97)(-2) + (13.54)(4) = \boxed{18.22\ J}$

8

Before : $\boxed{1850\,kg} \xrightarrow{1.6\,m/s}$ $\xleftarrow[1.1\,m/s]{} \boxed{1450\,kg}$

After : $\boxed{1850\,kg} \xrightarrow{0.25\,m/s}$ $\boxed{1450} \longrightarrow V$

$P_{before} = P_{after}$

$1850(1.6) + (1450)(-1.1) = 1850(0.25) + (1450)V$

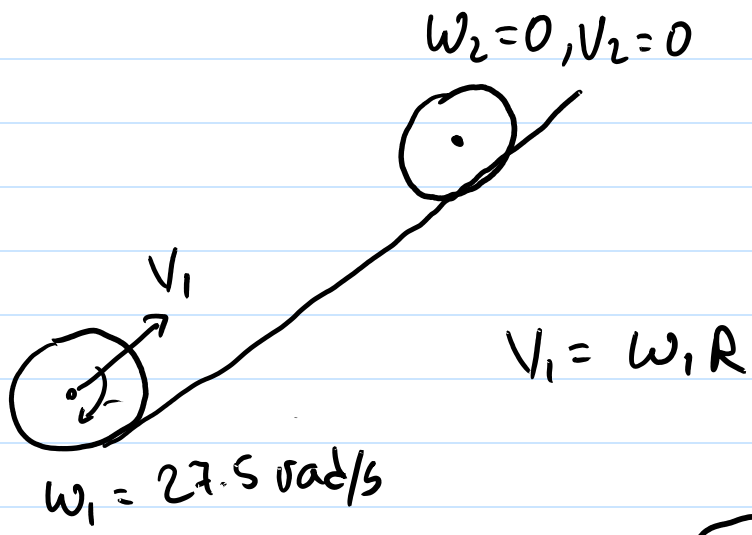
$V = \boxed{0.62241\ m/s}$

6) $\Delta K = K_{after} - K_{before} =$

$$= \frac{1}{2}\left(1850(0.25)^2 + 1450(0.6224)^2\right)$$

$$- \frac{1}{2}\left(1850(1.6)^2 + 1450(1.1)^2\right) = -2907 \text{ J}$$

9



$$V_1 = \omega_1 R$$

$$\frac{mV_1^2}{2} + \frac{I\omega_1^2}{2} - W_{friction} = \overbrace{\frac{mV_2^2}{2} + \frac{I\omega_2^2}{2}}^{0} + mgh$$

$$\frac{m}{2}(\omega_1 R)^2 + \frac{(0.8mR^2)\omega_1^2}{2} - W_{friction} = mgh$$

$$h = \frac{(\omega_1 R)^2}{2g} + \frac{0.8(\omega_1 R)^2}{2g} - \frac{W_{friction}}{mg} =$$

$$= \frac{1.8(\omega_1 R)^2}{2g} - \frac{W_{friction}}{mg} =$$

$$= \frac{1.8\,(27.5\ \text{rad/s} \times 0.6\ \text{m})^2}{2\,(9.8\ \text{m/s}^2)} - \frac{2600\ \text{J}}{392\ \text{N}}$$

$$= \boxed{18.37\ \text{m}}$$