Name: KEY
Last First

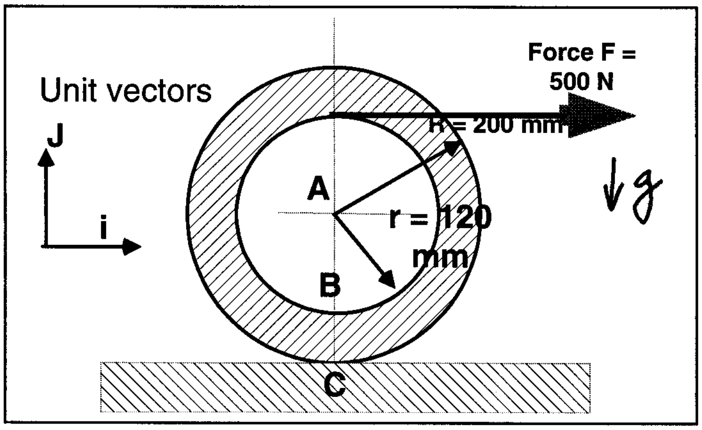
UNLV, DEPARTMENT OF MECHANICAL ENGINEERING
EGG 207, Spring 2000, Third Test

Closed Book, one page of handwritten notes allowed. Enter the answer for each question into the space provided. Enter SI units in **all** answer spaces with brackets ( ).

1. (25 points) The double disk (inner radius r =120 mm, outer radius R=200 mm, m = 125 kg, Radius of Gyration k = 125 mm) starts from rest and rolls on a flat surface without sliding. The cord, wrapped about inner radius r, is pulled to the right by force F = 500 N. Determine

(a) the angular acceleration of the disk.

(b) the acceleration, a_G, of the mass center A of the disk.



(a) C is inst. ctr.

$I_C = I_A + mR^2 = m(k^2+R^2)$

$\Sigma M_{(C)} = -(r+R)F = I_C \alpha$

$\alpha = -\dfrac{(r+R)F}{I_C}$

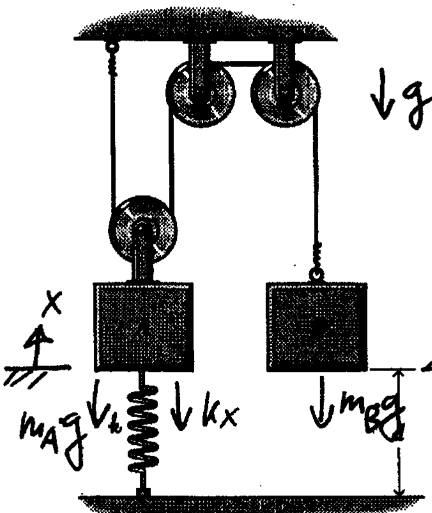
Numbers:

$$\alpha = -\frac{0.32 \cdot 500 \ N\cdot m}{125 kg \cdot 0.0556 \ m^2} = -23 k \ \frac{rad}{s^2}$$

(b) $a_A = R \cdot \alpha = 0.2 m \cdot 23 \frac{rad}{s^2} = 4.6 \frac{m}{s^2}$

Answers: a) α_{Disk} =	−23	(rad/s²	Units)
b) a_A =	4.6	(m/s²	Units)

2. (30 points) Given: mass A = 4 kg and mass B = 6 kg, d = 0.5 m, spring constant k = 150 N/m. The system is released from rest, and the spring is initially unstretched. Determine the velocity of mass B as it hits the ground. Work-Energy



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Geometry: $L = 2(x_0 - x) + y \Rightarrow 2\dot{x} = \dot{y}$ or $v_B = 2v_A$

$T_1 = 0$; $U_{1\to2} = -m_A g \frac{d}{2} + m_B g d - \frac{1}{2}k\left(\frac{d}{2}\right)^2$

$T_2 = \frac{1}{2} m_B v_B^2 + \frac{1}{2} m_A \left(\frac{v_B}{2}\right)^2$

$\cancel{T_1}^{0} + U_{1\to2} = T_2$

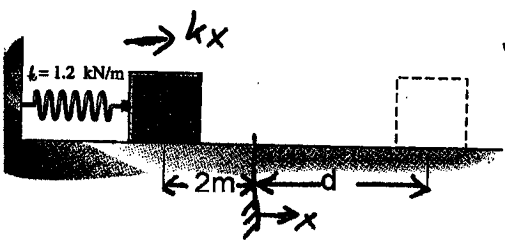
$gd(m_B - m_A/2) - \frac{1}{2}k\left(\frac{d}{2}\right)^2 = \frac{1}{2}v_B^2(m_B + m_A/4)$

$$v_B^2 = \frac{2gd(m_B - m_A/2) - kd^2/4}{m_B + m_A/4} = \frac{9.81\cdot 4 - 150\cdot 0.25/4}{7}\ \frac{kg\cdot m^2}{kg\ s^2} = \frac{30.4}{7}\ \frac{m^2}{s^2}$$

Answer v_B = 5.6 $\downarrow$ (m/s Units)

3. (20 points) The spring (k = 1200 N/m) is initially compressed by 2[illegible]m. The 5-kg block shown is not attached to the spring. After release from rest, the block travels 2 m along a smooth surface, and distance d along the rough surface ($\mu_k = 0.3$).

Determine the distance d at which the block comes to rest.



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$T_1 = 0 \quad T_2 = 0$

$U_{1\to2} = \frac{1}{2}kx^2\Big|_{x=2m} - \mu_K m g d$

$\cancel{T_1}^{0} + U_{1\to2} = \cancel{T_2}^{0}$

$\frac{1}{2}k\cdot(2m)^2 = 0.3\cdot 5kg\cdot 9.81\frac{m}{s^2}\cdot d$

$$d = \frac{2\cdot 1200\ Nm}{1.5\cdot 9.81\ \frac{kg\,m}{s^2}} = 163\ m$$

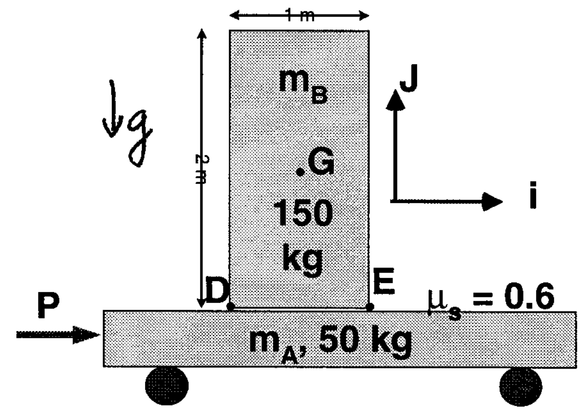
Answer d = 163 (m Units)

4. **(25 Points)** Homogeneous crate B (150 kg) rests on cart A (50 kg) as shown. μ_s between A and B is 0.6, and the crate will not slide on the cart.

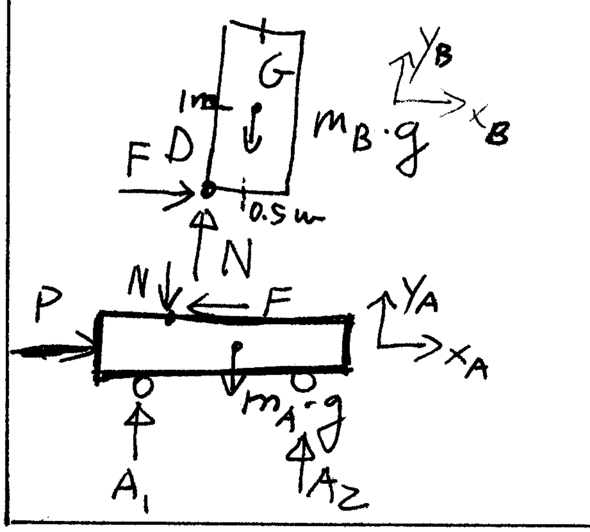
(a) Construct a free-body diagram for each mass **as tipping of crate B is about to occur**. *Draw a box around your free-body diagram and label it (4a).*

(b) Determine the acceleration of crate B at impending tipping conditions.

(c) Determine the maximum permissible force, P, so that the crate does not tip. Remember: both masses accelerate at the same rate.



Free Body Diagram for tipping cond.



for mass B:

$$(b)\ \sum M_{(G)} = 1m \cdot F - 0.5m \cdot N = 0 \quad (1)$$

$$\sum F_y = m_B \cdot g - N = 0 \Rightarrow N = m_B\, g \quad (2)$$

insert (2) into (1) and solve for F:

$$F = 0.5 \cdot N = 0.5 \cdot m_B \cdot g$$

$$\sum F_x = F = m_B \cdot \ddot{x}_B \Rightarrow \ddot{x}_B = F/m_B =$$

$$\ddot{x}_B = \frac{0.5\, m_B \cdot g}{m_B} = 0.5g = 4.9 \frac{m}{s^2}$$

(c) Cart:

$$\sum F_x = P - F = m_A \cdot \ddot{x}_A = m_A \ddot{x}_B$$

$$P = F + m_A \cdot \ddot{x}_B = 0.5\, m_B g + m_A\, 0.5g$$

$$P = 0.5g\,(m_A + m_B) = 4.9 \cdot 200\ kg \frac{m}{s^2}$$

Answer: (b) a_{crate} =	4.9	(m/s^2	Units)
(c) P =	981	(N	Units)