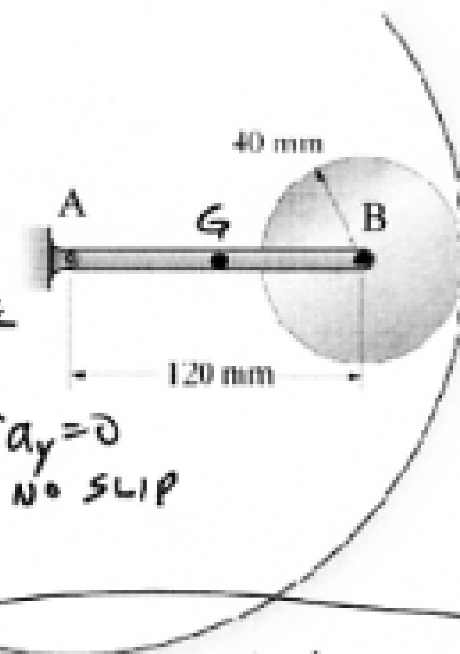
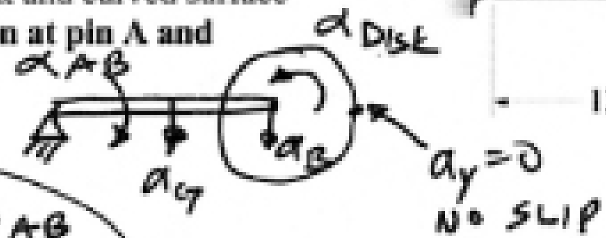
NAME ______________________________ Table ________

2. (25 pts) The 0.1-kg slender bar and 0.2-kg cylindrical disk are released from rest with the bar horizontal. The disk rolls on the curved surface and there is sufficient contact friction to prevent any slipping as it rolls. The two pins are frictionless.
   a. What are the **angular accelerations of the bar and the disk** immediately after they are released?
   b. What are the **friction force** between the disk and curved surface and the **vertical components** of the **reaction at pin A and internal force at pin B**?





NO SLIP

Kinematics: (2) $a_G = .06\,\alpha_{AB}$

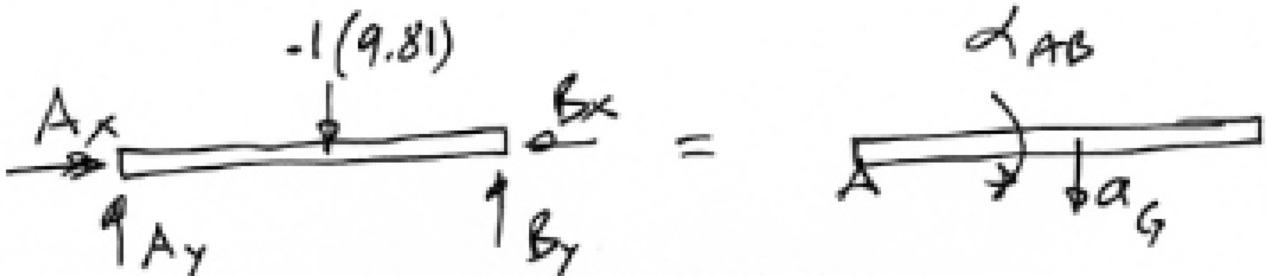
(2) $a_B = .04\,\alpha_{DISK}$

(2) $a_B = 2a_G$

$\therefore\ 2(.06\,\alpha_{AB}) = .04\,\alpha_{DISK}$

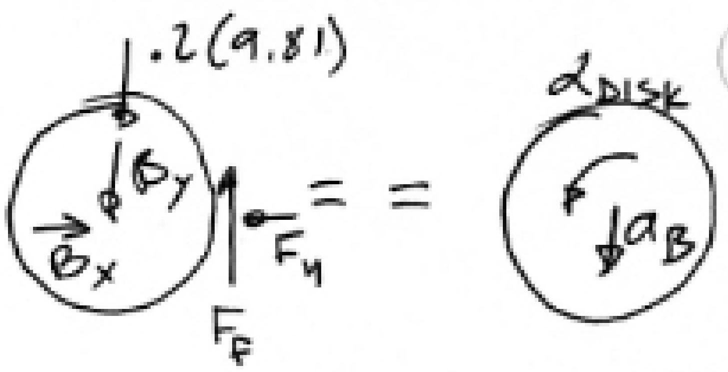
$\therefore\ \alpha_{DISK} = 3\alpha_{AB}$

Kinetics: (accel, force, moment = Newton)



(5) $+\downarrow \Sigma F_y = .981 - A_y - B_y = .1a_G = .1(.06\,\alpha_{AB})$

(4) $\circlearrowright \Sigma M_A = I_A\alpha_{AB} = .981(.06) - .12B_y = \frac{1}{3}(.1)(.12)^2\alpha_{AB}$



(5) $+\downarrow \Sigma F_y = .2(9.81) + B_y - F_f = .2a_B$

$= .2(2a_G)$

$1.962 - F_f + B_y = .2(2)(.06\,\alpha_{AB})$

(4) $\circlearrowleft + \Sigma M_B = .04F_f = I_B\alpha_{DISK} = \frac{1}{2}(.2)(.04)^2\alpha_{DISK}$

$.04F_f = .1(.04)^2(3\alpha_{AB})$

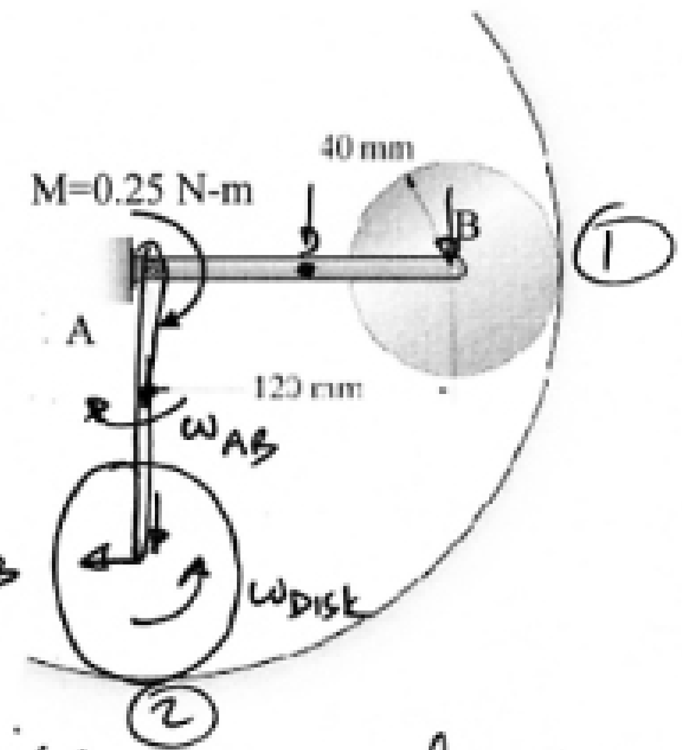
Solve 4 eqns for $A_y, B_y, F_f, \alpha_{AB}$

(1)

$A_y = 0.3812$ N ↑	$F_f = 0.654$ N ↑
$B_y = 0.2728$ N ↑ on AB	$\alpha_{AB} = 54.5$ rad/sec² ↻
↓ on Disk	$\alpha_{DISK} = 163.5$ rad/sec² ↺

NAME ____ Table _________

3. (25 pts) The 0.1-kg slender bar and 0.2-kg cylindrical disk are released from rest with the bar horizontal. At that time, a constant driving clockwise couple is applied to the bar with magnitude 0.25 N-m. The disk rolls on the curved surface and there is sufficient contact friction to prevent any slipping. The two pins are frictionless. What are the angular velocities of the bar and disk when the bar is vertical?



Kinematics: $v_B = \omega_{DISK}(.04)$

$v_B = \omega_{AB}(.12)$

$\therefore \omega_{DISK} = 3\,\omega_{AB}$

Kinetics: (Forces, couple, position, speed = W-E)

$T_1^{\,0} + U_{1\to 2} = T_2$

$$.25\left(\frac{\pi}{2}\right) + .1(9.81)(.06) + .2(9.81)(.12)$$

$$= \frac{1}{2}\left(\frac{1}{3}(.12)^2(.1)\right)\omega_{AB}^2 \quad \leftarrow \text{Bar about A}$$

$$+ \frac{1}{2}\left(\frac{1}{2}(.2)(.04)^2\right)\omega_{DISK}^2 \quad \leftarrow \text{Disk about G}$$

$$+ \frac{1}{2}(.2)v_B^2 \quad \leftarrow \text{Disk translation}$$

$\omega_{DISK} = 3\omega_{AB}$

$v_B = .12\,\omega_{AB}$

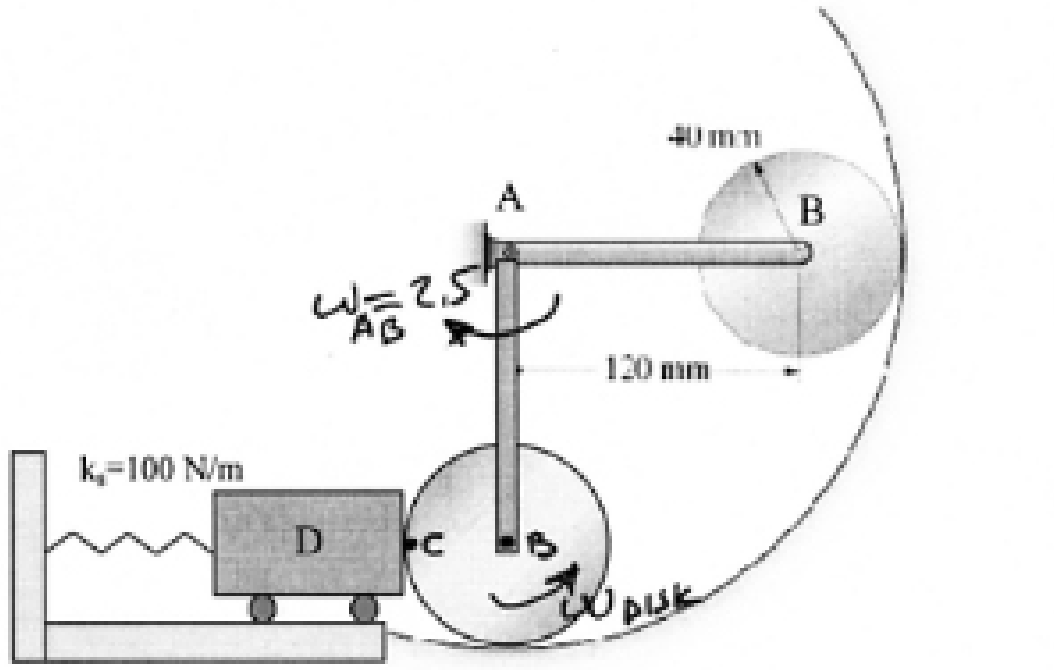
$$.6870 = .0024\,\omega_{AB}^2$$

$\omega_{AB} = 16.92$ rad/sec ↻

$\omega_{DISK} = 50.76$ rad/sec ↺

NAME ________________________________ **Table** ________

4. (25 pts) Let's say that the 0.1 kg slender bar has a clockwise angular velocity of 2.5 rad/sec when it reaches the vertical position shown (forget about what you found in problem 3), just prior to impacting the center of the side of the uniform block D. The 0.2 kg disk B still rolls without slip. Block D has a mass of 0.6 kg and is at rest on frictionless, massless rollers prior to impact. The linear spring stiffness is as shown. The impact surface is frictionless and the coefficient of restitution is 0.8. Find the velocity of the block and the angular velocities of the slender bar and disk the instant after the collision.



Kinematics:

just befor impact

$\omega_{AB} = 2.5$ ↻ $\quad \omega_{DISK} = 7.5$ ↺

$v_B = .12\,\omega_{AB} = 0.3\ \frac{m}{sec}$ ←

$\bar{v}_C = \bar{v}_B + \bar{\omega}_{DISK} \times \bar{r}_{C/B}$

$\bar{v}_C = -0.3\,\hat{i} - 0.3\,\hat{j}\ \frac{m}{sec}$

$\therefore v_{CN} = 0.3$ ←

$v_{CN2} = v_{B2}$, $\quad v_{DN2} = v_{D2}$

$\overset{+}{\leftarrow}\ e = \dfrac{v_{CN2} - v_{DN2}}{v_{DN1}^{\,0} - 0.3} = 0.8$

$v_{CN2} - v_{DN2} = -0.24$

Angular I-M abt A:

$\circlearrowleft^{+}\ \Sigma H_{A1} + 0 = \Sigma H_{A2}$

$\frac{1}{3}(.1)(.12)^2(2.5) - \frac{1}{2}(.2)(.04)^2(7.5) + (.2)(.12)(0.3) + 0$

$= \frac{1}{3}(.1)(.12)^2\,\omega_{AB_2} - \frac{1}{2}(.2)(.04)^2(3\,\omega_{AB_2}) + .2(.12)(v_{B2}) + 0.6(.12)(v_{D2})$

$\omega_{AB_2} = \dfrac{v_{B2}}{.12}$, $\quad v_{D2} = v_{B2} + .24$

$0.0072 = 0.096\,v_{B2} + 0.01728$

$v_{B2} = -.105 = 0.105\ m/sec$ →

$v_{D2} = .135\ m/sec$ ←

$\omega_{DISK_2} = \dfrac{v_{B2}}{.04} = 2.625\ \frac{rad}{sec}$ ↻

$\omega_{AB2} = \omega_{DISK}/3 = 0.875\ \frac{rad}{sec}$ ↺