

Instructor: Frank Secretain
 Course: Civil 46
 Date: September 30, 2026

Assessment: Test 1
 Time allowed: 110 minutes
 Devices allowed: Pencil, pen, eraser, calculator
 Notes from instructor: Be neat. Show your work where needed. Box final answers.

Marks allocated: 4 questions worth 20 marks
 Percentage of final grade: 20% of final grade

Body	Figure	Mass Center	Moments of Inertia
Rectangular Parallelepiped		—	$I_{xx} = \frac{1}{12} m(a^2 + l^2)$ $I_{yy} = \frac{1}{12} m(b^2 + l^2)$ $I_{zz} = \frac{1}{12} m(a^2 + b^2)$ $I_{y_1y_1} = \frac{1}{12} mb^2 + \frac{1}{3} ml^2$
Circular Cylinder		—	$I_{xx} = \frac{1}{4} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = \frac{1}{4} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = \frac{1}{2} mr^2$
Semicylinder		$\bar{x} = \frac{4r}{3\pi}$	$I_{xx} = I_{yy} = \frac{1}{4} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = I_{y_1y_1} = \frac{1}{4} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = \frac{1}{2} mr^2$
Circular Cylindrical Shell		—	$I_{xx} = \frac{1}{2} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = \frac{1}{2} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = mr^2$
Half Cylindrical Shell		$\bar{x} = \frac{2r}{\pi}$	$I_{xx} = I_{yy} = \frac{1}{2} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = I_{y_1y_1} = \frac{1}{2} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = mr^2$
Sphere		—	$I_{zz} = \frac{2}{5} mr^2$
Spherical Shell		—	$I_{zz} = \frac{2}{3} mr^2$
Hemisphere		$\bar{x} = \frac{3r}{8}$	$I_{xx} = I_{yy} = I_{zz} = \frac{2}{5} mr^2$
Hemispherical Shell		$\bar{x} = \frac{r}{2}$	$I_{xx} = I_{yy} = I_{zz} = \frac{2}{3} mr^2$
Uniform Slender Rod		—	$I_{yy} = \frac{1}{12} ml^2$ $I_{y_1y_1} = \frac{1}{3} ml^2$

Formula Sheet

Line equation

$$y = ax + b$$

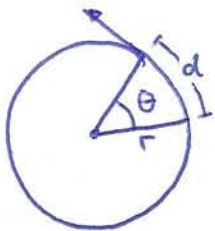
Quadratic formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Centre of mass

$$\vec{x}_{cg} = \frac{\sum m_i \vec{x}_i}{\sum m_i}$$

Uniform circular motion



$$d = \theta r$$

$$v = \omega r$$

$$a = \alpha r$$

$$a_r = -\omega^2 r = -\frac{v^2}{r}$$

Kinematics

$$\vec{x} = \vec{x}_o + \vec{v}_o t + \frac{1}{2} \vec{a} t^2$$

$$\vec{v}^2 = \vec{v}_o^2 + 2\vec{a}(\vec{x} - \vec{x}_o)$$

$$\vec{v} = \vec{v}_o + \vec{a} t$$

$$\theta = \theta_o + \omega_o t + \frac{1}{2} \alpha t^2$$

$$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_o)$$

$$\omega = \omega_o + \alpha t$$

Dynamics (Newton's 2nd Law)

$$\sum \vec{F} = \frac{d(m\vec{v})}{dt} = m\vec{a} \quad \vec{F}_g = \frac{Gm_1 m_2}{r^2} = mg \quad \vec{F}_f = \mu N$$

Moments (integral of Newton's 2nd Law with space)

$$\sum \vec{M}_p = \frac{d(I_p \vec{\omega}_p)}{dt} = I_p \vec{\alpha}_p \quad \vec{M} = \vec{F} \times \vec{x} = \vec{F} \perp \vec{x}$$

Conservation of momentum (integral of Newton's 2nd Law with time)

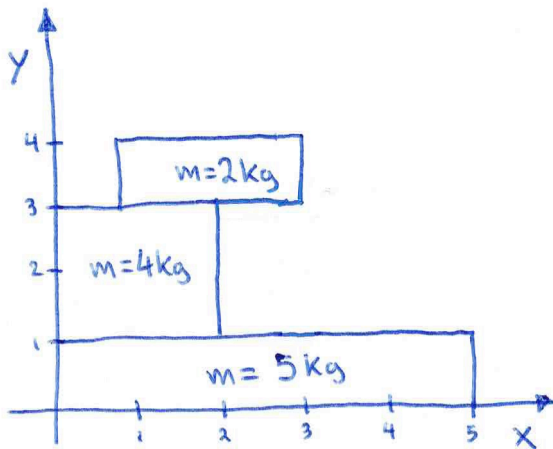
$$\vec{p} = m\vec{v} \quad \vec{p} - \vec{p}_o = \int \vec{F} dt = \vec{F}_{ave.}(t - t_o)$$

1st Law of Thermodynamics

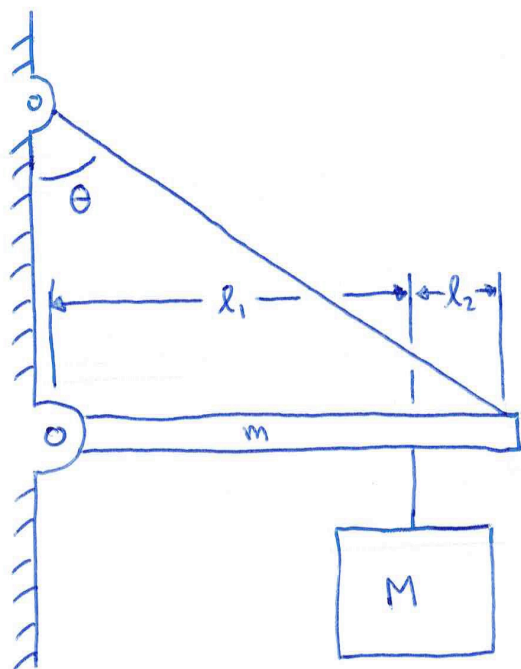
$$E_f - E_o = Q - W \quad E_{PE} = mg(y - y_o) \quad E_{KE} = \frac{1}{2}mv^2$$

$$W = \vec{F} \cdot (\vec{x} - \vec{x}_o)$$

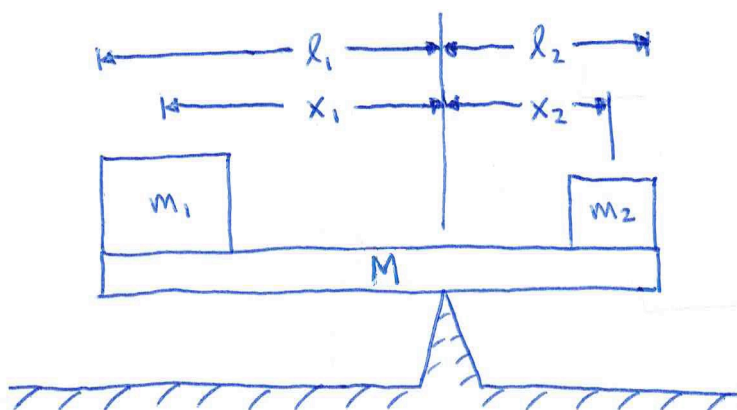
(5 marks) Determine the centre of mass of the object shown below and draw it on the diagram.



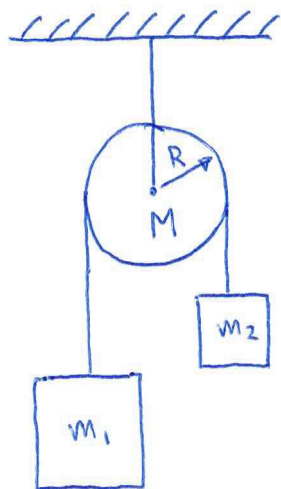
(5 marks) Determine the tension in each rope, given:
 $m=100\text{kg}$, $M=500\text{kg}$, $\theta=60^\circ$, $L_1=12\text{m}$ and $L_2=4\text{m}$.



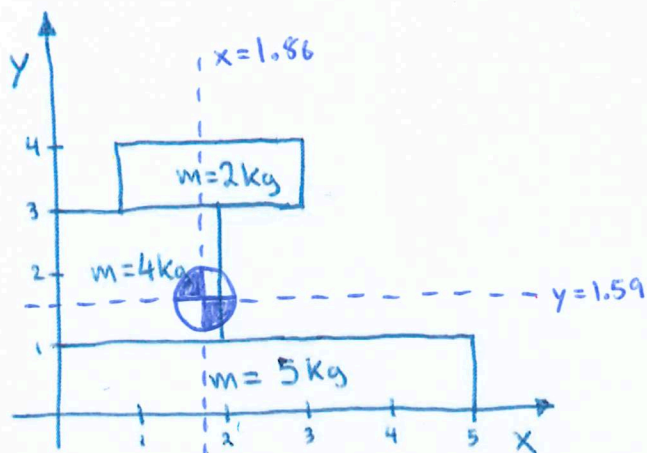
(5 marks) Determine the distance x_2 so the horizontal beam will not rotate, given:
 $m_1=100\text{kg}$, $m_2=800\text{kg}$, $M=500\text{kg}$, $L_1=12\text{m}$, $L_2=8\text{m}$ and $x_1=10\text{m}$..



(5 marks) Determine acceleration of the blocks, given:
 $m_1=1000\text{kg}$, $m_2=400\text{kg}$, $M=500\text{kg}$ and $R=1\text{m}$.



(5 marks) Determine the centre of mass of the object shown below and draw it on the diagram.



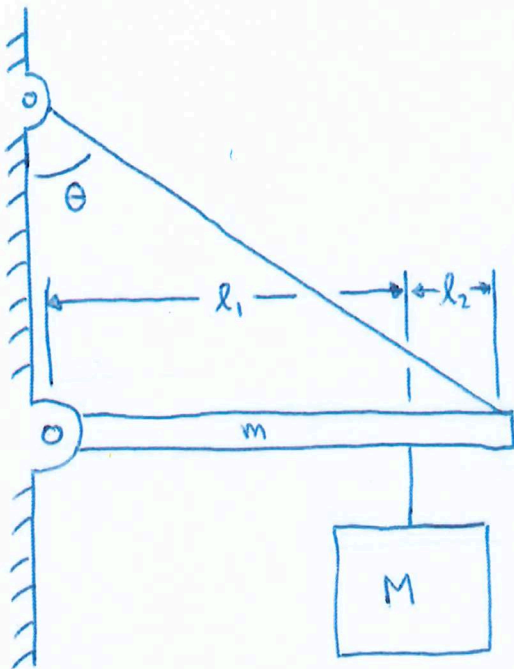
$$\vec{X}_{cg} = \frac{\sum m_i \vec{x}_i}{\sum m_i}$$

$$X_{cg} = \frac{\sum m_i x_i}{\sum m_i} = \frac{(5)(2.5) + (4)(2) + (2)(2)}{11} = 1.86$$

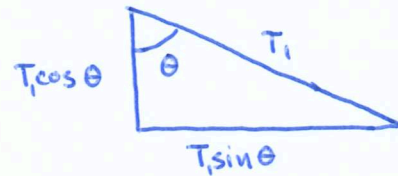
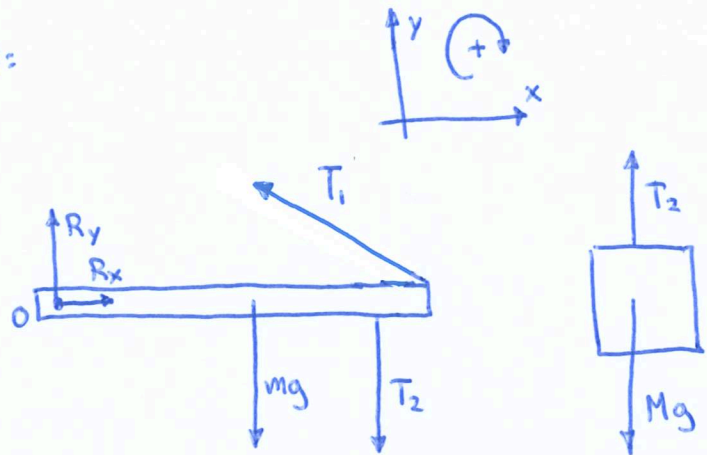
$$Y_{cg} = \frac{\sum m_i y_i}{\sum m_i} = \frac{(5)(0.5) + (4)(2) + (2)(3.5)}{11} = 1.59$$

$$\vec{X}_{cg} = (1.86 \hat{x}, 1.59 \hat{y})$$

(5 marks) Determine the tension in each rope, given:
 $m=100\text{kg}$, $M=500\text{kg}$, $\theta=60^\circ$, $L_1=12\text{m}$ and $L_2=4\text{m}$.



FBD:



Beam:

$$\sum F_x = m a_x = R_x - T_1 \sin \theta$$

$$\sum F_y = m a_y = R_y + T_1 \cos \theta - mg - T_2$$

$$\sum M_o = I_o \alpha_o = (8)mg + (12)T_2 - (16)T_1 \cos \theta \quad (3)$$

Block:

$$(1) \sum F_x = M a_x = 0$$

$$(2) \sum F_y = M a_y = T_2 - Mg \quad (4)$$

Solve (4) for T_2 :

$$T_2 = Mg = (500)(9.81) = 4905 \text{ N}$$

(4a)

sub (4a) into (3) and solve for T_1 :

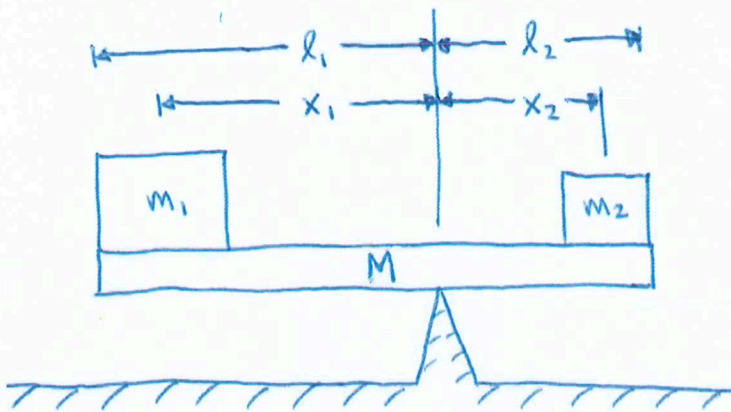
$$0 = 8mg + 12[4905] - 16T_1 \cos \theta$$

$$T_1 = \frac{(8)(100)(9.81) + (12)(4905)}{(16)(\cos 60)} = 8339 \text{ N}$$

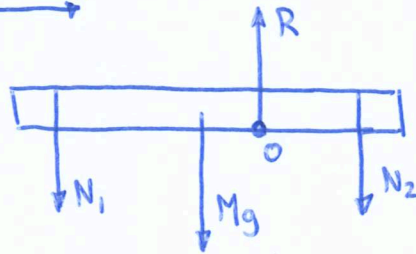
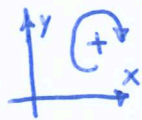
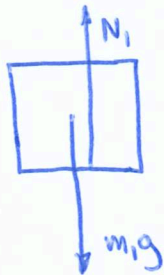
$$T_1 = 8.3 \text{ kN}$$

$$T_2 = 4.9 \text{ kN}$$

(5 marks) Determine the distance x_2 so the horizontal beam will not rotate, given:
 $m_1=100\text{kg}$, $m_2=800\text{kg}$, $M=500\text{kg}$, $L_1=12\text{m}$, $L_2=8\text{m}$ and $x_1=10\text{m}$.



FBD:



Newton Laws:

$$\sum F_x = m_1 a_x = 0$$

$$\sum F_y = m_1 a_y = N_1 - m_1 g$$

$$\sum F_x = M a_x = 0$$

$$(1) \sum F_y = M a_y = R - N_1 - Mg - N_2$$

$$\sum M_O = I_O \alpha_O = N_2 x_2 - N_1 x_1 - 2Mg$$

$$\sum F_x = m_2 a_x = 0$$

$$(2) \sum F_y = m_2 a_y = N_2 - m_2 g$$

$$(3) \quad (4)$$

Solve (1) & (4) for N:

$$N_1 = m_1 g \quad \& \quad N_2 = m_2 g$$

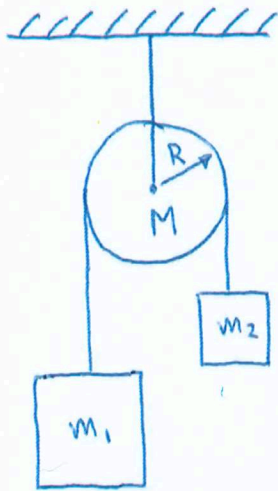
sub. normal eqns. (above) into (3), solve for x_2 :

$$0 = [m_2 g] x_2 - [m_1 g] x_1 - 2Mg$$

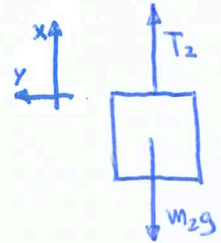
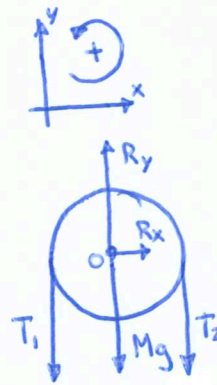
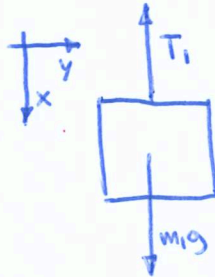
$$x_2 = \frac{1}{m_2 g} [m_1 g x_1 + 2Mg] = \frac{1}{(800)(9.81)} [(100)(9.81)(10) + 2(500)(9.81)] = 2.5 \text{ m}$$

$$x_2 = 2.5 \text{ m}$$

(5 marks) Determine acceleration of the blocks, given:
 $m_1=1000\text{kg}$, $m_2=400\text{kg}$, $M=500\text{kg}$ and $R=1\text{m}$.



FBD:



m_1 block:

$$\sum F_x = m_1 a_{x1} = m_1 g - T_1$$

$$\sum F_y = m_1 a_{y1} = 0$$

M pulley:

$$(1) \quad \sum F_x = M a_{x0} = R_x$$

$$\sum F_y = M a_{y0} = R_y - T_1 - Mg - T_2$$

$$\sum M_o = I_o \alpha_o = T_1 R - T_2 R$$

m_2 block:

$$(2) \quad \sum F_x = m_2 a_{x2} = T_2 - m_2 g$$

$$(3) \quad \sum F_y = m_2 a_{y2} = 0 \quad (5)$$

Solve (1) & (5) for tensions:

$$T_1 = m_1 g - m_1 a_{x1} \quad (4)$$

$$T_2 = m_2 g + m_2 a_{x2} \quad (5a)$$

assume inelastic rope & uniform circular motion:

$$a_{x1} = a_{x2} = a_x \quad (6)$$

$$a_x = \alpha R \quad (7)$$

sub. (4a), (5a), (6) & (7) into (4)

$$I_o \left[\frac{a_x}{R} \right] = [m_1 g - m_1 a_x] R - [m_2 g + m_2 a_x] R$$

sub. moment of Inertia ($I_o = \frac{1}{2} M R^2$) & solve for a_x :

$$\left[\frac{1}{2} M R^2 \right] \frac{a_x}{R} = (m_1 g - m_1 a_x) R - (m_2 g + m_2 a_x) R$$

$$\frac{1}{2} M a_x + m_1 a_x + m_2 a_x = m_1 g - m_2 g$$

$$a_x = \frac{m_1 g - m_2 g}{\frac{1}{2} M + m_1 + m_2} = \frac{(1000)(9.81) - (400)(9.81)}{\frac{1}{2}(500) + 1000 + 400} = 3.57 \text{ m/s}^2$$

Instructor: Frank Secretain
 Course: Civil 46
 Date: September 30, 2026

Assessment: Test 1 (practice)
 Time allowed: 110 minutes
 Devices allowed: Pencil, pen, eraser, calculator
 Notes from instructor: Be neat. Show your work where needed. Box final answers.

Marks allocated: 4 questions worth 20 marks
 Percentage of final grade: 20% of final grade

Body	Figure	Mass Center	Moments of Inertia
Rectangular Parallelepiped		—	$I_{xx} = \frac{1}{12} m(a^2 + l^2)$ $I_{yy} = \frac{1}{12} m(b^2 + l^2)$ $I_{zz} = \frac{1}{12} m(a^2 + b^2)$ $I_{y_1y_1} = \frac{1}{12} mb^2 + \frac{1}{3} ml^2$
Circular Cylinder		—	$I_{xx} = \frac{1}{4} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = \frac{1}{4} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = \frac{1}{2} mr^2$
Semicylinder		$\bar{x} = \frac{4r}{3\pi}$	$I_{xx} = I_{yy} = \frac{1}{4} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = I_{y_1y_1} = \frac{1}{4} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = \frac{1}{2} mr^2$
Circular Cylindrical Shell		—	$I_{xx} = \frac{1}{2} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = \frac{1}{2} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = mr^2$
Half Cylindrical Shell		$\bar{x} = \frac{2r}{\pi}$	$I_{xx} = I_{yy} = \frac{1}{2} mr^2 + \frac{1}{12} ml^2$ $I_{x_1x_1} = I_{y_1y_1} = \frac{1}{2} mr^2 + \frac{1}{3} ml^2$ $I_{zz} = mr^2$
Sphere		—	$I_{zz} = \frac{2}{5} mr^2$
Spherical Shell		—	$I_{zz} = \frac{2}{3} mr^2$
Hemisphere		$\bar{x} = \frac{3r}{8}$	$I_{xx} = I_{yy} = I_{zz} = \frac{2}{5} mr^2$
Hemispherical Shell		$\bar{x} = \frac{r}{2}$	$I_{xx} = I_{yy} = I_{zz} = \frac{2}{3} mr^2$
Uniform Slender Rod		—	$I_{yy} = \frac{1}{12} ml^2$ $I_{y_1y_1} = \frac{1}{3} ml^2$

Formula Sheet

Line equation

$$y = ax + b$$

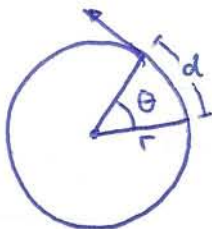
Quadratic formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Centre of mass

$$\vec{x}_{cg} = \frac{\sum m_i \vec{x}_i}{\sum m_i}$$

Uniform circular motion



$$d = \theta r$$

$$v = \omega r$$

$$a = \alpha r$$

$$a_r = -\omega^2 r = -\frac{v^2}{r}$$

Kinematics

$$\vec{x} = \vec{x}_o + \vec{v}_o t + \frac{1}{2} \vec{a} t^2$$

$$\vec{v}^2 = \vec{v}_o^2 + 2\vec{a}(\vec{x} - \vec{x}_o)$$

$$\vec{v} = \vec{v}_o + \vec{a} t$$

$$\theta = \theta_o + \omega_o t + \frac{1}{2} \alpha t^2$$

$$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_o)$$

$$\omega = \omega_o + \alpha t$$

Dynamics (Newton's 2nd Law)

$$\sum \vec{F} = \frac{d(m\vec{v})}{dt} = m\vec{a} \quad \vec{F}_g = \frac{Gm_1 m_2}{r^2} = mg \quad \vec{F}_f = \mu N$$

Moments (integral of Newton's 2nd Law with space)

$$\sum \vec{M}_p = \frac{d(I_p \vec{\omega}_p)}{dt} = I_p \vec{\alpha}_p \quad \vec{M} = \vec{F} \times \vec{x} = \vec{F} \perp \vec{x}$$

Conservation of momentum (integral of Newton's 2nd Law with time)

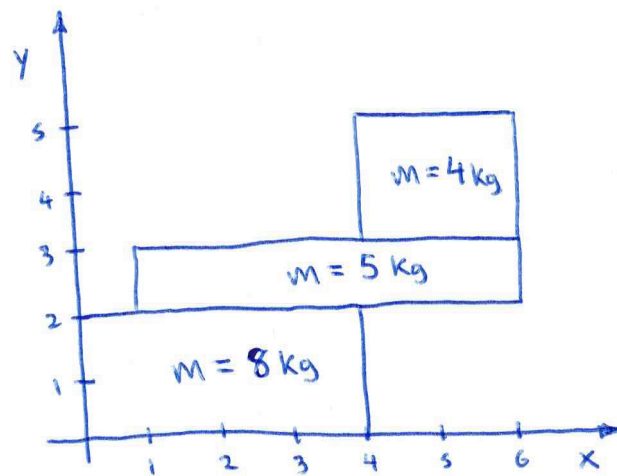
$$\vec{p} = m\vec{v} \quad \vec{p} - \vec{p}_o = \int \vec{F} dt = \vec{F}_{ave.}(t - t_o)$$

1st Law of Thermodynamics

$$E_f - E_o = Q - W \quad E_{PE} = mg(y - y_o) \quad E_{KE} = \frac{1}{2}mv^2$$

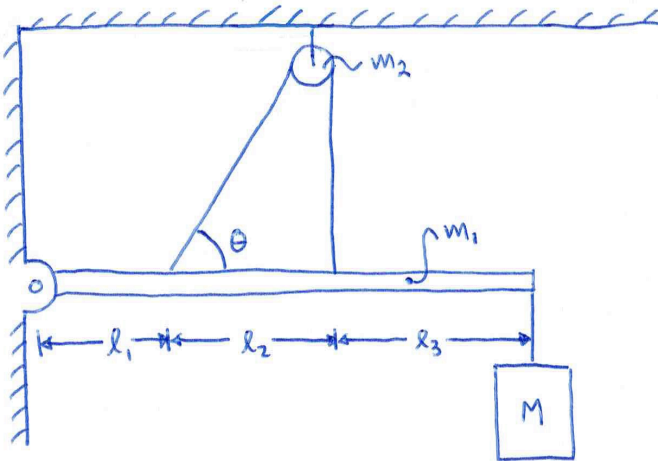
$$W = \vec{F} \cdot (\vec{x} - \vec{x}_o)$$

(5 marks) Determine the centre of mass of the object shown below and draw it on the diagram.

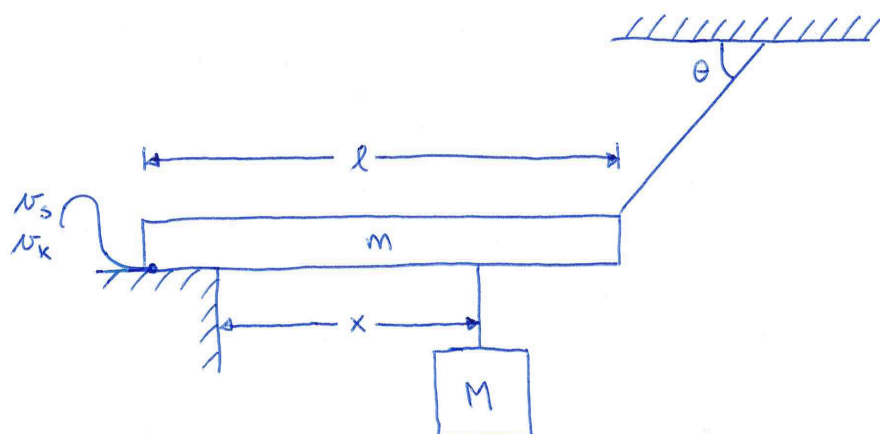


(5 marks) Determine the tension in each rope, given:

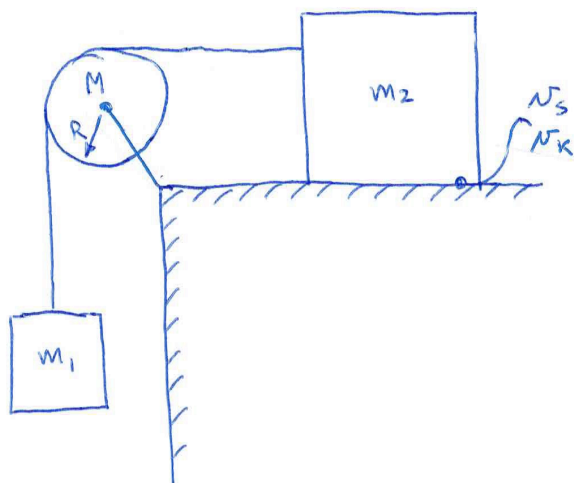
$m_1=100\text{kg}$, $m_2=50\text{kg}$, $R=1\text{m}$, $M=500\text{kg}$, $\theta=60^\circ$, $L_1=2\text{m}$, $L_2=4\text{m}$ and $L_3=5\text{m}$.



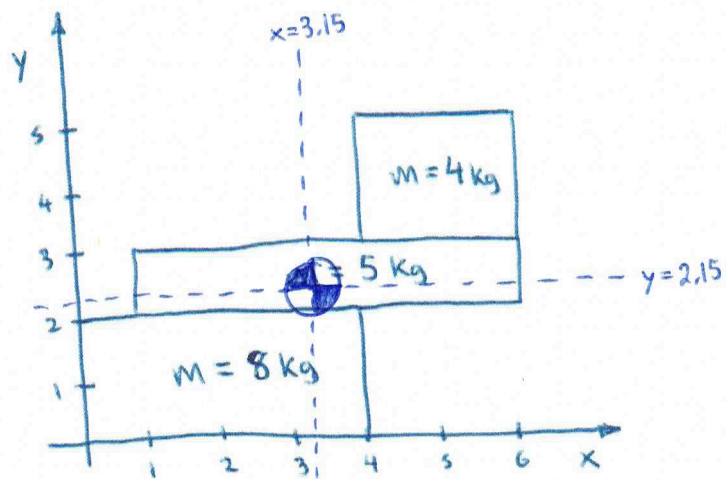
(5 marks) Determine the maximum distance x so the horizontal beam will not slide, given:
 $m=100\text{kg}$, $M=500\text{kg}$, $\theta=60^\circ$, $L=12\text{m}$, $\mu_s=0.6$ and $\mu_k=0.5$.



(5 marks) Determine if the blocks will accelerate and the resultant acceleration, if the blocks don't accelerate, determine the force of friction, given:
 $m_1=1000\text{kg}$, $m_2=400\text{kg}$, $M=500\text{kg}$, $R=1\text{m}$, $\mu_s=0.4$ and $\mu_k=0.3$.



(5 marks) Determine the centre of mass of the object shown below and draw it on the diagram.



$$\vec{x}_{cg} = \frac{\sum m_i \vec{x}_i}{\sum m_i}$$

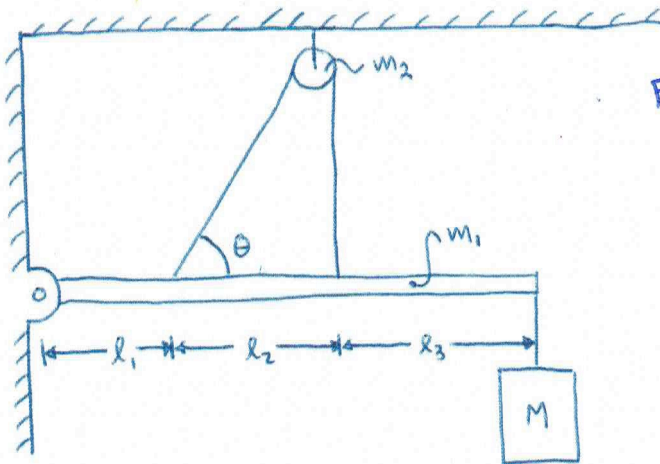
$$x_{cg} = \frac{\sum m_i x_i}{\sum m_i} = \frac{(8)(2) + (5)(3.5) + (4)(5)}{17} = 3.15$$

$$y_{cg} = \frac{\sum m_i y_i}{\sum m_i} = \frac{(8)(1) + (5)(2.5) + (4)(4)}{17} = 2.15$$

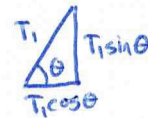
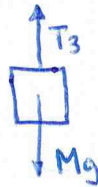
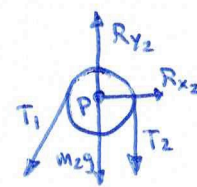
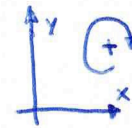
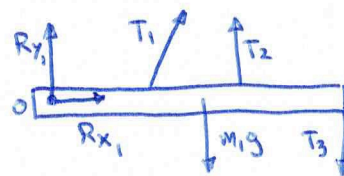
$$\vec{x} = (3.15 \hat{x}, 2.15 \hat{y})$$

(5 marks) Determine the tension in each rope, given:

$m_1=100\text{kg}$, $m_2=50\text{kg}$, $\theta=60^\circ$, $L_1=2\text{m}$, $L_2=4\text{m}$ and $L_3=5\text{m}$, $R=1\text{m}$, $M=500\text{kg}$.



FBD:



Horizontal Beam:

$$\sum F_x = m_1 a_x = R_{x1} + T_1 \cos \theta$$

$$\sum F_y = m_1 a_y = R_{y1} + T_1 \sin \theta + T_2 - m_1 g - T_3$$

$$\sum M_o = I_o \alpha_o = 5.5 m_1 g + 11 T_3 - 6 T_2 - 2 T_1 \sin \theta$$

Pully:

$$(1) \sum F_x = m_2 a_x = R_{x2} - T_1 \cos \theta \quad (4)$$

$$(2) \sum F_y = m_2 a_y = R_{y2} - T_1 \sin \theta - T_2 - m_2 g \quad (5)$$

$$(3) \sum M_p = I_p \alpha_p = T_2 R - T_1 R \quad (6)$$

Block:

$$\sum F_x = m a_x = 0$$

$$\sum F_y = m a_y = T_3 - M g \quad (7)$$

Solve (7) for T_3 :

$$T_3 = M g = (500)(9.81) = 4905 \text{ N} \quad (7a)$$

Solve (6) for T_1 :

$$T_1 = T_2 \quad (6a)$$

Sub (6a) & (7a) into (3) and solve for T_2 :

$$0 = 5.5 m_1 g + 11 [M g] - 6 T_2 - 2 [T_2] \sin \theta$$

$$T_2 = \frac{5.5 m_1 g + 11 M g}{6 + 2 \sin \theta} = \frac{5.5(100)(9.81) + 11(500)(9.81)}{6 + 2 \sin(60)} = 7675.9 \text{ N}$$

use (6a):

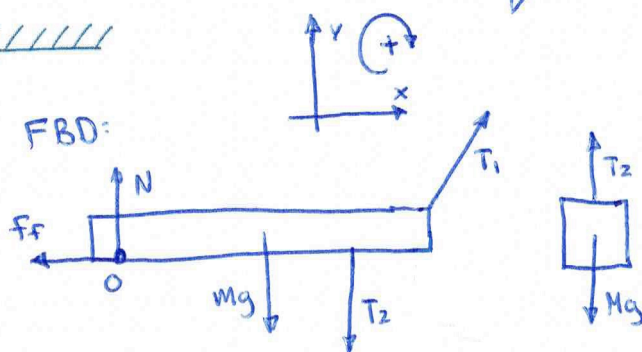
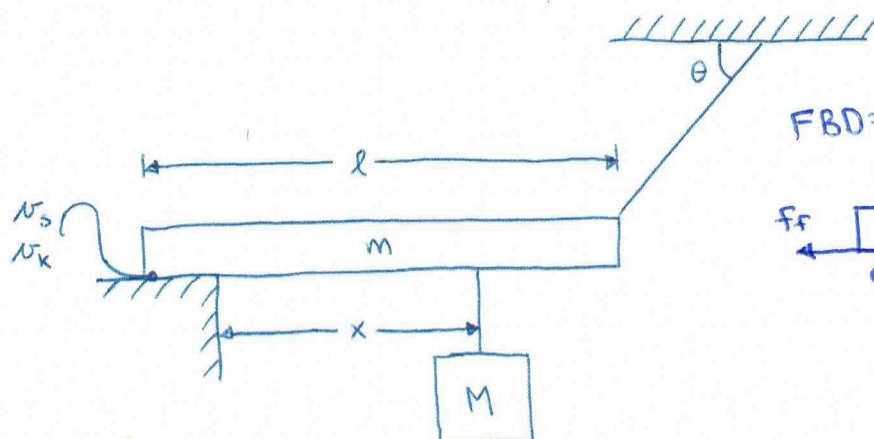
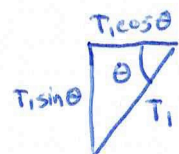
$$T_1 = T_2 = 7675.9$$

So:

$$T_1 = T_2 = 7.7 \text{ kN}$$

$$T_3 = 5.0 \text{ kN}$$

(5 marks) Determine the maximum distance x so the horizontal beam will not slide, given: $m=100\text{kg}$, $M=500\text{kg}$, $\theta=60^\circ$, $L=12\text{m}$, $\mu_s=0.6$ and $\mu_k=0.5$.



Horizontal Block:

$$\sum F_x = \cancel{m a_x} = T_1 \cos \theta - f_f$$

$$\sum F_y = \cancel{m a_y} = N + T_1 \sin \theta - mg - T_2$$

$$\sum M_o = \cancel{I_o \alpha_o} = 6mg + xT_2 - 12T_1 \sin \theta$$

Solve (4) for T_2 :

$$\boxed{T_2 = Mg}$$

sub (4a) into (2) and solve for N :

$$N = Mg + mg - T_1 \sin \theta$$

sub max. friction ($f_{f_{\max}} = \mu_s N$) and (2a) into (1)

$$0 = T_1 \cos \theta - \mu_s [Mg + mg - T_1 \sin \theta]$$

$$0 = T_1 \cos \theta + T_1 \mu_s \sin \theta - \mu_s mg - \mu_s Mg$$

$$T_1 = \frac{\mu_s mg + \mu_s Mg}{\cos \theta + \mu_s \sin \theta}$$

sub (1a) & (4a) into (3) and solve for x :

$$0 = 6mg + x[Mg] - 12 \left[\frac{\mu_s mg + \mu_s Mg}{\cos \theta + \mu_s \sin \theta} \right] \sin \theta$$

$$x = \frac{1}{Mg} \left[12 \left(\frac{\mu_s mg + \mu_s Mg}{\cos \theta + \mu_s \sin \theta} \right) \sin \theta - 6mg \right] = \frac{1}{(500)(9.81)} \left[12 \left(\frac{(0.6)(100)(9.81) + (0.6)(500)(9.81)}{\cos 60 + 0.6 \sin 60} \right) \right. \\ \left. \sin 60 - 6(100)(9.81) \right]$$

$$\boxed{x = 6.14 \text{ m}}$$

Block:

$$\sum F_x = \cancel{M a_x} = 0$$

$$\sum F_y = \cancel{M a_y} = T_2 - Mg \quad (4)$$

(1)

(2)

(3)

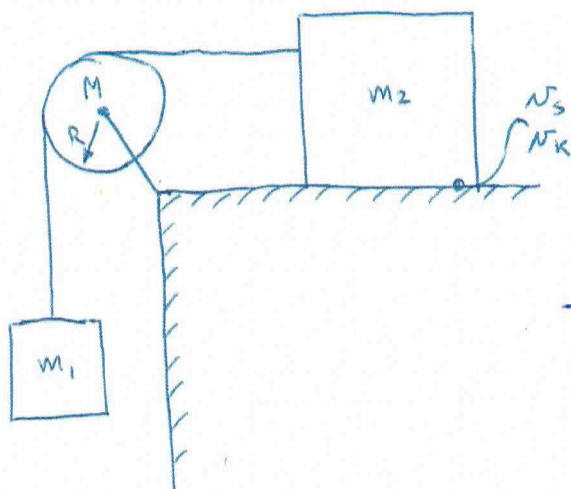
(4a)

(2a)

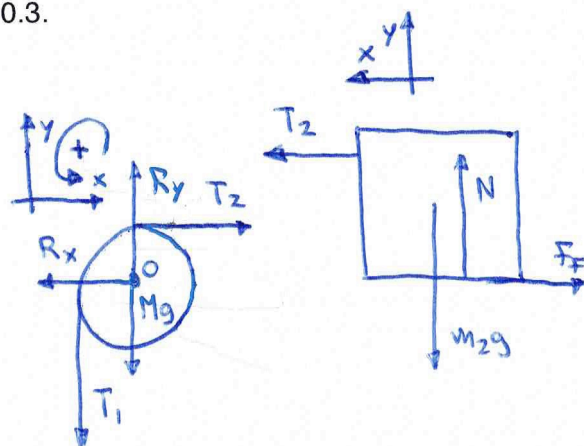
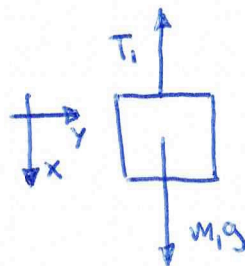
(1a)

(5 marks) Determine if the blocks will accelerate and the resultant acceleration, if the blocks don't accelerate, determine the force of friction, given:

$m_1=1000\text{kg}$, $m_2=400\text{kg}$, $M=500\text{kg}$, $R=1\text{m}$, $\mu_s=0.4$ and $\mu_k=0.3$.



FBD:



Hanging Block:

$$\sum F_x = m_1 a_{x1} = m_1 g - T_1$$

$$\sum F_y = m_1 a_{y1} = 0$$

Pulley:

$$(1) \sum F_x = M a_x = T_2 - R_x$$

$$\sum F_y = M a_y = R_y - T_1 - M g$$

$$\sum M_o = I_o \alpha_o = T_1 R - T_2 R$$

Sliding Block:

$$(2) \sum F_x = m_2 a_{x2} = T_2 - F_f$$

$$(3) \sum F_y = m_2 a_{y2} = N - m_2 g$$

Solve (6) for N:

$$N = m_2 g$$

(6a)

Sub max friction ($F_f = \mu_s N$) and (6a) into (5)

$$m_2 a_{x2} = T_2 - \mu_s [m_2 g]$$

$$T_2 = m_2 a_{x2} + \mu_s m_2 g$$

(5a)

Solve for T_1 in (1)

$$T_1 = m_1 g - m_1 a_{x1}$$

(1a)

Sub (1a) & (5a) into (4):

$$I_o \alpha_o = [m_1 g - m_1 a_{x1}] R - [m_2 a_{x2} + \mu_s m_2 g] R$$

(4a)

assume inelastic rope and uniform circular motion:

$$a_{x1} = a_{x2} = a_x \quad \& \quad a_x = \alpha R$$

(7)

Sub (7) into (4a):

$$I_o \left[\frac{a_x}{R} \right] = (m_1 g - m_1 a_x) R - (m_2 a_x + \mu_s m_2 g) R \quad (4b)$$

sub moment of Inertia ($I_o = \frac{1}{2} M R^2$) into (4b)

$$\left[\frac{1}{2} M \cancel{R^2} \right] \frac{a_x}{\cancel{R}} = (m_1 g - m_1 a_x) \cancel{R} - (m_2 a_x + \mu_s m_2 g) \cancel{R}$$

$$\frac{1}{2} M a_x + m_1 a_x + m_2 a_x = m_1 g - \mu_s m_2 g$$

$$a_x = \frac{m_1 g - \mu_s m_2 g}{\frac{1}{2} M + m_1 + m_2}$$

try with static friction ($\mu_s = 0.4$):

$$a_x = \frac{(1000)(9.81) - (0.4)(400)(9.81)}{\frac{1}{2}(500) + 1000 + 400} = 5.0 \text{ m/s}^2 \quad \text{+ive, so it does accelerate.}$$

use Kinetic Friction ($\mu_k = 0.3$):

$$a_x = \frac{(1000)(9.81) - (0.3)(400)(9.81)}{\frac{1}{2}(500) + 1000 + 400} = 5.2 \text{ m/s}^2$$

$$a_x = 5.2 \text{ m/s}^2$$