Panel 1

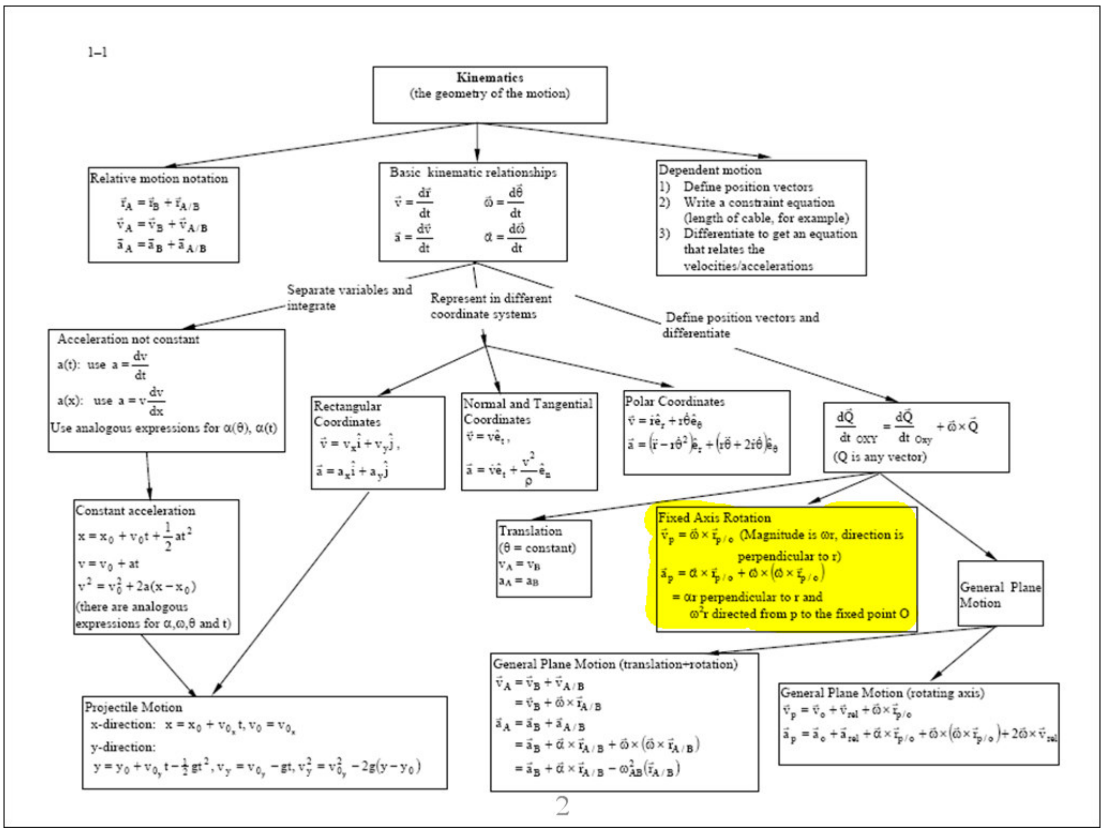
ES204 Mechanical Systems

Fixed Axis Rotation - Energy
Lecture 12

1

Dr. Fisher

Panel 2



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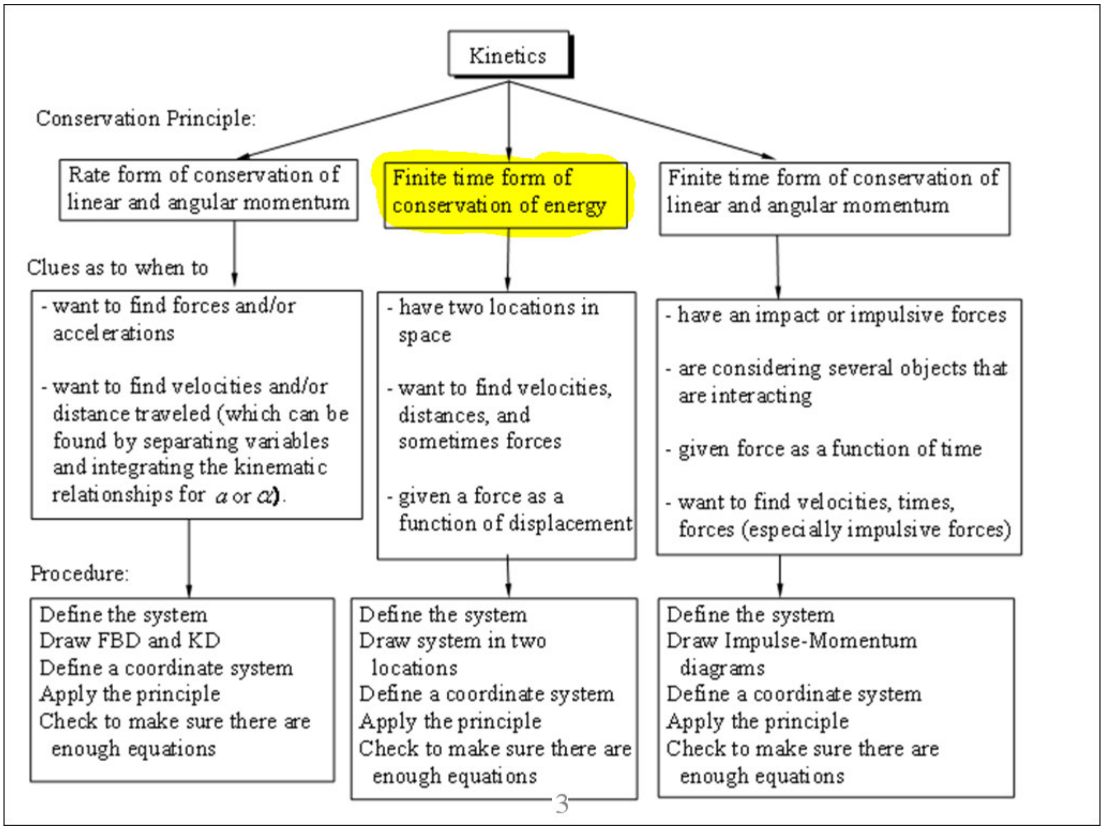
Panel 3



Panel 4

$$E_{sys} = E_k + E_G + E_s + U$$

where

	Comments
$E_k = \frac{1}{2}mv_G^2 + \frac{1}{2}I_G\omega^2$	(you will always need to use kinematics to relate v_G and ω.)
$E_G = mgz$	(z is the distance the center of mass is from the datum)
$E_s = \frac{1}{2}kx^2$	(x is measured from the free length of the spring)
U = internal energy	(this is usually zero in this class unless there is an impact)

and work is defined to be

$$W = \int_1^2 \vec{F}\cdot d\vec{r} \quad \text{or} \quad W = \int_1^2 M d\theta$$

Special Cases:

constant force: $W = \int_1^2 \vec{F}\cdot d\vec{r} = \int_1^2 F ds = F\int_0^s ds \Rightarrow W = Fs$

constant moment: $W = \int_1^2 M d\theta = M\int_0^\theta d\theta \Rightarrow W = M\theta$

rolling friction (on a fixed surface): $W = \int_1^2 \vec{F}\cdot d\vec{r} = \int_1^2 F ds_c\left(\frac{dt}{dt}\right) = \int_1^2 F v_c dt = 0 \Rightarrow W = 0$

velocity of the point of contact

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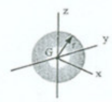
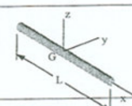
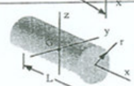
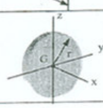
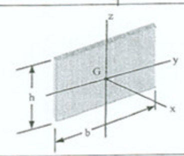
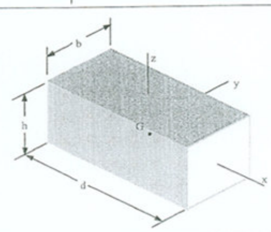
Panel 5

Solid Sphere $I_x = I_y = I_z = \frac{2}{5} mr^2$	
Slender Rod $I_y = I_z = \frac{1}{12} mL^2$	
Solid Circular Cylinder $I_x = \frac{1}{2} mr^2$ $I_y = I_z = \frac{1}{12} m\left(L^2 + 3r^2\right)$	
Thin Disk $I_x = \frac{1}{2} mr^2$ $I_y = I_z = \frac{1}{4} mr^2$	
Thin Rectangular Plate $I_x = \frac{1}{12} m\left(b^2 + h^2\right)$ $I_y = \frac{1}{12} mh^2$ $I_z = \frac{1}{12} mb^2$	
Brick $I_x = \frac{1}{12} m\left(b^2 + h^2\right)$ $I_y = \frac{1}{12} m\left(h^2 + d^2\right)$ $I_z = \frac{1}{12} m\left(b^2 + d^2\right)$	

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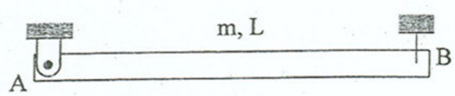
Panel 6

Given:



Find: When the cable at B breaks determine:

a) a_B
b) reaction at A
c) the reaction at A when the bar is in the vertical position

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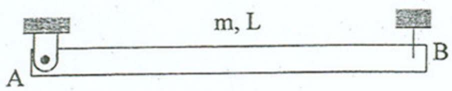
Panel 7

Given:



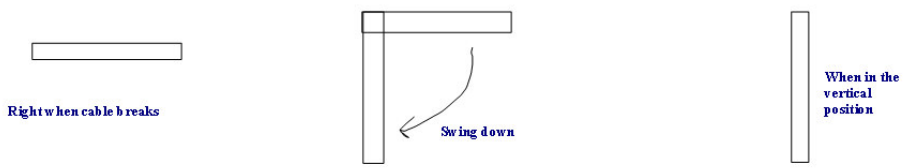
Find: When the cable at B breaks determine:

a) a_B

b) reaction at A

c) the reaction at A when the bar is in the vertical position

How do we want to approach each part?



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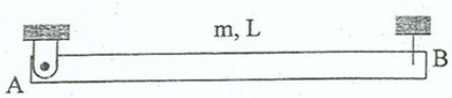
Panel 8

Given:



Find: When the cable at B breaks determine:

a) a_B

b) reaction at A

c) the reaction at A when the bar is in the vertical position

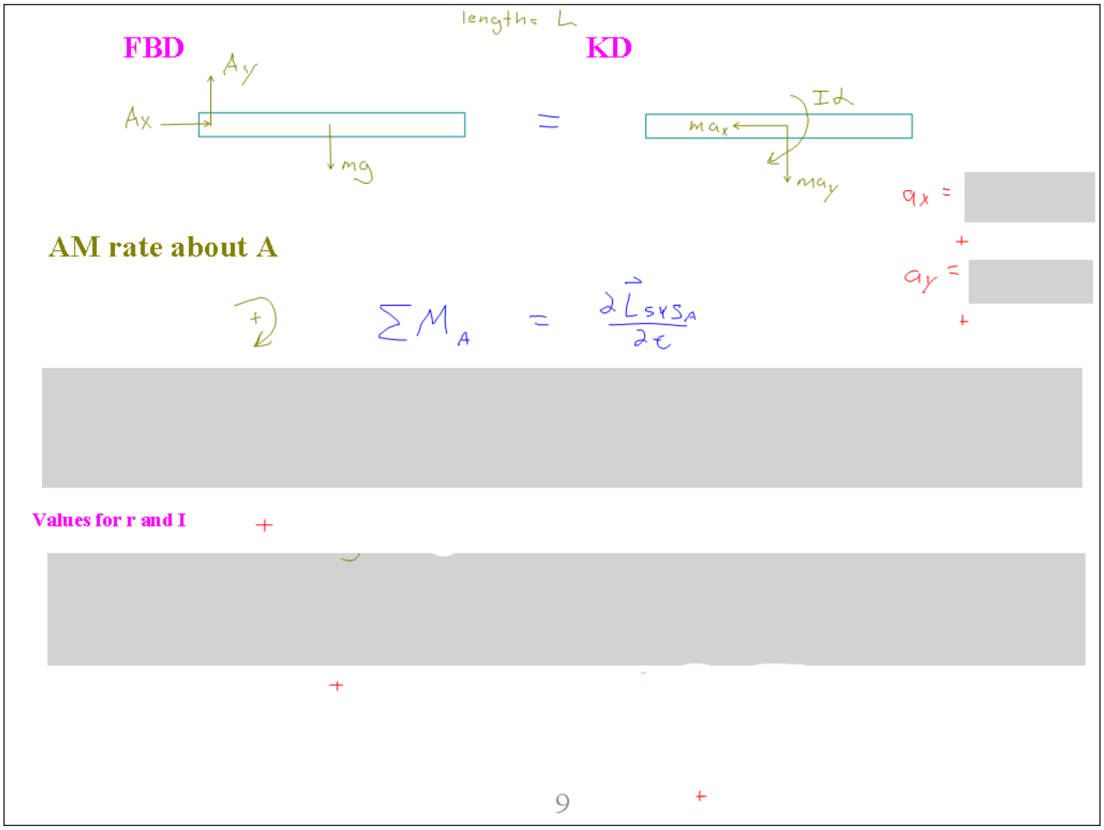
Parts A and B

FBD **KD**

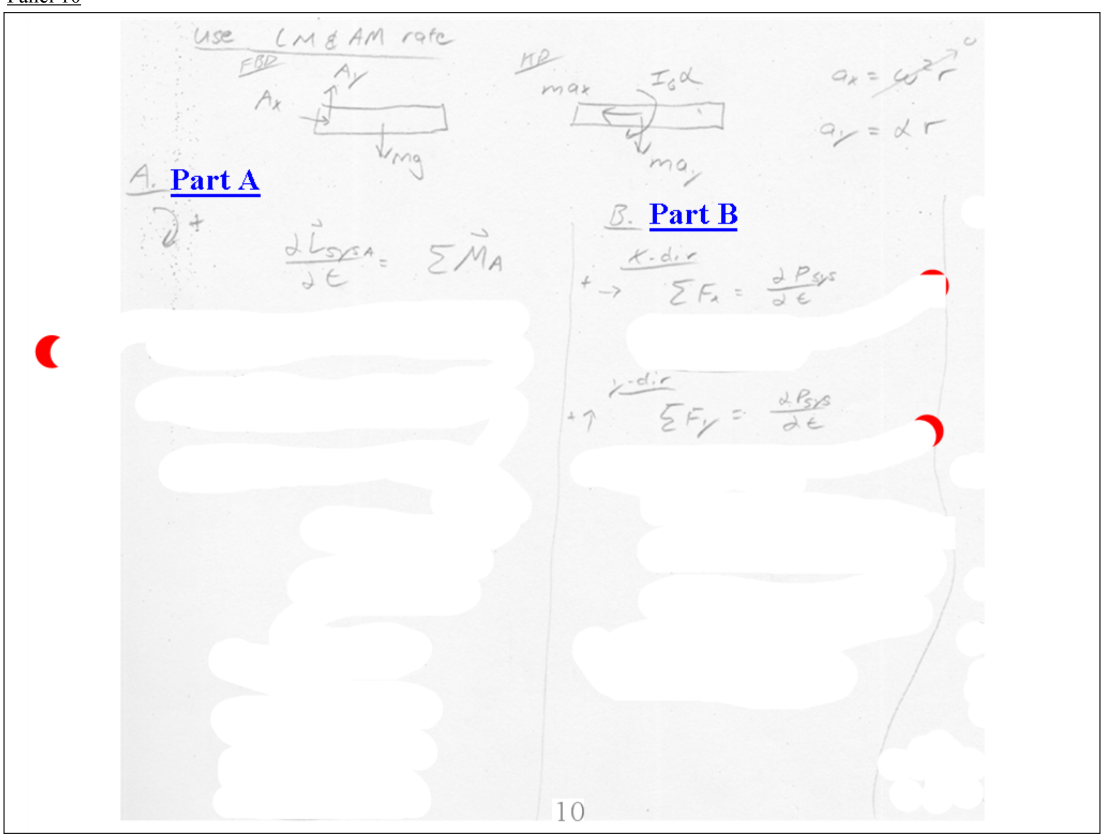
FBD **KD**

8

Panel 9

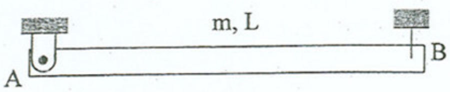


Panel 10



Panel 11

Given:



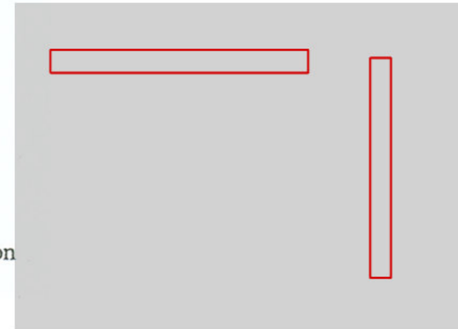
Find: When the cable at B breaks determine:

a) a_B Skip part B it's just CoLM rate again

~~b) reaction at A~~

c) the reaction at A when the bar is in the vertical position

Energy diagram



Write the energy equation (remember the new term)

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Panel 12

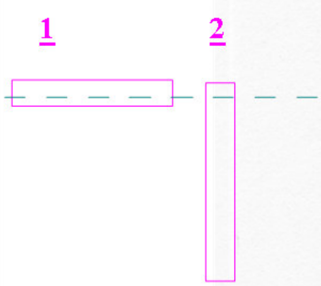
$\Delta E_{sys} = \cancel{W}^{\,0}$

$E_{K_1} + E_{G_1} = E_{K_2} + E_{G_2}$

$E_{K_1} =$

$E_{G_1} =$

$E_{K_2} =$



$E_{K_2} =$

$=$

$=$

$E_{G_2} =$

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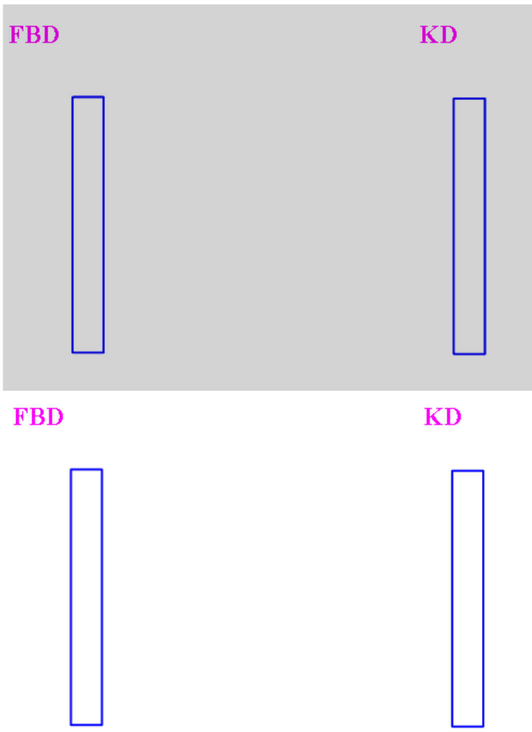
Panel 13



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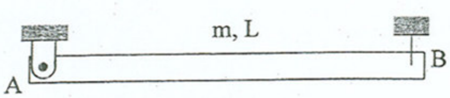
Panel 14

Given:



Find: When the cable at B breaks determine:

a) a_B

b) reaction at A

c) the reaction at A when the bar is in the vertical position

Rate CoAM about pivot

Rate CoLM X&Y Directions

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