Name (print): KEY

Section _____ Table _____ Group _____

Honor Code: *I have neither given nor received unauthorized aid on this test*

Signature: _____

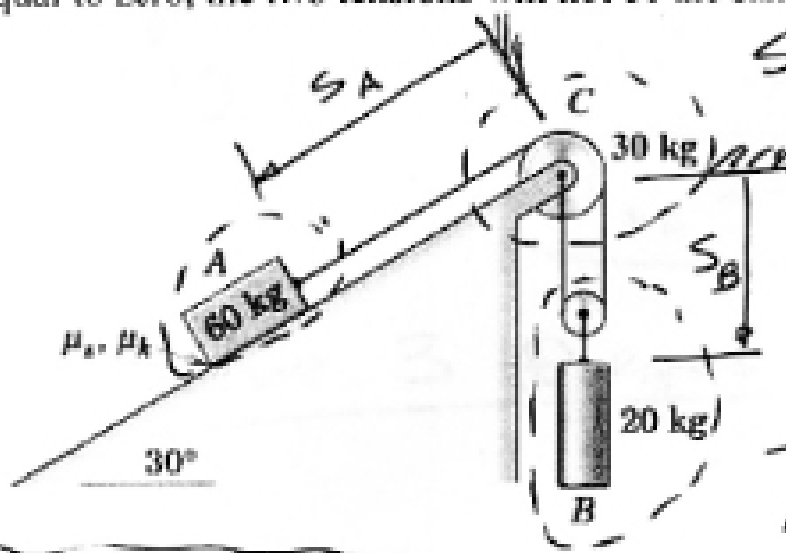
ME 201 Test #3

April 4, 2007

NOTES:

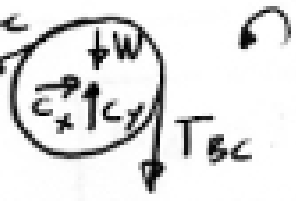
- ***Sign and provide identifying info on every sheet.***
- *Use proper **vector notation** in all cases where vectors are used.*
- *In cases involving Newton's Laws, you are **REQUIRED to draw** complete and correct **FBDs** and when the problem is dynamics, you must also draw complete and correct **KDs**. Then use these to develop your governing equations.*
- *If you use you **calculator to perform any calculus** that might involve trig or similar functions, set your calculator to the **radian mode** first.*
- *In all cases, remember to show results with **magnitude, direction, units** and put your **answer in a box**.*

1. (50 pts) The system is released from rest. The static and kinetic friction coefficients are 0.25 and 0.20, respectively. The mass of the cable small pulley near B are negligible and the bearings are frictionless. Pulley C has a mass of 30 kg and a radius of 0.4 m. (a) **Show** that the system of masses is **not in static equilibrium** and determine **the direction of motion**. (b) Then find the **tension in the cable from A to C and from C to B.** Treat the 30 kg pulley as a uniform disk. (Note: remember since the pulley mass is not equal to zero, the two tensions will not be the same in the dynamic case).



STATICS: Find F_f for all $\bar{a} = 0$

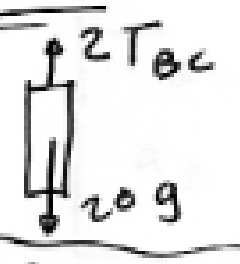
Pulley C:



$\circlearrowleft \Sigma M_C = 0 = .4T_{AC} - .4T_{BC}$

$\therefore \boxed{T_{AC} = T_{BC}}$

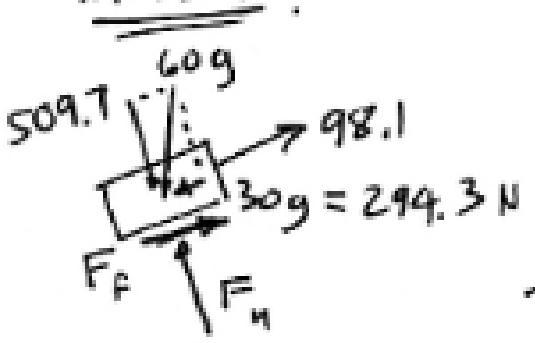
Mass B:



$\uparrow \Sigma F_y = 0 = 2T_{BC} - 20g$

$\boxed{T_{BC} = 98.1\ N}$

Mass A:



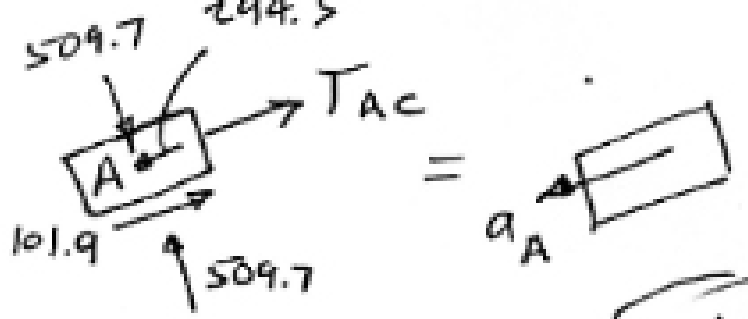
$\uparrow \Sigma F_y = F_n - 509.7 = 0 \quad \therefore \boxed{F_n = 509.7\ N}$

$\rightarrow \Sigma F_x = 98.1 - 294.3 + F_f = 0 \quad \therefore \boxed{F_f = 196.2\ N \nearrow}$

$(F_f)_{max} = .25\, F_n = \boxed{127.4\ N = (F_f)_{max}}$

$\therefore$ **F_f req'd $> F_{f\,max}$**
Mass A slips ↙

DYNAMICS: $F_f = \mu_k F_n = .2\,(509.7) = 101.9\ N$

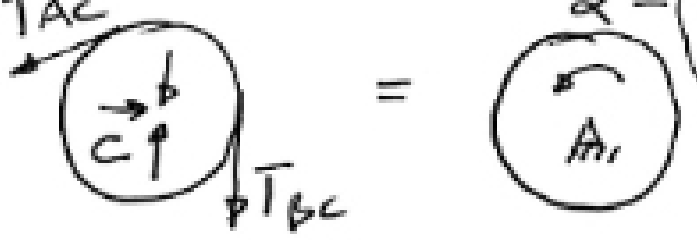


$\overset{+}{\rightarrow} \Sigma F_x = 294.3 - 101.9 = T_{AC} = m a_A = 60 a_A$

$\boxed{192.4 - T_{AC} = 60\, a_A}$ (*)

kinematics

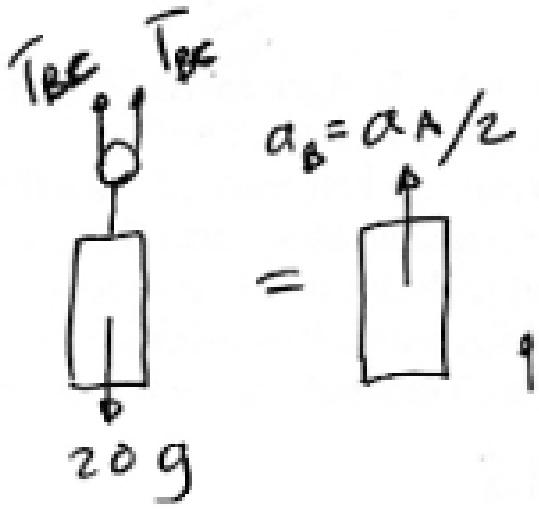
$\alpha = \dfrac{a_A}{.4}$



$\overset{+}{\circlearrowleft} \Sigma M_C = .4T_{AC} - .4T_{BC} = I_G \alpha =$

$= \frac{1}{2}(30)(.4)^2\left(\dfrac{a_A}{.4}\right)$

$\boxed{T_{AC} - T_{CB} = 15\, a_A}$ (*)



Kinematics: $L = S_A + 2S_B$

$\therefore a_A = -2a_B$

or using $a_A \downarrow$

$a_B \uparrow$

$a_A = 2a_B$

$+\uparrow \Sigma F_y = 2T_{BC} - 196.2$

$= 20\left(\frac{a_A}{2}\right)$

$T_{BC} - 98.1 = 5a_A$ (*)

Solve 3 ⊕ eqns:

$a_A = 1.179$ m/sec^2 ↓

$T_{AC} = 121.7$ N

$T_{BC} = 104.0$ N

$a_B = 0.59$ m/sec^2 ↑