Name ______________________________ Section _______________________

ES204

Examination III

February 11, 2005

Problem	Score
1	/21
2	/39
3	/40
Total	/100

Show all work for credit

AND

Turn in your signed help sheet

AND

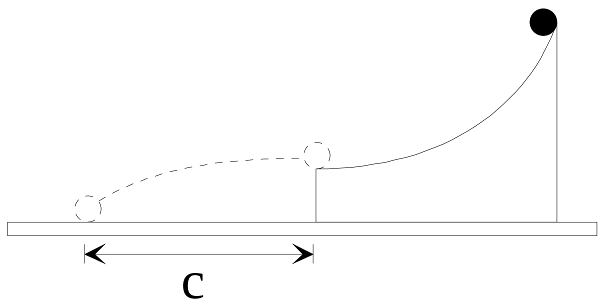
Stay in your seat until the end of class

CM ___________________________________ 21 pts

ES204 Examination III **Problem 1** Feb. 11, 2005

Problem 1.1

A round object is released from rest at the top of a curved surface as shown below.



Which object of mass m and radius r shown below will have the greatest velocity at the bottom of the ramp?

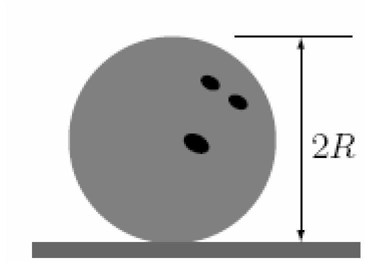
- A solid sphere rolling without slipping
- A solid cylinder rolling without slipping
- A hoop rolling without slipping

a) The solid sphere
b) The solid cylinder
c) The hoop
d) They will all have the same velocity.

Problem 1.2

The bowling ball shown at the right is rolling without slip on the rough surface shown. Which of the following friction laws apply?

(a) $f = \mu_k N$;
(b) $f = \mu_s N$;
(c) either $f = \mu_k N$ or $f = \mu_s N$ apply;
(d) neither $f = \mu_k N$ nor $f = \mu_s N$ apply;



where μ_k and μ_s are the kinetic and static coefficients of friction, respectively.

Problem 1.3

If this bowling ball is given an initial horizontal velocity and an zero initial angular velocity what is the condition for when the ball will start rolling without slipping?

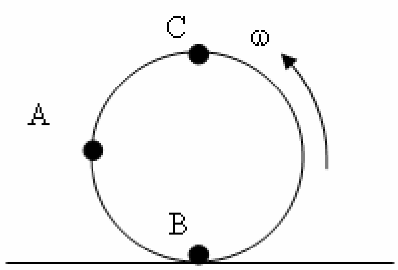
Problem 1.4

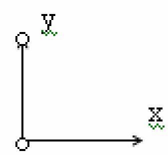
The equation relating the acceleration of two points on the same rigid body undergoing plane motion is (circle all the correct answers):

$a_B = a_A + \alpha\times r_{B/A} + \omega\times(\omega\times r_{B/A})$	$\vec{a}_B = \vec{a}_A + \vec{\alpha}\times\vec{r}_{B/A} + \omega^2\vec{r}_{B/A}$
$\vec{a}_B = \vec{a}_A + \vec{\alpha}\times\vec{r}_{B/A} - \omega^2\vec{r}_{B/A}$	$a_B = a_A + \alpha r + \omega^2 r$
$\vec{a}_B = \vec{a}_A + \vec{\alpha}\times\vec{r}_{B/A} + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{B/A})$	$\vec{a}_B = \vec{a}_A + \vec{\alpha}\times\vec{r}_{B/A} + \vec{\omega}\times\vec{v}_{B/A}$
$\vec{a}_B = \vec{a}_A + \vec{\alpha}\times\vec{r}_{A/B} + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{A/B})$	

Problem 1.5 and 1.6

The wheel shown rolls without slip on a horizontal surface. It has radius R and a constant counter-clockwise angular velocity of magnitude ω.





1.5 What is the velocity of point A?

a. $R\omega\hat{\mathbf{i}} - R\omega\hat{\mathbf{j}}$

b. $-R\omega\hat{\mathbf{i}} - R\omega\hat{\mathbf{j}}$

c. $-R\omega\hat{\mathbf{j}}$

d. $-R\omega\hat{\mathbf{i}}$

e. $R\alpha\hat{\mathbf{j}}$

1.6 What is the acceleration of point C?

a. $-R\omega^2\hat{\mathbf{j}}$

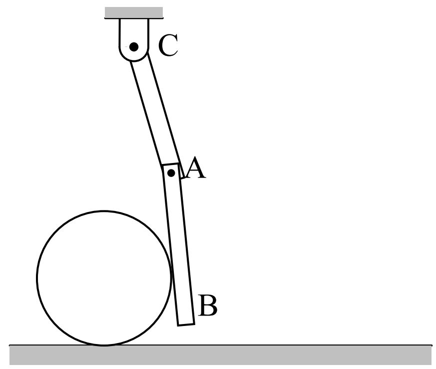
b. $-2R\omega^2\hat{\mathbf{j}}$

c. $R\omega^2\hat{\mathbf{j}}$

d. $2R\alpha\mathbf{i} - R\omega^2\mathbf{j}$

e. $R\omega^2\mathbf{i} + R\alpha\mathbf{j}$

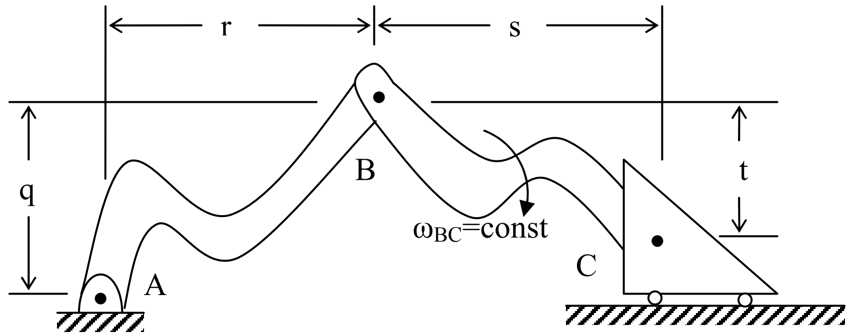
1.7 Where is the instantaneous center of velocity for bar AB at the instant shown? Assume there is no slipping between the disk and the ground and between the disk and bar AB.



CM ____________________________ 39 pts

ES204 Examination III **Problem 2** Feb. 11, 2005

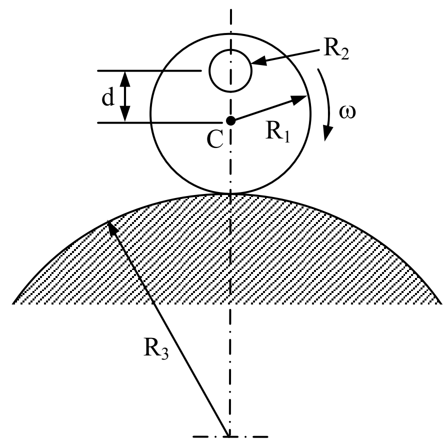
The Dr. Seuss slider-crank, shown at right, is magically driven with constant angular velocity ω_{BC} which makes the triangle move only in the horizontal direction. What is the angular acceleration of member AB at this instant? Set up but do not solve your equations – make sure to expand any vector equations into their component forms!



CM ___________________________________ /40 pts

ES204 Examination III **Problem 3** Feb. 11, 2005

The small cylinder with a circular hole is rolling on the large fixed cylinder without slipping. At the instant shown the object has an angular velocity ω. If the mass of the large cyclinder is m_1 (without the hole) and the mass of the material removed is m_2 determine equations necessary to determine the reaction forces between the two cylinders at the instant shown. Assume, R_1, R_2, R_3, d and ω are all known. You answer should consist of numbered equations and a list of unknowns.



Hint: If you don't know how to handle the removed mass assume that the mass m_2 is added to the disk.