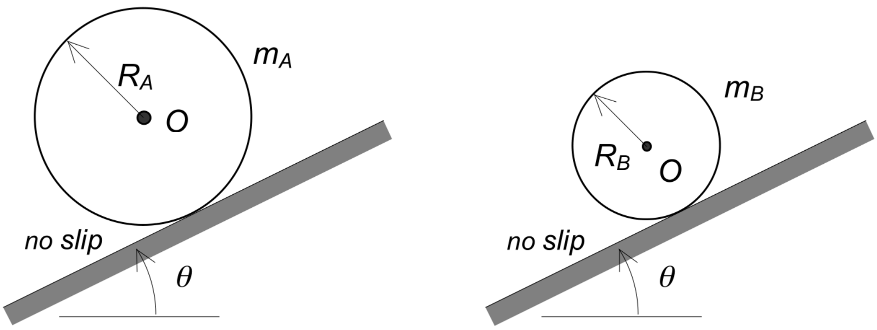
Question C5.1

Consider the homogeneous disks A and B with $m_A > m_B$ and $R_A > R_B$. The disks are released from rest. Circle the answer below that most accurately describes the relative sizes of the accelerations of the centers of the two disks, $(a_O)_A$ and $(a_O)_B$, on release.

(a) $(a_O)_A > (a_O)_B$

(b) $(a_O)_A = (a_O)_B$

(c) $(a_O)_A < (a_O)_B$



$$\sum M_C = (m_A g \sin\theta) R_A = I_C \alpha$$

$$\hookrightarrow \quad \alpha_A = \frac{\cancel{m}g\sin\theta\,\cancel{R_A}}{\frac{3}{2}\cancel{m_A} R_A^{\cancel{2}}}$$

$$a_{OA} = R_A \alpha_A$$

$$\sum M_C = (m g \sin\theta) R_B = I_C \alpha$$

$$\hookrightarrow \quad \alpha_B = \frac{(\cancel{m_B} g \sin\theta)\,\cancel{R_B}}{\frac{3}{2}\cancel{m_B} R_B^{\cancel{2}}}$$

$$a_{OB} = R_B \alpha_B$$

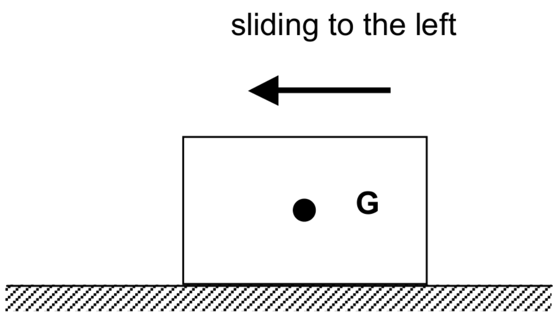
Question C5.2
A block with center of mass at G slides to the left on a rough horizontal surface. Circle the answer below that most accurately describes the location of the normal contact force on the block from the ground as the block slides.

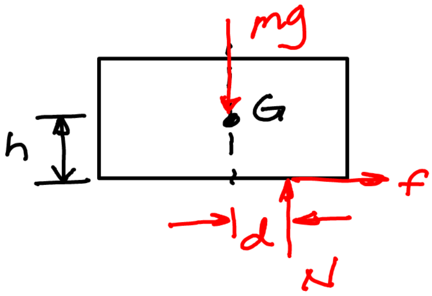
(a) The normal force acts at a point to the left of G

(b) The normal force acts at a point to the right of G

(c) The normal force acts at a point directly beneath G

(d) More information is needed to answer this question



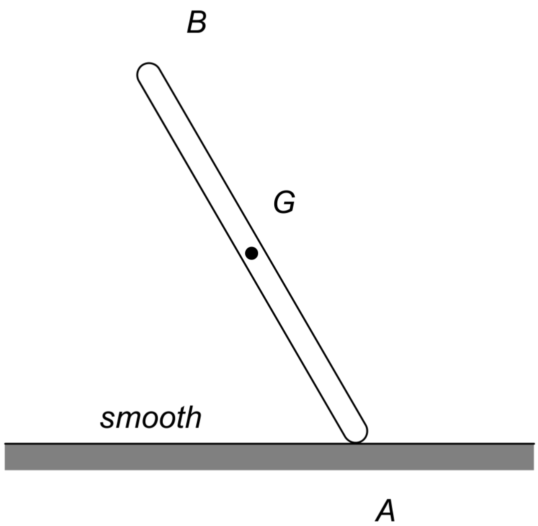


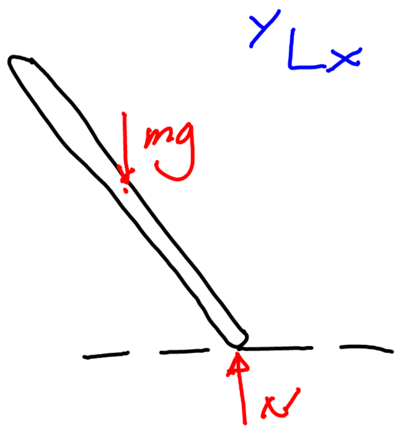
$$\Sigma M_G = Nd - fh = 0$$

What is the sign of d?

Question C5.3

The homogenous bar shown is released from rest while in contact with the smooth horizontal surface. Describe in words and with a sketch the path of the center of mass G after the bar is released.





$$\sum F_x = 0 = m a_{Gx}$$

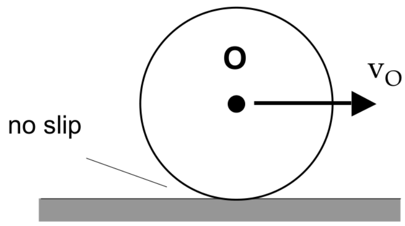
Question C5.4
The homogeneous disk shown is moving to the right with its center having a constant speed. Circle the answer below that most accurately describes the friction force on the disk as it moves.

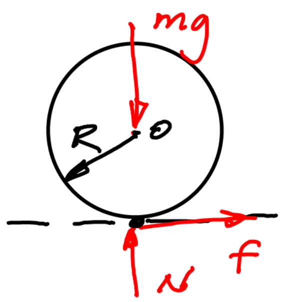
(a) The friction force acts to the right.

(b) The friction force acts to the left.

(c) The friction force is zero.

(d) A numerical value for the coefficient of friction is needed in order to answer this question.





- Constant $V_o \Rightarrow a_o = 0$

$$\alpha = \frac{a_o}{R} = 0$$

- $\Sigma M_o = fR = I_o\alpha$

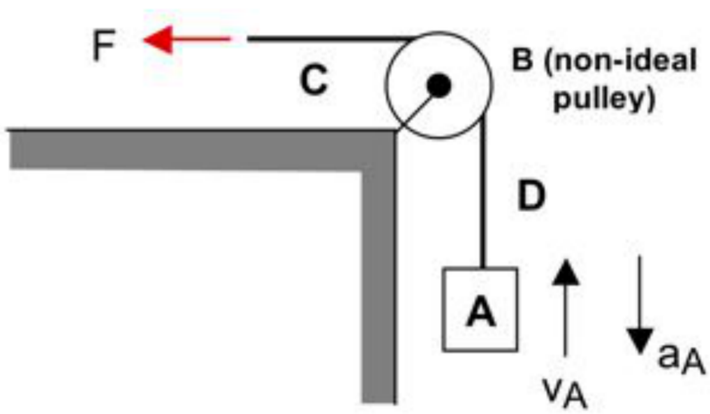
Question C5.5

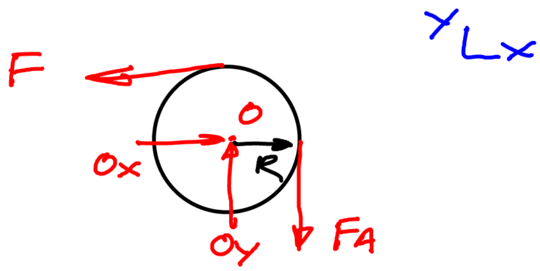
The force F is lifting block A; however, the speed of A is decreasing. The pulley is non-ideal (it has a non-zero mass moment of inertia). Circle the correct description below.

(a) The tension in section C of the cable is larger than the tension in section D.

(b) The tension in section C of the cable is smaller than the tension in section D.

(c) The tension in section C of the cable is the same as the tension in section D.

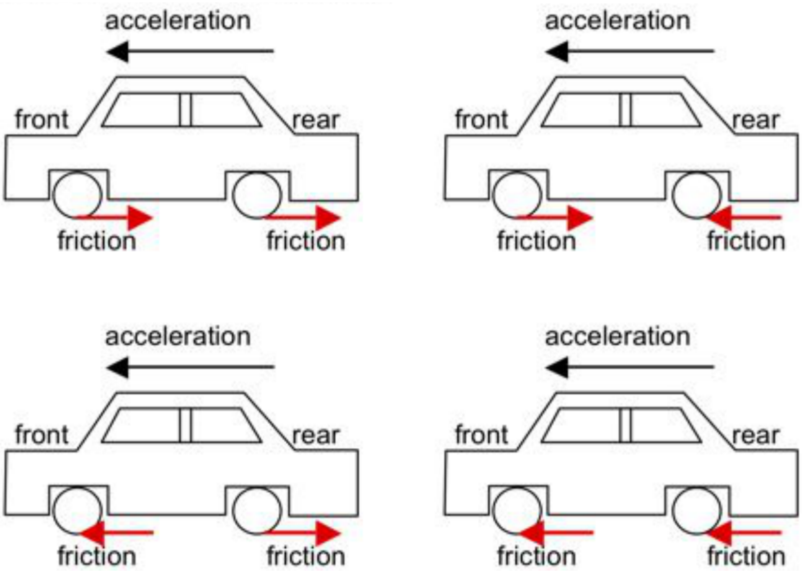


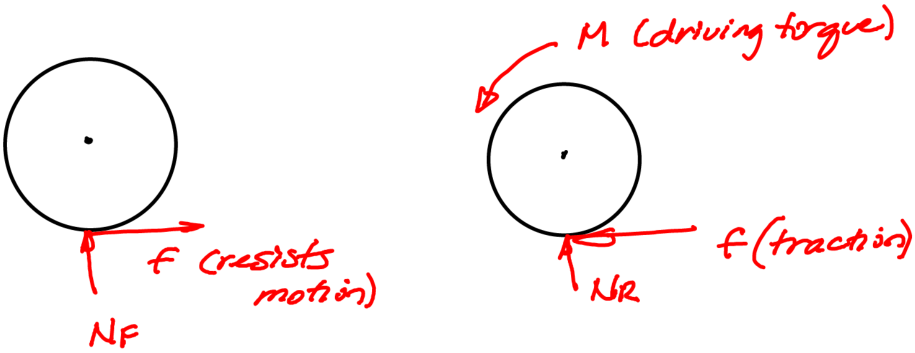


- $\sum M_o = (-F_A + F)R = I_o\alpha$
- $\alpha = \frac{a_A}{R} < 0$ (CW)

Question C5.6

A rear-wheel drive automobile is experiencing a forward acceleration on a horizontal roadway. Circle the figure below that correctly shows the direction of the friction forces between the tires and the roadway.





Question C5.7

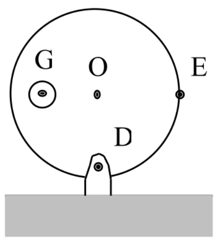
Which expressions below are not an acceptable formulation for the Euler Equation for relating moments and angular acceleration for the disk with the center of mass G and the geometric center O?

(a) $\sum M_D = I_D \vec{\alpha}$

(b) $\sum M_E = I_E \vec{\alpha}$

(c) $\sum M_O = I_O \vec{\alpha}$

(d) $\sum M_G = I_G \vec{\alpha}$



$$\sum \vec{M}_A = I_A \vec{\alpha} + m \vec{r}_{G/A} \times \vec{a}_A$$

Question C5.8

Circle the statement below that most accurately describes the Newton-Euler Equations for the bar shown below. G is the center of mass of the bar.

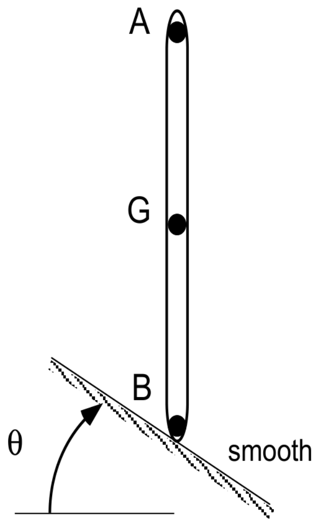
(a) $\sum \vec{F} = m\vec{a}_G$ and $\sum \vec{M}_A = I_G\vec{\alpha}$

(b) $\sum \vec{F} = m\vec{a}_G$ and $\sum \vec{M}_A = I_A\vec{\alpha}$

(c) $\sum \vec{F} = m\vec{a}_A$ and $\sum \vec{M}_G = I_G\vec{\alpha}$

(d) All of the above

(e) None of the above



$$\sum \vec{M}_A = I_A\vec{\alpha} + m\vec{r}_{G/A}\times\vec{a}_A$$

Question C5.9

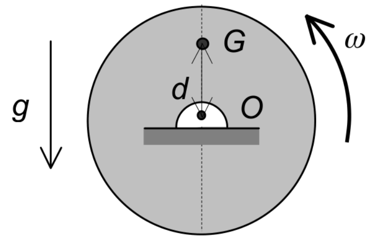
An inhomogeneous disk has its center of mass at G and is rotating about the geometric center of the disk O. At position I, G is directly above O; at position II, G is directly below O. Let $(F_O)_I$ and $(F_O)_{II}$ represent the magnitudes of the reaction force on the disk at O at positions I and II, respectively. Circle the correct answer below.

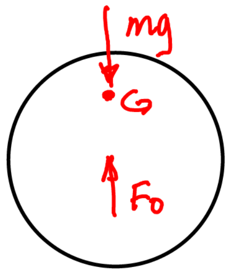
(a) $(F_O)_I > (F_O)_{II}$

(b) $(F_O)_I = (F_O)_{II}$

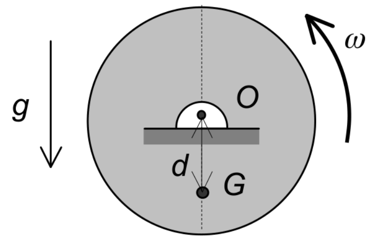
(c) $(F_O)_I < (F_O)_{II}$

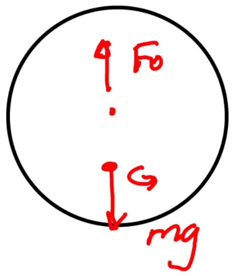
Position I





Position II





- $\sum F_y = F_O - mg = m a_{Gy}$
- $\vec{a}_G = \cancel{\vec{a}_O}^{\,0} + \vec{\alpha} \times \vec{r}_{G/O} - \omega^2 \vec{r}_{G/O}$

→ $a_{Gy} < 0$ for I

> 0 for II

Question C5.10

A cable is wrapped around the inner radius of a stepped drum. A force F is applied to the center of the drum. Let μ_s and μ_k be the coefficients of static and kinetic friction, respectively, between the drum and ground. Circle the answer below that most accurately describes the friction force acting on the drum at the contact point C.

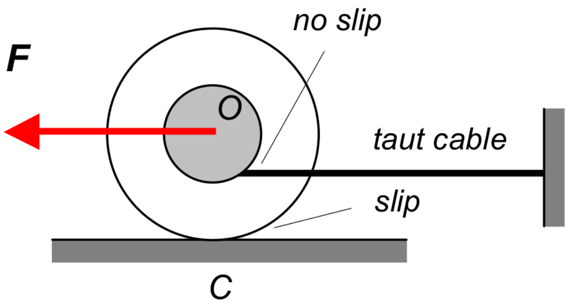
(a) $f = \mu_s mg$ (to the left)

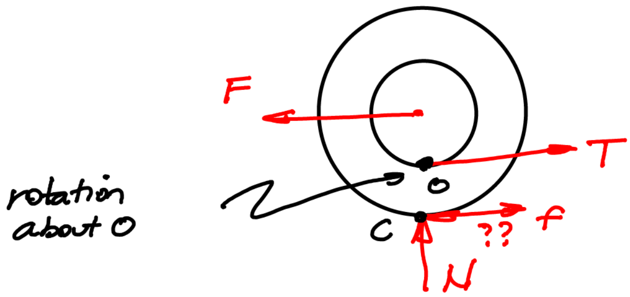
(b) $f = \mu_k mg$ (to the left)

(c) $f = 0$

(d) $f = \mu_s mg$ (to the right)

(e) $f = \mu_k mg$ (to the right)





Wheel slips w/ C moving to right

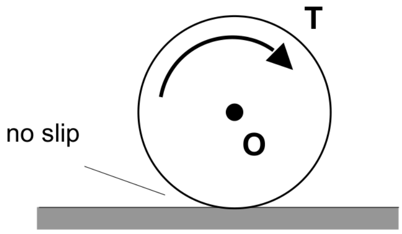
Question C5.11
A homogeneous disk is acted upon by a torque T. Circle the answer below that most accurately describes the friction force on the disk as it rolls without slipping.

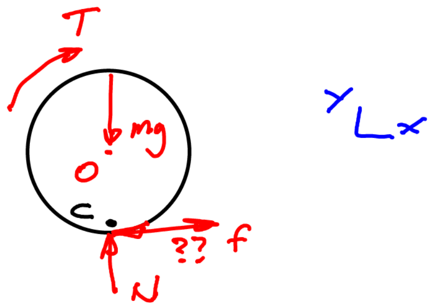
(a) The friction force acts to the right.

(b) The friction force acts to the left.

(c) The friction force is zero.

(d) The coefficient of static friction is needed to determine the direction of the friction force.





If smooth: $\sum M_O = -TR = I_O \alpha \Rightarrow \alpha = CW$

$\Rightarrow$ c slips to left

Since not smooth: friction opposes motion at C

Question C5.12

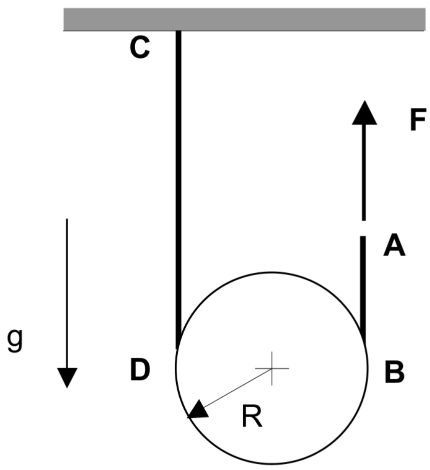
The center of the disk shown below is known to have a downward acceleration. Assume that the cable does not slip on the homogeneous disk. Circle the answer below that most accurately describes the tension in sections AB and CD of the cable.

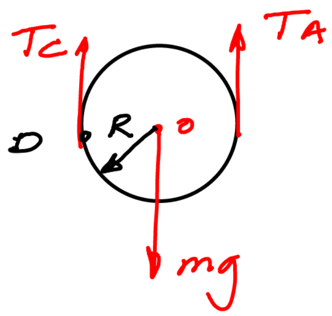
(a) The tension in section AB is smaller than the tension in section CD.

(b) The tension in section AB is equal to the tension in section CD.

(c) The tension in section AB is larger than the tension in section CD.

(d) More information is needed on the problem to answer this question.





- $\sum M_O = (T_A - T_C)R = I_O \alpha$
- $a_O < 0 \Rightarrow \alpha < 0$ (CW)

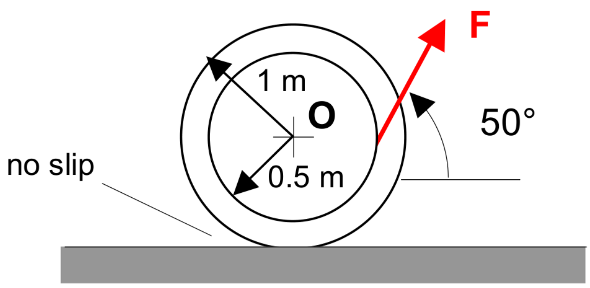
Question C5.13
The force F is applied to the end of a cable wrapped around the inner radius of the stationary spool shown. If the cable does not slip on the spool, circle the answer below that most accurately describes the acceleration of the center O of the spool. Note that the drawing is not to scale.

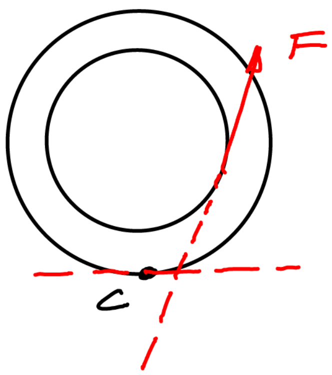
(a) O accelerates to the right

(b) O accelerates to the left

(c) O remains stationary

(d) More information is needed on the problem to answer this question.





Does line of action of F lie to left or right of c??

Question C5.14

The rigid body shown below has its center of mass at G. Circle the answer below that most accurately describes the mass moment of inertia of the body about point B.

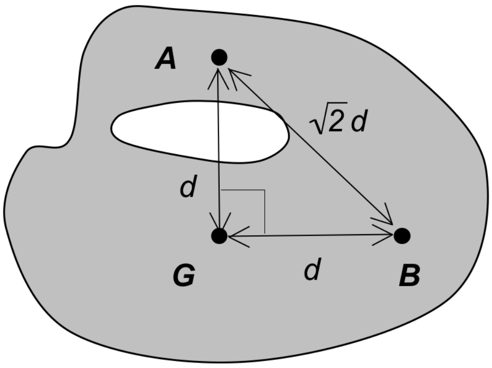
(a) $I_B = 0$

(b) $I_B = I_G$

(c) $I_B = I_A$

(d) $I_B = I_A + m(\sqrt{2}d)^2$

(e) None of the above



$I_A = I_G + md^2$

$I_B = I_G + md^2$

Chapter 5

Question C5.15
The centroidal radius of gyration for a thin, homogeneous bar of length L and mass m is:

(a) L

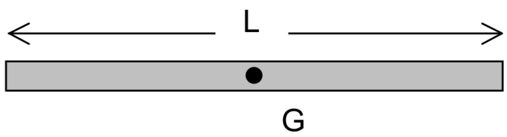
(b) $L/2$

(c) $L/3$

(d) $L/2\sqrt{3}$

(e) $L/12$

(f) None of the above



$$k_G = \sqrt{\frac{I_G}{m}}$$

Question C5.16

For the disk shown below, line AG is perpendicular to line BG. If I_B is the mass moment of inertia of the disk about B, circle the answer below that most accurately describes the mass moment of inertia about A (I_A):

(a) $I_A = I_B$

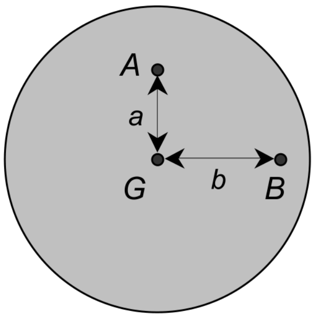
(b) $I_A = I_B + ma^2$

(c) $I_A = I_B + mb^2$

(d) $I_A = I_B + m(a^2 + b^2)$

(e) $I_A = I_B + m(a^2 - b^2)$

(f) None of the above



$I_A = I_G + ma^2$

$I_B = I_G + mb^2$

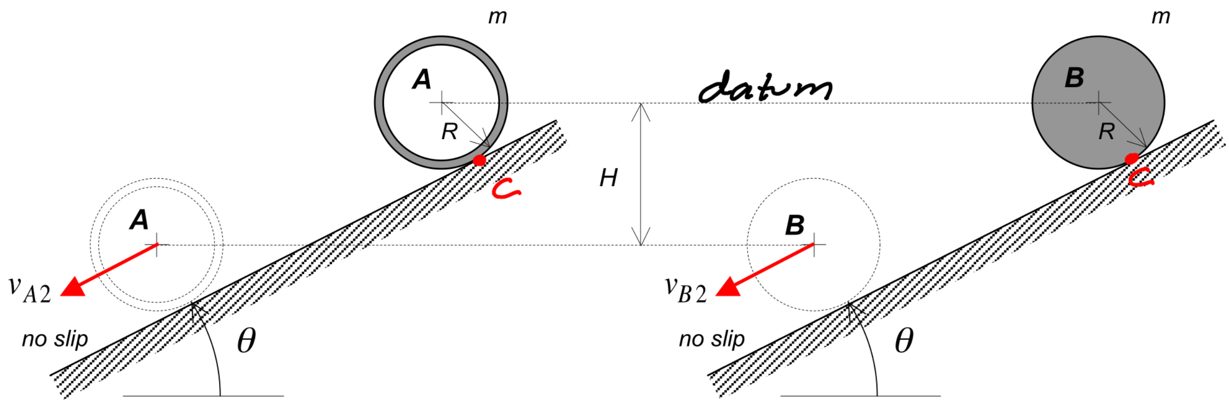
Question C5.17

The homogeneous ring and disk are released from rest at the same height. Let v_{A2} and v_{B2} represent the speeds of the centers of the ring and disk after they have dropped through the same vertical distance H. Circle the answer below that most accurately describes the relative sizes of v_{A2} and v_{B2}.

(a) $v_{A2} > v_{B2}$

(b) $v_{A2} = v_{B2}$

(c) $v_{A2} < v_{B2}$



- $\cancel{T_1}^{0} + \cancel{V_1}^{0} = T_2 + V_2$

$$0 = \frac{1}{2} I_C \omega^2 - mgH$$

- $V_A = R\omega_A$

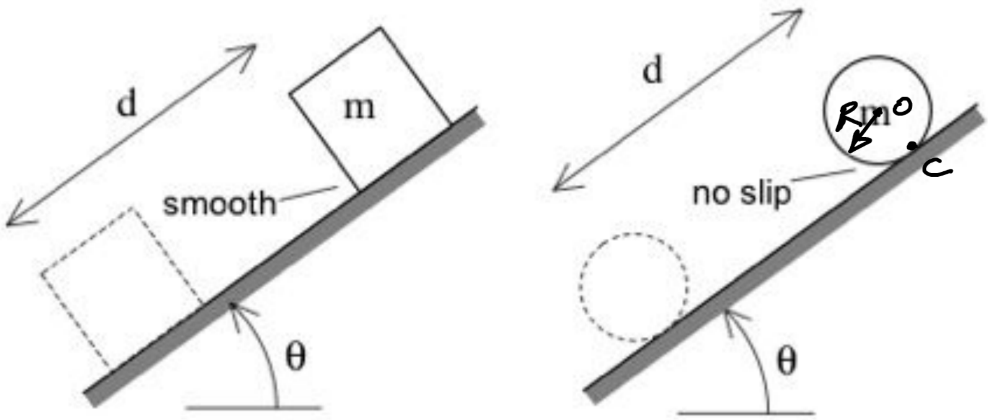
  $V_B = R\omega_B$

Question C5.18
The block and homogeneous sphere are released from the same height. Circle the answer below that most accurately describes the relative speeds of the block and the center of the sphere after each has moved a distance down the inclines.

(a) The block is moving faster than the center of the sphere

(b) The block is moving more slowly than the center of the sphere

(c) The block and the center of the sphere are moving with the same speed



$$\frac{1}{2}mv^2 = mgd\sin\theta$$

$$\begin{cases} \frac{1}{2}mv_o^2 + \frac{1}{2}I_o\omega^2 = mgd\sin\theta \\ v_o = R\omega \\ I_o = \frac{2}{5}mR^2 \end{cases}$$

Question C5.19
Cables AC and BD are of equal length. At the instant shown, the cables are rotating with an angular speed of ω and with points A and G moving with speeds of v_A and v_G, respectively. The plate has a mass of m and has mass moments of inertia about points A and G of I_A and I_G, respectively. Circle the answer below that most accurately describes the kinetic energy of the plate.

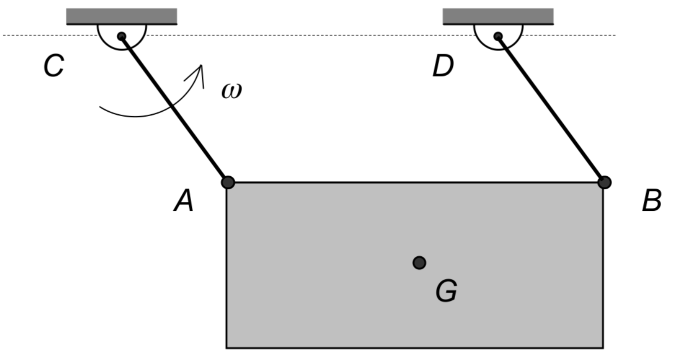
(a) $T = \frac{1}{2}mv_G^2 + \frac{1}{2}I_G\omega^2$

(b) $T = \frac{1}{2}mv_A^2 + \frac{1}{2}I_G\omega^2$

(c) $T = \frac{1}{2}mv_G^2 + \frac{1}{2}I_A\omega^2$

(d) $T = \frac{1}{2}mv_A^2 + \frac{1}{2}I_A\omega^2$

(e) $T = \frac{1}{2}mv_A^2$

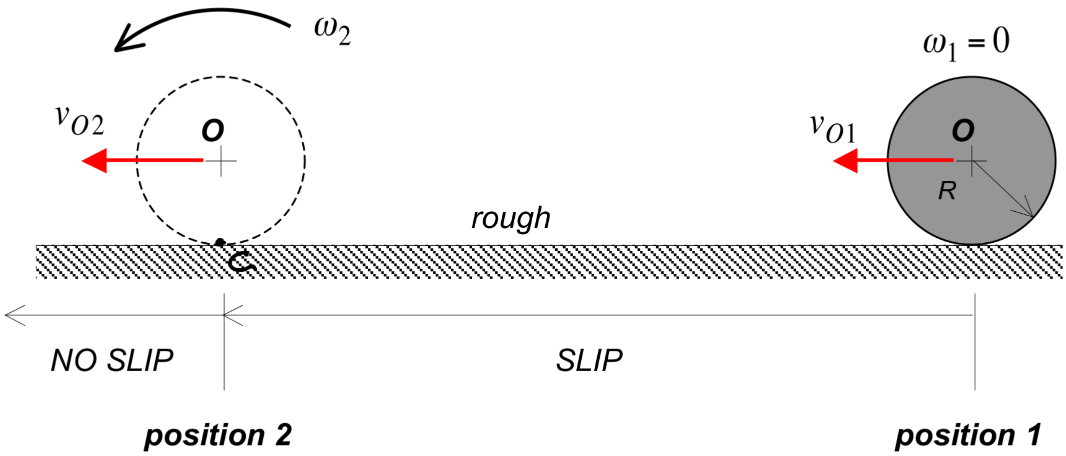


$$T = \frac{1}{2} m V_O^2 + \frac{1}{2} I_O \omega_{plate}^2$$

if O = fixed point or c.m.

Question C5.20

The homogeneous disk shown below has a mass of $m = 16$ kg and outer radius of $R = 0.5$ m. The disk is gently placed on the rough horizontal surface with a speed of $v_{O1} = 20$ m/s and with zero angular velocity. The disk initially moves to the left, slipping, until it reaches position 2. At position 2, the slipping ceases and the disk begins to roll without slipping. At position 2, it is known that $v_{O2} = 10$ m/s. Determine the work done by friction on the disk between positions 1 and 2.



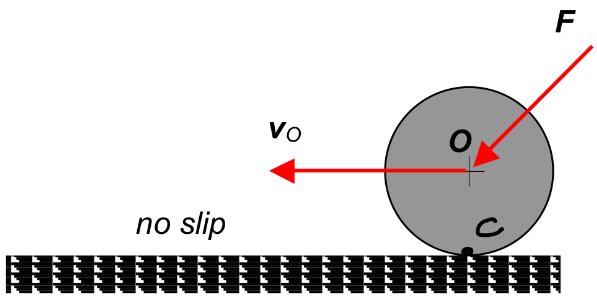
$$T_1 = \frac{1}{2} m v_{O1}^2$$

$$T_2 = \frac{1}{2} I_C \omega^2 \quad ; \quad I_C = I_O + mR^2$$

$$U_{1\to 2}^{(nc)} = T_2 - T_1$$

Chapter 5

Question C5.21
A force F acts at the center of a wheel as the wheel rolls without slipping along a rough horizontal surface. Explain in words why friction does not do work on the wheel as it rolls.



For no slip, $v_C = 0$ (no motion)