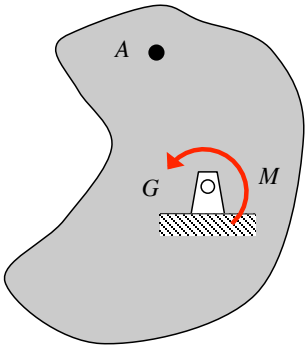
Chapter 5

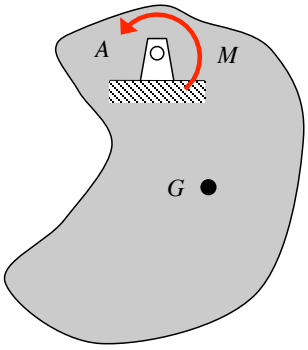
Rigid Body Kinetics Conceptual Questions

Question C.5.22

Systems I and II are made up of the same rigid body having its center of mass at point G and moving in a HORIZONTAL PLANE. In System I, the body is pinned to ground at G, whereas in System II the body is pinned to ground at point A, which is an aribitrary non-centroidal point. A couple M acts of each body. Let α_I and α_{II} represent the angular accelerations of the bodies in Systems I and II, respectively.



SYSTEM I

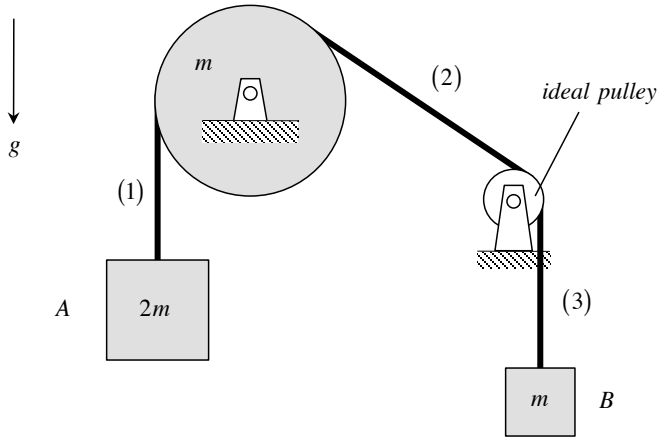


SYSTEM II

Which of the following best represents the comparison of the two angular accelerations:
(a) $|\alpha_I| < |\alpha_{II}|$
(b) $|\alpha_I| = |\alpha_{II}|$
(c) $|\alpha_I| > |\alpha_{II}|$

Question C.5.23

A system is made up of blocks A and B (having masses of $2m$ and m, respectively. The blocks are connected by an inextensible cable. The cable is pulled over a homogeneous disk of mass m that is pinned to ground at its center, and over an ideal pulley that is pinned to ground at its center. Let T_1, T_2 and T_3 represent the tensions in the cable segments labled as (1), (2) and (3), respectively, in the figure.



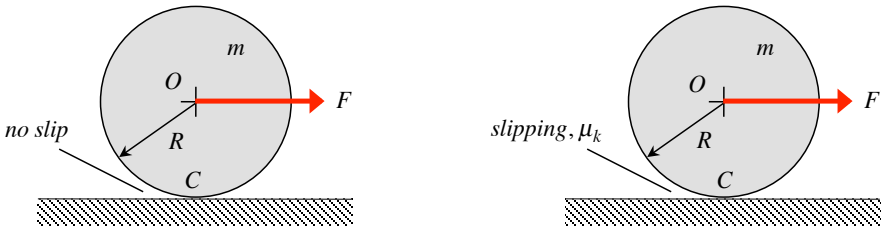
Which of the following best represents the comparison of tensions T_1 and T_2 :
(a) $T_1 < T_2$
(b) $T_1 = T_2$
(c) $T_1 > T_2$

Which of the following best represents the comparison of tensions T_1 and T_3 :
(a) $T_1 < T_3$
(b) $T_1 = T_3$
(c) $T_1 > T_3$

Which of the following best represents the comparison of tensions T_2 and T_3 :
(a) $T_2 < T_3$
(b) $T_2 = T_3$
(c) $T_2 > T_3$

Question C.5.24

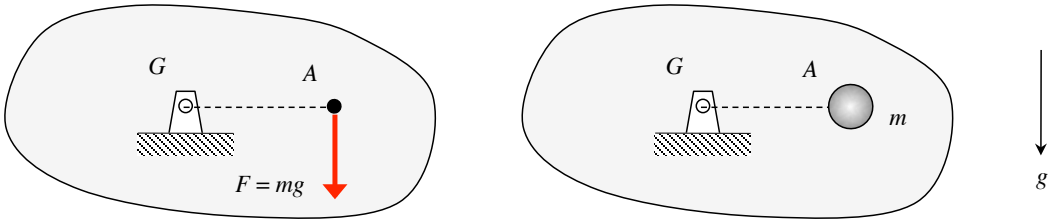
In System I, a homogeneous disk of radius R and mass m is able to roll without slipping as it moves along a rough horizontal surface under the action of force F. In System II, the same disk now moves along a rough ($\mu_k = 0.3$) horizontal surface but here the disk slips as it rolls under the action of the same force F. Let $(a_O)_I$ and $(a_O)_{II}$ represent the acceleration of the disks' centers O, for Systems I and II, respectively.



Which of the following best represents the comparison of the accelerations $(a_O)_I$ and $(a_O)_{II}$:
(a) $(a_O)_I < (a_O)_{II}$
(b) $(a_O)_I = (a_O)_{II}$
(c) $(a_O)_I > (a_O)_{II}$

Question C.5.25

A rigid body is pinned to ground at its center of mass G. In System I, a force F acts vertically at point A on the rigid body. In System II, a particle of mass m is attached to rigid body at A. The force acting on the body in System I is given by $F = mg$. Let α_I and α_{II} represent the angular accelerations of the bodies in Systems I and II, respectively.

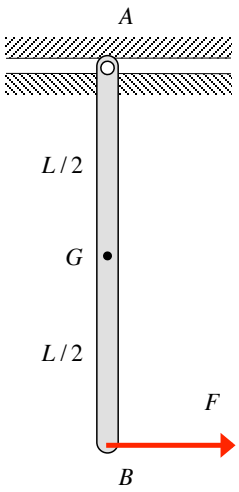


System (I) **System (II)**

Which of the following best represents the comparison of the two angular accelerations:
(a) $|\alpha_I| < |\alpha_{II}|$
(b) $|\alpha_I| = |\alpha_{II}|$
(c) $|\alpha_I| > |\alpha_{II}|$

Question C.5.26

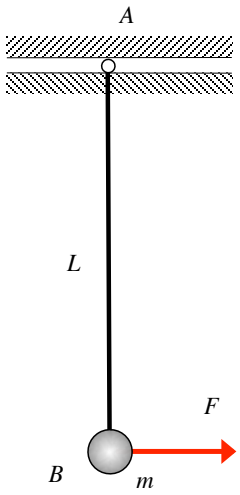
A thin, homogeneous bar has a mass m and a length of L. End A of this bar is constrained to move within a smooth, horizontal guide. A force F acts in the horizontal direction at end B. Let $\vec{a}_A$ represent the acceleration of end A of the bar.



Which of the following best represents the direction of the acceleration of end A:
(a) $\vec{a}_A$ is to the left
(b) $\vec{a}_A = \vec{0}$
(c) $\vec{a}_A$ is to the right

Question C.5.27

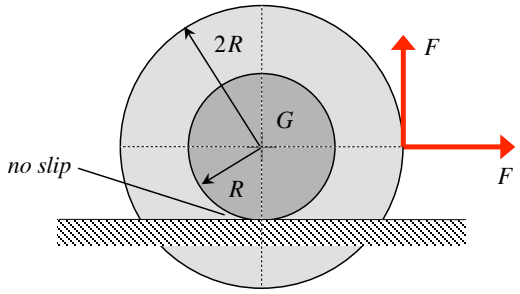
Particle B (having a mass of m) is attached to a rigid bar AB that is of negligible mass. End A of the bar is constrained to move within a smooth, horizontal guide. A force F acts in the horizontal direction at end B. Let $\vec{a}_A$ represent the acceleration of end A of the bar.



Which of the following best represents the direction of the acceleration of end A:
(a) $\vec{a}_A$ is to the left
(b) $\vec{a}_A = \vec{0}$
(c) $\vec{a}_A$ is to the right

Question C.5.28

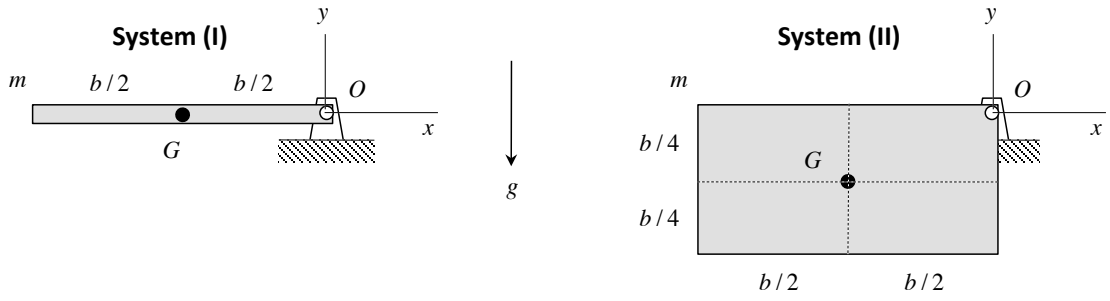
The inner radius of a spool (whose center of mass is at its geometric center G) is able to roll without slipping along a rough, horizontal surface. A pair of forces, each of magnitude F, act at a point on the outer circumference of the spool that is directly to the right of G, as shown in the figure below. Let $\vec{a}_G$ represent the acceleration of point G on the spool.



Which of the following best represents the direction of the acceleration a_G:
(a) $\vec{a}_G$ is to the left
(b) $\vec{a}_G = \vec{0}$
(c) $\vec{a}_G$ is to the right

Question C.5.29

System I is made up of a thin, homogeneous bar having a length of b and a mass of m, with the bar pinned to ground at end O. System II is a homogeneous, rectangular plate of mass m that is pinned to ground at corner O. Both systems are released from rest. Let α_I and α_{II} represent the angular accelerations of the bodies in Systems I and II, respectively. Also, let $(a_{Gx})_I$ and $(a_{Gx})_{II}$ represent the x-components of the centroidal accelerations of the bodies in Systems I and II, respectively.



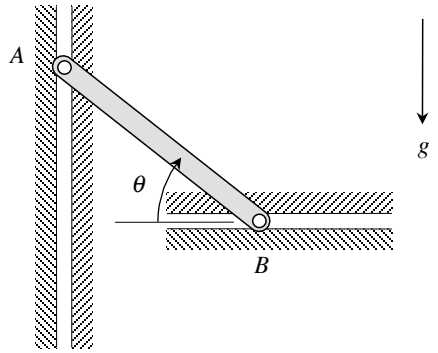
Which of the following best represents the comparison of the two angular accelerations:
(a) $|\alpha_I| < |\alpha_{II}|$
(b) $|\alpha_I| = |\alpha_{II}|$
(c) $|\alpha_I| > |\alpha_{II}|$

Which of the following best represents the x-components of the centroidal acceleration for System I:
(a) $(a_{Gx})_I < 0$
(b) $(a_{Gx})_I = 0$
(c) $(a_{Gx})_I > 0$

Which of the following best represents the x-components of the centroidal acceleration for System II:
(a) $(a_{Gx})_{II} < 0$
(b) $(a_{Gx})_{II} = 0$
(c) $(a_{Gx})_{II} > 0$

Question C.5.30

Ends A and B of a homogeneous bar are constrained to move within smooth vertical and horizontal guides, respectively. The bar is released from rest at an intial angle of $\theta > 0$. Let $\vec{v}_{B2}$ and $\vec{a}_{B2}$ represent the velocity and acceleration, respectively, of end B of the bar when $\theta = 0$.

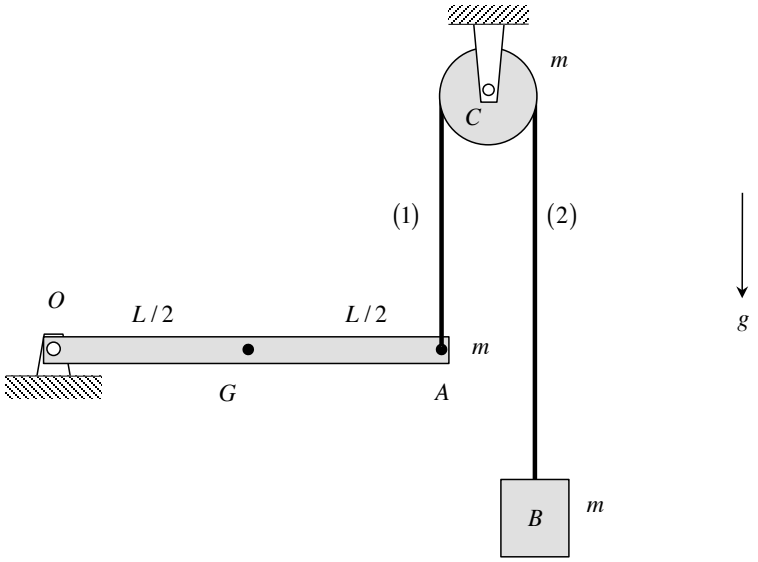


Which of the following best represents the velocity of B at this second state:
(a) $\vec{v}_{B2}$ is to the left
(b) $\vec{v}_{B2} = \vec{0}$
(c) $\vec{v}_{B2}$ is to the right

Which of the following best represents the acceleration of B at this second state:
(a) $\vec{a}_{B2}$ is to the left
(b) $\vec{a}_{B2} = \vec{0}$
(c) $\vec{a}_{B2}$ is to the right

Question C.5.31

A thin, homogeneous bar OA of mass m is pinned to ground at end O. A cable connects end A of the bar to block B (of mass m) with the cable being pulled over a homogeneous pulley of mass m, with the pulley pinned to ground at its center C. The system is released from rest with segments (1) and (2) of the cable being vertical. Let $\vec{a}_B$ represent the acceleration of block B on release, and let T_1 and T_2 represent the tensions in segments (1) and (2) of the cable, respectively.

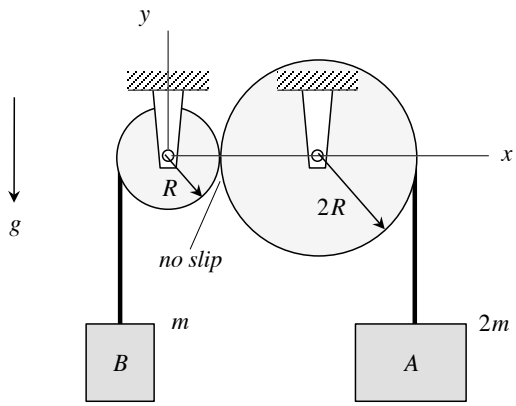


Which of the following best represents the acceleration of B on release:
(a) $\vec{a}_B$ is upward
(b) $\vec{a}_B = \vec{0}$
(c) $\vec{a}_B$ is downward

Which of the following best represents the relative sizes of the tensions in the two segments of the cable:
(a) $T_1 < T_2$
(b) $T_1 = T_2$
(c) $T_1 > T_2$

Question C.5.32

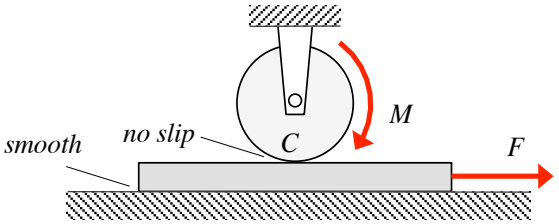
Two drums, having radii of R and $2R$, are pinned to ground and are able to rotate without slipping between their outer surfaces. Cables wrapped around the two drums support blocks A and B, having masses of $2m$ and m, respectively. Let $\vec{a}_B$ represent the acceleration of block B.



Which of the following best represents the acceleration of block B on release:
(a) $\vec{a}_B$ is upward
(b) $\vec{a}_B = \vec{0}$
(c) $\vec{a}_B$ is downward

Question C.5.33

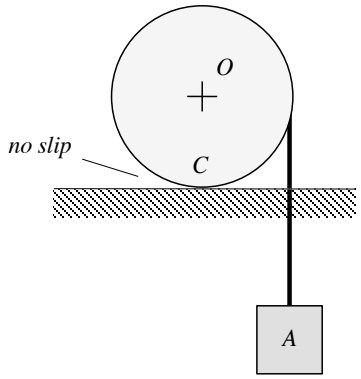
A block is able to slide along a smooth horizontal surface while in no-slip contact with a homogeneous drum that has its center pinned to ground. A force F acts to the right on the block, and a couple M acts on the drum. Let $\vec{f}$ represent the friction force acting on the block due to its contact with the drum at point C.



Which of the following best represents the direction of the friction force on the block:
(a) $\vec{f}$ is to the right
(b) $\vec{f} = 0$
(c) $\vec{f}$ is to the left

Question C.5.34

A homogeneous disk is able to roll without slipping on a rough, horizontal surface. A cable is wrapped around the circumference of the disk, with block A being attached to the free end of the cable. The system is released from rest. Let $\vec{a}_O$ represent the acceleration of the center O of the disk, and let f_C represent the friction force acting on the disk at the contact point C.

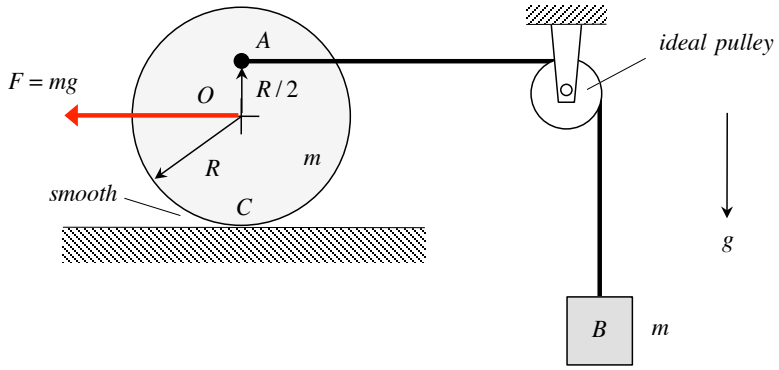


Which of the following best represents the direction of the acceleration of point O:
(a) $\vec{a}_O$ is to the right
(b) $\vec{a}_O = 0$
(c) $\vec{a}_O$ is to the left

Which of the following best represents the direction of the friction force on the disk at C:
(a) f_C is to the right
(b) $f_C = 0$
(c) f_C is to the left

Question C.5.35

A homogeneous disk moves on a smooth, horizontal surface. A cable is attached to point A on the disk, with block B (having a mass of m) being attached to the free end of the cable. A force $F = mg$ acts to the left on the disk at its center O. The system is released from rest. Let $\vec{a}_C$ represent the acceleration of the ground contact point C on the disk.



Which of the following best represents the direction of the acceleration of point C:
(a) $\vec{a}_C$ is to the right
(b) $\vec{a}_C = 0$
(c) $\vec{a}_C$ is to the left