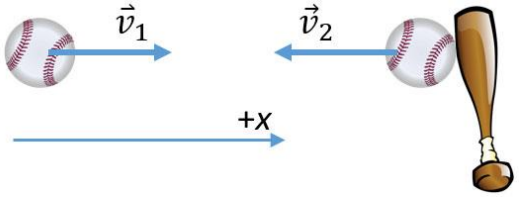
Physics P20: Exam 2. Practice Name:_____

Write directly on these sheets. Show work. You may use a calculator. You may use the 3×5 card if you brought one; staple it to the exam. The exam ends with word "END". The total score is 40pts.

Problem 1 (8pts) The figure shows a 0.3kg baseball just before and just after it collides with a bat. Just before, the ball has velocity $\vec{v}_1$ of magnitude 12.0m/s. Just after, it returns in the opposite direction with velocity $\vec{v}_2$ of magnitude 10.0 m/s. The duration of the collision is 2ms.



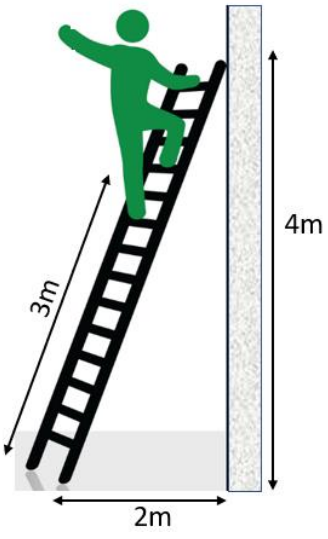
a) What are the magnitude and direction of the impulse on the ball from the bat?

b) What are the magnitude and direction of the average force on the ball from the bat?

Problem 2 (5pts): Dan is gliding his skateboard at 5m/s. He suddenly jumps backward off the skateboard, kicking the skateboard forward 7m/s. How fast is Dan going as his feet hit the ground? Dan's mass is 70kg and the skateboard's mass is 5kg.

Problem 3 (8pts): A 10-kg ladder is supported by a wall, 4m along the wall and 2m along floor, as shown in the figure. The wall is frictionless, but the floor has a coeffcient of static friction of 0.2 with the ladder. A 70-kg person climbs to the height of 3m along the ladder.

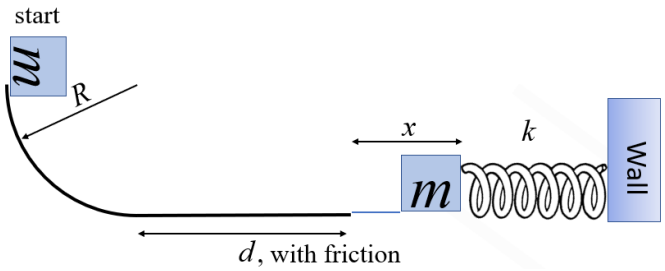
a) Draw the FBD of the ladder



b) Calculate the magnitude *and* direction of the force by the wall on the ladder. Answer in N.

c) Calculate the magnitude *and* direction of the force by the floor on the ladder. Answer in N and degrees.

Problem 4 (7pts) A block of mass m=0.8 kg is released from rest at the top of a *frictionless* circular ramp of radius R=1.5 m. At the bottom, it continues to travel on the horizontal segment of length d=2m with coefficient of kinetic friction μ_k=0.15 between the surfaces of the block and the track. The block then compresses the spring to a distance x and comes to a momentary stop, on a frictionless surface again. The spring k=100N/m.

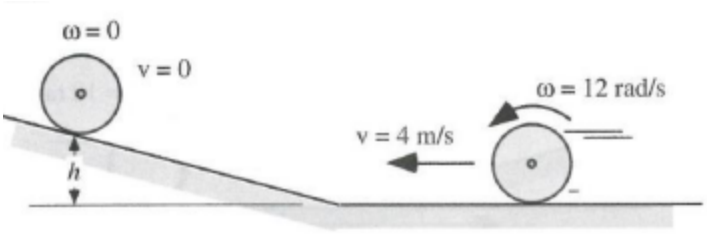


a) Calculate x. Answer in meters. 4pts.

b) If the radius of the circular track is too small (so the initial height is too small), the block might not make it to the spring and compress it. What is the minimum radius of the circular track, so that the block just touches the spring, but not compress it? Answer in meters. 3pts

Problem 5 (7pts) A solid 2-kg disk is initially rolling without slipping along a flat, level surface. It then rolls up an incline, coming momentarily to rest as shown.

a) Calculate the radius of the disk. Answer in m.

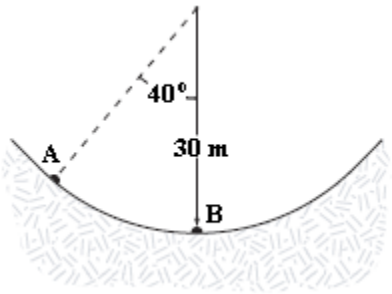


b) Calculate the moment of inertia for the disk, about the disk's axis. Answer in kg m^2

c) Calculate the height *h* at which the disk stops above the level surface (see the figure). Answer in m.

MC Questions (1pt each)

1. A skier weighing 0.80 kN comes down a frictionless ski run that is circular (R = 30 m) at the bottom, as shown. If her speed is 12 m/s at point A, what is her speed at the bottom of the hill (point B)?



17 m/s
19 m/s
20 m/s
18 m/s
12 m/s

2. A champion athlete can produce one horsepower (746 W) for a short period of time. If a 70-kg athlete were to bicycle to the summit of a 500-m high mountain while expending power at this rate, she would have used at least ____ J of energy.

3.43×10^5
746
7.46×10^5
3.73×10^5
2.61×10^7

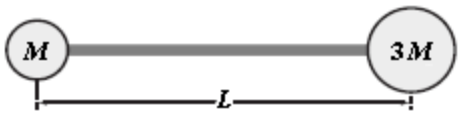
3. A 3.0-kg object moving in the positive x direction has a one-dimensional elastic collision with a 5.0-kg object initially at rest. After the collision the 5.0-kg object has a velocity of 6.0 m/s in the positive x direction. What was the initial speed of the 3.0 kg object?

7.0 m/s
8.0 m/s
6.0 m/s
5.5 m/s
4.5 m/s

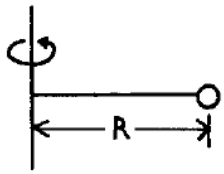
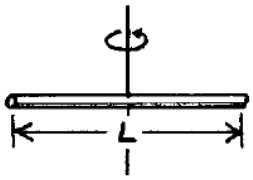
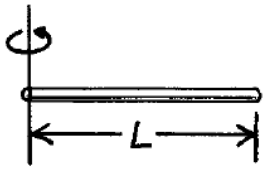
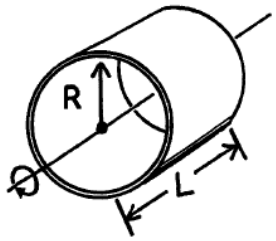
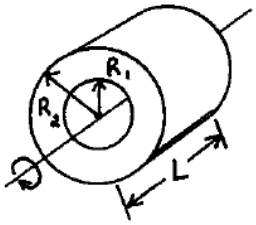
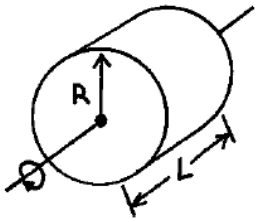
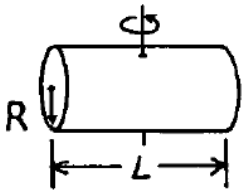
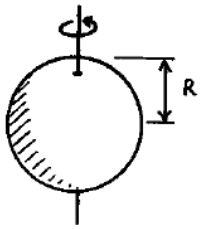
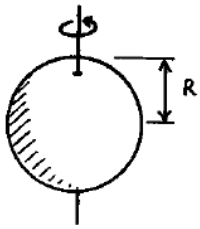
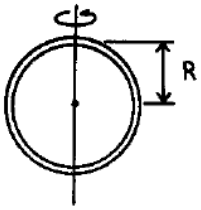
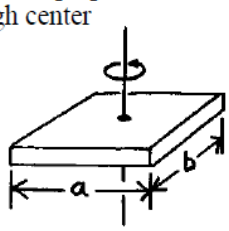
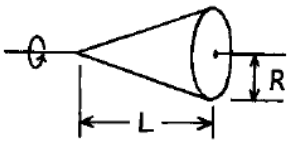
4. A wheel rotating about a fixed axis with a constant angular acceleration of 2.0 rad/s2 turns through 2.4 revolutions during a 2.0-s time interval. What is the angular velocity at the end of this time interval?

9.5 rad/s
9.7 rad/s
8.8 rad/s
9.3 rad/s
9.1 rad/s

5. The rigid body shown rotates about an axis through its center of mass and perpendicular to the paper. If M = 2.0 kg and L = 80 cm, what is the kinetic energy of this object when its angular speed about this axis is equal to 5.0 rad/s? Neglect the mass of the connecting rod and treat the masses as particles.



23 J
26 J
12 J
15 J
18 J

Point mass at a radius R  $I = MR^2$	Thin rod about axis through center perpendicular to length  $I = \frac{1}{12}ML^2$	Thin rod about axis through end perpendicular to length  $I = \frac{1}{3}ML^2$
Thin-walled cylinder about central axis  $I = MR^2$	Thick-walled cylinder about central axis  $I = \frac{1}{2}M(R_1^2 + R_2^2)$	Solid cylinder about central axis  $I = \frac{1}{2}MR^2$
Solid cylinder about central diameter  $I = \frac{1}{4}MR^2 + \frac{1}{12}ML^2$	Solid sphere about center  $I = \frac{2}{5}MR^2$	Thin hollow sphere about center  $I = \frac{2}{3}MR^2$
Thin ring about diameter  $I = \frac{1}{2}MR^2$	Slab about perpendicular axis through center  $I = \frac{1}{12}M(a^2 + b^2)$	Cone about central axis  $I = \frac{3}{10}MR^2$

Note: All formulas shown assume objects of uniform mass density.