PHYSICS 211.1, Assignment 0

Assigned: January 4, 2005; Due: January 18, 2005.

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1) Two astronauts, joined together by a 7.00 metre cord, are floating freely and at rest inside the International Space Station. The masses of the astronauts are 60.0 kg and 80.0 kg. If the cord is initially taut and the astronauts pull themselves in together until they meet, how much does each astronaut move relative to the interior of the space station?

2) A railroad flatcar is loaded with crates having a coefficient of static friction of 0.250 with the floor. If the train is moving with a speed of 15.0 m/s (54.0 km/hr), in how short a distance can the train be stopped at constant (negative) acceleration without causing the crates to slide?

3) problem 11P, Chapter 12.

4) A "yo-yo" is pulled by its string (held horizontally) with a force $F = 0.10$ N as shown in Figure 1, so that the yo-yo rolls along the horizontal floor without slipping. If the yo-yo has mass $m = 0.10$ kg, outer radius $R = 0.030$ m, inner radius $r = 0.010$ m, and moment of inertia $I = \frac{9}{20}mR^2$, find the linear acceleration, a, of the yo-yo. In particular, does the yo-yo roll to the right (so that the string winds up) or to the left (so that the string unwinds)? (Hint: In your free-body diagram, don't forget the static friction force preventing the yo-yo from slipping along the floor.)

5) Consider a circular ring of material, total mass M and radius R as shown in Figure 2. If a mass m lies along the axis of the ring at a distance x from the centre of the ring, with what gravitational force does the ring attract m? Express your answer in terms of G, M, m, R, and x. [Hint: Break the ring up into small bits of mass dM as indicated in the figure, and note that each bit is the same distance away from m. Next, note that by symmetry, only the x-component of the gravitational force from each bit will contribute to the overall gravitational force, since the perpendicular components all cancel. Then add up (integrate) the x-components of the gravitational forces from all the bits, using the fact that $\int_M dM = M$.]

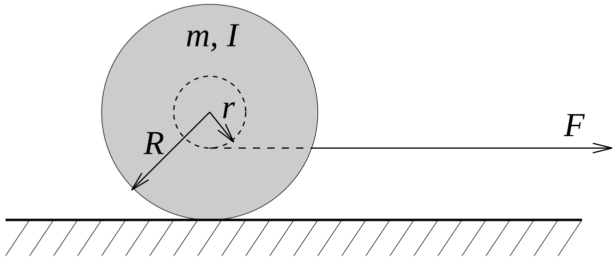

Figure 1.—Problem 4.

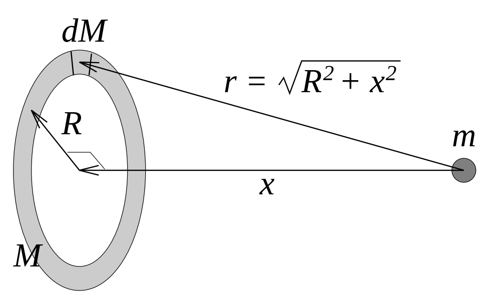

Figure 2.—Problem 5.