Problem Set 8: Conservation of Energy: Restoring Forces and Harmonic Motion, Center of Mass, Momentum, Impulse and Newton's Second Law

Design Engineering Challenge: "The Big Dig" 2.007 Contest
Ball Pyramid Breaking Strategies

<u>Problem 1</u>: How many different ways can you think of breaking the pyramid and directing the flow of balls (there are at least 4 distinct strategies)?

I. Ways to break pyramid:

a) Design a machine that drives onto the platform and pushes balls toward your bin
b) Remove bottom balls on your side of the pyramid
c) Projectile that pierces balls
d) Reloadable poking arm
e) Rotating arm

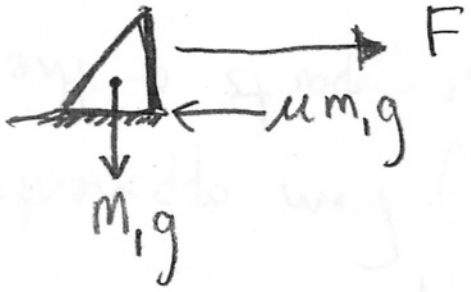
II. Ways to direct flow:

a) Place a wall/obstruction between the pyramid and your opponent's side of the table.
b) Shield attached to your machine that directs the flow of balls
c) Hit the balls on your opponent's side so the balls move towards your side
d) Arm pushes in direction of bin

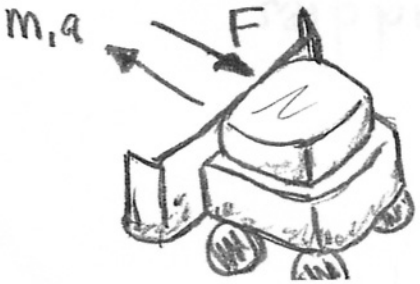
Problem 2: What are the physics associated with each of these strategies?

As with any physics problem, you should draw a FBD. For example:

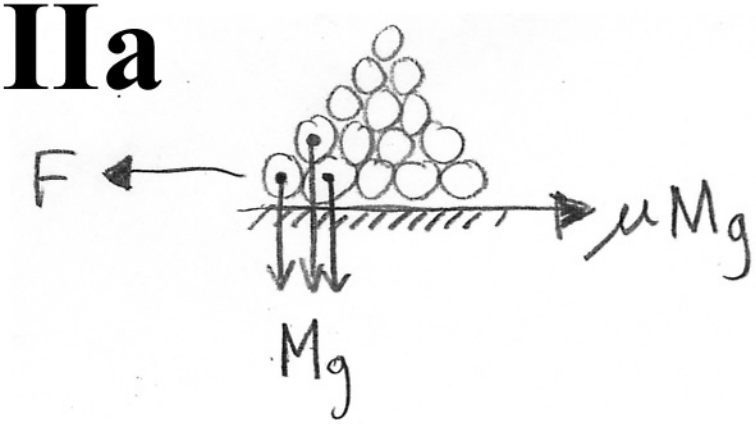
Ia



Ib



IIa



Then some simple, general descriptions of the physics involved with each strategy. Overall, there is always our friend Newton (F=m*a) and our enemy (opportunity!) friction ($F_r=\mu*N$).

Examples on ways to break pyramid:

a) Projectile – projectile motion, force to knock loose balls
b) Reloadable poking arm – spring force equation (F=k*x)
c) Rotating arm – rotational forces, $F=I*\alpha$ and T=FxR

Problem 3: How can you mitigate the risk (what countermeasures can you devise) of the balls rolling onto your opponent's side?

Some possible countermeasures are:

- Cover your opponents scoring bin and paddles
- Direct balls away from opponents bin
- Score big time on other parts of the table
- Pull balls out of opponent's bin (Really risky countermeasure!! Is it worth it?)