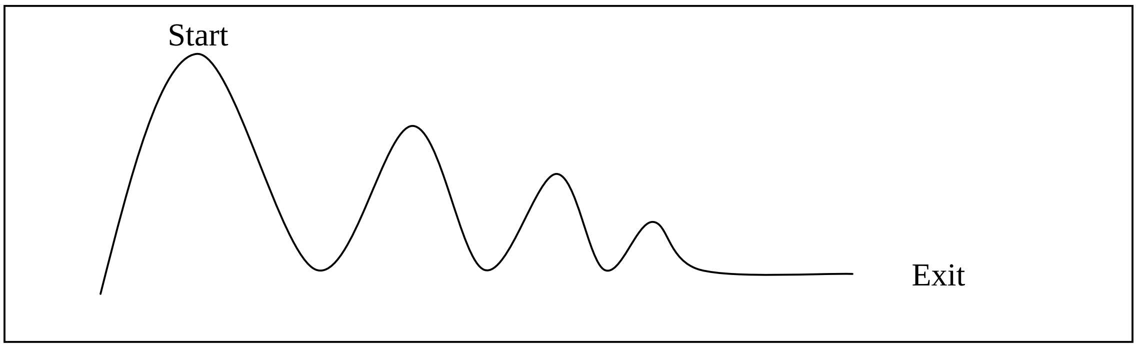
Physics 206a

Homework Assignment VI
due February 16, 2007

1. A car travels at a constant speed around a circular track. The track is perfectly horizontal. Draw a free-body diagram showing all the external forces on the car. If the force of static friction between the car's tires and the road is μ_s, what is the maximum speed with which the car can travel if it is to remain on a circular path? Express your result as a function of the mass of the car, the radius of the track, and μ_s.
2. Assuming the car in Problem #8 has a mass of 1300 kg (that's about a VW Golf—which is what I drive), the track has a radius of 63 meters, and μ_s is 0.8, what is the maximum speed of the car?
3. Consider again the car in the previous problem. If there is no friction between the tires and the road, at what angle must the road be banked to allow the car not to skid? Draw a free-body diagram of this situation.
4. A man with a mass of 110 kilograms stands in an elevator. The elevator is lifted by a single rope. The elevator has a mass of 1030 kilograms. The elevator accelerates upward at $0.8\,\frac{\text{meters}}{\text{second}^2}$.
   a) Draw a free body diagram for the person indicating all relevant forces.
   b) State the size of each of the forces indicated in (a).
   c) Draw a free body diagram for the elevator.
   d) State the size of each of the forces indicated in (c).
5. A man is standing in a train accelerating at $0.1\,\frac{\text{meter}}{\text{second}^2}\,\hat{x}$. He drops a nickel (m=5 grams) from a height of 1.5 meters. In his frame of reference, what force appears to act on the nickel? How far off the vertical path is the nickel deflected by the time it strikes the ground?

6. A car is traveling at a constant speed of $23.4 \frac{\text{meters}}{\text{second}}$ around a perfectly circular, perfectly horizontal track. The radius of the track is 63 meters. A cup of coffee with a total mass of $300\,\text{grams}$ sits on the dashboard of the car. The dash is perfectly flat and horizontal. What is the magnitude of the force the cup appears to experience in this non-inertial reference frame? What coefficient of friction between the dash and the cup is necessary to keep the cup from sliding off the dash?



7. A roller coaster is built with four "humps," as shown. The hump from which the coaster is launched is 40 meters tall. The second hump is 30 meters tall. The third hump is 20 meters tall. The final hump is 10 meters tall. Assuming the coaster is launched with negligible initial speed, what is the speed at the top of each of the humps? What is the speed at the exit (at a height of zero)? Assume no friction.

8. Refer once again to the roller coaster above. What is the gravitational potential energy on each of the humps and at the exit?

9. A man drags a heavy box across the floor at a constant speed using a rope. The rope makes an angle θ with the floor. The man exerts a force F_T on the rope. If he walks a distance *d*, how much work does he do?

10. For the previous problem, assume the box has a mass of 15 kg, $\theta = 17°$, $F_T = 75$ N, and *d*=6 meters. Now how much work does he do?

11. In the previous problem, is there an angle and an F_T such that the man could do *no* work moving the box across the floor? Explain.

12. Instead of dragging the box, the man in problem #9 gives the box a mighty shove such that it slides across the floor at speed v. (He doesn't touch the box after giving it the shove.) If the coefficient of sliding friction between the box and the floor is μ_k, how far does it slide? Use energy considerations to calculate this.