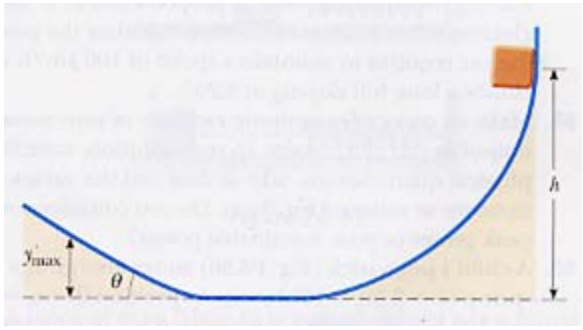
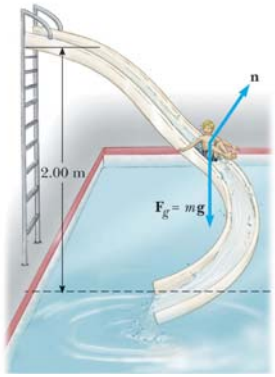
Physics 110
Spring 2006
Work and Energy Problems

1. A block slides down a curved frictionless tract and then up an incline. The coefficient of kinetic friction between the block and the incline is μ_k. Using energy methods show that the maximum height reached by the block is $y_{max} = \dfrac{h}{1+\mu_k \cot\theta}$.

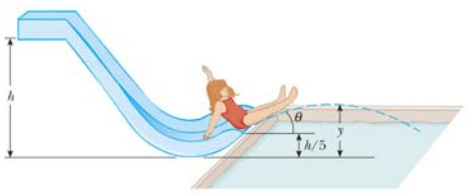


2. Suppose that the Nott Memorial is topped with an approximately hemispherical dome. Suppose that the dome is frictionless when wet. Somehow an individual has balanced a pumpkin at the top to the dome at an angle of $\theta_i = 0^o$ with the vertical. Suppose that on a rainy night, a gust of wind starts the pumpkin sliding from rest. It loses contact with the dome when the line from the center of the hemispherical dome to the pumpkin makes a certain angle with respect to the vertical. At what angle does this happen?

3. A child of mass m rides on an irregularly curved slide of height h = 2m. The child starts from rest at the top of the slide.
   a. What is the speed of the child at the bottom of the slide assuming that no friction is present (the slide is wet)?
   b. If a force of kinetic friction acts on the child, how much mechanical energy does the system lose? Assume that v_f = 3.0 m/s and that m_{child} = 20kg.

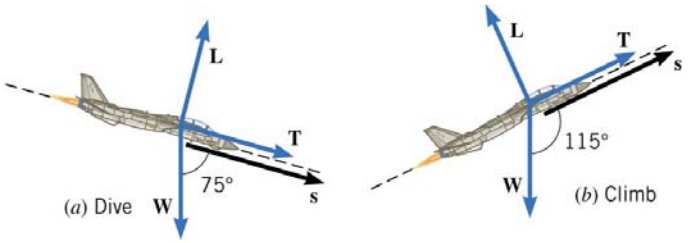


4. A child slides without friction from a height *h* along a curved water slide. If she is launched from a height *h/5* into the pool, what is her maximum airborne height *y* in terms of *h* and θ?



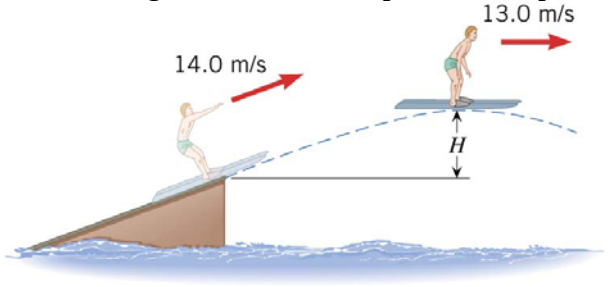
5. A child starts from rest and slides down a frictionless slide. In terms of *R* and *H*, at what height *h* will he lose contact with the section of radius *R*?

6. The drawing below shows a plane diving toward the ground and then climbing back upward. During each part of the motion, the lift force, **L** acts perpendicular to the displacement **s**, and has magnitude 1.7×10^3m in both cases. The thrust, **T** is provided by the engines and points in the direction of the displacement, and has the same magnitude during the dive and the climb. The weight of the plane, **W** has magnitude 5.9×10^4 N. In both cases the net work done is due to the combined action of the forces **L**, **T**, and **W**.
    a. Is more net work done during the dive or the climb? Explain
    b. Find the difference between the net work done during the diving and climbing motions.



7. A 1200kg car is being driven up a 5^o hill. The frictional force is directed opposite the motion of the car and has magnitude of $F_{fr} = 524$N. A force **F** is applied to the car by the road and propels the car forward. If the length of the road is 290m, what should the magnitude of F be so that the net work done by all of the forces acting on the car is +150kJ?

8. A water skier lets go of the tow rope upon leaving the end of a jump ramp at a speed of 14m/s. The skier has a speed of 13m/s at the highest point of the jump. What is the skier's height H above the top of the ramp if air resistance is ignored?



9. A wrecking ball swings at the end of a 10.0m long cable on a vertical circular arc. The crane operator manages to give the ball a speed of 6.5 m/s as the ball passes through the lowest point of its swing and then gives the ball no further help. If friction and air resistance are negligible, what is the speed v_f does the ball have then the cable makes and angle of 32^o with respect to the vertical?

10. A projectile of mass 0.75kg is launched straight up in the air with an initial speed of 18m/s.
    a. How high would the projectile go if there were no air friction?
    b. If the projectile rises to a maximum height of 11.8m, what is the average force exerted on the projectile due to air resistance?

11. At a carnival, you try to impress your significant other by trying to ring a bell at the top of a pole by striking a target with a 9.0kg hammer. In response, a 0.40kg metal piece is sent up the pole toward the bell, which is located 5.0m above the ground. Suppose that 25% of the hammer's kinetic energy is used to do the work of sending the metal piece upward, how fast much the hammer be moving when it strikes the target so that the bell just barely rings?

12. A person is making homemade ice cream. She exerts a force of magnitude 22N on the free end of a crank handle, and this end moves in a circular path of radius 0.28m. The force is always applied parallel to the motion of the handle. If the handle is turned once every 1.3s, what is the average power being expended by the woman?