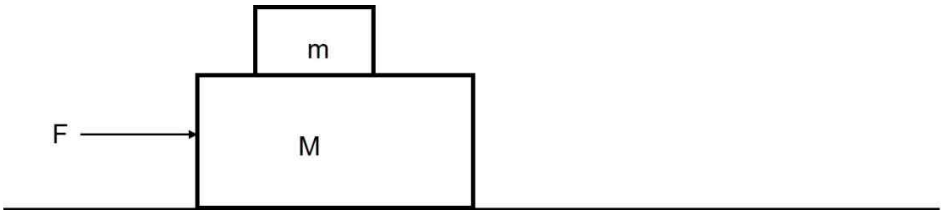
HW 2 (Due date: 5:00 pm 4/6)

* Use a gravitational acceleration g=10.0 m/s^2 whenever needed. Each problem gives 10 points.

1. A crate with mass m sits on another crate with mass M on the ground, and the coefficient of static friction between two crates is μ_s. A constant force F is applied to the crate with mass M. What is the maximum value of the force F if the two crates move together without sliding each other. Assume that there is no friction at all between the ground and crate M.



2. A physics student, Young-Mee, throws a 0.315 kg ball directly into a 4.00 kg box which is at rest on a table top. The baseball strikes the box with a pre-impact speed of 30.0 m/s with an incoming angle of 20.0^o against the table top. The box is filled with towels to help *absorb the blow* and effectively *catch* the ball. The static and kinetic coefficients of friction between the box and the table are 0.700 and 0.650, respectively. Determine the distance which the ball and box slide across the table after the collision. (Assume that the collision is completed in a very small collision time interval)

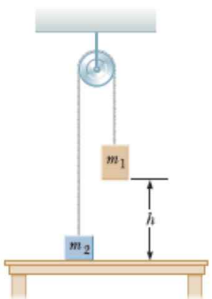
3. Prove the Work-Kinetic Energy Theorem in a more general case of force applied. Remember that the force is a 3D vector so it can vary in both direction and magnitude along the path.

4. A 72 kg boy and a 48 kg girl, both wearing ice skates face each other at rest on a skating rink. The boy pushes the girl, sending her eastward with a speed of 4.5 m/s. When the impulse is completed, the boy and girl are a distance of 1.5 m apart.

(a) Calculate the average force exerted on the girl during the impulse.

(b) Determine the distance of separation between the boy and the girl 5.0 seconds after the impulse is completed.

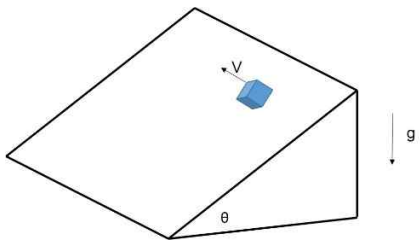
5. Two blocks (m_1=4.00 kg, m_2=2.00 kg) are connected by a massless string which goes around a massless pulley. Initially two masses are at rest and m_1 is 5.00 m above the table top.



(a) After released, what are the velocities of two masses at the moment they are passing by each other?

(b) Calculate the work done by external forces on the system of two blocks from the start to the point when two masses are passing by. From this result, confirm that work-kinetic energy theorem is valid.

6. A block is placed on a plane inclined at angle θ. The coefficient of kinetic friction between the block and the plane is μ = tan θ. The block is given a kick so that it initially moves with speed V horizontally along the plane (that is, in the direction perpendicular to the direction pointing straight down the plane). What is the speed of the block after a very long time?



7. A mass m attached to a spring (a relaxed-state length *l*, spring constant *k*) is in a rotating motion on a vertical plane. At the top position, the spring is in a relaxed state. (a) What is the instant speed of the mass at the top position? (b) What is the speed of the mass at the lowest (bottom) position?

8. Electric motor drives up an escalator (the length is 5.0 m) to move passengers to upper level. It takes 2.0 minute to reach the upper level which is 3.0 m above the ground with an average load weight 15000 N including passengers and escalator moving parts. Calculate the average power provided by the electric motor during the steady operation with a frictional force of 100 N present.

9. The city police are in pursuit of Robin Banks after his recent robbery at the National bank. The high speed police chase ends at an intersection as a 2.00×10^3 kg Range Rover (driven by Robin) traveling north at 32.0 m/s collides with a 1.85×10^4 kg garbage truck moving east at 12.0 m/s. The Range Rover and the garbage truck entangle together in the middle of the intersection and move as a single object. Determine the post-collision speed and direction of the two entangled vehicles.

10. A tennis ball with (small) mass m_2 sits on top of a basketball with (large) mass m_1. The bottom of the basketball is a height h above the ground, and the bottom of the tennis ball is a height h + d above the ground. The balls are dropped. To what height does the tennis ball bounce? Note: Work in the approximation where m_1 is much larger than m_2, and assume that the balls bounce elastically.