Answer all questions in the blue notebook provided. Show all your work and indicate your reasoning in order to receive most credit.

1. A horizontal merry-go-round is a uniform solid disk of radius 2 m and mass 100 kg, started from rest by a constant horizontal force of 50 N applied tangentially to the edge of the disk. Find the kinetic energy of the disk after 2 s.

2. A cylinder of unknown internal structure has mass 1 kg and diameter 6 cm. It is placed at rest at the top of a 10 m long incline that is at 30° to the horizontal, and it is then released to roll straight down. Assuming mechanical energy conservation, calculate the moment of inertia of the cylinder if it takes 2 s to reach the bottom of the incline. (Assume $g = 10.0\,\mathrm{m/s^2}$.)

3. A 40 kg child is standing on a plank that has a mass of 120 kg. The plank, originally at rest, is free to slide on a frozen lake, which is a flat, frictionless supporting surface. The child begins to walk along the plank at a constant speed of 2. m/s relative to the plank.

   - What is child's speed relative to the ice surface?
   - What is the speed of the plank relative to the ice surface?

4. Assume that you attend a state university that started out as an agricultural college. Close to the center of the campus is a tall silo topped with a hemispherical cap. Someone has somehow balanced an exactly spherical pumpkin at the highest point of the cap. While you happen to be standing nearby in the middle of a night, a breath of wind makes the pumpkin start rolling without sliding downward from rest. It loses contact with the cap when the line from the center of the hemisphere to the pumpkin makes a certain angle with the vertical. What is this angle?

5. A block which can move on a horizontal, frictionless surface is attached to one end of a light horizontal spring. The other end of the spring is held fixed. The spring is compressed 0.1 m from equilibrium and the block is released. The speed of the block is 1.0 m/s when it passes the equilibrium position of the spring. The same experiment is now repeated with the frictionless surface replaced by a surface for which the coefficient of kinetic friction k = 0.36. Determine the speed of the block at the equilibrium position of the spring. (Assume $g = 10.0\,\mathrm{m/s^2}$.)

6. A weightless ladder is leaning against a frictionless vertical wall, with which it makes a 45° angle. The coefficient of friction between ladder and ground is 0.25. Can a person climb to the top of the ladder without it slipping? If not, how far can the person climb?