Newton’s Laws B – FR

#1

A block is at rest on a rough inclined plane and is connected to an object with the same mass as shown. The rope may be considered massless; and the pulley may be considered frictionless. The coefficient of static friction between the block and the plane is $\mu_s$; and the coefficient of kinetic friction is $\mu_k$.

a. Calculate the magnitude of the static frictional force acting on the block.

b. If the rope were cut between the block and the pulley, calculate the magnitude of the acceleration of the block down the plane.

c. If the mass of the suspended object is doubled, calculate the acceleration of the block up the plane.
The two guide rails for the elevator shown above each exert a constant friction force of 100 N on the elevator car when the elevator car is moving upward with an acceleration of 2 m/s². The pulley has negligible friction and mass. Assume $g = 10 \text{ m/s}^2$ (1976-B1).

a. On the diagram below, draw and label all forces acting on the elevator car. Identify the source of each force.

b. Calculate the tension in the cable lifting the 400-kilogram elevator car during an upward acceleration of 2 m/sec². (Assume $g 10 \text{ m/sec}^2$.)

c. Calculate the mass $M$ the counterweight must have to raise the elevator car with an acceleration of 2 m/sec².
A crane is used to hoist a load of mass $m_1 = 500$ kilograms. The load is suspended by a cable from a hook of mass $m_2 = 50$ kilograms, as shown in the diagram above. The load is lifted upward at a constant acceleration of $2 \text{ m/s}^2$ (1982-B2).

a. On the diagrams below draw and label the forces acting on the hook and the forces acting on the load as they accelerate upward.

b. Determine the tension $T_1$ in the lower cable and the tension $T_2$ in the upper cable as the hook and load are accelerated upward at $2 \text{ m/s}^2$. Use $g = 10 \text{ m/s}^2$. 
Three blocks of masses 1.0, 2.0, and 4.0 kilograms are connected by massless strings, one of which passes over a frictionless pulley of negligible mass, as shown above. Calculate each of the following (1986-B1).

a. The acceleration of the 4-kilogram block.

b. The tension in the string supporting the 4-kilogram block.

c. The tension in the string connected to the 1-kilogram block.
A rope of negligible mass passes over a pulley of negligible mass attached to the ceiling, as shown above. One end of the rope is held by Student A of mass 70 kg, who is at rest on the floor. The opposite end of the rope is held by Student B of mass 60 kg, who is suspended at rest above the floor. Use \( g = 10 \text{ m/s}^2 \) (2003-B1)

a. On the dots below that represent the students, draw and label free-body diagrams showing the forces on Student A and on Student B.

b. Calculate the magnitude of the force exerted by the floor on Student A.

c. Student B now climbs up the rope at a constant acceleration of 0.25 m/s\(^2\) with respect to the floor. Calculate the tension in the rope while Student B is accelerating.

d. As Student B is accelerating, is Student A pulled upward off the floor? Justify your answer.

e. With what minimum acceleration must Student B climb up the rope to lift Student A upward off the floor?
Two small blocks, each of mass $m$, are connected by a string of constant length $4h$ and negligible mass. Block A is placed on a smooth tabletop as shown above, and block B hangs over the edge of the table. The tabletop is a distance $2h$ above the floor. Block B is then released from rest at a distance $h$ above the floor at time $t = 0$. Express all algebraic answers in terms of $h$, $m$, and $g$ (1998-B1).

a. Determine the acceleration of block B as it descends.

b. Block B strikes the floor and does not bounce. Determine the time $t = t_1$ at which block B strikes the floor.

c. Describe the motion of block A from time $t = 0$ to the time when block B strikes the floor.

d. Describe the motion of block A from the time block B strikes the floor to the time block A leaves the table.

e. Determine the distance between the landing points of the two blocks.
A 5.0-kilogram monkey hangs initially at rest from two vines, A and B, as shown above. Each of the vines has length 10 meters and negligible mass (1991-B1).

a. On the figure below, draw and label all of the forces acting on the monkey. (Do not resolve the forces into components, but do indicate their directions.)

b. Determine the tension in vine B while the monkey is at rest.
#8
A helicopter holding a 70-kilogram package suspended from a rope 5.0 meters long accelerates upward at a rate of 5.2 m/s². Neglect air resistance on the package (1988-B1).

a. On the diagram below, draw and label all of the forces acting on the package.

b. Determine the tension in the rope.

c. When the upward velocity of the helicopter is 30 meters per second, the rope is cut and the helicopter continues to accelerate upward at 5.2 m/s². Determine the distance between the helicopter and the package 2.0 seconds after the rope is cut.