# Applications of Newton's Laws: Equilibrium

Physics 513

### Straightforward Tension Problem

• A gymnast with mass 50.0 kg suspends herself from the lower end of a hanging rope of negligible mass. The upper end of the rope is attached to the gymnasium ceiling. What force (magnitude and direction) does the rope exert on her?

# Non-Straightforward Tension Problem

• On the next slide, a car engine with weight of magnitude *w* hangs from a chain that is linked at ring O to two other chains, one fastened to the ceiling and the other to the wall. Find expressions for the tension in each of the three chains in terms of w. The weights of the ring and chains are negligible compared with the weight of the engine



#### Tilted-Axis Problem

A car, the magnitude of whose weight is *w*, rests on a slanted ramp attached to a tow truck. Only a cable running from the truck to the car prevents the car from rolling off the ramp. The ramp makes an angle θ with the ground. Find the tension in the cable and the force the ground exerts on the car

### Bent-Axis Problem

• Blocks of granite are to be hauled up a 15° slope out of a quarry, and dirt is to be dumped into the quarry to fill up old holes (see figure on next slide). Therefore, you design a system in which a granite block on a cart (weight of magnitude 10,000 N) is pulled uphill on steel rails by a dirt-filled bucket that descends vertically into the quarry. What must be the weight of the bucket in order for the system to move with constant speed? Assume no friction everywhere

#### **Bent-Axis Problem**



# Applications of Newton's Laws: Non-Equilibrium

Physics 513

### What Does the Scale Say?

• A 50.0-kg woman stands on a bathroom scale while riding in an elevator. The elevator is initially moving downward at 10.0 m/s; it slows to a stop in a distance of 25 m with constant acceleration. What is the reading on the scale?

### Now let's Tilt Our Axes

A toboggan loaded with students (total weight of magnitude w) slides down a snow-covered slope. The hill slopes at a constant angle α, and the toboggan is so well waxed that there is virtually no friction. What is its acceleration? Answer in terms of a<sub>g</sub> and α



#### When Push Comes to Shove...

• You push a 1.00-kg food tray through the cafeteria line with a constant 9.0-N force. The tray pushes on a 0.50-kg carton of milk (See next slide). The tray and carton slide on a horizontal surface so greasy that friction can be neglected. Find the acceleration of the tray and carton and the horizontal force that the tray exerts on the carton

# Graph



