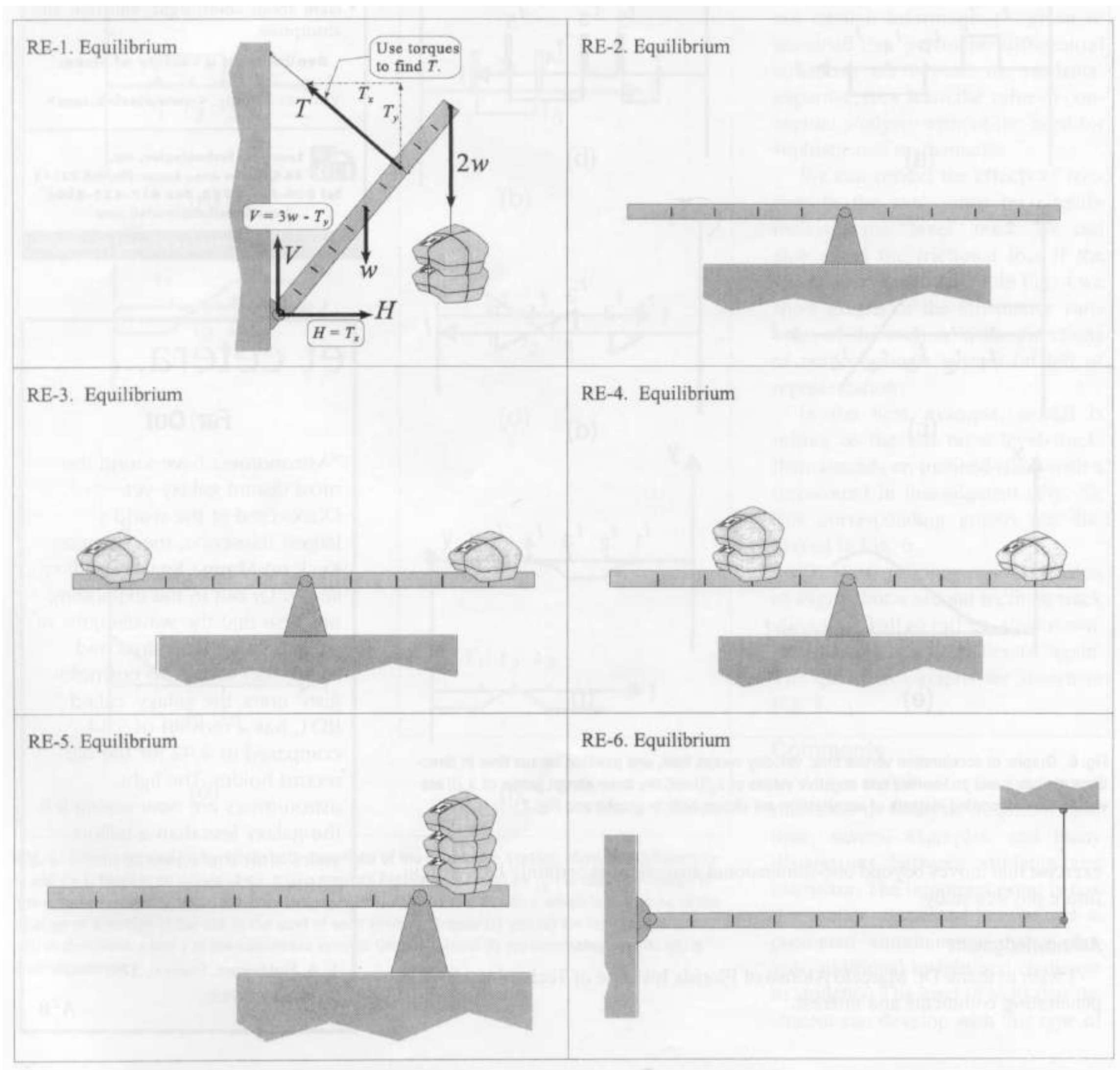
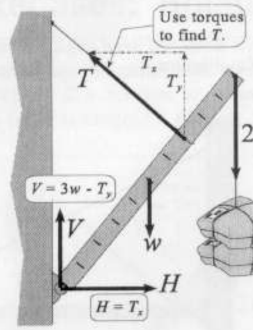
Free-Body Diagrams Revisited - II

Free-Body Exercises: Rotational Equilibrium

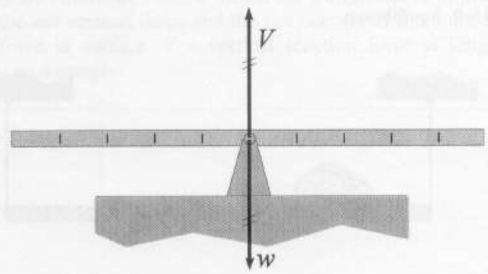
All of the beams and the packages have the same weight *w,* and they are "uniform," which means the weight can be applied at the center. These systems are in equilibrium, so the net torque, the net vertical force and the net horizontal force are all zero. Symbols: w = weight, T = tension, n = normal reaction force at surface, V = vertical reaction force at hinge, H - horizontal reaction force at hinge, f = friction. RE-1 is done as an example.



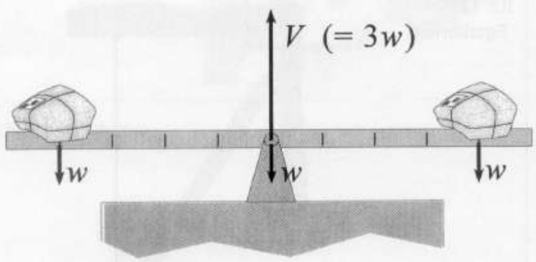
RE-1



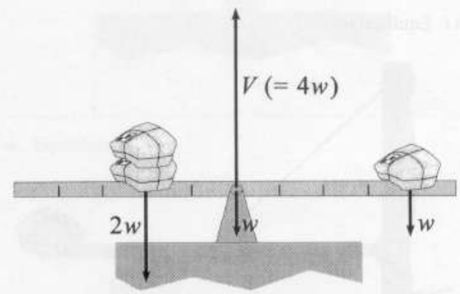
RE-2



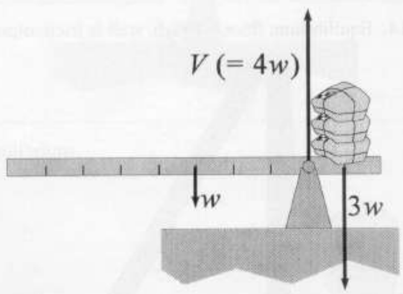
RE-3



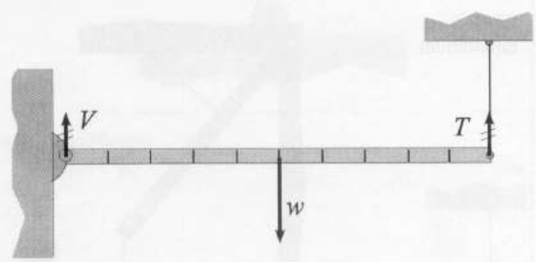
RE-4



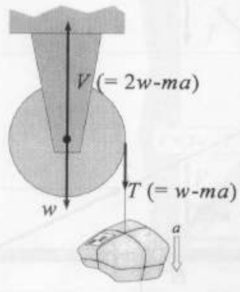
RE-5



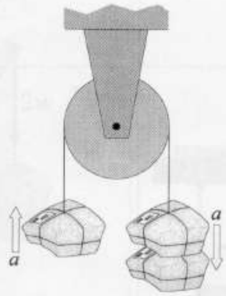
RE-6



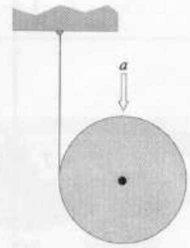
RN-1. Cylinder is supported on a frictionless horizontal axle.



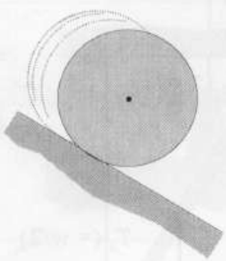
RN-2. Same as RN-1.



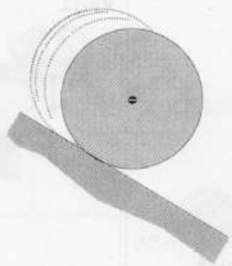
RN-3. String is tied to ceiling and wrapped around cylinder. Cylinder is falling.



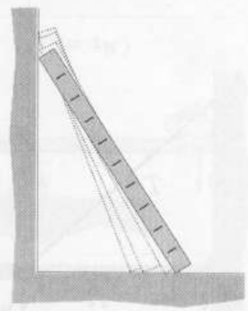
RN-4. Cylinder is rolling down a rough (not frictionless) incline.



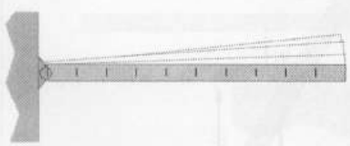
RN-5. Cylinder was released with zero angular velocity on a frictionless incline. Is it rolling?



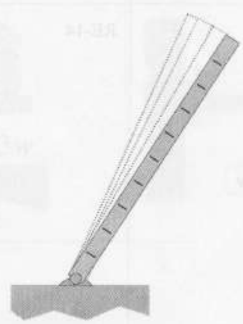
RN-6. Beam is slipping. Both wall and floor are frictionless.



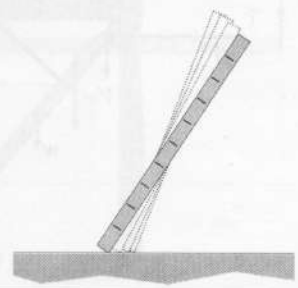
RN-7. Beam is swinging down through horizontal position.

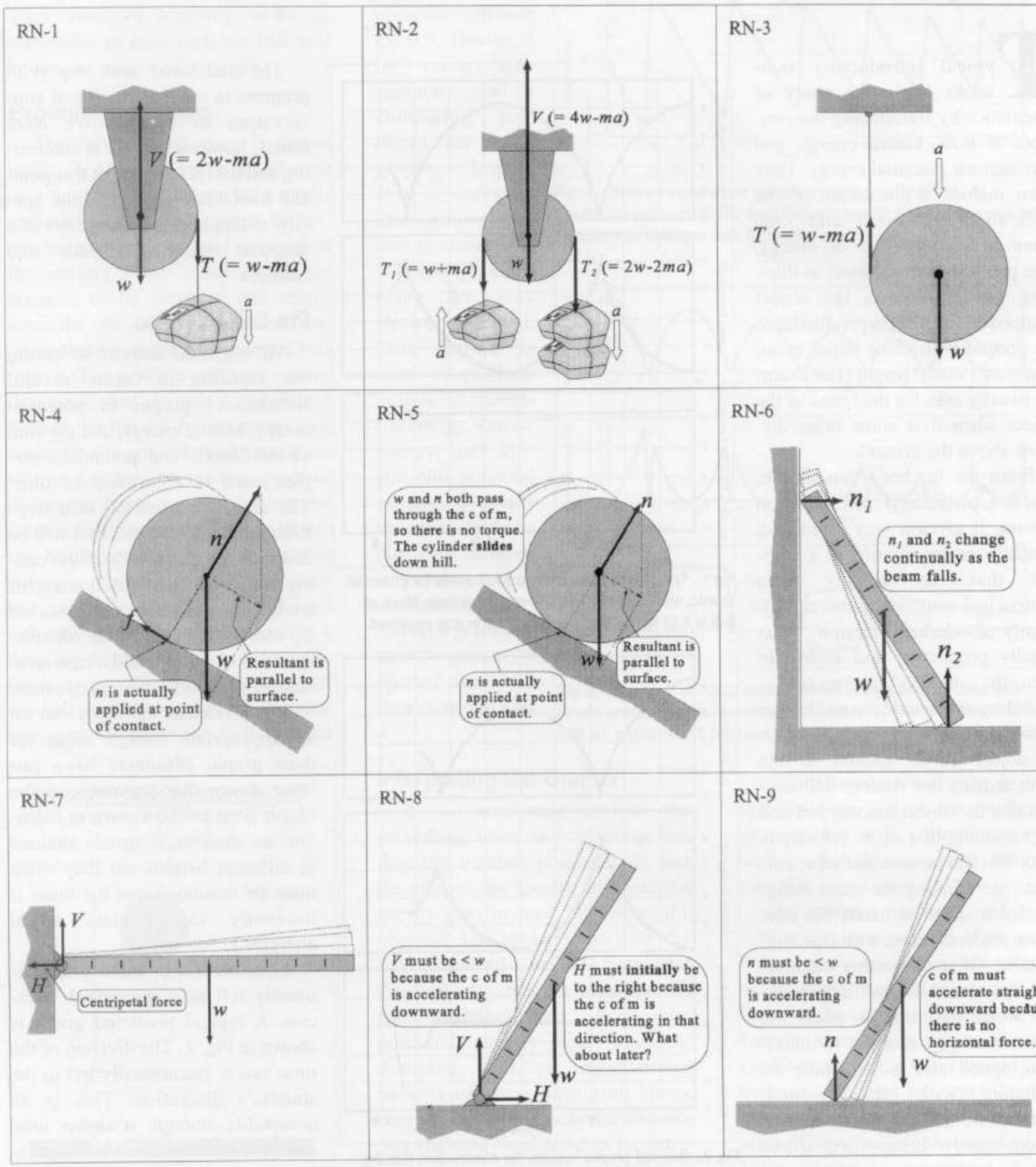


RN-8. Beam is swinging downward.



RN-9. Beam is falling on a smooth (frictionless) floor. If the beam is released from rest, what path does the c of m take?





RN-1
V (= 2w-ma)
T (= w-ma)
w
a
RN-2
V (= 4w-ma)
T1 (= w+ma)
w
T2 (= 2w-2ma)
a
a
RN-3
a
T (= w-ma)
w
RN-4
n
f
w
Resultant is parallel to surface.
n is actually applied at point of contact.
RN-5
w and n both pass through the c of m, so there is no torque. The cylinder slides down hill.
n
w
Resultant is parallel to surface.
n is actually applied at point of contact.
RN-6
n1
n1 and n2 change continually as the beam falls.
n2
w
RN-7
V
H
Centripetal force
w
RN-8
V must be < w because the c of m is accelerating downward.
H must initially be to the right because the c of m is accelerating in that direction. What about later?
V
w
H
RN-9
n must be < w because the c of m is accelerating downward.
c of m must accelerate straight downward because there is no horizontal force.
n
w