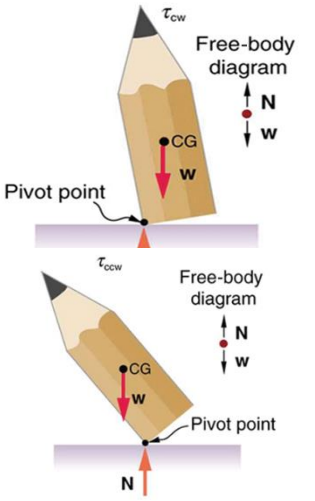
Stability



_____ Equilibrium

- When _____ from equilibrium, the system experiences a net _____ or _____ in a direction _____ to the direction of the _____.

_____ equilibrium

- When _____ from equilibrium, the net _____ or _____ is in _____ direction of the displacement

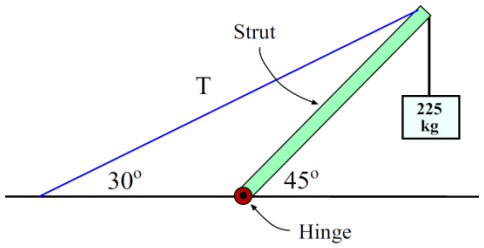
_____ Equilibrium

- Equilibrium is independent of _____ from its original position

Problem-Solving Strategy for Static Equilibrium

1. Is it in _____? (no _____ or _____ rotation)
2. Draw _____ body _____
3. Apply _____ and/or _____
4. Choose a _____ point to _____ the problem
5. Check your _____ for _____.

The system is in equilibrium. A mass of 225 kg hangs from the end of the uniform strut whose mass is 45.0 kg. Find (a) the tension *T* in the cable and the (b) horizontal and (c) vertical force components exerted on the strut by the hinge.



Homework

1. A round pencil lying on its side is in neutral equilibrium relative to displacements perpendicular to its length. What is its stability relative to displacements parallel to its length?
2. Explain the need for tall towers on a suspension bridge to ensure stable equilibrium.
3. When visiting some countries, you may see a person balancing a load on the head. Explain why the center of mass of the load needs to be directly above the person's neck vertebrae.
4. Suppose a horse leans against a wall as in Figure 1. Calculate the force exerted on the wall assuming that force is horizontal while using the data in the schematic representation of the situation. Note that the force exerted on the wall is equal in magnitude and opposite in direction to the force exerted on the horse, keeping it in equilibrium. The total mass of the horse and rider is 500 kg. Take the data to be accurate to three digits. (OpenStax 9.6) $\mathbf{1.43 \times 10^3\ N}$

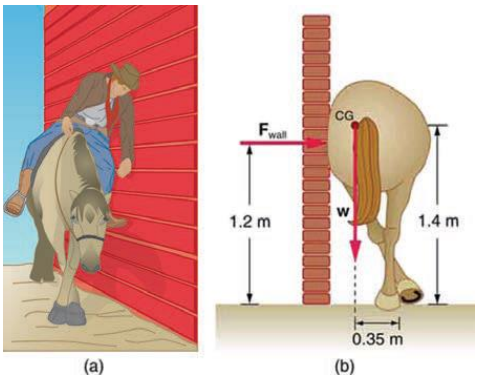


Figure 1

5. Two children of mass 20 kg and 30 kg sit balanced on a seesaw with the pivot point located at the center of the seesaw. If the children are separated by a distance of 3 m, at what distance from the pivot point is the small child sitting in order to maintain the balance? (OpenStax 9.7) **1.8 m**
6. A person carries a plank of wood 2 m long with one hand pushing down on it at one end with a force F_1 and the other hand holding it up at 50 cm from the end of the plank with force F_2. If the plank has a mass of 20 kg and its center of gravity is at the middle of the plank, what are the magnitudes of the forces F_1 and F_2? (OpenStax 9.9) **392 N, 196 N**
7. (a) What force must be exerted by the wind to support a 2.50-kg chicken in the position shown in Figure 2? (b) What is the ratio of this force to the chicken's weight? (c) Does this support the contention that the chicken has a relatively stable construction? (OpenStax 9.11) **11.0 N, 0.450**

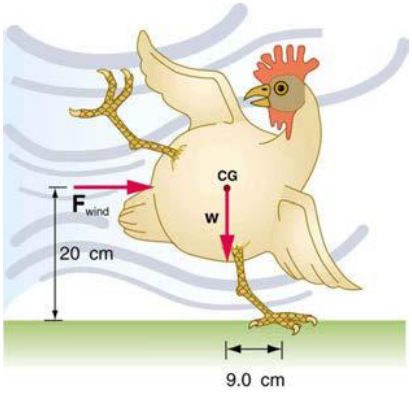


Figure 2

8. Suppose the weight of the drawbridge in Figure 3 is supported entirely by its hinges and the opposite shore, so that its cables are slack. (a) What fraction of the weight is supported by the opposite shore if the point of support is directly beneath the cable attachments? (b) What is the direction and magnitude of the force the hinges exert on the bridge under these circumstances? The mass of the bridge is 2500 kg. (OpenStax 9.12) $\mathbf{\frac{1}{6}}$ **of the weight,** $\mathbf{2.0 \times 10^4}$ **N up**
9. Suppose a 900-kg car is on the bridge in Figure 3 with its center of mass halfway between the hinges and the cable attachments. (The bridge is supported by the cables and hinges only.) (a) Find the force in the cables. (b) Find the direction and magnitude of the force exerted by the hinges on the bridge. (OpenStax 9.13) $\mathbf{7.20 \times 10^3 N}$**,** $\mathbf{65.2°}$

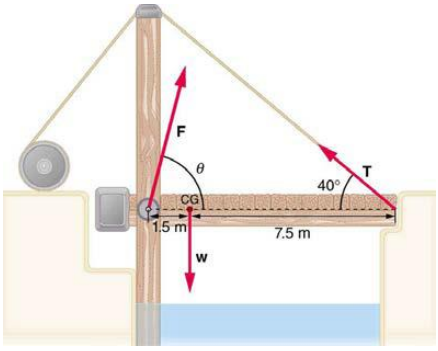


Figure 3

10. A gymnast is attempting to perform splits. From the information given in Figure 4, calculate the magnitude and direction of the force exerted on each foot by the floor. (OpenStax 9.16) $\mathbf{1.11 \times 10^3\ N}$ **along each leg**
11. To get up on the roof, a person (mass 70.0 kg) places a 6.00-m aluminum ladder (mass 10.0 kg) against the house on a concrete pad with the base of the ladder 2.00 m from the house. The ladder rests against a plastic rain gutter, which we can assume to be frictionless. The center of mass of the ladder is 2 m from the bottom. The person is standing 3 m from the bottom. What are the magnitudes of the forces on the ladder at the top and bottom? (OpenStax 9.17) **126 N, 751 N**

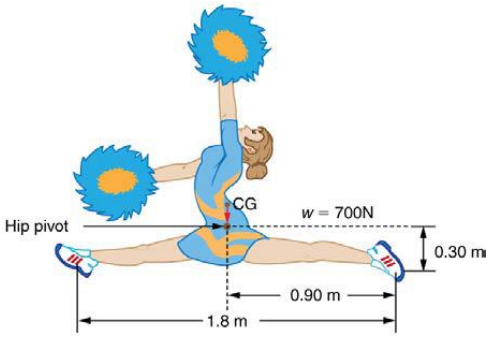


Figure 4