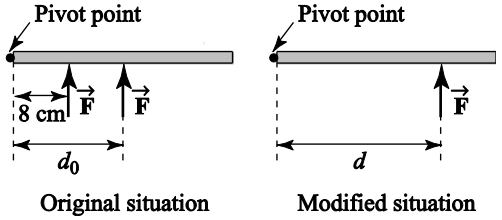
ANSWERS TO EVEN-NUMBERED CONCEPTUAL QUESTIONS

2. If the bar is, say, seven feet above the ground, a high jumper has to lift his center of gravity approximately to a height of seven feet in order to clear the bar. A tall person already has his center of gravity higher than that of a short person. Thus, the taller athlete has to raise his center of gravity through a smaller distance.

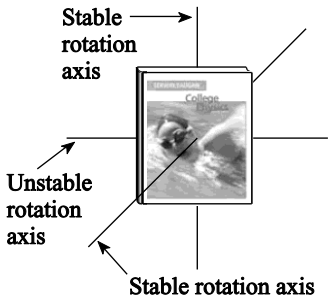
4. The lever arm of a particular force is found with respect to some reference point. Thus, an origin for calculating torques must be specified. However, for an object in equilibrium, the calculation of the total torque is independent of the location of the origin.

6. The critical factor is the total torque being exerted about the line of the hinges. For simplicity, we assume that the paleontologist and the botanist exert equal magnitude forces. The free body diagram of the original situation is shown on the left and that for the modified situation is shown on the right in the sketches below:



In order for the torque exerted on the door in the modified situation to equal that of the original situation, it is necessary that $Fd = Fd_0 + F(8\text{ cm})$ or $d = d_0 + 8\text{ cm}$. Thus, the paleontologist would need to relocate about 8 cm farther from the hinge.

8.



10. After the head crosses the bar, the jumper should arch his back so the head and legs are lower than the midsection of the body. In this position, the center of gravity may pass under the bar while the midsection of the body is still above the bar. As the feet approach the bar, the legs should be straightened to avoid hitting the bar.

12. (a) Consider two people, at the ends of a long table, pushing with equal magnitude forces directed in opposite directions perpendicular to the length of the table. The net force will be zero, yet the net torque is not zero.

(b) Consider a falling body. The net force acting on it is its weight, yet the net torque about the center of gravity is zero.

14. As the cat falls, angular momentum must be conserved. Thus, if the upper half of the body twists in one direction, something must get an equal angular momentum in the opposite direction. Rotating the lower half of the body in the opposite direction satisfies the law of conservation of angular momentum.