Boom’ s problem

Science, Physics

BOOM’ S PROBLEM PS 4. 3 — Torque (Rotational Equilibrium) Problems 1. A crane supports a 3. 0 kN weight as shown. The crane's boom is 8. 0 m long and is at an angle of 30Ëš from the horizontal. If the hydraulic support is attached to the boom 2. 0 m from the bottom of the boom, then: a) what is the compressional force in the hydraulic? b) what is the magnitude and direction of the force on the pin at the bottom of the boom? a) âˆ' Torque = 0 F cos 30Ëš x 2. 0 = 3000 cos 30Ëš x 8. 0 F = 24 000 Ã· 2. 0 F = 12 000 N b) âˆ' Fy = 0 (the sum of the forces up must equal the sum of the forces downward) V + 3000 = 12000 V = 9000 N down 2. A crate is 8. 0 m tall and 3. 0 m wide. Its coefficient of friction to the floor is 0. 70. What is the maximum distance from the floor a horizontal force may be used to slide the crate without tipping it? âˆ' T = 0 âˆ' Fx = 0 F x d = mg(1. 5) F = Ffr F = µmg µmgd = mg(1. 5) d = 1. 5 Ã· 0. 7 d = 2. 1 m Sample Problem 1: One mass on a See-Saw A 3. 0kg mass is place 2. 00m to the right of the pivot point of a see-saw. What is the the magnitude and the sign of the torque applied? This problem looks like the figure The force exerted by the mass is due to gravity and is found from F= mg. The distance between the force and the pivot point is r= 2. 00m. We can find the magnitude of the torque by If the mass is to the right of the pivot point, the rotation will be in a clockwise direction, so the torque is negative: . As always, note the use of significant figures. The distance r was given to three significant figures, but the mass (and therefore the force) is only known to two significant figures. Thus the torque must have only two significant figures. EXAMPLE PROBLEM ON TORQUE: The Swinging Door Question In a hurry to catch a cab, you rush through a frictionless swinging door and onto the sidewalk. The force you extered on the door was 50N, applied perpendicular to the plane of the door. The door is 1. 0m wide. Assuming that you pushed the door at its edge, what was the torque on the swinging door (taking the hinge as the pivot point)? Hints 1. Where is the pivot point? 2. What was the force applied? 3. How far from the pivot point was the force applied? 4. What was the angle between the door and the direction of force? Solution The pivot point is at the hinges of the door, opposite to where you were pushing the door. The force you used was 50N, at a distance 1. 0m from the pivot point. You hit the door perpendicular to its plane, so the angle between the door and the direction of force was 90 degrees. Since = r x F = r F sin() | Figure 1 Diagram of Example Problem 1 | then the torque on the door was: = (1. 0m) (50N) sin(90) = 50 N m Note that this is only the magnitude of the torque; to complete the answer, we need to find the direction of torque. Using the right hand rule, we see that the direction of torque is out of the screen. Worked example 10. 3: Leaning ladder Question: A uniform ladder of mass and length is leaned against a smooth vertical wall. A person of mass stands on the ladder a distance from the bottom, as measured along the ladder. The foot of the ladder is from the bottom of the wall. What is the force exerted by the wall on the ladder? What is the normal force exerted by the floor on the ladder? Answer: The angle subtended by the ladder with the ground satisfies Let be the normal reaction at the wall, let be the normal reaction at the ground, and let be the frictional force exerted by the ground on the ladder, as shown in the diagram. Consider the torque acting on the ladder about the point where it meets the ground. Only three forces contribute to this torque: the weight, , of the ladder, which acts half-way along the ladder; the weight, , of the person, which acts a distance along the ladder; and the reaction, , at the wall, which acts at the top of the ladder. The lever arms associated with these three forces are , , and , respectively. Note that the reaction force acts to twist the ladder in the opposite sense to the two weights. Hence, setting the net torque to zero, we obtain which yields The condition that zero net vertical force acts on the ladder yields Hence,