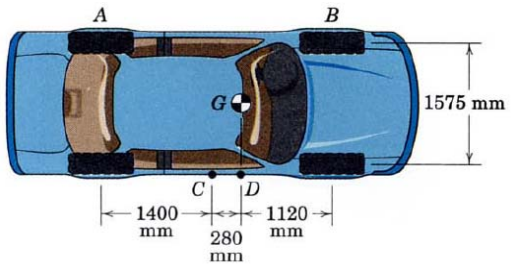
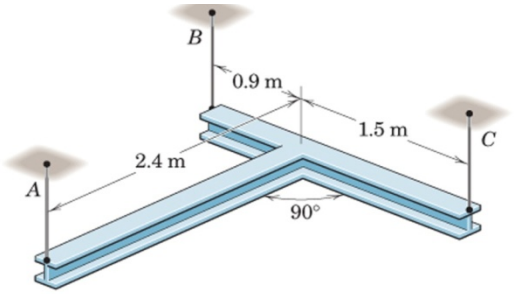
MECHANICS (ME10001)

Tutorial 3: Equilibrium - II

1. For a car of mass 1600 kg, two different locations C and D are considered for a single jack. In each case, the entire right side of the car is lifted just off the ground. Determine the normal reaction forces at A and B, and the vertical jacking force required in each case.

Ans: at C: N_A =2354.4 N, N_B =5493.6N, at D: N_A =3139.2 N, N_B =4708.8 N



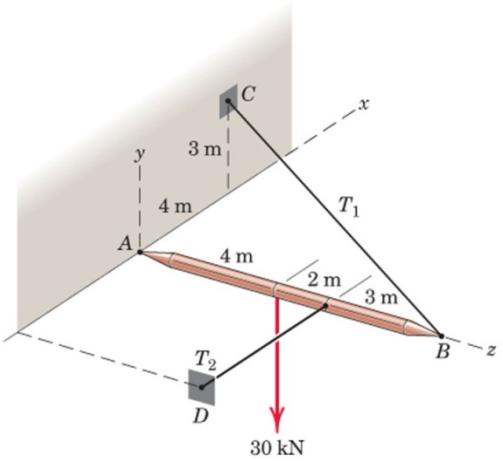


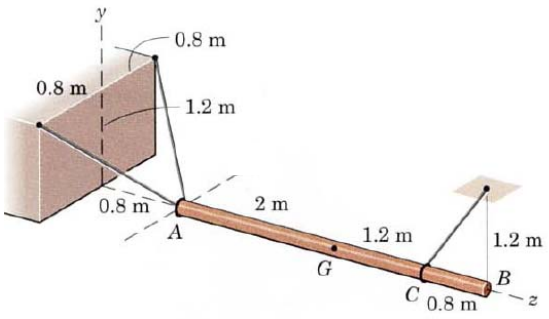
2. Two steel beams, each of mass 100 kg are welded together at right-angle and suspended by three vertical cables so that the assembly remains horizontal. Compute the tension in the three cables.

Ans: T_A =490 N, T_B =797 N, T_C =674 N

3. Neglecting the weight of the boom, determine the cable tensions and the magnitude of the force acting at the ball-and-socket joint A due to the 30 kN load as shown.

Ans: T_1 =45.8 kN, T_2 =26.7 kN, F_A =44.2 kN

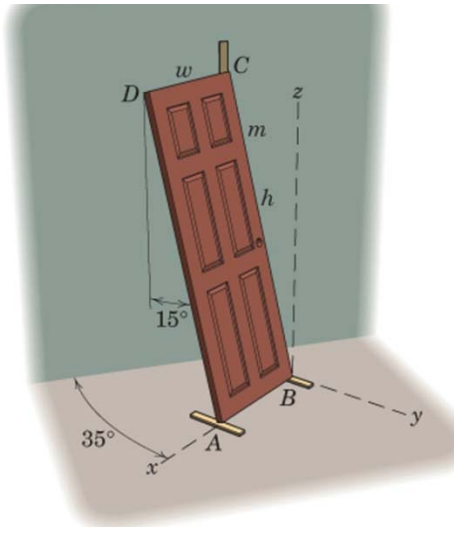




4. Is the 50 kg uniform circular rod suspended by massless inextensible strings in a uniform gravitational field in static equilibrium?

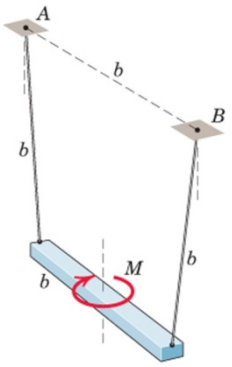
5. A homogeneous door of mass *m*, height *h* and width *w* is leaned against a frictionless wall and on a rough floor. The door is in contact at A and B on the floor and is in contact at C on the vertical wall. Determine y and z components of the floor reactions and normal reaction at C.

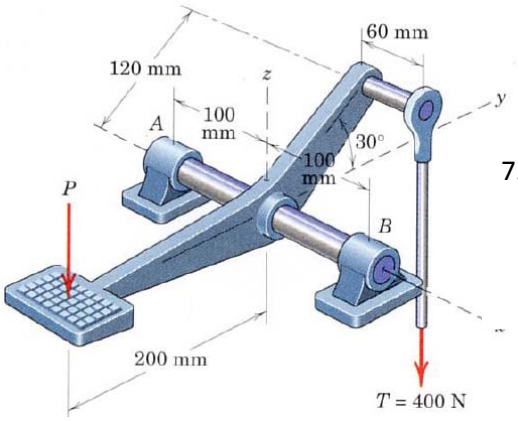
$$C_N = 0.164mg \quad A_y = -0.024mgh/w$$
$$A_z = mg(0.5 + 0.091h/w)$$
$$B_y = mg(0.024h/w - 0.134)$$
$$B_z = mg(0.5 - 0.091h/w)$$



6. A uniform bar of length b and mass m is suspended at its ends by two wires each of length b from points A and B in the horizontal plane a distance b apart. A couple moment M is applied to the bar causing it to rotate about the vertical axis to the static equilibrium position shown. Determine the height h to which the bar rises from its original equilibrium position with no applied moment.

Ans: $h = b\left[1 - \sqrt{1 - \left\{\frac{2M}{bmg}\right\}^2}\right]$

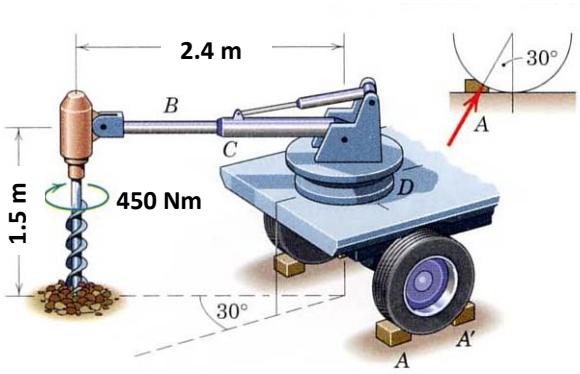


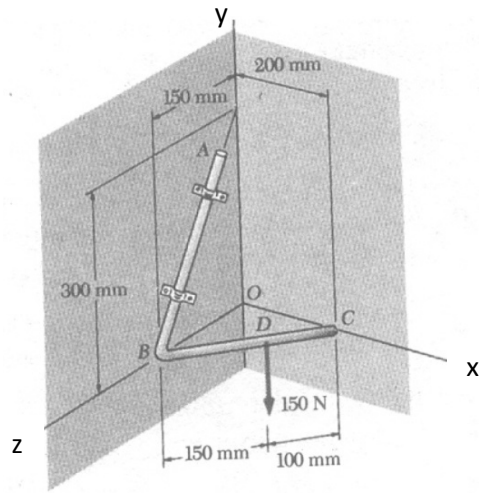


7. A vertical force P on the foot pedal of the bell crank is required to produce a tension T of 400 N in the vertical control rod. Determine the corresponding bearing reactions at A and B.

Ans. $A = 183.9$ N up, $B = 424$ N up

8. The power unit of the post-hole digger supplies a torque of 450 Nm to the drill. The arm B is free to slide in the supporting sleeve C but is not free to rotate about the horizontal axis of C. If the unit is free to swivel about the vertical axis of the mount D, determine the force exerted against the right rear wheel by the block A (or A'), which prevents the unbraked truck from rolling. Ans: $F_{A'} = 93.75$ N





9. The bent rod ABC is hinged to a vertical wall by means of two brackets and bears at C against another vertical wall. Upper bracket fits in a groove in the rod to prevent the rod from sliding down. Neglecting friction, determine the reaction at C when a 150N load is applied at D as shown.

Ans: C= 45k kN

10. During a test, the left engine of the twin-engine airplane is revved up and a 2 kN thrust is generated. The wheels at B and C are braked in order to prevent motion. Determine the change in the nominal values of the normal reaction forces at A, B and C compared to their nominal values with the engine turned off.

Ans: $\Delta N_A = 1000$ N, $\Delta N_B = \Delta N_C = -500$ N