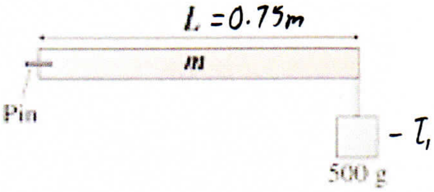
Name________________

U1: Homework Questions #2

Torque Equilibrium and Center of Mass

1. How much torque must the pin exert to keep the rod from rotating if the rod has a length $L = 75$ cm and a mass $m = 1.0$ kg? Calculate this torque about an axis that passes through the point where the pin enters the rod and is perpendicular to the plane of the figure.

| 7.35 | N·m



$\tau_1 = (0.5\,kg)(0.75\,m)(9.8\,\frac{N}{kg}) = 3.675\,Nm$

$\tau_2 = (1\,kg)(.375\,m)(9.8\,\frac{N}{kg}) = 3.675\,Nm$

$3.675\,Nm + 3.675\,Nm = \boxed{7.35\,Nm}$

2. Find the net torque on the wheel shown below about the axle through O, taking $a = 6.00$ cm and $b = 20.0$ cm. (Assume that the positive direction is counterclockwise.)

| -3.08 | N·m

Clockwise Torque (negative)

$(10\,N)(0.2\,m) = -2\,Nm$

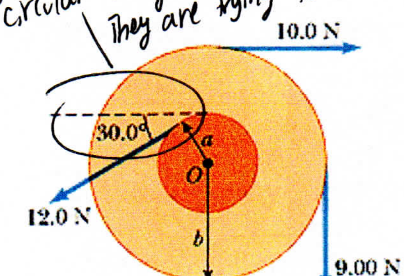
$(9\,N)(0.2\,m) = -1.8\,Nm$

$\tau_C = -3.8\,Nm$

Counter Clockwise Torque (Positive)

$(12\,N)(0.06\,m) = .72\,Nm$

angle doesn't matter on circular things!! They are trying to trick you.



$\tau_{Net} = -3.8\,Nm + 0.72\,Nm = \boxed{-3.08\,Nm}$

3. The two objects in the figure below are balanced on the pivot, with $m = 2.4$ kg. What is the distance d?

| 1.31 | m

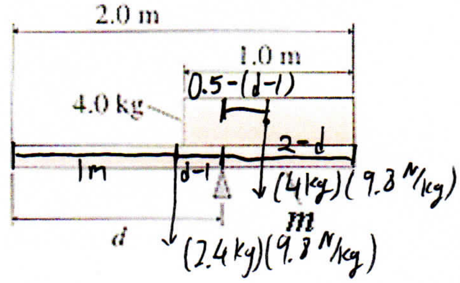
Set Torques Equal

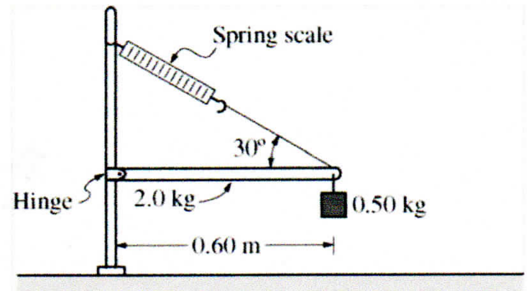
$(2.4\,kg)(9.8\,N/kg)(d-1) = (4\,kg)(9.8\,N/kg)(1.5-d)$

Solve for d

$23.52d - 23.52 = 58.8 - 39.2d$

$d = \boxed{1.3125\,m}$

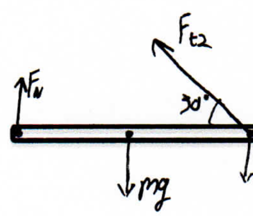




Part of an actual AP Exam Question

4. The horizontal uniform rod shown above has length 0.60 m and mass 2.0 kg. The left end of the rod is attached to a vertical support by a frictionless hinge that allows the rod to swing up or down. The right end of the rod is supported by a cord that makes an angle of 30° with the rod. A spring scale of negligible mass measures the tension in the cord. A 0.50 kg block is also attached to the right end of the rod.

(a) On the diagram below, draw and label vectors to represent all the forces acting on the rod. Show each force vector originating at its point of application.



5. The figure below shows a cubical box that has been constructed from uniform metal plate of negligible thickness. The box is open at the top and has edge length $L = 46$ cm. Find the coordinates of the center of mass of the box.

Lets say each side has a mass of m.

each side labelled in top right.

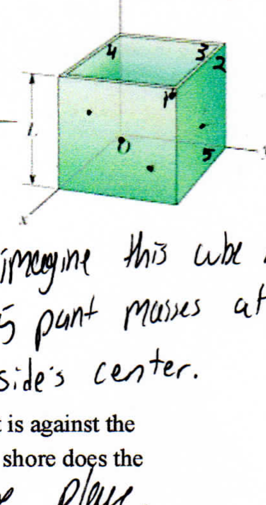
X: 23 cm

Y: 23 cm

Z: 18.4 cm

C.O.M. X-direction

$$\frac{(m)(0)+(m)(23)+(m)(23)+(m)(46)+(m)(23)}{5m} = 23$$



C.O.M. Y-direction

$$\frac{(m)(0)+(m)(23)+(m)(23)+(m)(23)+(m)(46)}{5m} = 23$$

C.O.M. Z-direction

$$(m)(0)+(m)(23)+(m)(23)+(m)(23)+(m)(23)$$

$= 18.4$

imagine this cube has 5 point masses at each side's center.

6. A 50 kg man stands at the edge of a raft of mass 10 kg that is 10 meters long. The edge of the raft is against the shore of the lake. The man walks toward the shore, the entire length of the raft. How far from the shore does the raft move?

8.40 m

C.O.M. of a system stays in same place.

As the C.O.M of the raft-man system changes, the raft will move to keep the C.O.M in same place. So ultimately, you are finding the change in C.O.M before and after.

C.O.M Before: (center is reference)

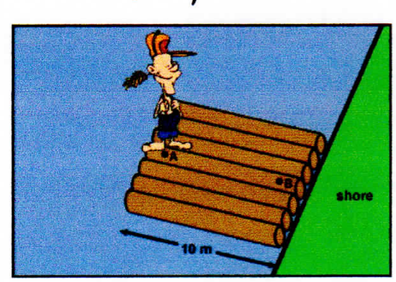
$$\frac{(50kg)(5m)+(10kg)(0m)}{60kg} = 4.166m \text{ from center}$$

C.O.M After = 4.166 from center (other side)

4.166 4.166

C.O.M Before | C.O.M after

$4.166 \times 2 = 8.333m.$



* Kupiec rounded so he got 8.4m.