2.3.1 How does one know what forces and moments to use in

a) the statics force balance and moment-balance equations?

b) the dynamics linear momentum balance and angular momentum balance equations?

Answer:
(a) The forces and moments that show on a free-body diagram, the *external* forces and moments.
(b) The forces and moments that show on a free-body diagram, the *external* forces and moments. No "inertial" or "acceleration" forces show.

2.3.2 In a free-body diagram of a whole man standing with his right hand extended how do you show the force of his right arm on his body?

Answer:
You don't.

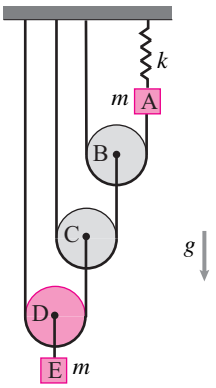
2.3.10 Nested pulleys. In the nested arrangement of pulleys shown in the figure, assume that all the pulleys are massless. Draw the free-body diagram of

a) mass A,

b) mass E, and

c) pulley D.

Write the expression for the net force on pulley D.



Problem 2.10

3.3.10

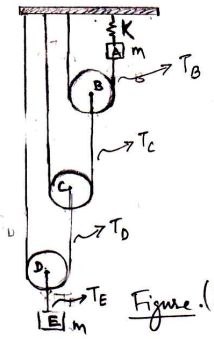
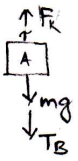


Figure.(1)

Tension in the strings are as shown in the figure.

F.B.D of mass A :



F_K : spring force
mg : weight of mass
T_B : Tension in the string.

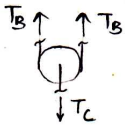
In equilibrium net force acting on mass A is zero.

$\Sigma F_A = 0$

$\Rightarrow F_K - mg - T_B = 0$

$\Rightarrow T_B = F_K - mg$ —— (1)

F.B.D of pulley B

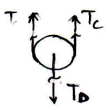


$\Sigma F_B = 0$

$\Rightarrow 2T_B - T_C = 0$

$\Rightarrow T_C = 2T_B$ —— (2)

F.B.D of pulley C

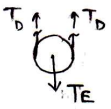


$\Sigma F_C = 0$

$\Rightarrow 2T_C - T_D = 0$

$\Rightarrow T_D = 2T_C$ —— (3)

F.B.D of pulley D



$\Sigma F_D = 0$

$\Rightarrow 2T_D - T_E = 0$

$\Rightarrow 2T_D = T_E$ —— (4)

3.3.10 continued

F.B.D. of mass E

$\Sigma F_E = 0$

$\Rightarrow T_E - mg = 0$

$\Rightarrow T_E = mg$ — (5)

Net force on pulley D:

from eqn (4)

$$2T_D - T_E = 0$$

$\Rightarrow 2T_D - mg = 0$ [using eqn 5]

$\Rightarrow 4T_C - mg = 0$ [using eqn 3]

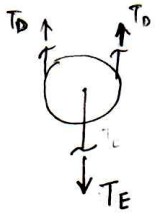
$\Rightarrow 8T_B - mg = 0$ [using eqn 2]

$\Rightarrow 8(F_K - mg) - mg = 0$ [using eqn 1]

$\Rightarrow 8F_K - 9mg = 0$

Since the whole system is in static balance, the net force on pulley D is zero.

For this to happen, $\boxed{T_D = \frac{T_E}{2} = \frac{mg}{2}}$



2.3.16 FBD of an arm throwing a ball. An arm throws a ball up. A crude model of an arm is that it is made of four rigid bodies (shoulder, upper arm, fore-arm and a hand) that are connected with hinges. At each hinge there are muscles that apply torques between the links. Draw a FBD of

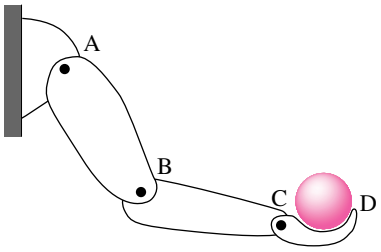
a) the system consisting of the whole arm (three parts, but not the shoulder) and the ball.

b) the ball,

c) the hand, and

d) the fore-arm,

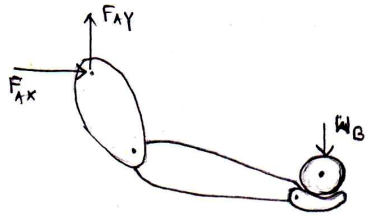
e) the upper arm,



Problem 2.16

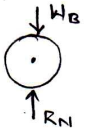
3.3.16

(a) The system consisting of the whole arm and the ball.



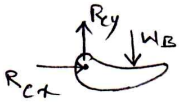
W_B – weight of ball

(b) The ball

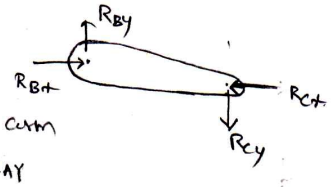


R_N – Reaction force exerted by the hand on the ball

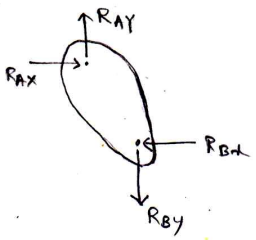
(c) The hand



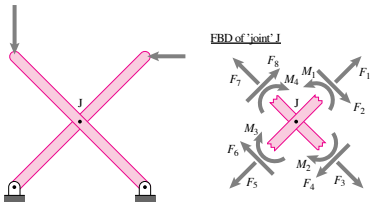
(d) The fore-arm



(e) The upper arm



2.3.19 An X structure. Two rods are pinned together in the middle to form a structure in the shape of 'X' as shown in the figure. A freebody diagram of the joint J with a little bit of the bars near J is shown. Draw free-body diagrams of each bar and of the whole structure.



Problem 2.19

Answer:
Note, no couples show on any of the free-body diagrams asked for.