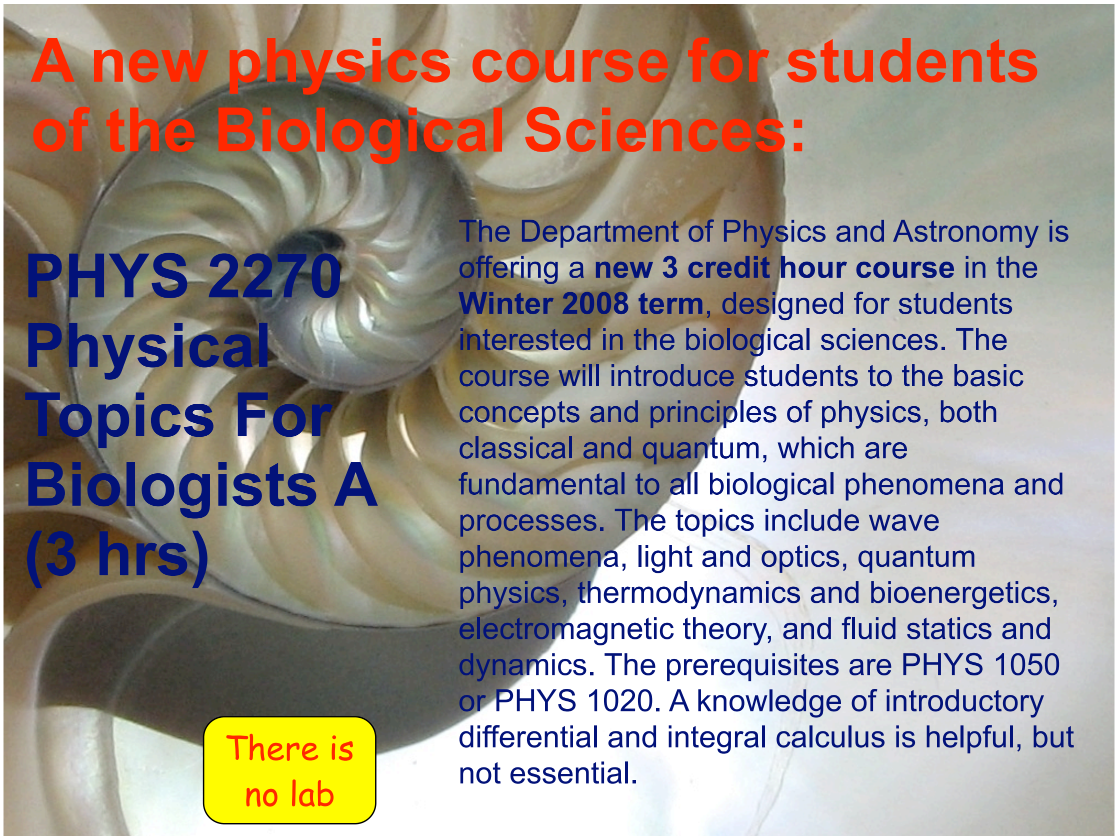


GENERAL PHYSICS I: PHYS 1020

Schedule - Fall 2007
(lecture schedule is approximate)

8	M	22	19	Chapter 7	Impulse and momentum	No lab or tutorial
	Tue	23	MID-TERM TEST, Ch 1-5, Tuesday, October 23, 7-9 pm			
	W	24	20	Chapter 7	Impulse and momentum	
	F	26	21	Chapter 8, sections 1-3 only	Rotational kinematics	
9	M	29	22			Experiment 3: Forces in Equilibrium
	W	31	23	Chapter 9 sections 1 - 3, 6	Rotational dynamics	
	F	Nov 2	24			
10	M	5	25	Chapter 10 exclude 10.7 and 10.8	Simple harmonic motion, sections 10.5 and 10.6, for self study only	Tutorial and Test 3 ~~(chapters 7, 8)~~ Chapters 6, 7
	W	7	26			
	F	9	27	Chapter 11 exclude 11.11	Fluids	

Week of November 5

Tutorial and Test 3: Chapters 6 & 7

Mastering Physics Assignment 4

Is due Monday, November 12 at 11 pm

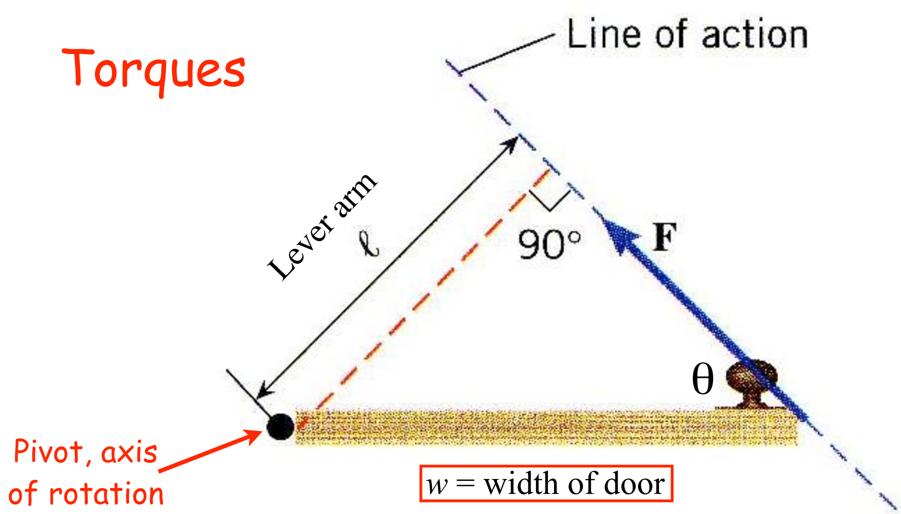
Covers material from chapters 6 and 7

There are 8 questions for practice and 6 for credit

The Final Exam Schedule is Now Final!

PHYS 1020: Monday, December 17, 6 - 9 pm
Frank Kennedy Brown & Gold Gyms
The whole course
30 multiple choice questions
Formula sheet provided

Torques



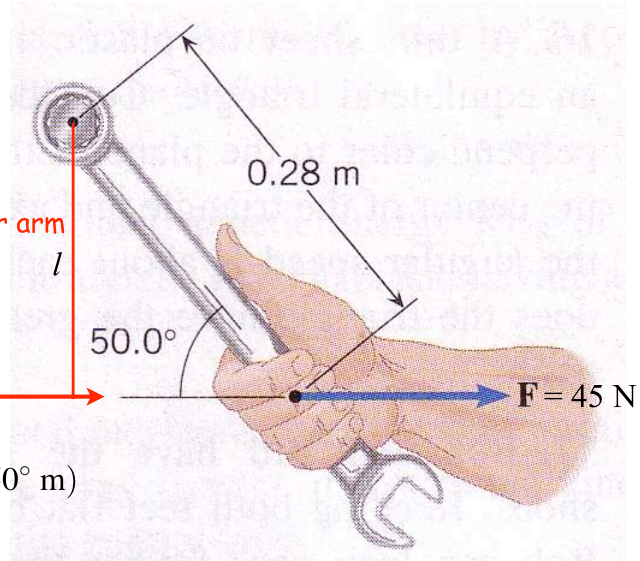
Lever arm: $l = w\sin\theta$

Torque, $\tau = Fl = Fw\sin\theta$

9.1/2: The torque applied to the bolt is:

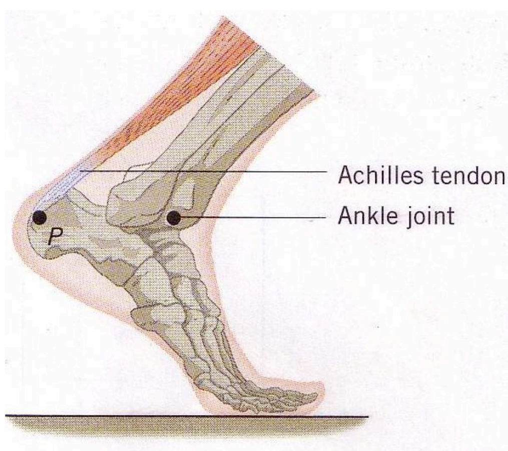
$$\tau = Fl$$

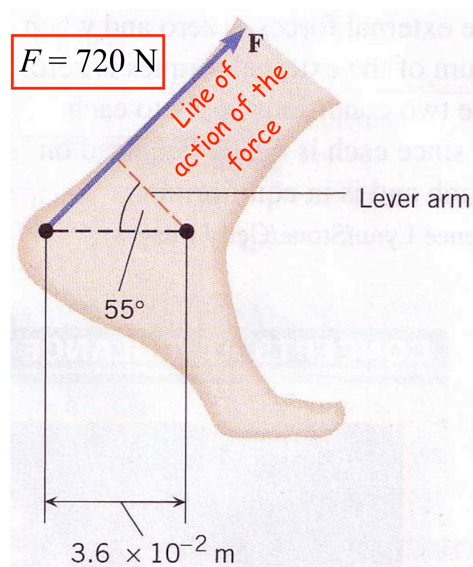
$$l = 0.28 \sin 50^\circ \text{ m}$$



$$\tau = (45 \text{ N}) \times (0.28 \sin 50^\circ \text{ m})$$

$$= 9.65 \text{ N.m}$$





Torque generated by Achilles tendon about ankle joint:

$$l = (0.036 \text{ m}) \times \cos 55^\circ = 0.0207 \text{ m}$$

$$\tau = Fl = (720 \text{ N})(0.0207 \text{ m}) = 14.9 \text{ N.m}$$

Sign convention: torque is positive when tending to rotate counterclockwise about reference point. So, torque = –14.9 N.m.

9.8: One end of a metre stick is pinned to a table, so that the stick can rotate freely around the surface of the tabletop. Two forces, both parallel to the tabletop, are applied in such a way that the net torque is zero. Where along the stick must the 6 N force be applied?

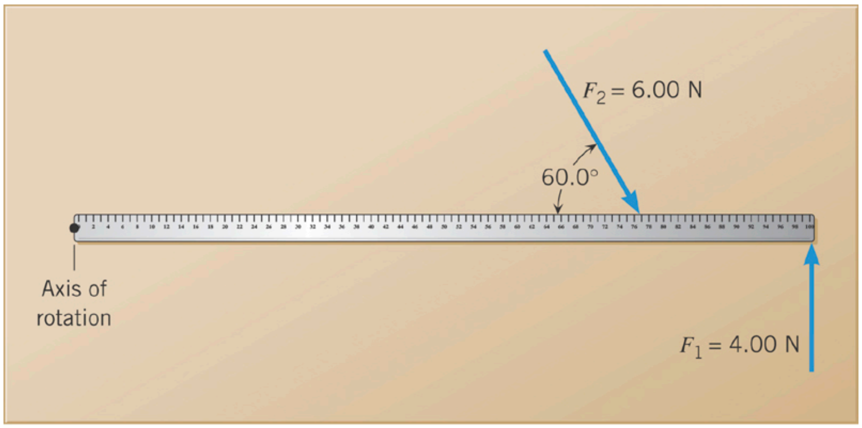
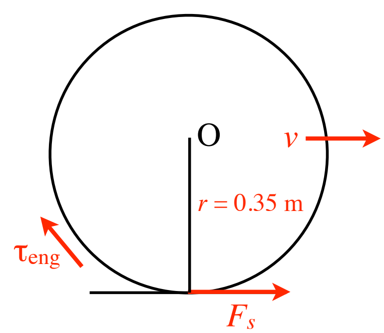


Table (top view)

9.3: The engine applies a torque of τ_{eng} = 295 N.m to the wheel of a car, which does not slip against the road surface because the static friction force applies a countertorque. The car is travelling at constant velocity.

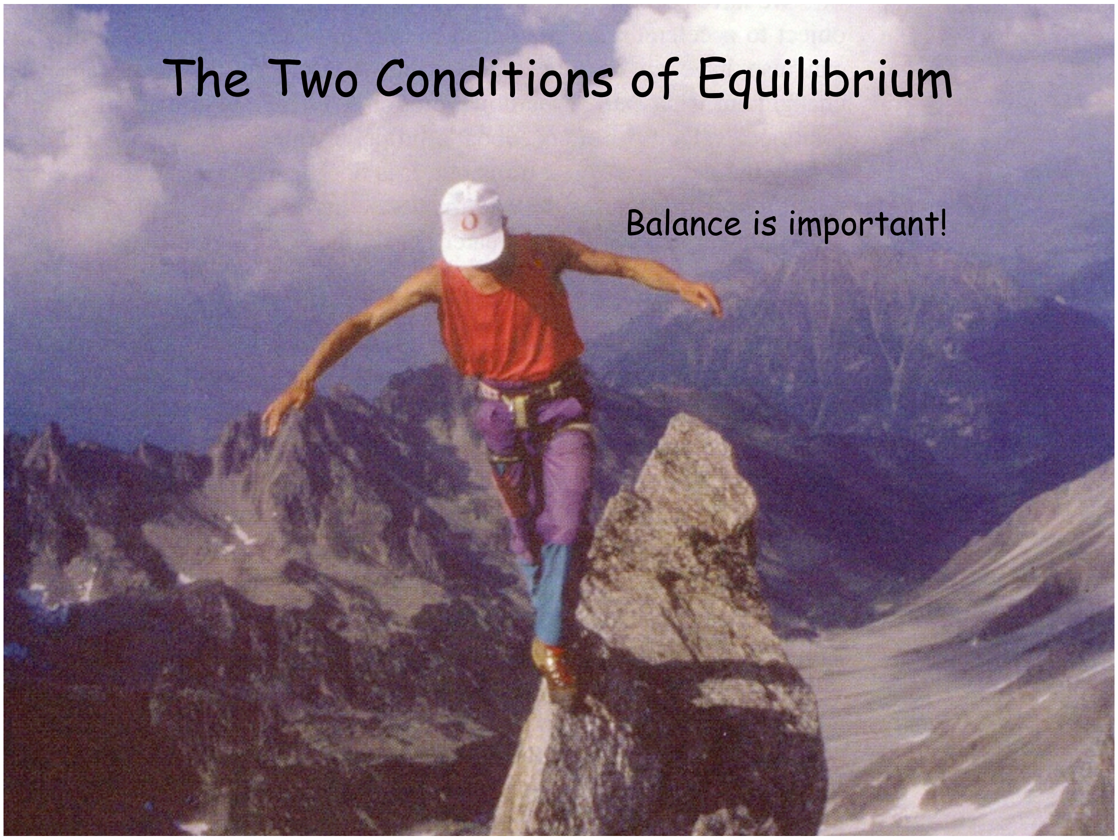
What is the static friction force?



As the wheel is turning at constant rate, the net torque applied to it must be zero.

Therefore, $\tau_{eng} = F_s \times r$

$F_s = \tau_{eng}/r = 295/0.35 = 843$ N



The Two Conditions of Equilibrium

For an object to be in equilibrium:

1) The sum of forces acting on the object must be zero:

$$\Sigma\vec{F}_i = \vec{F}_1 + \vec{F}_2 + \ldots = 0$$

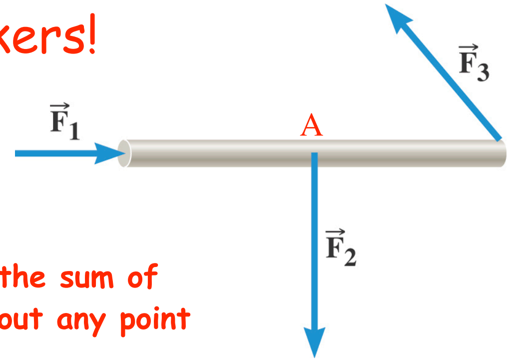
Then the acceleration is zero by Newton's first law.

2) Balance: the sum of torques **about any point** must be zero:

$$\Sigma\tau_i = \tau_1 + \tau_2 + \ldots = 0$$

Then the angular acceleration is zero.

Clickers!



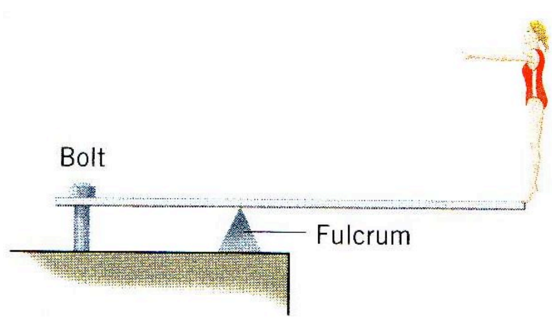
9.C8: Are the three forces shown sufficient to keep the rod in equilibrium?

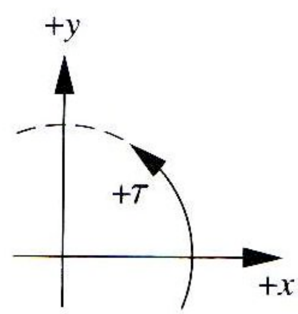
For the rod to be in equilibrium, the sum of the forces and of the torques about any point must be zero.

A) It is not possible to adjust the magnitudes of the forces so that the net force is zero.

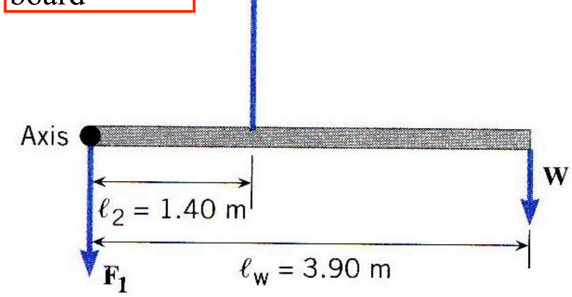
B) It is possible to adjust the magnitudes of the forces so that the net force is zero, but the net torque cannot be zero.

C) It is possible to adjust the magnitudes of the forces so that the net force and the net torque are both zero.





Forces acting on the diving board



Conditions of equilibrium:

Forces:

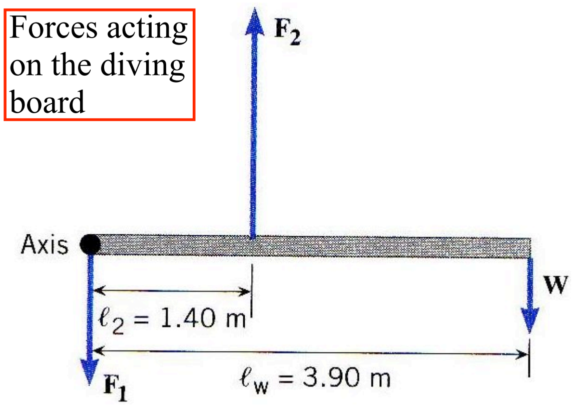
$$-F_1 + F_2 - W = 0$$

Torques about axis:

$$0 \times F_1 + 1.4F_2 - 3.9W = 0$$

$$\text{That is, } F_2 = \frac{3.9W}{1.4} = 2.786W$$

Forces acting on the diving board



$$-F_1 + F_2 - W = 0$$

$$F_2 = 2.786W$$

$$F_1 = F_2 - W = 1.786W$$

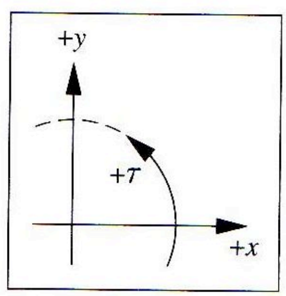
If the weight of the diver is 530 N, then

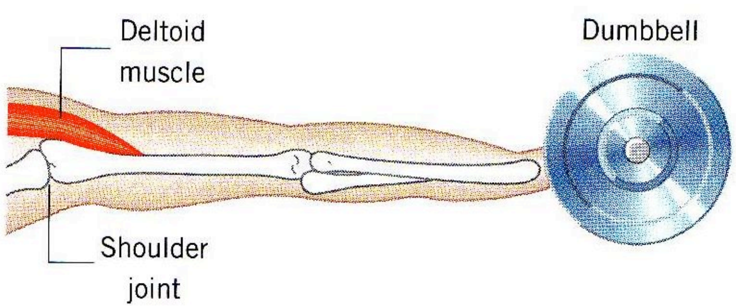
$F_1 = 947$ N,

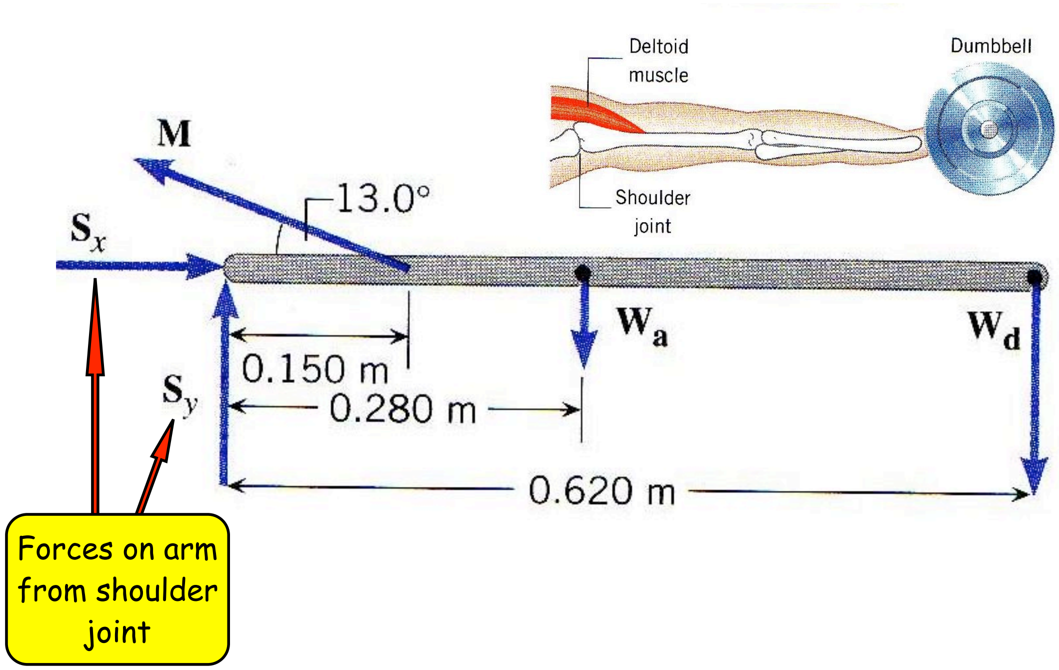
$F_2 = 1480$ N

What weight can the muscle lift?

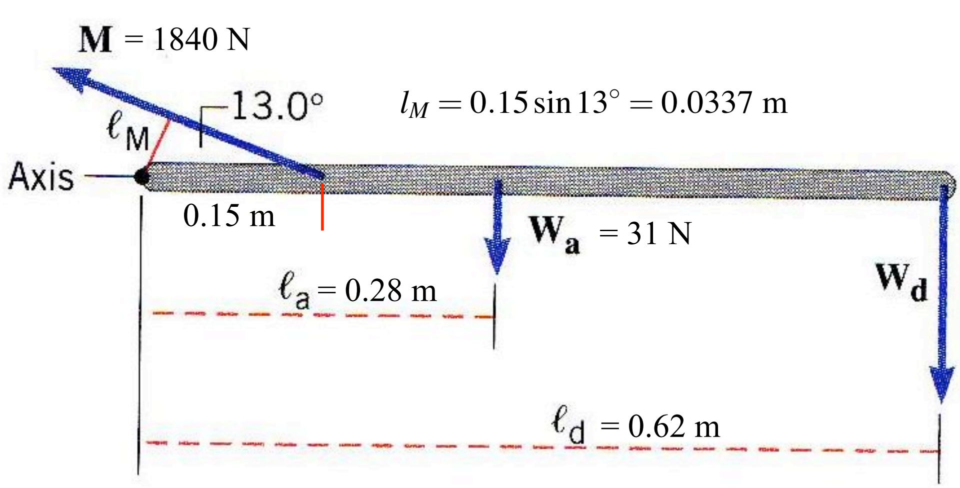
Maximum tension in muscle = 1840 N







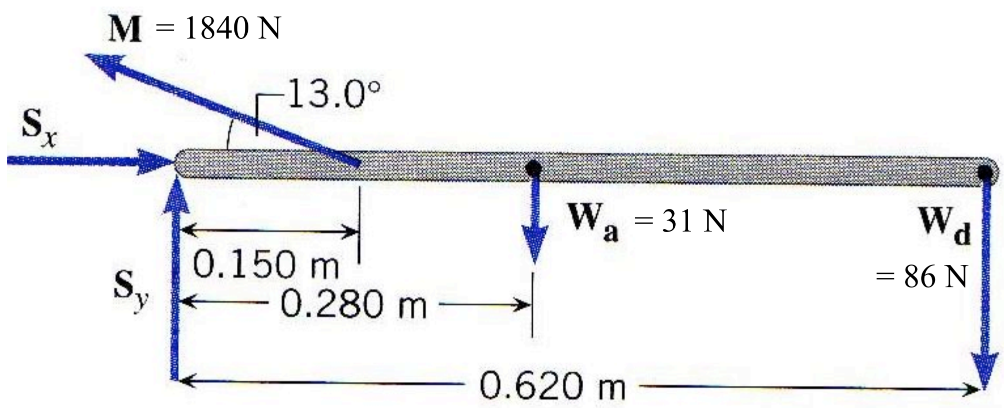
Calculate torques about the shoulder joint to eliminate S_x, S_y from the torque equations.



Torques about shoulder joint (axis):

$$1840 \times 0.0337 - 31 \times 0.28 - W_d \times 0.62 = 0$$

$$W_d = 86 \text{ N}$$



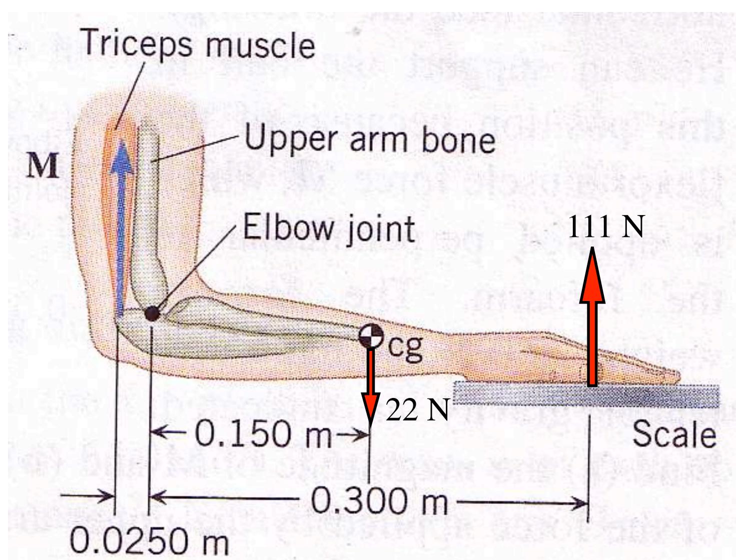
Forces:

$$x:\ S_x - M\cos 13^\circ = 0 \qquad S_x = 1840\cos 13^\circ = 1793\ \mathrm{N}$$

$$y:\ M\sin 13^\circ + S_y - W_a - W_d = 0$$

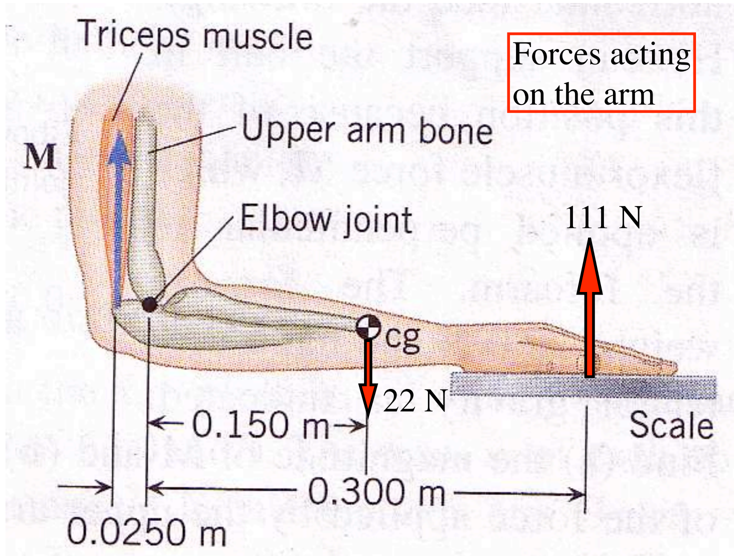
$$S_y = -1840\sin 13^\circ + 31 + 86 = -297\ \mathrm{N}$$

9.18



The hand presses down on the scale.
The scale reads 111 N.
The weight of the forearm is 22 N.

Find the force due to the muscle, M.



Torques about elbow joint:

$$-M \times 0.025 - 22 \times 0.15 + 111 \times 0.3 = 0$$

$$M = 1200 \text{ N}$$

The Two Conditions of Equilibrium

For an object to be in equilibrium:

1) The sum of forces acting on the object must be zero:

$$\Sigma\vec{F}_i = \vec{F}_1 + \vec{F}_2 + \ldots = 0$$

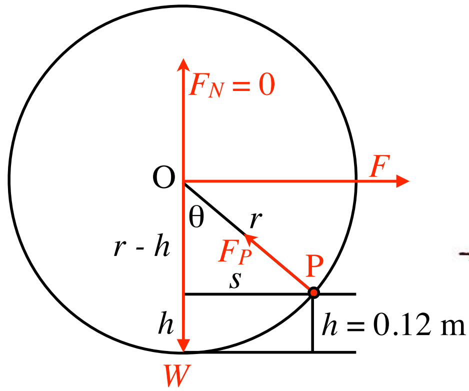
Then the acceleration is zero by Newton's first law.

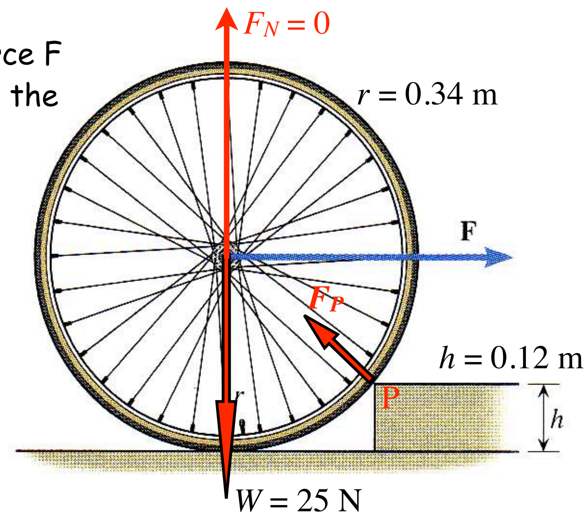
2) The sum of torques **about any point** must be zero:

$$\Sigma\tau_i = \tau_1 + \tau_2 + \ldots = 0$$

The angular acceleration is then zero.

9.66/20: What horizontal force F is needed to pull the wheel up the step?



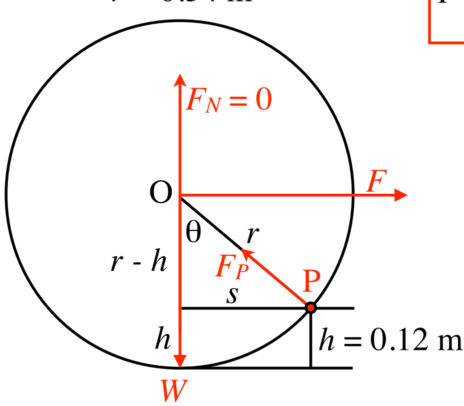


Torques about P: $W\,s - F(r - h) = 0$

$$F = \frac{W\,s}{r - h}$$

(normal force of ground on tire drops to zero as tire is about to leave ground)

$r = 0.34$ m



$$F = \frac{W\,s}{r - h}$$

What is s ?

$s = r \sin\theta$

$$\cos\theta = \frac{r - h}{r} = \frac{0.34 - 0.12}{0.34}$$

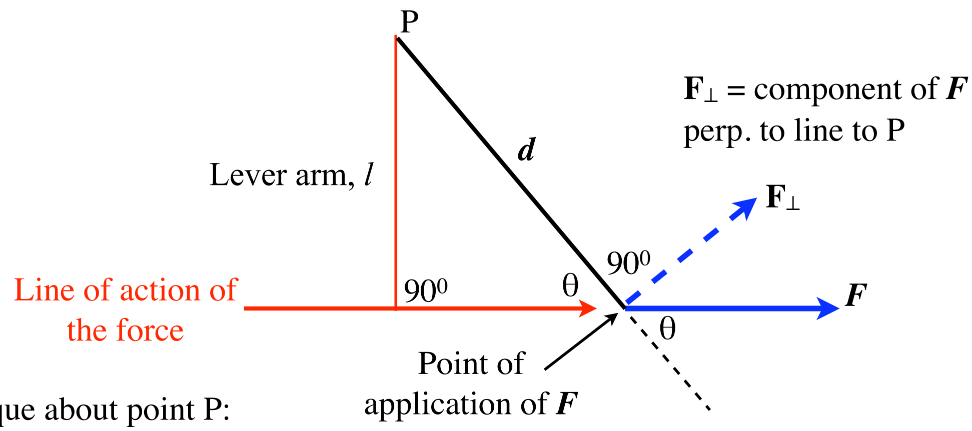
$\theta = 49.68°$

$s = r\sin\theta = 0.259$ m

$W = 25$ N

$$\text{So, } F = \frac{25 \times 0.259}{0.34 - 0.12} = 29.4 \text{ N}$$

Two ways to calculate torques (moments)



Torque about point P:

1) Torque = (force) × (lever arm): $\tau = Fl = F \times d \sin\theta$

2) Torque = $\mathbf{F}_\perp \times d$: $\tau = F_\perp d = F \sin\theta \times d$

Choose the method that is the more convenient...