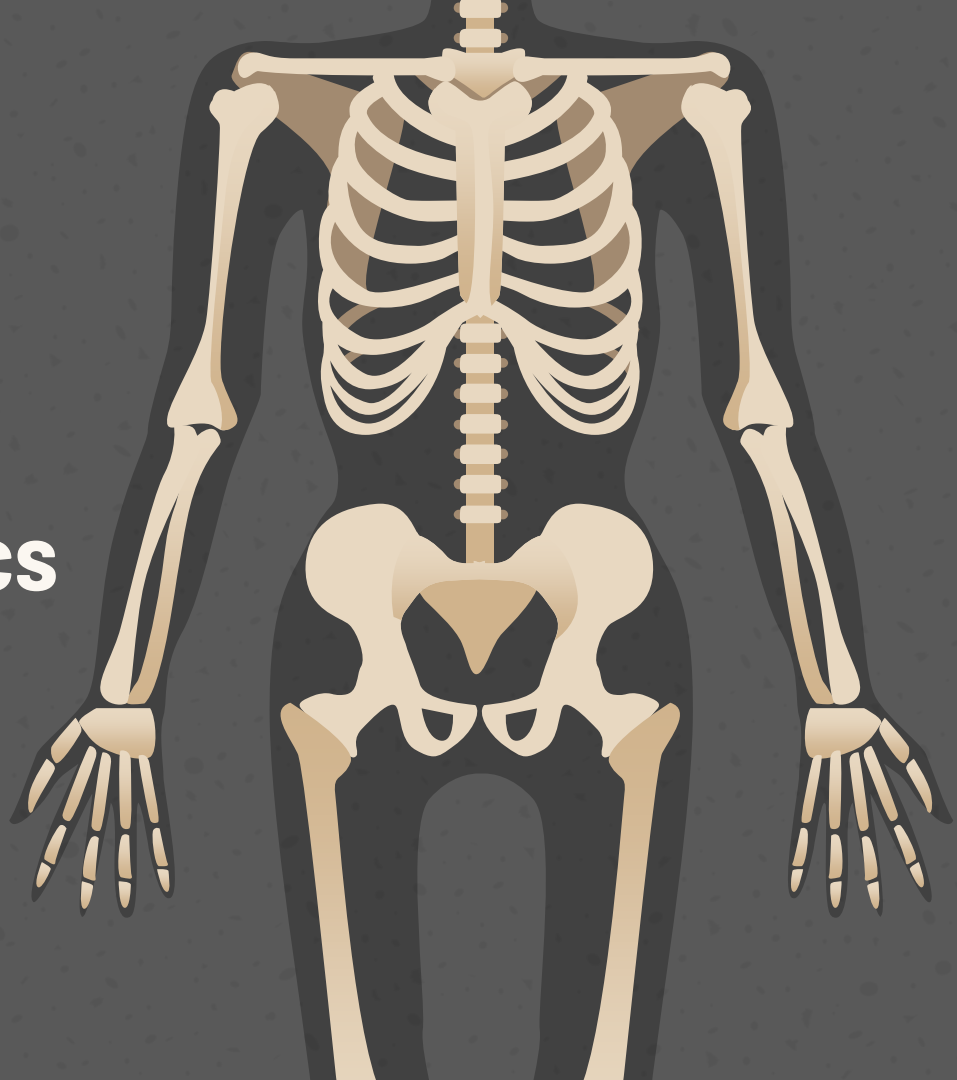
Statics and Dynamics of Body

Pouya Taghipour
Dr. Malikeh Nabaei
Winter 2024



01. Overview

First of all, we're going to take a general look at this concept.

02. Generals

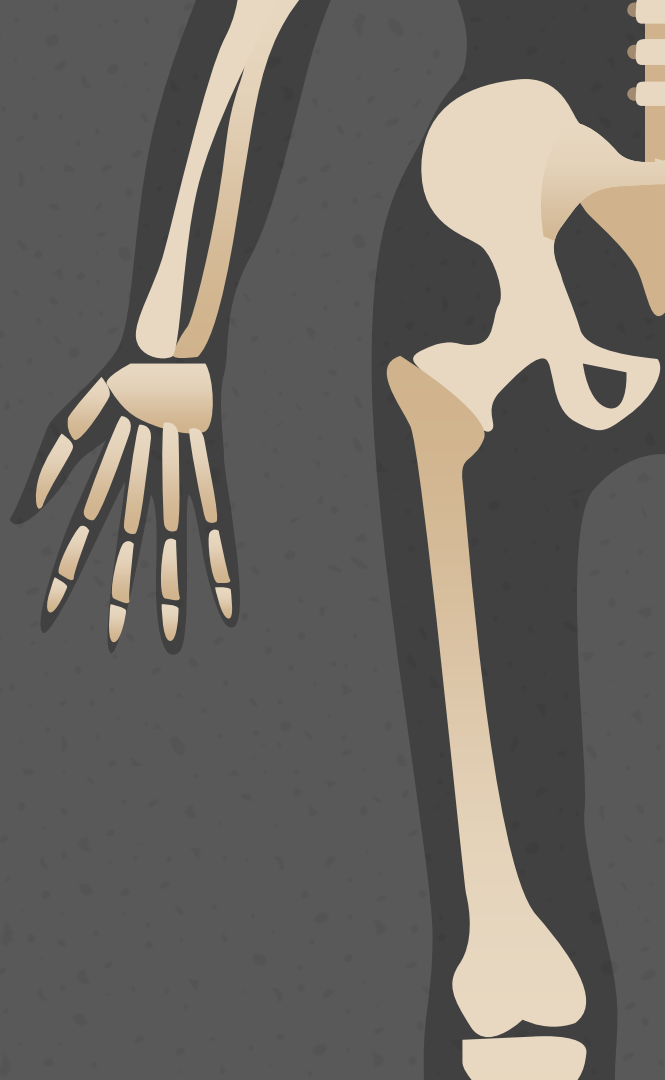
Some useful advice

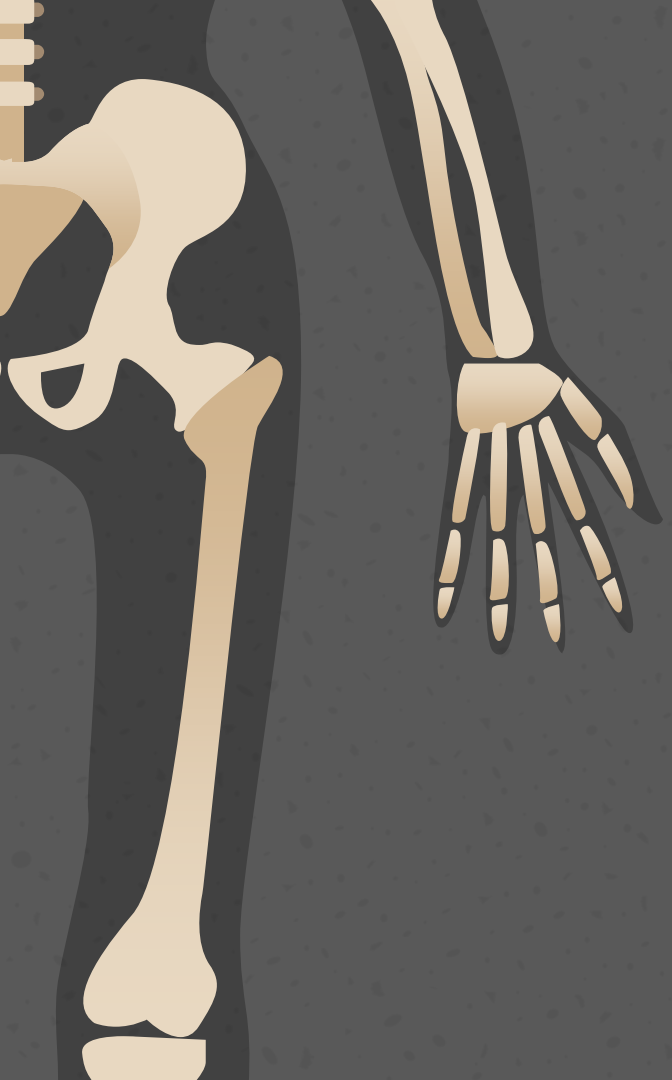
03. Examples

There are some educational and some practical examples which we will discuss.

04. Assignment

At the end, we will take an overview of your homework and explain some possible problems.





Introduction

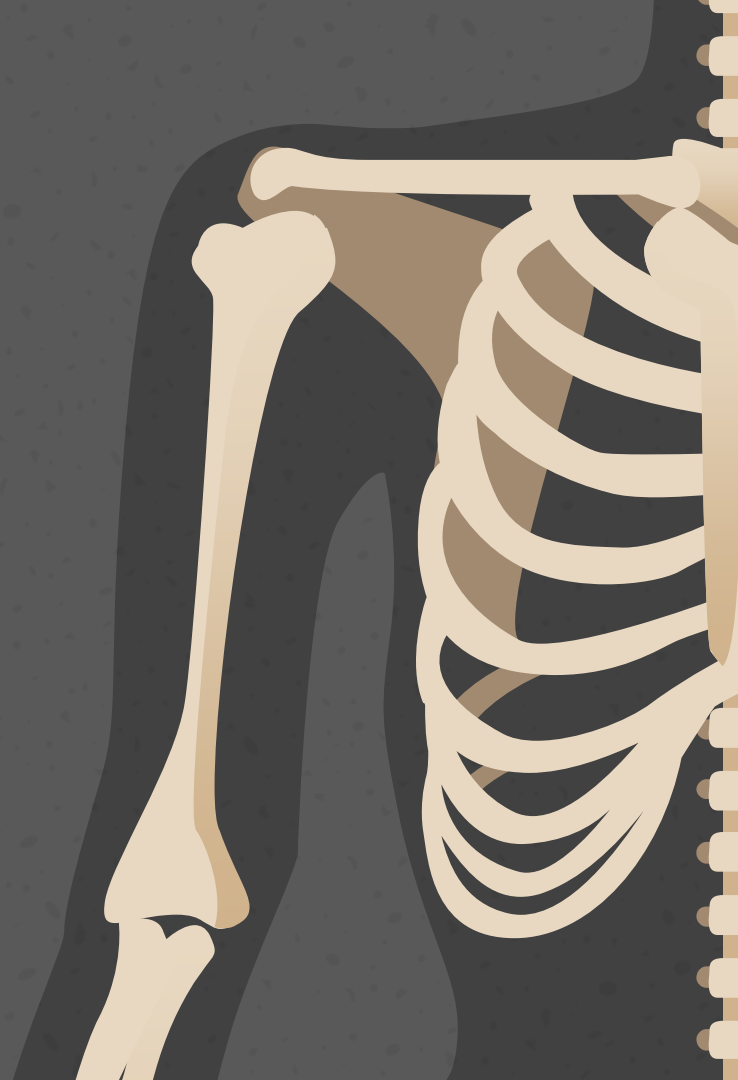
The study of the force balance of an object at rest is called “statics.” Moreover, the study of very slow motion can usually be treated as a series of static conditions – as if there were no motion; this is called “quasistatics.”

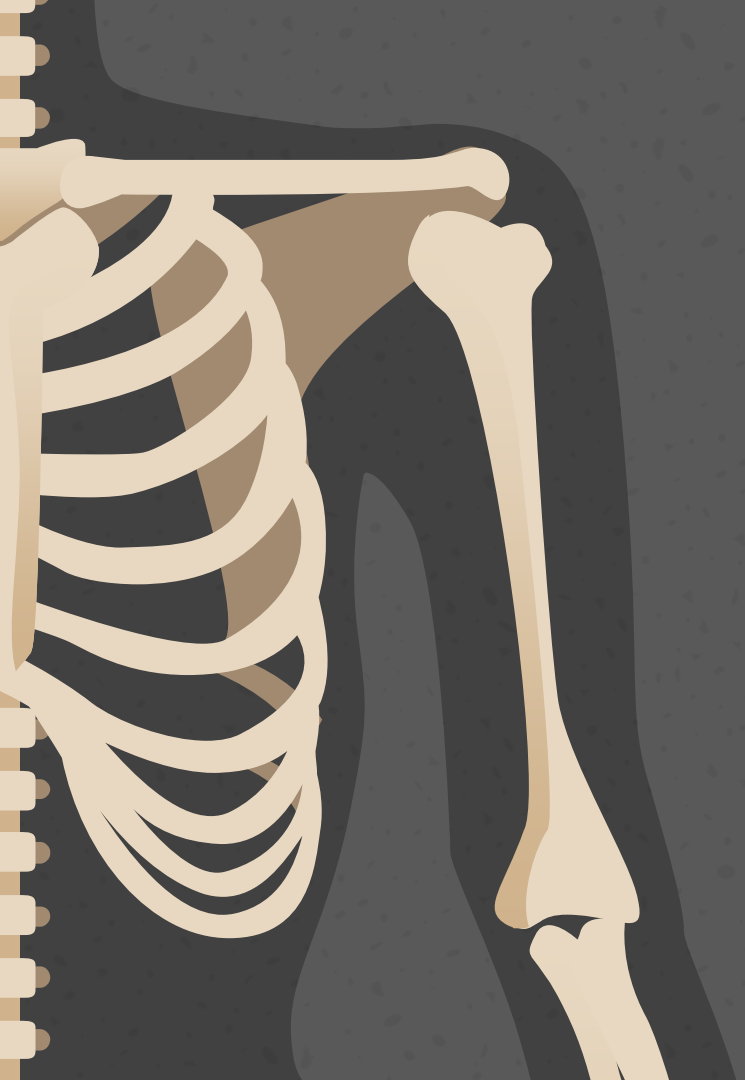
After reviewing the conditions for static equilibrium in three dimensions, we will examine the useful simplification to two dimensions, examples of which can often be characterized as one of the three types of levers. We will then apply these equilibrium conditions to the lower arm, hip, and the spine (lower back). Statics is one important area in biomechanics

—The course's reference

01.

OVERVIEW



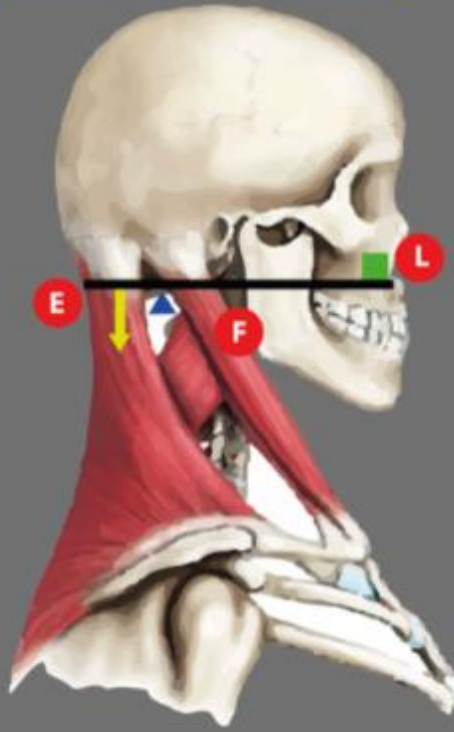


What Is This Topic About?

- At the end of this course, we are able to solve statics and dynamical questions
- We will review the topics and formulas here
- You could give a brief description of the topic you want to talk about after this class
- You will able to find your way to challenging problems

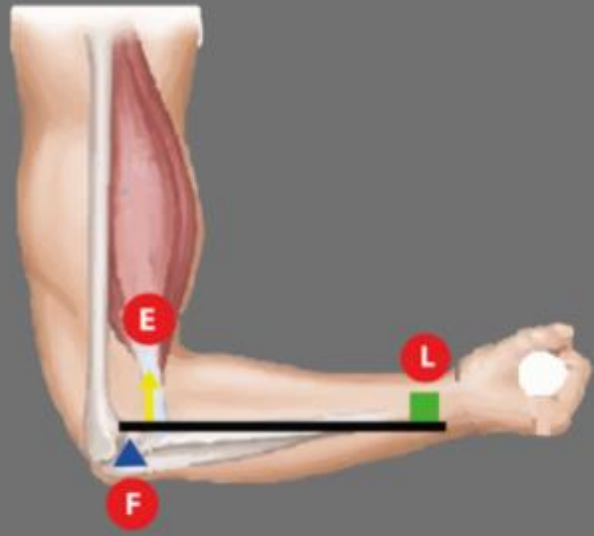
Levers Of Human Body

First Class Lever



Second Class Lever

Third Class Lever



Equilibrium conditions

x

$$\sum F_x = 0$$

$$\sum \tau_x = 0$$

y

$$\sum F_y = 0$$

$$\sum \tau_y = 0$$

z

$$\sum F_z = 0$$

$$\sum \tau_z = 0$$

In general, the torque (vector τ) about any axis is defined as the vector cross product between the distance vector from that axis to the point where the force is applied r and the force vector F

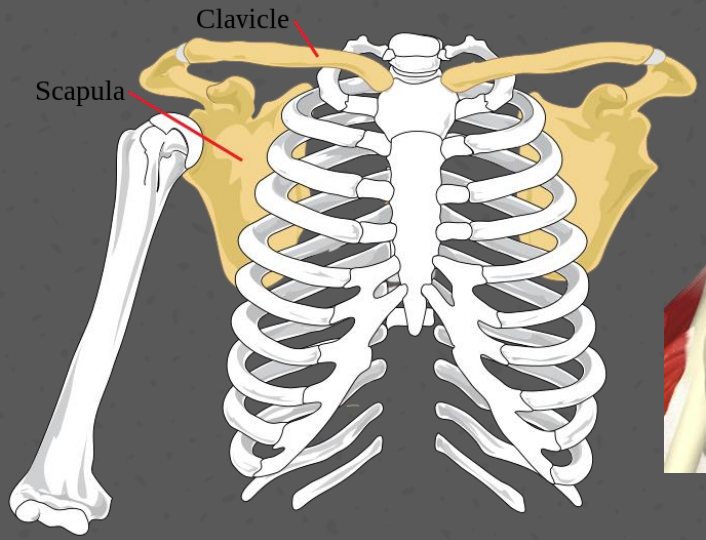
$$\tau = r \times F$$

$$\tau_z = r\ F sin\theta$$

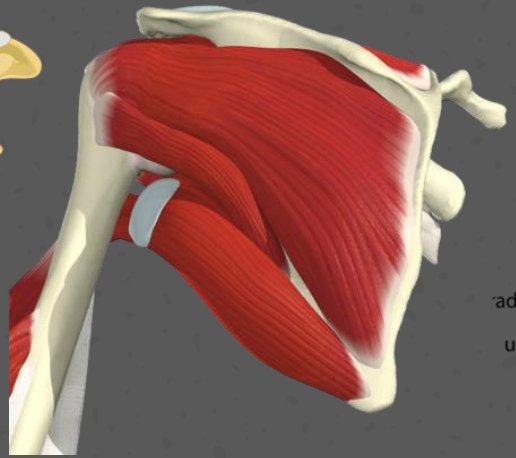
Bones and muscles of the hand

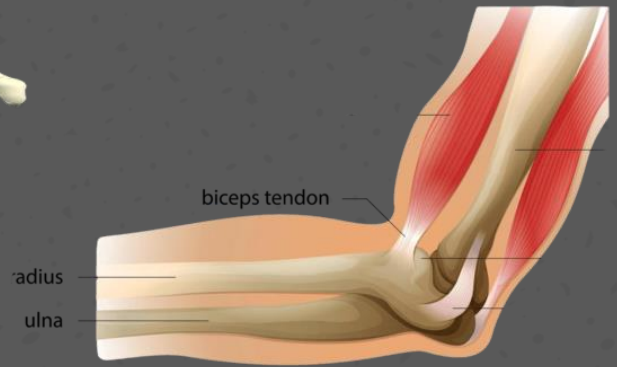
Radius, Ulna, Scapula — Bone

Muscle — Deltoid, Biceps

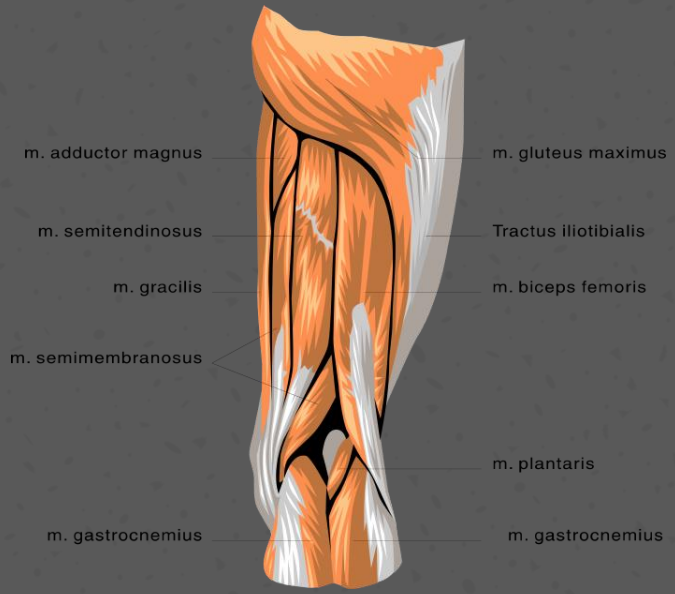


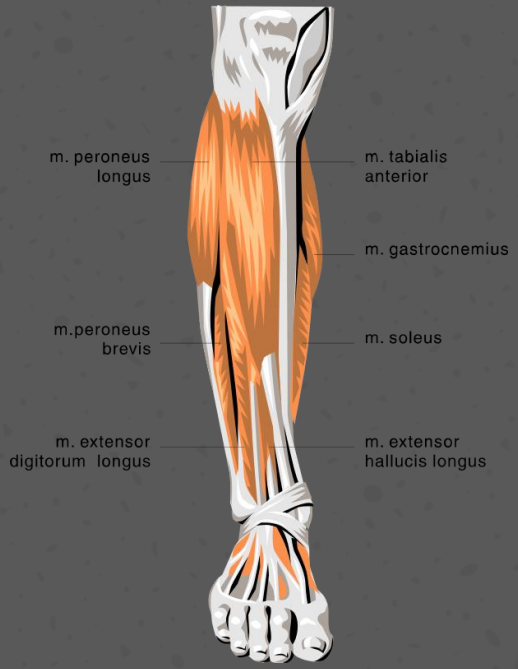
Front view

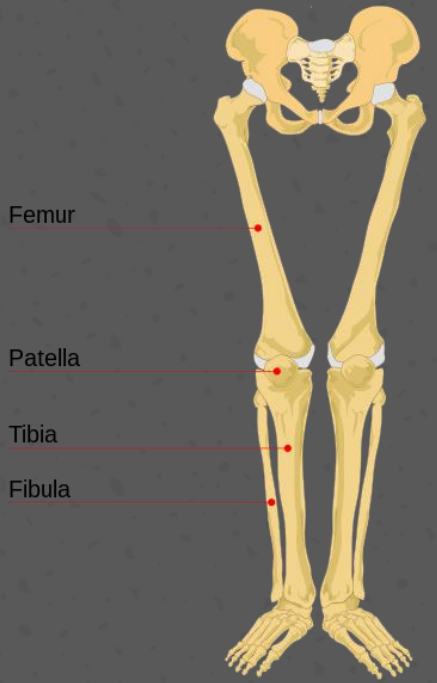




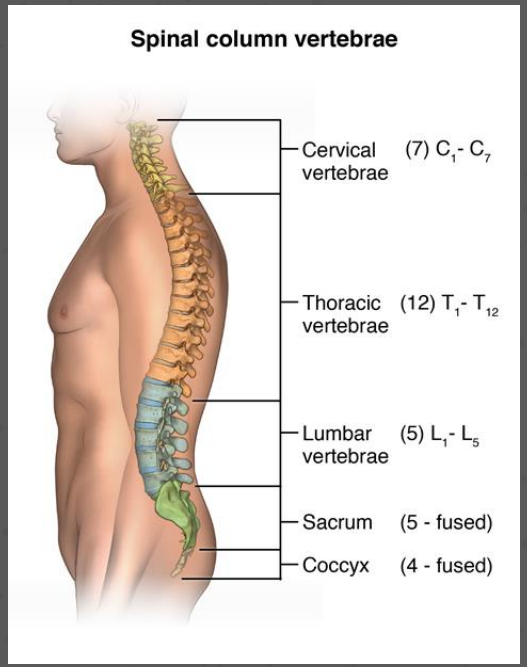
Leg bones and muscles

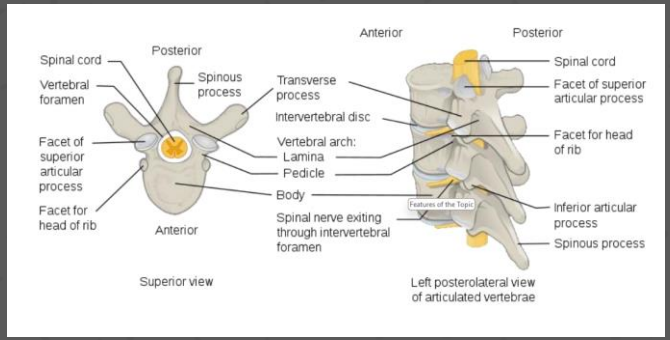






Back Bones and muscles





$$F = m \times a$$

$$\frac{\Delta(mV)}{\Delta t} = F$$

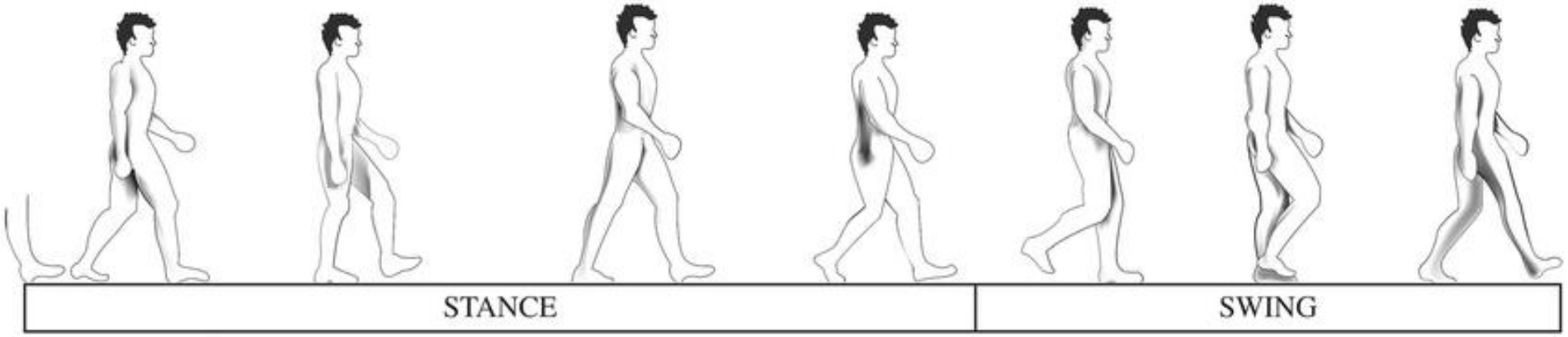
$$E = KE + PE$$

$$PE = m_b g h$$

$$KE = KE_H + KE_V$$

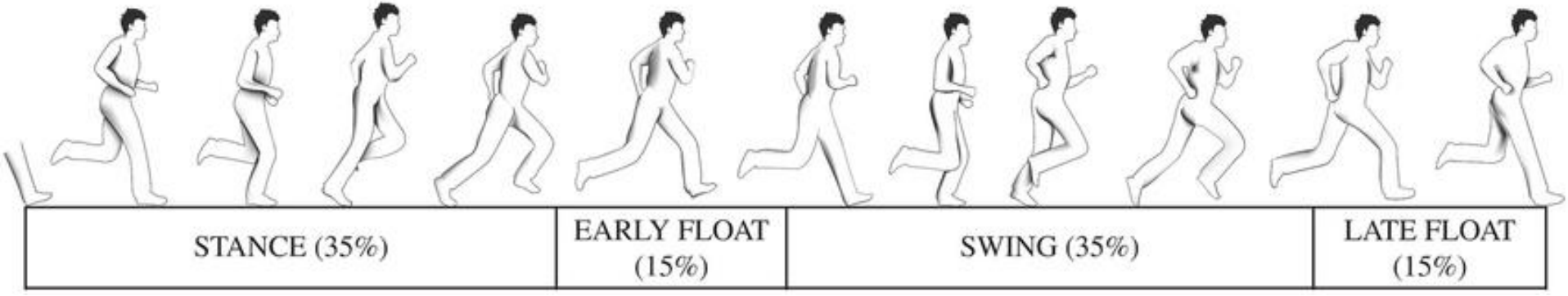
$$KE_H = \frac{1}{2} m_b v_x^2 = \frac{1}{2} m_b \left(\frac{dx}{dt}\right)^2$$

$$KE_V = \frac{1}{2} m_b v_z^2 = \frac{1}{2} m_b \left(\frac{dz}{dt}\right)^2$$



WALKING

RUNNING



02.

Generals

Process

Statics of Human Body

01.

02.

Examples

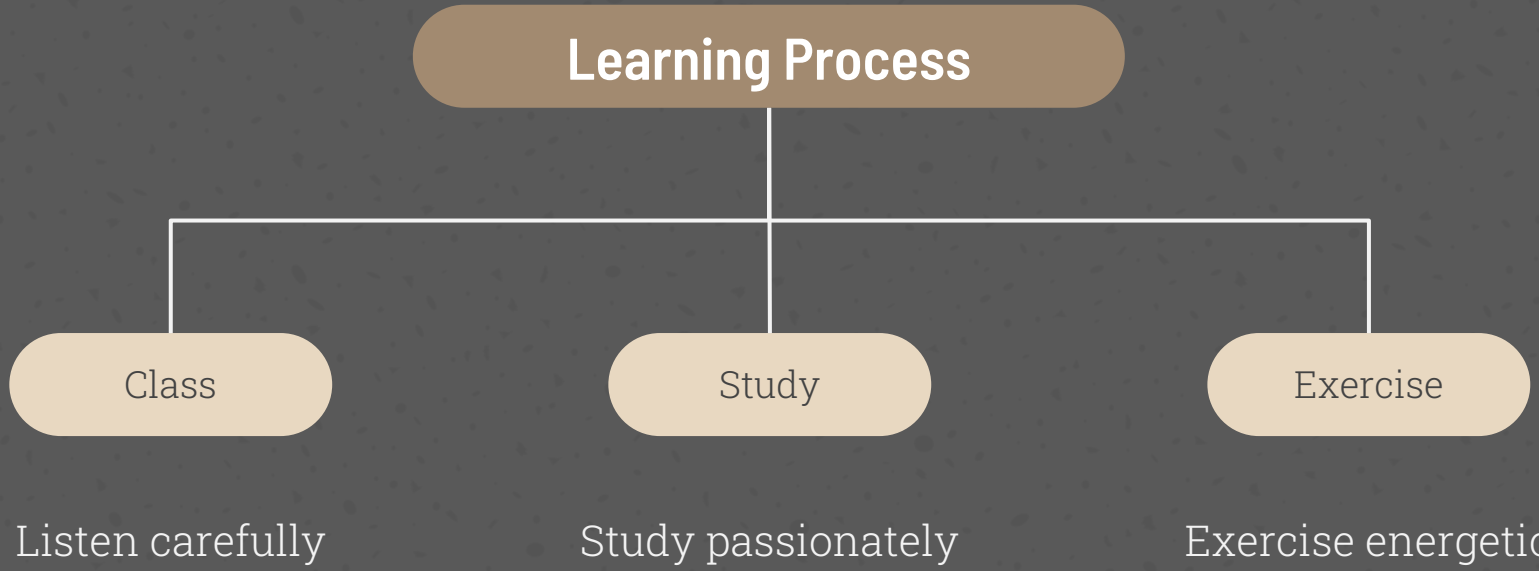
Dynamics of Human Body

03.

04.

Examples

Learning Diagram



More Passion

More Passion

More Energy

More Energy

Team Works

%50

Your understanding of the question

%30

The right approach in solving the question

%20

The final answer

Steps to solve a problem

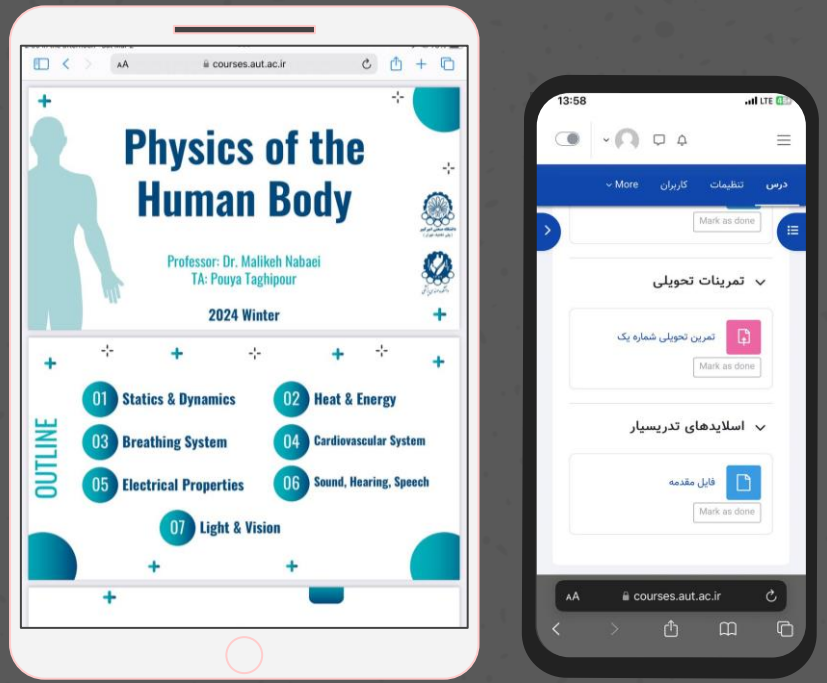
Block Diagrams

Problem Solving

Assumptions

Calculations

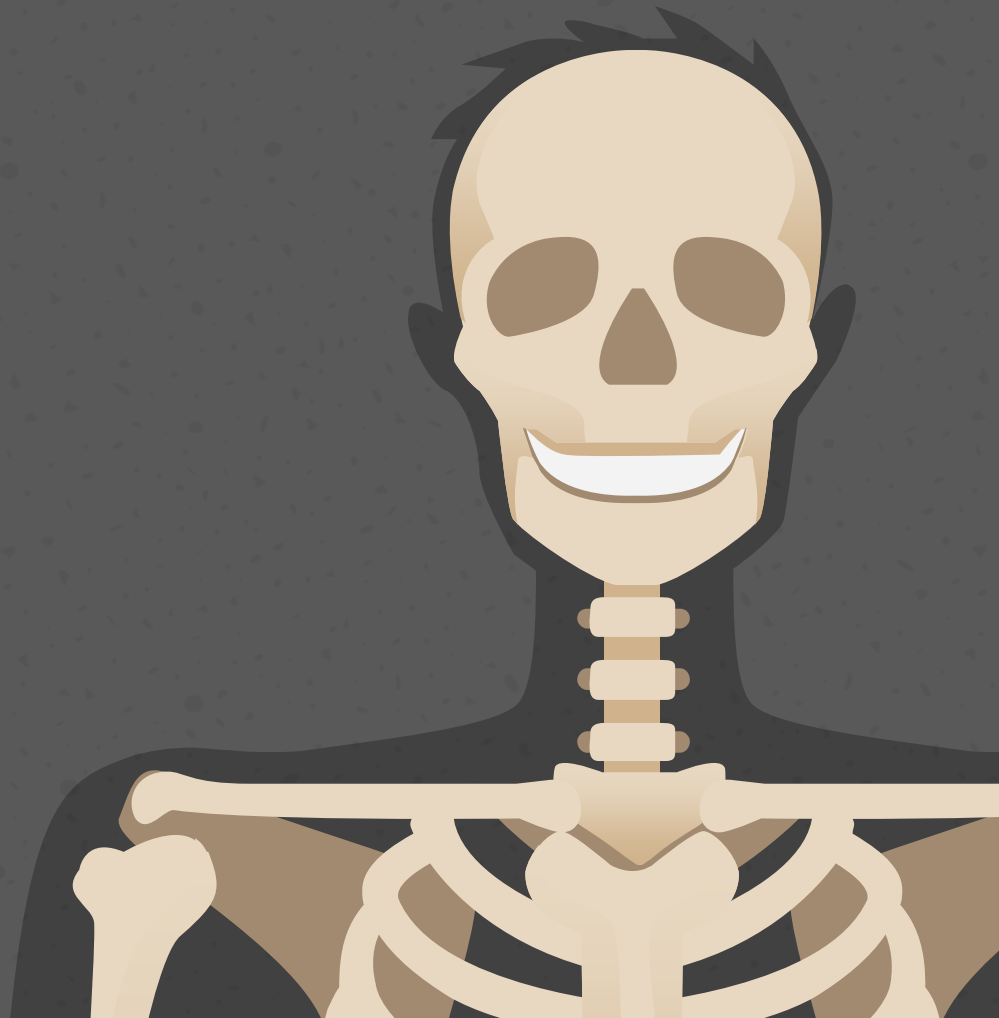
Courses



A place to upload assignments and course materials

03.

Examples



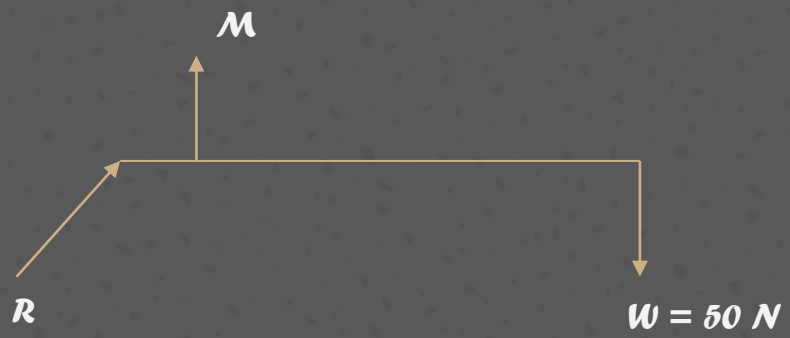
Example 2-1

A basket with a handle containing 5 kg of fruit is placed on the table. Suppose you want to lift the basket from the table in two ways.

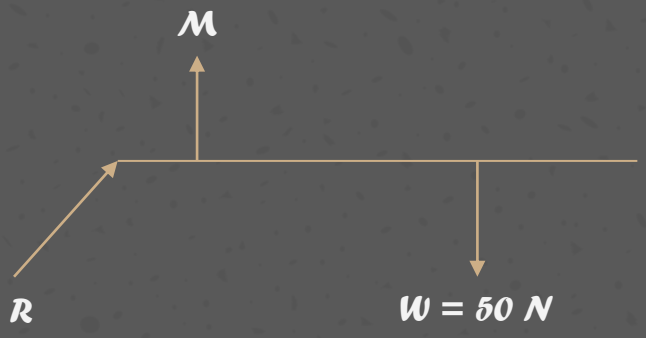
1) In the situation where the angle of your forearm is 90 degrees with your arm, try to hold the basket handle with your palm and lift it.
2) Throw the basket handle around your forearm (at a distance of half the length of the forearm) and lift the basket.

Example 2-1

Answer:



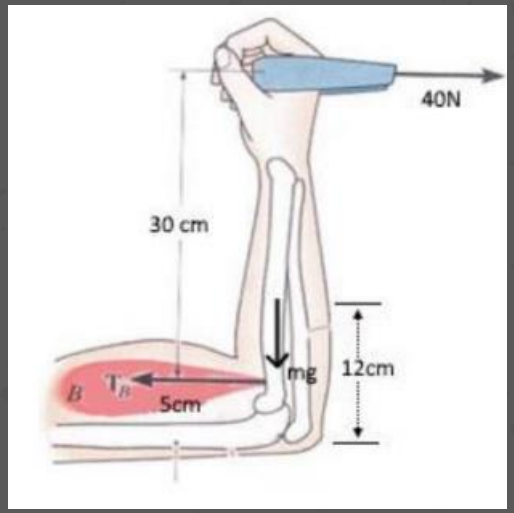
Using hands



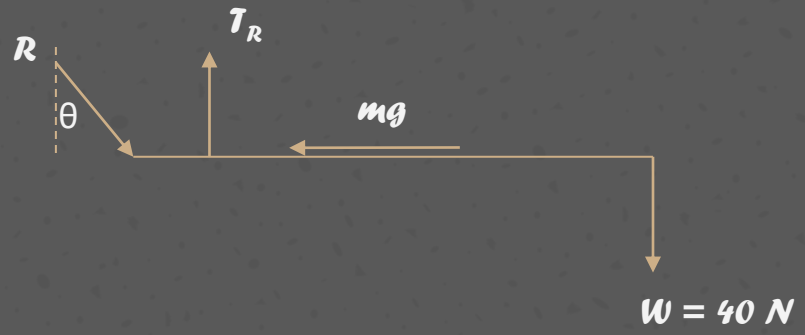
Using forearm

Example 2-2

According to the figure below, a force of 40 newtons is applied to the elastic and the person tries to keep his hand straight. If the mass of the forearm is 2 kg, find the force of the muscle and the joint.



Example 2-2



Answer:

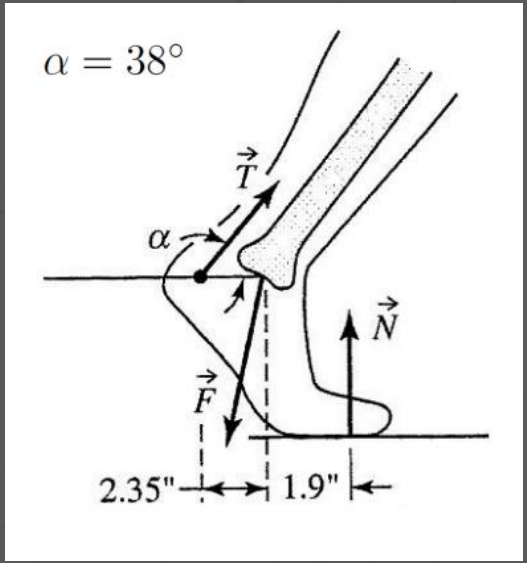
$$\sum M_o = 0 \rightarrow T \times 5 = 40 \times 35 \rightarrow T_R = 280N$$

$$\sum F_y = 0 \rightarrow mg = Rsin\theta = 20$$

$$\sum F_x = 0 \rightarrow 40 + Rcos\theta = T_R \rightarrow Rcos\theta = 240 \begin{cases} \theta = \tan^{-1}\dfrac{20}{240} \rightarrow \theta = 4.76 \\ R = 240.83N \end{cases}$$

Example 2-3

A person weighing 200 pounds is standing on his toes as shown below. Find the force on the ankle joint and hamstring.



Example 2-3

A person weighing 200 pounds is standing on his toes as shown below. Find the force on the ankle joint and hamstring.

$$\sum M_o = 0 \rightarrow T_x(sin38) \times 2.35 = N \times 1.9$$

$$N = 100$$

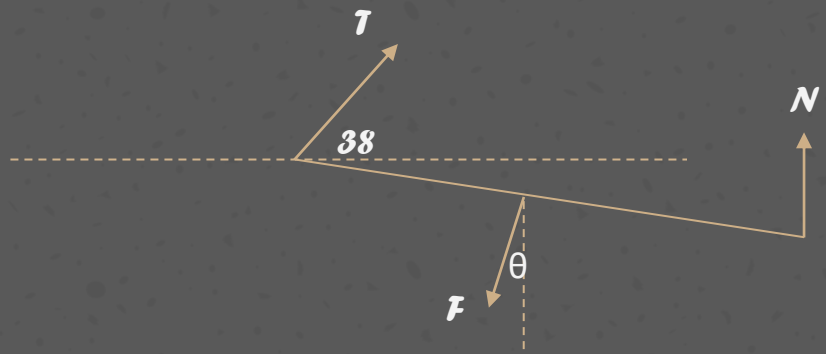
$$T = 131.3$$

$$\sum F_x = 0 \rightarrow Tcos38 = Fsin\theta = 103.48$$

$$\sum F_y = 0 \rightarrow N + Tsin38 = Fsin\theta = 180.8$$

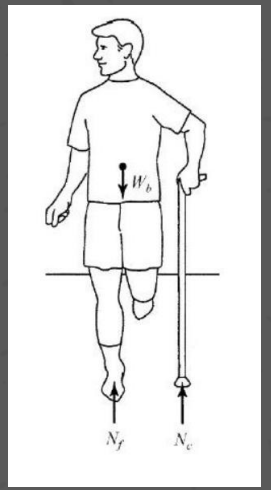
$$\theta = 29.76$$

$$F = \frac{103.48}{sin\theta} = 208.47$$



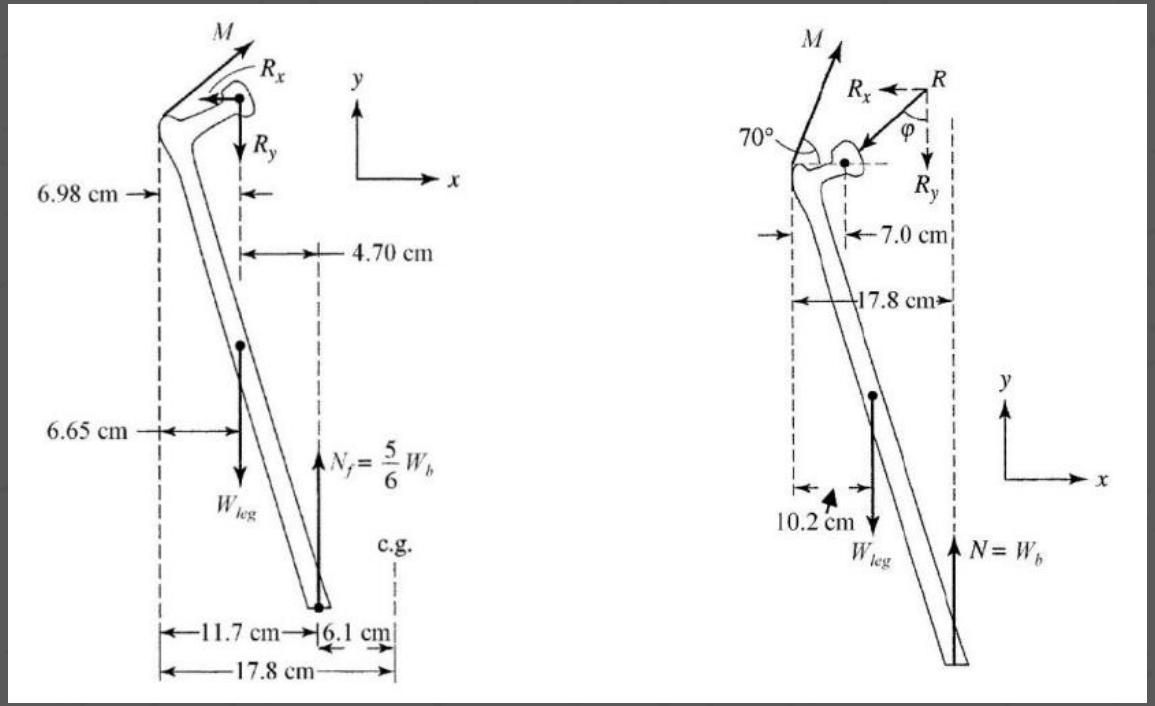
Example 2-4

A person is standing on his right leg with the help of a cane as shown in the figure below, and suppose that the cane supports one-sixth of the body weight, find the force on the hip joint and the muscle force. (The weight of the foot is equal to 0.16 of the body weight.)



Example 2-4

Attention:



Example 2-4

Answer:

$$\sum f_y = 0 \rightarrow N_f + N_C - W_b = N_f - \frac{5}{6}W_b = 0 \rightarrow N_f = \frac{5}{6}W_b$$

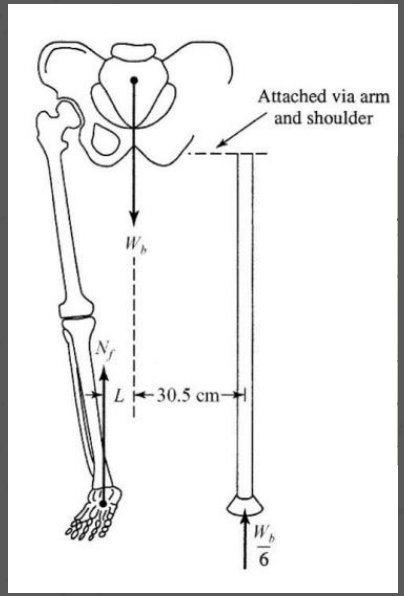
$$\sum M = 0 \rightarrow L(N_f) + 30.5(N_C) = L = \frac{1}{5}(30.5) = 6.1\ cm$$

$$\sum M_O = 0 \rightarrow M(sin70) \times 6.98 = 4.7 \times \frac{5}{6}W_b + (6.98 - 6.65)0.16W_b = M = 0.602W_b$$

$$\sum F_x = 0 \rightarrow Mcos70 = R_x = 0.21W_b$$

$$\sum F_y = 0 \rightarrow Msin70 + \frac{5}{6}W_b = R_y + 0.16W_b \rightarrow R_y = 1.24W_b$$

$R = 1.26W_b$
$\theta = 9.5$



04.

Assignment

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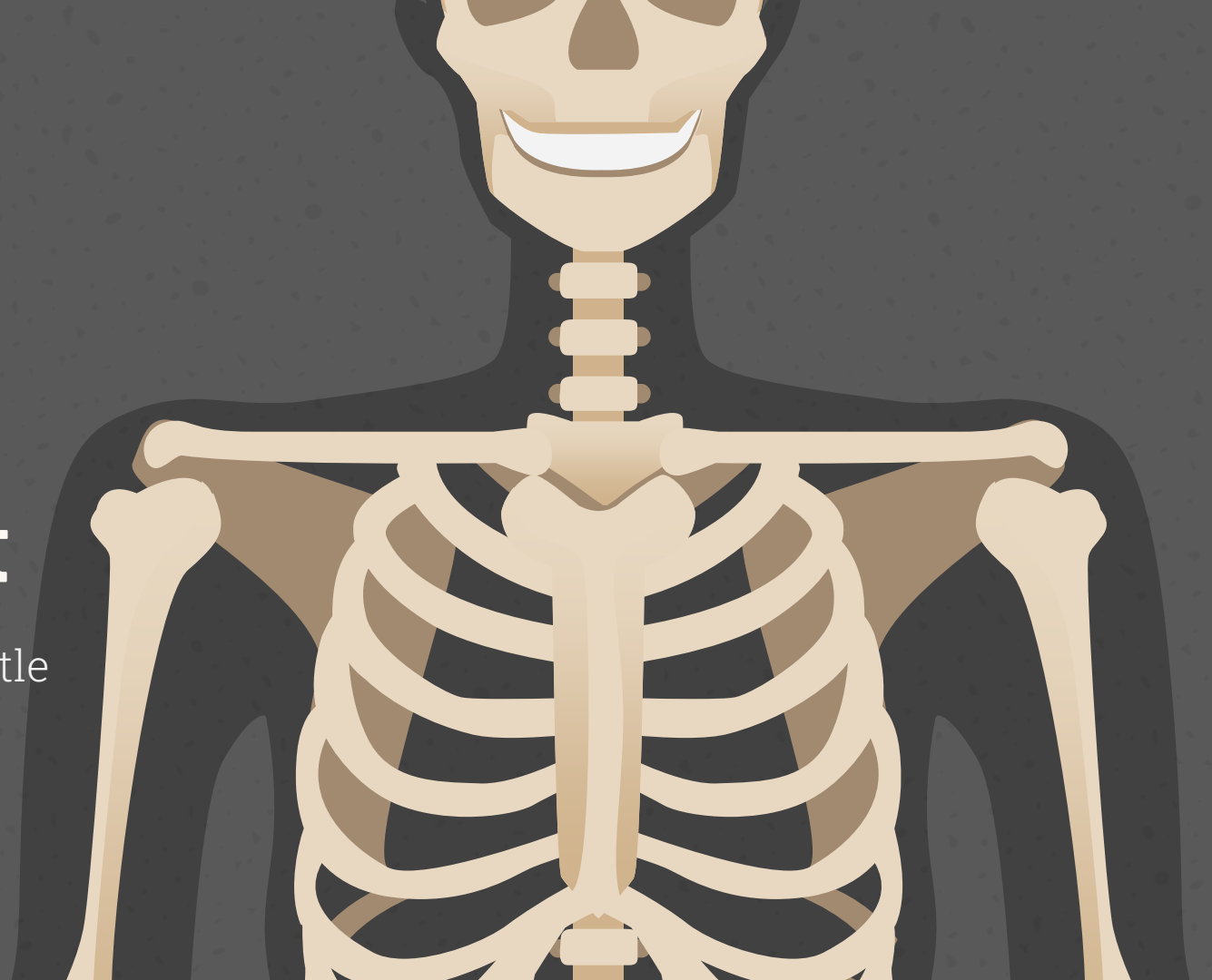


Future Works

Deadline

Monday
What then?

Next Session

HW & Our Lessons

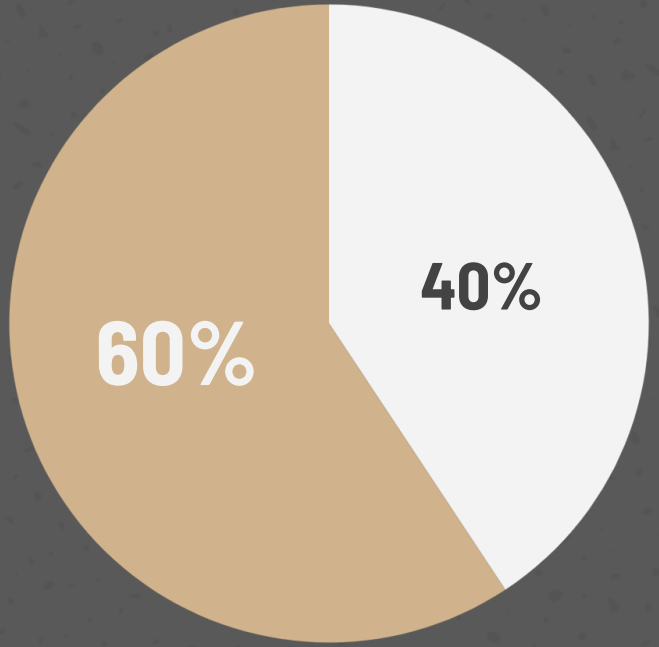
Your Understanding Process

Reviewing

The importance of learning the same topic more than once is faded for university students

Examples

You will learn much more than you'd thought during the process of solving problems



Class Activity

_____?

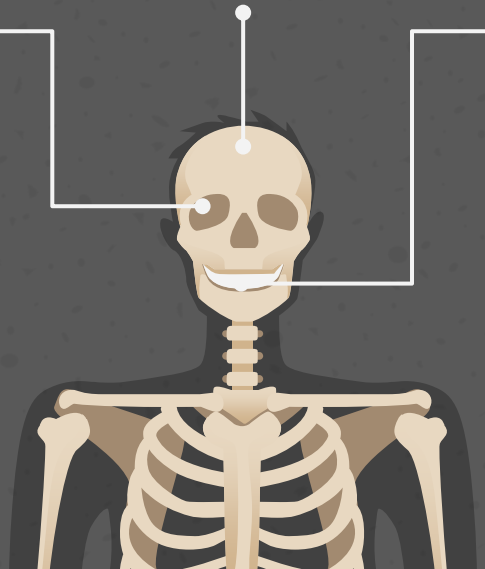
Think

_____?

Observe

_____?

Discuss



Assignment

Your First Class Activity!

Resources

Dr. Malikeh Nabaei

- Slides
- Classes

Faezeh Jahani

- Slides

Thanks!

Do you have any questions?

Taghipourpouyaa@gmail.com
@PouyaTghpr
Pouya Taghipour

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Have a good afternoon