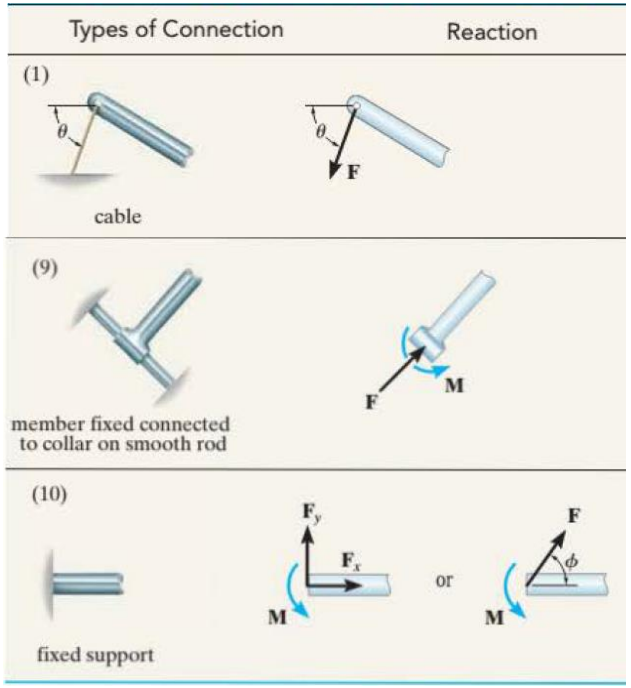
- **Course:** 2nd year Biomechanics (Statics and Strength of Materials)

- **Context for the activity**
  - Newton's 3rd Law: for every action there is an equal and opposite reaction
  - In biomechanics, we represent the way an object is connected to other objects by the mathematical concept of a "support"
  - Supports can provide translational and/or rotational support

The cable exerts a force on the bracket in the direction of the cable. (1)

The floor beams of this building are welded together and thus form fixed connections. (10)

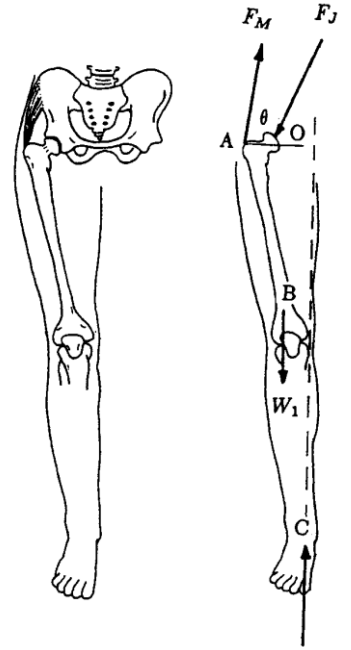


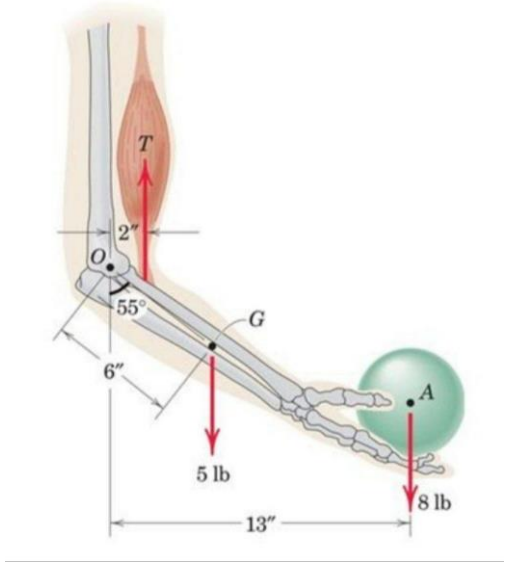
Hibbeler, R. C. (2017). *Statics and mechanics of materials.* Fifth edition. Hoboken: Pearson.

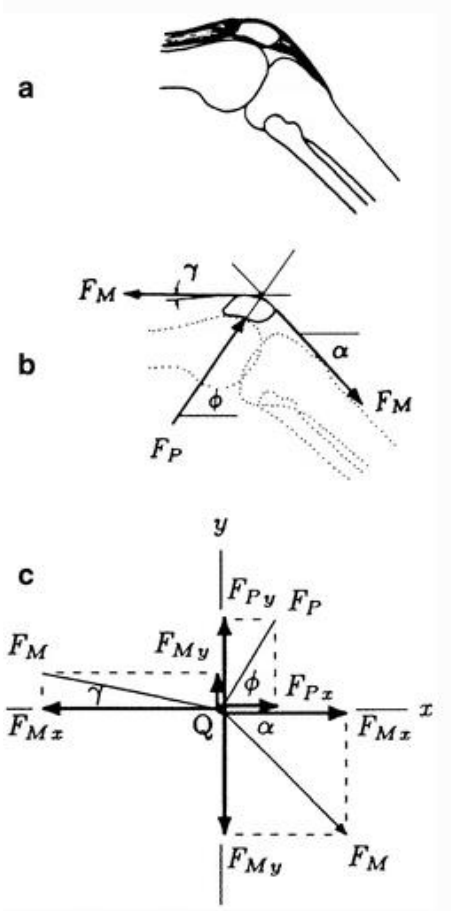
Penn Engineering
University of Pennsylvania

- **In class pre-activity discussion**
  - Force and moment/torque equilibrium
  - Free body diagrams
  - Newton's 3rd Law
    - Reminder that they've seen normal forces (physics)
  - Vectors can be broken into 3 orthogonal components
  - **No** discussion of "supports"

- **Activity goals**
  - Establish physical relevance of reaction forces and moments
  - Introduce how to represent these concepts on a free body diagram
  - Introduce how musculoskeletal systems can be modeled using mechanics principles





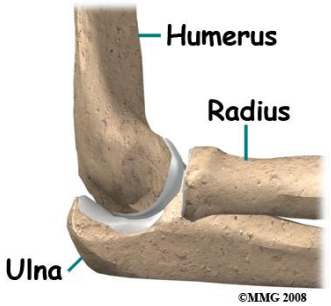


Özkaya, N., Leger, D., Goldsheyder, D., Nordin, M. (2017). Applications of Statics to Biomechanics. In: Fundamentals of Biomechanics. Springer, Cham.

Penn Engineering
University of Pennsylvania

SUPPORT: HINGE

The elbow is limited in its directions of motion. Post-operative elbow braces mimic the elbow joint by using a hinge mechanism.



1. Using the materials and tools in front of you, create a model of this hinge joint. Imagine it being simplified to a point.

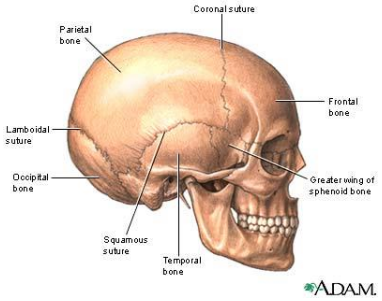
2. Try rotating, pushing, and pulling on your model in all 3 planes. Focus on what is happening to one piece of wood relative to the other piece. It may be helpful to hold one block still and try to move the other one. Describe/list what is happening. Specifically, is there is a resistance to translational or rotational motion that one block exerts on the other? Be specific which direction the resistance is in or about. Is there a reaction (recall Newton's 3rd law) that prevents rotation or translation in a particular direction from one block applied on the other?

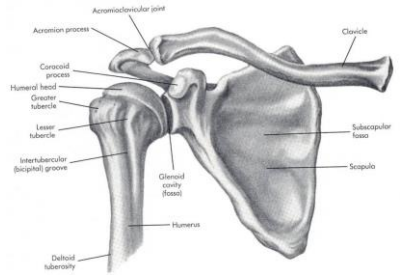
3. At a point where the fixed support is acting, what mechanical reactions does this joint produce in 3D? Remember to think about rotation and translation. How are you going to represent a resistance to rotation?

4. Draw the beginnings of a FBD to represent the reactions produced by a 3D hinge joint. Isolate (draw) one block of your model for the FBD and represent the reactions of the other block at the point of connection (the elbow support).

Other scenarios in this activity

- 2D pin joint
- Skull sutures/fixed support
- Shoulder/ball and socket





Penn Engineering
University of Pennsylvania