

Mechanical Engineering and the Human Body: A Hard Dive

Mechanical Engineering · Answer Key · 16 Questions

1. The primary mechanical function of the Achilles tendon, a key component in human locomotion, is to transmit forces from which muscle group to the calcaneus bone, enabling plantarflexion?

- A) Quadriceps femoris
- B) Hamstrings
- C) Gastrocnemius and soleus**
- D) Deltoid

2. In the context of joint biomechanics, the hip joint is a ball-and-socket joint. What is the approximate average range of motion for hip flexion in a healthy adult human, considering typical daily activities?

- A) 30-45 degrees
- B) 60-75 degrees
- C) 90-120 degrees**
- D) 150-180 degrees

3. The human heart, acting as a sophisticated pump, generates pressure to circulate blood. What is the typical diastolic blood pressure reading for a healthy young adult at rest?

- A) 130-140 mmHg
- B) 110-120 mmHg
- C) 70-80 mmHg**
- D) 50-60 mmHg

4. The vertebral column, a marvel of bio-engineering, provides support and flexibility. What is the approximate number of cervical vertebrae found in a typical human spine?

- A) 5
- B) 7**
- C) 12
- D) 5

5. The mechanics of breathing involve the diaphragm and intercostal muscles. During quiet inspiration, the volume of the thoracic cavity increases primarily due to the contraction and downward movement of which muscle?

- A) External oblique
- B) Diaphragm**
- C) Serratus anterior
- D) Pectoralis major

6. The human eye's lens functions mechanically to focus light onto the retina. What is the approximate refractive power of the human eye's lens in diopters when relaxed for distance vision?

- A) 10-15 D
- B) 20-25 D
- C) 30-35 D**
- D) 50-60 D

7. The skeletal structure of the hand allows for complex manipulation. The metacarpophalangeal joints (knuckles) allow for flexion and extension. What is the approximate maximum degree of flexion at the metacarpophalangeal joint of the index finger?

- A) 45 degrees
- B) 70 degrees
- C) 90 degrees**
- D) 120 degrees

8. The jaw joint (temporomandibular joint or TMJ) is a complex hinge and gliding joint. What is the typical maximum vertical opening of the mouth for a healthy adult, measured from the incisal edges of the upper and lower incisors?

- A) 20-30 mm
- B) 30-40 mm
- C) 40-50 mm**
- D) 50-60 mm

9. The elasticity of arteries is crucial for maintaining blood pressure. The aorta, the largest artery, has significant elastic recoil. What is the approximate typical wall thickness of the human aorta?

- A) 0.5 - 1.0 mm
- B) 1.0 - 2.0 mm**
- C) 2.0 - 3.0 mm
- D) 3.0 - 4.0 mm

10. The structure of bone, a composite material, provides strength and rigidity. Cortical bone, the dense outer layer, has a typical porosity that influences its mechanical properties. What is the approximate percentage of porosity in healthy cortical bone?

- A) 1-5%**
- B) 5-10%
- C) 10-20%
- D) 20-30%

11. The knee joint is a complex hinge joint. The menisci within the knee act as shock absorbers. What is the approximate thickness of the medial meniscus in the human knee?

- A) 1-2 mm
- B) 3-4 mm**
- C) 5-6 mm
- D) 7-8 mm

12. The mechanics of swallowing involve coordinated muscle contractions. The pharyngeal phase of swallowing is a rapid, involuntary process. What is the approximate duration of the pharyngeal phase of a single swallow in seconds?

- A) 0.1 - 0.2 seconds**
- B) 0.5 - 1.0 seconds
- C) 1.5 - 2.0 seconds
- D) 2.5 - 3.0 seconds

13. The human ankle joint, primarily a hinge joint, allows for dorsiflexion and plantarflexion. What is the approximate range of motion for ankle dorsiflexion in a healthy adult, with the knee extended?

- A) 5-10 degrees
- B) 10-20 degrees
- C) 20-30 degrees**
- D) 30-40 degrees

14. The structure of cartilage in joints provides a low-friction surface. Articular cartilage, particularly in weight-bearing joints, has a remarkable ability to withstand compressive loads. What is the approximate compressive strength of articular cartilage?

- A) 5-10 MPa
- B) 10-20 MPa
- C) 20-30 MPa**
- D) 30-40 MPa

15. The process of bone healing involves complex mechanical and biological remodeling. The initial stage of fracture healing involves the formation of a soft callus. What is the approximate duration of the soft callus formation stage after a bone fracture?

A) 1-2 weeks

B) 2-4 weeks

C) 4-6 weeks

D) 6-8 weeks

16. The movement of the shoulder joint (glenohumeral joint) is highly mobile. The supraspinatus muscle is crucial for initiating abduction. What is the approximate torque generated by the deltoid muscle during shoulder abduction, relative to the supraspinatus?

A) Equal to

B) Half of

C) Twice that of

D) Ten times that of