



AMREF INTERNATIONAL UNIVERSITY
SCHOOL OF MEDICAL SCIENCES
DEPARTMENT OF REHABILITATION MEDICINE
BACHELOR OF SCIENCE IN PHYSIOTHERAPY

END OF TRIMESTER EXAMINATIONS JANUARY TO APRIL 2025

UNIT CODE: PHT 126

UNIT NAME: Medical physics exam

DATE: 7th APRIL 2025

TIME: 9am-11am

INSTRUCTIONS

- 1. All students will have two (2) hours to complete the examination**
- 2. This is an online exam, Attempt all questions as per the instruction**
- 3. It is the student's responsibility to report any page and number missing in this paper.**
- 4. Check that the paper is complete**
- 5. Total number of pages is 5 including the cover.**
- 6. Read through the paper quickly before you start.**

Section A Multiple choice questions. Answer all the questions (30 Marks)

1. According to the impulse-momentum principle, which of the following strategies can help a stroke patient increase forward momentum during gait training?
 - A. Taking shorter steps
 - B. Increasing step length and push-off force
 - C. Reducing ground reaction force
 - D. Decreasing stride frequency
2. Why does wheeling an **endomorph** man require more force than wheeling an **ectomorph** man?
 - A. The endomorph has a greater muscle-to-fat ratio
 - B. The endomorph has a greater mass, requiring more force to accelerate according to Newton's Second Law
 - C. The ectomorph has more resistance to motion
 - D. The ectomorph has a greater gravitational pull
3. Which principle explains why jumping exercises help in sports rehabilitation?
 - A. Newton's First Law (Inertia)
 - B. Newton's Second Law ($F = ma$)
 - C. Newton's Third Law (Action-Reaction)
 - D. Law of Conservation of Energy
- 4.
5. Which of the following BEST describes how principles of physics contribute to improving rehabilitation outcomes in physiotherapy?
 - A. Investigating biomechanical reactions that influence musculoskeletal function
 - B. Analyzing forces, energy transfer, and motion mechanics to enhance rehabilitation outcomes
 - C. Evaluating gravity's role in joint stability and injury prevention
 - D. Studying neural pathways controlling voluntary and involuntary muscle contractions
6. To effectively improve postural stability and minimize the risk of falls, which biomechanical adjustment is MOST beneficial?
 - A. Increasing walking speed to generate momentum and shorten unstable phases
 - B. Lowering the center of mass and widening the base of support for better control
 - C. Reducing muscle engagement to minimize strain on postural muscles
 - D. Decreasing sensory input from proprioceptors and the vestibular system
7. When analyzing a patient's gait pattern, which of the following forces is PRIMARILY responsible for initiating movement in the lower limb?
 - A. Gravitational force
 - B. Muscular force
 - C. Frictional force
 - D. Reaction force
8. During a shoulder abduction movement, which anatomical plane and axis of rotation are involved in determining the motion?
 - A. Frontal plane, anteroposterior axis
 - B. Sagittal plane, mediolateral axis
 - C. Transverse plane, vertical axis
 - D. Frontal plane, mediolateral axis

9. A patient is instructed to hold a dumbbell in a fixed position for 10 seconds during therapy. How does this affect the amount of mechanical work done?
- A. No mechanical work is done
 - B. Work is maximized
 - C. Work depends on muscle fiber recruitment
 - D. Work increases with time
10. A person uses a lever to lift a heavy object. If the force arm is **10 cm** and the resistance arm is **25 cm**, how much force is required to lift a **15 kg** object?
- A. 30 kg
 - B. 37.5 kg
 - C. 50 kg
 - D. 75 kg
11. Which of the following motions PRIMARILY occurs within the transverse plane when assessing joint movements in human motion analysis?
- A. Knee flexion during walking
 - B. Shoulder internal rotation around a vertical axis
 - C. Ankle dorsiflexion when lifting the foot upward
 - D. Hip abduction moving the thigh laterally
12. When evaluating stability in a standing posture, which factor plays the MOST significant role in maintaining balance?
- A. Position of the center of mass relative to the base of support
 - B. Speed of movement
 - C. Level of muscular activity
 - D. External load on the body
13. A patient applies force against a resistance band, generating an acceleration of 6 m/s^2 . If the mass of the arm segment involved is 2 kg , how much force is applied according to Newton's second law?
- A. 6 N
 - B. 3 N
 - C. 9 N
 - D. 12 N
14. During refraction, how does the direction of a sound wave change when it moves from a medium with lower speed to one with higher speed?
- A. The wave bends away from the normal due to an increase in velocity
 - B. The wave continues in the same direction without deviation
 - C. The wave bends toward the normal as it slows down in the second medium
 - D. The wave is completely reflected back into the original medium
15. Which of the following is an example of a first-class lever in the human body?
- A. Atlanto-occipital joint (head nodding motion)
 - B. Elbow joint during flexion
 - C. Ankle joint during plantarflexion
 - D. Knee joint during walking

16. Which of the following best describes the focus of "Kinematics" when analyzing the movement of a gymnast performing a flip?
- A. Analyzing the muscular force needed for the flip
 - B. Describing the trajectory and rotation without considering forces
 - C. Studying the forces exerted by the gymnast's muscles
 - D. Determining the body's energy expenditure during the flip
17. When analyzing the propagation of sound waves, which factor primarily determines the speed of sound in a given medium?
- A. Frequency of the sound wave
 - B. Density and elasticity of the medium
 - C. Wavelength of the sound wave
 - D. Amplitude of the sound wave
18. When a physiotherapist applies resistance to a patient's limb to build muscle strength, which of the following is most directly affected?
- A. Impulse
 - B. Work-energy theorem
 - C. Shear stress
 - D. Gravitational potential energy
19. Which of the following expands the most for the same rise in temperature?
- A. Solids
 - B. Liquids
 - C. Gases
 - D. All expand equally
20. Which of the following properties of sound determines its pitch in a medium?
- A. Frequency
 - B. Amplitude
 - C. Wavelength
 - D. Velocity

Section B. Short answer questions. Answer all the question (20 Marks)

1. A person weighing 90 kg stands up from a sitting position. Analyze the forces at the knee joint during this closed-chain motion, where the distal end (foot) is fixed on the ground. (8 Marks)

- a. Calculate Superincumbent mass assuming it accounts for 60% of total body weight (typical distribution).
- b. Calculate the gravitational force acting on the superincumbent Force
- c. Calculate Torque (τ). Assume $d=0.3$ (distance from knee to center of gravity of the superincumbent mass).
- d. The quadriceps muscles at the knee joint generate force to counteract this torque and lift the body. If the quadriceps attach at a distance $r=0.05$ Calculate the Muscle force (F_{muscle}) required

2. Critically analyze the role of intensive and extensive properties of matter in clinical decision-making and material selection in physiotherapy. (6 Marks)

3. Outline variables of interest in kinematics (3 Marks)

4. A lever system is used to lift a **6 kg** load with a resistance arm of **20 cm**. If the force arm is **5 cm**, calculate the force required to lift the load (3 Marks)

Section C. Long answer questions. Answer all the questions (20 Marks)

1. Evaluate the application of Newton's three laws of motion in optimizing movement, rehabilitation strategies, and therapeutic interventions in physiotherapy. (10 Marks)

2. Examine the properties of sound and justify its clinical significance in physiotherapy, particularly in diagnostic and therapeutic modalities. (10 Marks)