UNIVERSITY OF BOLTON
SCHOOL OF ENGINEERING
BIOMEDICAL ENGINEERING
SEMESTER 1 EXAMINATIONS 2017/18
INTRODUCTION TO BIOMECHANICS
MODULE NO. BME4003

Date: Monday 15 January 2018
Time: 2.00 pm – 4.00 pm

INSTRUCTIONS TO CANDIDATES:

Answer **ALL** questions on this paper.

This Paper contains both multiple choice and short-answer questions:

For multiple choice questions, select one answer per question unless otherwise directed and write it down in the answer book provided.

For the short-answer questions write down your answer using concise scientific language and diagrams where applicable. Use the marks offered for each question as a guide for time allocation to complete your answers.
1. What are the main aims of analysis of human movement through biomechanics?

   a) Increasing injury, preventing rehabilitation and reducing performance
   b) Monitoring the motivation of the athlete to perform
   c) Reducing injury, improving rehabilitation and improving performance
   d) Assessing how the body consumes and utilises oxygen

   (1 mark)

2. Which of the following statements best describes postural control in balance.

   a) A summation of static reflexes.
   b) Maintaining neutral spinal alignment.
   c) A complex skill based on the interaction of multiple, dynamic sensorimotor processes.
   d) Not falling over when stood on one leg.

   (1 mark)

3. The two main branches of biomechanics are known as:

   a) Velocity: the rate of change of position; Acceleration: the rate of change of velocity.
   b) Kinetics: the study quantities of motion; Kinematics: the study of forces that cause motion
   c) Kinetics: the study forces that cause motion; Kinematics: the study of quantities of motion
   d) Strength: the study of how strong an athlete is; Power: the study of how fast an athlete is

   (1 mark)

Please turn the page
4. List three ways to improve static or dynamic stability. 

(3 marks)

5. General motion in biomechanics is defined as:
   a) Motion around an axis of rotation
   b) Motion around an axis of rotation that brings about motion on a linear or curvilinear path
   c) Motion of a body along a linear or curvilinear path
   d) Motion along a linear path

(1 mark)

6. What is the Mass of a 735.1 N person?

(1 mark)

7. Calculate the Stride Length of a person walking at 5 km•h⁻¹ with a cadence of 2.1 strides per second?
   a) 0.66 m
   b) 2.91 m
   c) 0.66 m•s⁻¹
   d) 2.91 m•s⁻¹
   e) 10.2 m

(1 mark)

Please turn the page
8. What is the average velocity of a person’s centre of gravity (CoG), when they stand from a seated position, raising their CoG with a vertical displacement of 0.85 metres in 0.53 seconds?

a) 1.60 m\(\cdot\)s\(^{-2}\)
b) 1.60 m\(\cdot\)s\(^{-1}\)
c) 0.45 m\(\cdot\)s\(^{-1}\)
d) 0.45 m\(\cdot\)s\(^{-2}\)

(1 mark)

9. The differences between scalar and vector quantities are best described as:

a) Scalar and Vector quantities both only have a magnitude
b) Scalar quantities have magnitude only; Vector quantities have a magnitude, direction and point of application
c) Scalar and Vector quantities both have a magnitude, direction and point of application
d) Scalar quantities have a magnitude, direction and point of application; Vector quantities have a magnitude only

(1 mark)

10. A projectile is thrown with an average acceleration of 11.14 m\(\cdot\)s\(^{-2}\), during the first 1.34 seconds of its’ flight. What would be the projectile’s resultant velocity at this time point?

a) 9.90 m\(\cdot\)s\(^{-1}\)
b) 14.93 m\(\cdot\)s\(^{-1}\)
c) 9.43 m\(\cdot\)s\(^{-1}\)
d) 10.56 m\(\cdot\)s\(^{-1}\)

(1 mark)
11. What is **Newton’s first law of motion**? Give a brief description and an applied example of when this law is in action.

(5 marks)

12. A person’s Centre of Gravity (CoG) has a vertical velocity of -2.09 m.s\(^{-1}\) immediately prior to initial contact (IC) during walking. In the instance immediately following IC, CoG vertical velocity was -1.76 m.s\(^{-1}\). What was the average **acceleration** of the person’s CoG if the change in velocity was achieved in 0.09s?

a) -3.67 m\(\cdot\)s\(^{-1}\)

b) 3.67 m\(\cdot\)s\(^{-2}\)

c) -3.67 m\(\cdot\)s\(^{-2}\)

d) 3.67 m\(\cdot\)s\(^{-1}\)

(1 mark)

13. What three components of ankle movement are generated in Supination?

(3 marks)
14. According to **Newton’s second law** of motion:

a) For every action by one body on a second there is an equal and opposite reaction by the second body on the first

b) A body will remain in a state of rest or constant motion in a straight line until acted on by an force

c) A force applied to a body causes an acceleration of that body which has a magnitude proportional to the force, and takes place in the direction in which the force acts.

d) All bodies are attracted to one another with a force which is proportional to the product of their masses, and inversely proportional to the square of the distance between them.

(1 mark)

15. What is the force required to horizontally accelerate a 190.51 kg bariatric patient 2.56 m s\(^{-2}\), on a porters trolley?

a) 487.71 N
b) 74.42 N
c) 744.20 N
d) 4877.15 N

(1 mark)

16. Sketch 2 graphs for **time vs. velocity** and **time vs. acceleration** for a 100 m sprint race completed in 10 seconds. You should consider the phases of such a race. Include all axis labels and units.

(6 marks)

Please turn the page
17. List the missing *phases* and *stages* of the gait cycle from the boxes on the diagram below.

![Gait Cycle Diagram]

(4 marks)

18. Outline a procedure for collecting *semi-quantitative* technique data of a Race Walker. Consider the protocol you would use and the equipment you would require to collect the data and how you may then analyse it.

(10 marks)

19. Which one of the following statements is true?

a) Momentum is a product of force and velocity; Impulse is a product of mass and time
b) Momentum is a product of force and time; Impulse is a product of mass and velocity
c) Impulse and Momentum cannot be calculated in kinetics
d) Impulse is a product of force and time; Momentum is a product of mass and velocity

(1 mark)

Please turn the page
20. If an elderly person falls with a velocity of 8.4 m.s\(^{-1}\) immediately prior to collision with the floor, assuming a constant mass of 57.92 kg, what is the momentum of the fall victim at the instance of impact?

(2 marks)

21. A pick-pocket (mass = 86.6 kg) steals a gentlemen’s wallet, and makes off with the loot at an average resultant velocity of 10.2 m.s\(^{-1}\). If the thief is brought to an immediate halt (in 0.23s) by an off-duty police officer who clotheslines (i.e. suddenly stops) the crook, what was the average force applied by the police-officer to the criminal?

(3 marks)

22. I am bored in my office, so I begin to throw balled-up pieces of paper into the bin on the opposite side of the room. I score ten out of ten immediately because I know I need to release the ball with a horizontal velocity of 6.5 m.s\(^{-1}\) and a vertical velocity of 4.2 m.s\(^{-1}\) (and I'm awesome at this game). Calculate the paper balls resultant release velocity and angle of projection.

(5 marks)

23. Sketch a graph to indicate the **vertical force vs. time** relationship you would expect for a *countermovement jump* (include axis labels and units)

(3 marks)
24. A NFL offensive lineman performs a standing vertical jump test during the combine with a vertical velocity of 3.2 m.s\(^{-1}\), what was his jump height?

(2 marks)

25. Sketch a graph to indicate the vertical force vs. time relationship you would expect for a ‘Heel Strike’ runner (include axis labels and units).

(3 marks)

26. List three important considerations to optimise jumping technique.

(3 marks)

27. List three ways of improving aerodynamics for a cyclist.

(3 marks)

28. Sketch a graph to highlight the relationship between friction force and applied horizontal force considering static and dynamic friction.

(3 marks)
29. In a lever within the human body that is said to have a **mechanical disadvantage** which **two** of the following statements are true:

a) The resistive force moment arm is greater than the muscle force moment arm  
b) The ankle joint in a calf raise exercise is an example of this lever  
c) The muscle force moment arm is greater than the resistive force moment arm  
d) This type of lever does not occur within the human body  
e) The elbow joint in a bicep curl exercise is an example of this lever  

(2 marks)

30. **Stair climbing** is a multi-joint activity - which plane of movement would we observe Flexion/Extension at the hip, knee and ankle? What muscles are the prime movers in the ascent or upward phase at the hip, knee and ankle joints?  

(6 marks)

31. What major muscles are stressed in a vertical **Shoulder Press** movement? And what type of muscle contraction are these muscles involved in with the descent or **lowering phase** of the movement?  

(6 marks)
32. Calculate the amount of force required in contraction of the Biceps Brachii to maintain a static position/isometric contraction in the image below. You should consider the resistance from the segments involved, and the external load in your answer.

33. Outline a procedure for collecting force platform data from an athlete running at 4-5 m.s\(^{-1}\). Consider the protocol you would use and the equipment you would require to collect the data.

END OF QUESTIONS