**ST MARY’S UNIVERSITY**

**TWICKENHAM, LONDON**

BA/BA(ITT)/BSc Degree Examination students registered for

Level **FIVE**

Title**: Sports Biomechanics**

Code: **SPS5041** Semester: **One**

Date: **8th January, 2020** Time: **1:30 – 3:00 PM**

TIME ALLOWED: **ONE HOUR** AND **THIRTY** MINUTES

A formula sheet has been provided to help you answer the questions.

You are permitted to use calculators for this exam.

Answer **ALL** questions in the answer book provided. There is a total of 75 marks available. Some of these marks are available for correct units and correct rounding of your answers.

##### **Formula Sheet**

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| **Linear Motion** | **Angular Motion** |
| v = s ÷ t | ω = θ ÷ t |
| a = Δv ÷ t | α = Δω ÷ t |
|  |  |
| F = m × a | T = I x α |
| I = F × Δt | M = F × d |
| F × Δt = m × vf – m × vi | H = I × ω |
| F = μ × R |  |
| W = F × d |  |
| W = ∆KE + ∆PE |  |
| KE = ½ x m × v2 |  |
| PE = m × g × h |  |
| SE = ½ x k × x2 |  |
| P = W ÷ t |  |
| P = F × v |  |
|  |  |
| Cr = (vb minus va) divided by (ua-ub) |  |
|  |  |
| v = u + a × t |  |
| s = u × t + ½ × a × t2 |  |
| v2 = u2 + 2 × a × s |  |

1. In 2D video analysis, what is the role of a calibration/scaling object? (2 marks)
2. Explain why an increased iris is required when a fast shutter speed is selected in 2D video analysis. (4 marks)
3. If you want to measure knee angle using 2D video analysis, which three anatomical landmarks would you need to digitise? (3 marks)
4. Which of Newton’s laws is the basis of force measurement? (1 mark)
5. During a vertical jump, in which direction would the greatest ground reaction force be recorded? (1 mark)
6. The figure below represents the anterior-posterior ground reaction force recorded during a run.
   1. Using the letters on the diagram, identify the period where a braking force is being exerted (1 mark)
   2. Using the letters on the diagram, identify the period where a propulsive force is being exerted (1 mark)
   3. Is the runner speeding up or slowing down? (1 mark)

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| figure represents the anterior-posterior ground reaction force recorded during a run |

1. A cricket players’ elbow extends from 44° to 175° when throwing a ball. If this movement took 0.13 s, calculate the average angular velocity of elbow extension. (3 marks)
2. During the final 100 m of a 5000 m race, Mo Farah increases his horizontal centre of mass velocity from 8.0 m/s to 9.5 m/s. If it takes him 0.80 s to do this;
3. Calculate the average horizontal acceleration of his centre of mass over this time period. (3 marks)
4. Given that Mo Farah’s mass was 61 kg during this race, calculate the average horizontal force that he required to achieve this acceleration. (3 marks)
5. Identify the THREE basic tasks of gait. (3 marks)
6. Define what is meant by the term *coefficient of friction*. (1 mark)

a) Calculate the angular momentum of an airborne trampolinist who is rotating at 2.3 rad/s and has a moment of inertia of 7.1 kg·m2. (3 marks)

1. The trampolinist then tucks in and reduces her moment of inertia to 5.5 kg·m2. Work out what her angular velocity has changed to. (3 marks)
2. A weightlifter lifts a 95 kg weighted barbell to a height of 1.8 m.

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| weightlifter lifting a 95kg barbell to a height of 1.8m |

1. What is the potential gravitational energy of the barbell at the end of the lift? (3 marks)
2. If the lifter performs the lift in 0.9 seconds, what is the average power produced during the lift? (3 marks)
3. If the lifter drops the weight from the final lift position, what would the velocity of the weight be the moment before it strikes the ground? (4 marks)
4. A pole-vaulter uses a pole with a stiffness constant of 1250 N/m. Calculate how much strain potential energy is stored in the pole when it deforms by 1.4 m. (3 marks)
5. Calculate the coefficient of restitution when a tennis player hits a volley. The ball is travelling into the racket at 7 m/s and the racket moves towards the ball with a velocity of 3 m/s. Immediately after the ball is hit, the ball has a velocity of 5 m/s and the racket is travelling at 1 m/s. (5 marks)
6. What does a coefficient of restitution of 1 represent? (1 mark)
7. In the correct order, list the four typical steps involved in a qualitative biomechanical analysis of a sporting skill (as used in the four-task model proposed by Knudson and Morrison, 2002). (4 marks)
8. In theory, the optimum projection angle for a shot put is 45°. Explain why research has shown elite shot-putters use a lower projection angle than this. (4 marks)
9. Neglecting air resistance, what can we say about the horizontal velocity of a projectile during flight? (1 mark)

**Use the equations of constant acceleration to help you answer question 19.**

1. Owen Farrell takes a place kick, 40 m from the try line. He kicked the ball with a velocity of 22 m/s at an angle of 38° above the horizontal.
   1. What were the horizontal and vertical velocities of the ball? (6 marks)
   2. How long would it take for the ball to reach the goal? (3 marks)
   3. What height was the ball when it crossed the try line? (4 marks)
   4. Did the ball pass over the crossbar (i.e. 3.0 m high)? (1 marks)

**END OF EXAMINATION**