**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: **January 17th 2019**

Time: **9:30 – 11:00AM**

TIME ALLOWED: **ONE** HOURAND **THIRTY** MINUTES

Answer **ALL** questions in the answer book provided. There are a total of 75 marks available. Some of these marks are available for correct units and correct number of decimal places.

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

You are permitted to use calculators for this exam.

##### **Formula Sheet**

|  |  |
| --- | --- |
| **Linear Motion** | **Angular Motion** |
| v = d ÷ 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-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. For a 2D video analysis, explain why a high shutter speed is needed for a fast movement. (2 marks)
3. During a vertical jump, in which direction would the greatest ground reaction force be recorded? (1 mark)
4. When landing from a jump shot, a basketball player’s knee flexes from 165° to 90° in 0.2 seconds. Calculate the average angular velocity of the player’s knee flexion. (3 marks)
5. During a 100 m sprint, Usain Bolt increases his horizontal centre of mass velocity from 10.2 m/s to 12.5 m/s. If it takes him 0.90 s to do this;
6. Calculate the average horizontal acceleration of his centre of mass over this time period. (3 marks)
7. Given that Usain Bolt’s mass was 94 kg during this race, calculate the average horizontal force that he required to achieve this acceleration. (3 marks)
8. Identify the FIVE sub-divisions of the stance phase of the gait cycle. (5 marks)
9. a) A gymnast leaves the floor with an angular momentum 25 kg·m2/s.

When fully extended he has a moment of inertia of 10 kg·m2 – calculate his angular velocity. (3 marks)

1. The gymnast then tucks in and reduces his moment of inertia to 6 kg·m2. Work out what his angular velocity has changed to. (2 marks).
2. A weightlifter lifts a 85 kg weight to a height of 1.8 m.

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| --- |
| Image of a weighlifter lifting an 85kg weight to a height of 1.8m |

1. What is the potential gravitational energy of the weight at the end of the lift? (3 marks)
2. If the lifter performs the lift in 0.8 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 1100 N/m. Calculate how much strain potential energy is stored in the pole when it deforms by 1.6 m. (3 marks)
5. During the take-off phase of a vertical jump, a basketball player applies an average force of 1250 N and raises his centre of mass by 42 cm. If the take-off phase lasted for 0.45 s, calculate his average power production during the take-off phase. (4 marks)
6. Identify FIVE methods of reducing drag. (5 marks)
7. Calculate the coefficient of restitution when a tennis player hits a volley. The ball is travelling into the racket at 8 m/s and the racket is stationary before the ball hits it. Immediately after the ball is hit, the ball has a velocity of 4 m/s and the racket is travelling at 1 m/s. (5 marks)
8. 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)
9. Define friction and state the equation we use to calculate it. (2 marks)
10. 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)

1. 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.

1. David DeGea is taking a goal kick. He kicks the ball with a velocity of 30 m/s at an angle of 38° above the horizontal. Assuming that no-one touches the ball before it bounces;
   1. What were the horizontal and vertical velocities of the ball? (6 marks)
   2. How long was the ball in the air for? (4 marks)
   3. How far did the ball travel by the point it first bounced? (3 marks)

**END OF EXAMINATION**