ATAR 12 Physical Education Studies

*Biomechanics & Functional Anatomy*

Name: \_\_\_\_\_\_\_ MARKING KEY\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*TIME ALLOWED FOR THIS PAPER*

Reading time before commencing work: Five minutes

Working time for paper: Fifty minutes

Section one 10 marks

Section two 30 marks

Section two 15 marks

***TOTAL* 55 marks**

*IMPORTANT NOTE TO CANDIDATES*

* Answer all questions as neatly as possible.
* Raise your hand if you have a question or have finished your test.
* Please NO talking or yelling out!
* It is *your* responsibility to ensure that you do not have any unauthorised notes in the exam room. If you do, hand it to the supervisor immediately.

**SECTION ONE – Multiple Choice (10 marks)**

This section has **10** questions. Answer **all** questions. If you make a mistake, place a cross through that letter, do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any reason.

Suggested working time:15 minutes.

1. Once a diver is airborne off the 10 metre platform, which of the following can they alter to improve their performance?
   1. angular momentum & moment of inertia
   2. moment of inertia & angular velocity
   3. angular momentum & angular velocity
   4. none of the above
2. An example of where ‘transfer of momentum’ occurs would be
   1. a long jump take-off
   2. a drag flick in hockey
   3. forehand smash in badminton
   4. all of the above

**3.**  The thick myofilament is also known as

1. Z line
2. Myosin
3. Actin
4. I band

**4.**  The fascicles are made up of a bundle of muscle fibres.The fascicles are protected by a dense sheath known as the:

1. endomysium
2. epimysium
3. perimysium
4. cardiomysium

**5**. The part of the motor neuron that receives nerve impulses from other neurons is the

1. cell body
2. axon
3. synapse
4. dendrite

**6.** Upon receiving a neural stimulus to contract a muscle, what happens first?

1. The actin cross-bridges reach out and grab-on to the myosin and begin to oscillate
2. the sarcomere length is reduced
3. the sarcomere length is increased
4. the myosin cross-bridges reach out and grab-on to the actin and begin to oscillate

**7**. Moment of inertia is best described as a body’s:

a) mass

b) resistance to change its motion

c) resistance to change its rotational motion

d) resistance to change its linear motion

**8.** A cricket fast bowler has to generate a great deal of ball velocity by using expert timing within their technique. This is mostly an application of which biomechanical principle?

a) segmental interaction

b) optimal projection

c) balance

d) spin

**9.** During the Paralympics a wheelchair basketballer gets the chair in motion by

1. applying force coupling
2. increasing the range of motion their arms go through
3. applying torque to the wheels with their hands
4. balancing in the chair

**10.** The explanation of how muscles shorten and produce force is known as

a) cross bridge shortening.

b) muscular contraction.

c) muscle fibre activitation.

d) sliding filament theory

**END OF SECTION ONE**

**SECTION TWO – Short Answer (30 marks)**

This section has **five (5)** questions. Answer **all** questions. Write your answers in the spaces provided in this Question/Answer Booklet. Wherever possible, confine your answers to the lines provided. Use a blue or black pen (**not** pencil) for this section.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

* Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
* Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 20 minutes.

**Question 11 (3 marks)**

Identify **three** characteristics of slow-twitch fibres that enhance their ability to take up and utilise oxygen? Briefly discuss the role of each of these characteristics.

1 mark for any 3 of:

**Characteristic Aerobic performance benefit**

|  |  |
| --- | --- |
| **Characteristic** | **Aerobic performance benefit** |
| Oxidative enzymes | Assists aerobic production of ATP – more enzymes mean more aerobic ATP |
| Myoglobin content | Increases oxygen supply to mitochondria and aerobic ATP production |
| Mitochondria density | Increased sites for the production of ATP phosphate |
| capillary density | Greater supply of oxygen and fuels as well as removal of wastes |
| Triglyceride stores | Delayed use of carbohydrates (glycogen sparing) and increased length of  aerobic performance |
| Resistance to fatigue high | Most ATP from oxidation – rapid supply thus sustained contractions without fatigue |

**Question 12 (5 marks)**

1. For a drop punt kick, identify **three** biomechanical principles a player can apply to produce maximum velocity on the ball. ( 3 marks)

1 mark for any two of:

• segmental interaction/summation of momentum (or kinematic chaining)

• force-motion

• range of motion

• force-time

1. Explain **two** reasons why the biomechanical principles identified do not apply to the golf putt or the netball goal shot. (3 marks)

1 mark for each of:

• putting and goal shooting require simultaneous summation of force

• skills require that all body parts move together

• tasks do not require maximum force or velocity – accuracy is key factor

**Question 13 (8 marks)**

Using the sliding filament theory. Provide **three** factors that explain how contraction occurs in skeletal muscle. Include a diagram in your answer and label **five** parts of the sliding filament.

(8 marks)

1 mark for each factor:

• myofibrils have several sections known as sarcomeres

• within each myofibril are two myofilaments (myosin and actin)

• during muscular contraction, the bunching occurs when myosin glides between the actin and the sarcomere shortens and creates movement

Or any other appropriate factor

Appropriate diagram that correctly indicates any **five** of (1 mark each):

• sarcomere

• Z-line, H-zone, I-band, A-band

• myosin filament

• actin filament

• crossbridges

**Question 14 (6 marks)**

For an athlete’s thought ‘to bounce and catch a tennis ball’ to become a precise motor action, the information must be sent from the brain to the arm and hand muscles.

1. Describe the function of the following elements of the neuromuscular system involved in producing this action.

Axons of the motor neuron

Dendrites of the sensory neuron

Spinal cord

**Description Marks**

**Axons of motor neurones** transmit electrical signals/stimulation/information away (from cell body) to muscle fibres (to contract), or similar words

**Dendrites of sensory neurones** are the sensory receptors signalling / sensing movement has occurred, or similar worlds

**Spinal cord** relays (carries) information between (from and to) brain (central nervous system) and muscles (periphery)

**Total 3**

(b) Define the motor unit.

**Description Marks**

**Motor unit** is term for the motor neurone and all the muscle fibres with which it connects/innervates or similar words, (may also state that for precision movements few muscle fibres per MU; for gross actions that large numbers of muscle fibres per MU but not essential for full mark)

**Total 1**

(c) Explain the ‘all-or-nothing’ principle of muscle stimulation.

**Description Marks**

**‘All or nothing’ principle:** if the motor neurone electrical threshold is reached then all the muscle fibres with which it connects will contract to maximum and all at the same time, or similar words.

**Total 2**

**Question 15 (4 marks)**

A rugby league player is about to tackle an oncoming opponent. Outline **two** actions the player (tackler) could take to increase stability just before the impact of the tackle (4 marks)

1 mark identifing each factor: increase size of base of support, lower centre of gravity, move line of gravity towards oncoming player.

1 mark for explanation.

**Question 16**

**(3 marks)**

Explain why the motor unit of the eye would have fewer muscle fibres than that of the quadriceps group.

The size of the motor unit depends on the degree of control needed when a muscle is stimulated.

**1 mark**

Smaller motor units are not particularly strong but provide subtle and precise control such as the muscles of the eye. They have small motor units with small neurons which are easily stimulated.

**1 mark**

Large motor units are needed for strength (quads) larger neurons present in large motor units are harder to stimulate and not as good with fine control.

**1 mark**

**Section Three: Extended answer (15 MARKS)**

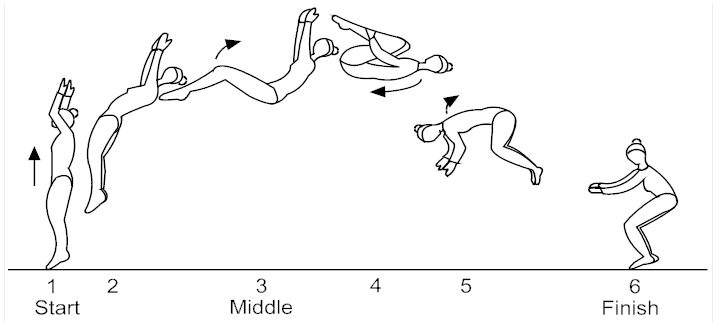
This section contains one (1) question. Write your answer in the spaces provided.

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Suggested working time: 20 minutes.

**Question 16 (15 marks)**

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Samantha Spinalotski (pictured above performing a backflip from a standing position) has been selected to represent Australia in the Gymnastics world championships.

1. Referring to the diagram above, discuss how the gymnast’s moment of inertia, angular momentum and radius of rotation enable her to successfully complete a backflip (divide the movement into three sections to structure your response). Explain why it would be harder for Samantha to successfully complete a backflip from a standing start in a layout position (as opposed to a tuck position). (12 marks)

***(a)***

***3 marks (per section) for any of the following (maximum of 9)***

***Start or take off position***

* moment of inertia (or rotational inertia) refers to the resistance of angular acceleration of a body (and is related to the distribution of mass about the point of rotation/resistance of a body being rotated)
* large moment of inertia due to gymnast being in a standing/stationary position
* large radius from the point at which gymnast will rotate, no change in mass
* when standing, no angular momentum

***Middle or tuck position***

* decreased/minimum moment of inertia as gymnast moves into a tuck position
* radius of rotation is minimised (which is why moment of inertia is decreased)
* increased/maximum angular velocity as gymnast tucks
* increase in angular velocity is due to decrease in moment of inertia (requirement of law of conservation of angular momentum)

***Finish or landing position***

* return to large moment of inertia
* decrease of angular velocity just prior to landing due to increase in moment of inertia
* radius of rotation was increased (layout position at landing) this is what causes the large moment of inertia

***1 mark for any of the following (maximum of 3)***

* in the layout position, the distance from the axis of rotation is large
* this causes resistance to rotation (or rotational inertia)
* to overcome the larger rotational inertia, more force must be applied at take off – which is difficult from a standing start

the layout position backflip is therefore harder because you must apply the force prior to take off because angular momentum cannot be changed once in the air

b) The position of the leg when of kicking an AFL ball as shown in the image above is considered to result in an optimal muscle length. Explain the force-length relationship of muscle contraction with respect to a very flexed, middle and extended knee joint. (3 marks)

1 mark each for:

* Force generation is increased when a muscle is slightly stretched beyond its normal resting length.
* Amount of force is proportional to the number of active actin/myosin binding sites, the greater the length the greater the number of binding sites.
* Peak force occurs at normal resting length or midrange of a range of movement as a result of maximum binding of actin and myosin filaments

**END OF TEST**