Charles Darwin University

Final Examination

Family Name	
Given Name/s	
Student Number	
Teaching Period	Semester 1, 2018

SPE205 – Biomechanics 1	DURATION
	Reading Time: 10 minutes
	Writing Time: 180 minutes

INSTRUCTIONS TO CANDIDATES

There are three (3) sections to this exam

Section A: 40 marks (1 mark per question)
Suggested Time: 40 mins
Multiple Choice Questions: Answer ALL (40) questions.

Section B: 80 marks (10 marks per question).
Suggested Time: 80 mins
Short Answer Questions: Answer ALL (8) questions

Section C: 50 marks (10 marks per question)
Suggested Time: 60 mins
Short Answer Questions: Answer ALL (5) questions

Total marks for this examination: ***170***

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper College Multiple Choice Answer Sheet Formula Sheet/s Reference Information

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Section A

Section B

Short Answer Questions

Total No. of Marks for this section: 80

This section should be answered in the Answer Booklet provided.

All eight questions are made up of more than one component.

Answer all components

Marks for each question are indicated.

Suggested Time allocation for Section B: 80 mins

Question 1

A swimmer orients himself perpendicular to the banks of a river. The banks run parallel to each other. If the swimmer's velocity is 2 m/s and the velocity of the current is 0.5 m/s with the flow running from his left to right when making the crossing.

A: What is his resultant Velocity in m/s?

(Marks: 4)

B: How far will he actually have to swim to get to the other side if the banks of the river are 50 m apart?

(Marks: 6)

Total marks: 10

Question 2

The following data has been taken from an infrared data capture of a reflective marker placed on S1 of the sacrum as it is the closest landmark to a person's centre of mass (CoM). The CoM's vertical positional change has been recorded along with the capture frequency (measured in seconds) while a person performed a single deadlift repetition. The reference point 0 m is the person's CoM when the barbell and weights were resting on the lifting mat. Using the **Central Difference Method**, first determine what the vertical velocity of the CoM's change in position, second; determine the CoM's vertical acceleration. **Show only one (1)** working out for the vertical velocity and one (1) for vertical acceleration as examples of your complete table. **Only replicate the entire vertical velocity and vertical acceleration columns in your answer booklet.**

Frame number	Time (s)	Vertical position (m)	Vertical velocity (ms^{-1})	Vertical acceleration (ms^{-2})
1	0	0		
2	0.123	0.075		
3	0.246	0.148		
4	0.369	0.225		
5	0.492	0.298		
6	0.615	0.329		
7	0.738	0.346		
8	0.861	0.346		
9	0.984	0.288		
10	1.107	0.212		
11	1.23	0.173		
12	1.353	0.11		
13	1.476	0		

Total marks: 10

Question 3

A man with a body mass of 96 kg and lower limb segment anthropometrics of: thigh = 0.48 m (48 cm); shank = 0.39 m (39 cm); foot = 0.28 m (28 cm).

Table 1. Modified Winter's Table

Segment	Definition	Segment weight/ Total Body Weight	Centre of Mass/ Segment Length	
			Proximal	Distal
Foot	lateral malleolus/head metatarsal II	0.0145	0.5	0.475
Shank	femoral condyles/medial malleolus	0.0465	0.433	0.567
Thigh	greater trochanter / femoral condyles	0.1	0.433	0.567
Foot and shank	femoral condyles /medial malleolus	0.061	0.606	0.394
Total leg	greater trochanter /medial malleolus	0.161	0.447	0.553

Using the modified Winter's Table (Table 1) determine true or false:

A: True or false, the mass of his right thigh is 9.6 kg

(Marks: 2)

B: True or false, the distance of the centre of mass (CoM) of his left shank from the ankle is 0.221 m

(Marks: 2)

C: True or false, the mass of his whole right leg is 13.52 kg

(Marks: 2)

D: True or false, the CoM of his left thigh from the hip is 2.08 kg

(Marks: 2)

E: True or false, the distance from his toes to his hip of his left leg is 1.15 m

(Marks: 2)

Total marks: 10

Question 4

A: Form (or profile) drag affects the laminar flow of air around a ball in flight. Discuss the effects that this drag has on balls at high, very high and extremely high velocities. **Justify your answer using biomechanical knowledge.** Diagrams can be used to help explain your reasoning.

(Marks: 3)

B: A primary goal of a sprint swimmer is to achieve maximum velocity. However there are three types of drag that can influence their velocity. One type is known as "wave drag". Describe what is wave drag and what effects it has on a swimmer. Include what strategies can be applied to overcome it **Justify your answer using biomechanical knowledge.**

(Marks: 4)

C: A cyclist is riding with a head wind of 2.8 meters per second (m/s). Their velocity is 36.5 km/h. What is the velocity of the cyclist, relative to the wind? Provide your answer in m/s.

(Marks: 3)

Total marks: 10

Question 5

A: A relative angle is the measure of a body segment with respect to an _____ segment.

(Marks: 1)

B: An absolute angle is the angular orientation of a body segment with respect to a _____ line of reference.

(Marks: 1)

C: _____ radians is equal to 75°

(Marks: 1)

D: _____ rotational motion is negative and _____ rotational motion is positive.

(Marks: 2)

E: Angular _____ is equal to the change in angular _____ divided by the change in _____.

(Marks: 3)

F: To determine linear velocity, the angular velocity has to be calculated in _____ per second, otherwise large errors will be occur if _____ per second are used.

(Marks: 2)

Total marks: 10

Question 6

A: List two (2) examples where greater frictional force improves sporting performance.

(Marks: 2)

B: List two (2) examples where minimal frictional force improves sporting performance.

(Marks: 2)

C: What two (2) factors affect the magnitude of friction?

(Marks: 2)

D: A bobsled is being pushed by the rider at the start of a run and from your view point, right to left. Draw a free body diagram of the sled. Identify (name) and indicate the direction of any forces acting on the sled.

(Marks: 4)

Total marks: 10

Question 7

A: When assessing objects in flight, it is often considered to be preferable to analyse horizontal and vertical components separately. Ignoring air resistance, why is this method suggested? When taking air resistance into account, what differences occur to the object?

(Marks: 5)

B: A ball is thrown perfectly horizontal and simultaneously, a ball is dropped. Release height for both balls is identical. Ignoring drag factors, which will hit the ground first?

(Marks: 1)

C: Patrick Dangerfield of Geelong has marked right on the siren in the clash against Richmond. He has the chance to steal the game from the Tigers if he can kick a goal. The point where Dangerfield kicks from is 58 metres out from the goal line and dead in front. If the flight time is 2.6 seconds and the ball's horizontal velocity is 21.92 m/s. Assuming no player touches it, how far will the ball's flight be before hitting the ground? Show all workings including the equation.

(Marks: 4)

Total marks: 10

Question 8

Kinematic v kinetic data

A: What is an example of each?

(Marks: 3)

B: List two (2) types of technology could you use to measure kinematic output and two (2) types of technology could you use to measure kinetic output?

(Marks: 4)

C: What is the mathematical equation that best explains the link between the kinetics and kinematics?

(Marks: 1)

D: How is velocity and displacement derived from acceleration?

(Marks: 2)

Total marks: 10

This is the end of Section B. Total 80 marks

Please ensure that you have written your name and student number on your answer booklet.

Section C

Short Essay Questions

Total Number of Marks for this section: 50

This section should be answered in the Answer Booklet provided.

Answer all five questions
Marks for each question are indicated.
Suggested Time allocation for Section C: 60 mins

Question 1

Overall, there are 3 classes of levers that act in human movement. One can be seen at the knee when a person kicks a ball where the knee typically goes through extension (Figure 3). Identify what lever system is acting at the knee during this action. Draw a free body diagram (FBD) to highlight where the external forces are acting on the system of interest (the leg distal to the knee) – assume the ball is in contact with the system of interest. Provide an example of the remaining 2 lever systems within the human body and provide an example of a function in human movement of each of the systems. Use FBDs to identify where external forces are acting on each of the levers. Furthermore, identify whether each of the 3 lever systems has, has not, or both a mechanical advantage.

Figure 3. Kicking a ball. Sourced from:

https://www.vexels.com/png-svg/preview/141230/soccer-player-hitting

(Marks: 10)

Question 2

A person who weighs 62 kg is maintaining an isometric contraction while holding a 1.2 litre bottle of water (note: 1 litre of water = 1 kg) in a position where her upper arm is at the body's side and the elbow is held at approximately 90° of flexion. To maintain the static position, how much force is she producing at the biceps brachi (assume no other muscles are involved)? Use the following variables to provide the answer:

1. The perpendicular distance between the line of force developed by the biceps barachi and the centre of the elbow joint is 29.5 mm.
2. The length of her forearm and hand is 424 mm.
3. The distance from the elbow to the centre of mass (CoM) of the water bottle being held is 335 mm.
4. According to Winter's Table, the point of the CoM of the forearm and hand position is 68.2% of that length.
5. The same table states that the forearm and hand is 2.2% of a person's total body weight.

(Marks: 10)

Question 3

A sled with a mass of 4.5 kg and its μ is 0.73 is placed on a 33° slope.

- What is the weight force of the sled?
- What is the normal force of the sled?
- What is the frictional force?
- What is the propulsive force?
- From these results, will the sled remain stationary, or will it slide?

The use of a free body diagram should be used. Show all workings and equations.

(Marks: 10)

Question 4

You are an owner of a growing exercise service business. You are considering the purchase of new equipment to better monitor and assess your clients. For it to be beneficial, you will need to get at least four (4) years use from the equipment. At this stage you have narrowed your preference down to an infrared camera system and wearable monitoring devices.

You intend to apply a cost benefit analysis to the two options to assist in the correct purchase. Along with this there is Moore's Law to consider. Please consider and comment on:

- Describe in detail what makes up a cost benefit analysis and how is it applied.
- What is Moore's Law?

(Marks: 10)

Question 5

Elite sprint swimmers typically use a six beat kick. Sandra Swit competed at the 2018 Commonwealth Games. She held a stroke rate of 105 strokes per minute (s/min) for the entire distance of the 100 m final and used a six beat kick the whole time. The RoM of Sarah's right knee during each kick is 72°.

1. Using degrees, what was the average angular velocity at the knee during extension phase of each kick?
2. Using radians, what was the average angular velocity at the knee during extension phase of each kick?

Show all workings.

(Marks: 10)

This is the end of Section C. Total 50 marks

Please ensure that you have written your name and student number on your answer booklet