***Year 11 ATAR  
Physical Education Studies***

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***Task 2***

***Biomechanics Lab & Investigation Book***

***Weighting: 7.5%***

***STUDENT NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

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| --- | --- | --- |
|  | **Possible Marks** | **Allocated Marks** |
| **Lab 1** | **20 Marks** |  |
| **Lab 2** | **16 Marks** |  |
| **Lab 3** | **15 Marks** |  |
| **Lab 4** | **11 Marks** |  |
| **Lab 5** | **11 Marks** |  |
| **Lab 6** | **27 Marks** |  |
| **TOTAL MARKS** | **100 Marks** |  |

###### LABORATORY REPORT 1: VELOCITY & ACCELERATION

**Aim**

* To measure students’ velocity and acceleration in the 50m sprint
* To compare the difference between velocity and acceleration

**Equipment**

12 cones

6 stopwatches

Tape measure (50m)

**Method**

* Accurately measure a 50-metre distance. Place markers at the start and at 10-metre intervals up to 50 metres.
* A student with a stopwatch stands at each marker and records the time of a sprinter as they pass the marker.
* Another student/whistle signals the start of the sprint and the students with stopwatches need to commence timing.

**Results**

1. Record the time, velocity and acceleration for each distance, using the following formulas:

velocity = displacement / time taken

acceleration = (final velocity – initial velocity) / interval time taken

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Position | Time (s) | Interval time (s) | velocity (m/s) | Acceleration (m/s2) |
| 0m | 0 | 0 | 0 | 0 |
| 10m | 2.02 | 10-0m 2.02 | 10m/t 4.95 | 10m v – 0m v / it 2.45 |
| 20m | 3.28 | 20-10m 1.26 | 20m/t 6.097 | 20m v – 10m v / it 0.90 |
| 30m | 4.51 | 30-20m 1.23 | 30m/t 6.65 | 30m v – 20m v / it 0.45 |
| 40m | 5.87 | 40-30m 1.36 | 40m/t 6.814 | 40m v – 30m v / it 0.11 |
| 50m | 7.13 | 50-40m 1.26 | 50m/t 7.01 | 50m v – 40m v / it 0.16 |

(6 Marks)

1. Draw a graph of the final results, showing the velocity and acceleration over the 50 metres

Velocity of Acceleration of Running 50m

Time (sec)

|  |  |  |  |  |  |  |  |  |  |
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Distance (m)

(2 Marks)

Discussion Questions

1. At which point was the velocity the lowest? Why? (2 Marks)

- Lowest at the beginning/in the first 10m  
- No movement hence no distance covered.   
- In the beginning you are trying to build up speed

1. Where did the sprinter reach maximum velocity? Can you explain why it may have occurred at this distance?   
    (2 Marks)

- Reached maximum velocity at 50m – kept increasing velocity  
- Takes the sprinter that long to get to maximum speed – had to build up to it  
- The sprinter may still not even be at max speed at 50m – his velocity may well still be increasing

1. Where did the sprinter reach maximum acceleration? Can you explain why it may have occurred at this distance?

(2 Marks)

- Max acceleration = Rate of change of velocity   
- Answers depends on results and when max acceleration occurred  
- Usually occurs from 0 – 10m as the athlete powers from the start and then smaller acceleration occurs in the other intervals

1. Define Zero Acceleration – what does it mean? Did the sprinter experience zero acceleration at any stage? Explain.

(2 Marks)

- Zero acceleration means travelling at a constant speed, so neither getting faster or slower.  
- Answer will depend on if the runner experienced zero acceleration (note if they came close to it).

1. Define Negative Acceleration – what does this mean? Did the sprinter experience negative acceleration at any stage? Explain.

(2 Marks)

- Negative acceleration is when a body/object is slowing down.

- If results are accurate – the sprinter should decrease their rate of acceleration at some point throughout the 50m   
- Velocity can still be faster at the end (depending on results) – also known as deceleration

6. Notice that elite male sprinters have a very large mass. How would they manage to achieve faster velocities at each interval in comparison to an individual with a smaller inertia, or someone who has less resistance to overcome?  
 (2 Marks)

- F=MA  
- Therefore: Increase Force = Increase Mass = Increase Acceleration

- Male sprinter with a large mass can produce a greater muscular force then a smaller massed male.  
- Smaller mass = less inertia = less resistance = increase in speed   
and also means less force production = decreased momentum.  
- Faster velocities can be achieved when more force is applied AND more force can be applied by a great mass, therefore acceleration will be greater, hence velocities increase.

###### LABORATORY REPORT 2: THE PRINCIPLE OF OPTIMAL PROJECTION

**Lab 2 - Part 1**

**Equipment**

* Garden Hose
* Brick wall to run the water stream against and measure
* Tape Measure
* Large Maths Protractor

**Procedure**

*Condition A – Angle of Release*

Using a hose, direct a stream of water from ground level to cover the greatest distance possible. Record the distance and the angle of the nozzle.

*Condition B – Height of Release*

Repeat A, but hold the nozzle of the hose at hip height. Record the distance and the angle of the nozzle.

*Condition C – Velocity of Release*

Repeat B, keeping the angle of the projection the same and increase the velocity of the stream of water (Turn the tap on as fast as possible). Record the distance.

**Results**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Distance(m)** | | |
| **Angle** | Condition A | Condition B | Condition C |
| 10° |  |  |  |
| 20° |  |  |  |
| 30° |  |  |  |
| 40° |  |  |  |
| 50° |  |  |  |
| 60° |  |  |  |
| 70° |  |  |  |

(1.5 Marks)

Discussion Questions

1. Use the below area to draw the OPTIMAL trajectory/water pathway of each Condition, ensuring you clearly label each (A, B & C).   
(i.e.- only plot the path of the furthest result for each condition)

(should form 3 separate parabolas)

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Distance (cm)

Degrees (1.5 Marks)

2a. Identify what would be the optimal angle of release for Condition A? Why?

- 45 degrees would be the optimal angle of release to gain the greatest distance

- The angle it’s projected at is the angle at which it lands

(1 Mark)

2b. Describe the shape of this trajectory/water pathway (why is it this shape)?

- The angle it’s projected is the angle which it lands (parabola)

(1 Mark)

3. Identify what the optimal angle of release is for Condition B?

- 45 degrees (depending on results) - 30 degrees for 2019

(1 Mark)

4. Compare the angle of release in Condition A to Condition B

- Same angle of release for greatest distance (depending on results)  
- Just the high point of release = greatest distance

(1 Mark)

5. What factors influence the angle of release in Condition B?

- Velocity and height of release (being at hip height)

(1 Mark)

6. What observations can be made relating to the difference in pathways in Condition B & C? You may wish to support your response with a diagram.

- Height of release was the same

- Increasing the Velocity of release increases the distance of the projection of water at the point of release  
- I.e. – The water travels further when there is greater velocity

(2 Marks)

7. Of the factors that determine the distance a projectile travels, which is the most important in achieving the greatest distance? Explain.

- Factors: Velocity of Release, Height of Release and Angle of Release

- Angle of release: Changing the angle has greater changes in results than when there is a change in velocity

- Doubling the angle leads to bigger results than doubling the speed

- Human error can affect these results (i.e. – finger on the hose).

(2 Marks)

**Lab 2 - Part 2**

Study a video of a long jumper and answer the following questions.

1. Describe the pathway of the long-jumper

- Long jumper moves in a flat arc as max horizontal distance is the aim  
- The long jumpers starting velocity was 0, he accelerated all the way up to point of the jump. After he jumped his pathway made the shape of a parabola as he hurled his limbs forward.

(1 Marks)

1. What is the angle of take-off?

According to text page 126:  
- The optimal angle of release is dependant on the activity  
- Approximate angle for long jump is 18 – 27 degrees as they want to achieve max horiztonal distance.  
- A high jumper is about 40 – 48 as they want to achieve a particular vertical height  
- A release angle of 45 degrees will result in the greatest possible distance an object will travel as the horiztonal velocity is equal to the vertical velocity

(1 Marks)

1. What factors investigated in task one would cause a reduction in take-off angle from 45-degrees?

Velocity (may not be travelling fast enough)

- Horizontal velocity  
- Vertical Velocity

- Mass of an object

(1 Mark)

1. What aspect of a long-jumper’s technique would account for the angle of take-off?

- Aim/angle: Maximum distance

###### - Speed (velocity) – Horizontal Velocity

- Power

- Body Position

(1 Mark)

###### LABORATORY REPORT 3: NEWTON’S LAWS OF MOTION

**Lab 3 - Task 1**

###### Aim By completing this experiment outlined below you will observe and evaluate the role of the key movement principles in velocity development of the tennis serve.

**Equipment**

* Four tennis racquets
* One child’s racquet
* One weighted racquet
* Bucket tennis balls

**Procedure**

* In groups of four you will be required to examine the effects of the following activities
* Complete the table

|  |  |  |
| --- | --- | --- |
| **Activity** | **What movement principle(s) was (were) affected?** | **How?** |
| 1. Tennis serve with no knee flexion or extension | Force – Submaximal (Less force production)  Angular Motion | No knee flexion meant there was disruption to building up forces to generate Maximum Force. |
| 2. Tennis serve with no follow-through | Less power, force and decreased momentum | Lack of summation of force  Impulse at contact will have decreased |
| 3.  a) Tennis serve front on  b) Tennis serve with a variety of ball toss locations | a) Less force/power  b) Accuracy affected | a) No rotational inertia (p 135)     b) Summation of force is not smooth and therefore cannot produce maximum force/power |
| 4.  a) Tennis serve with racquets of different length  b) Tennis serve with racquets with varying weights attached (or of different mass) | a) Shorter racquet will generate more speed (however our plastic racquet used showed otherwise).  b) Accuracy, Power, Momentum | b) Due to bringing the mass of the racquet (head of racquet) closer to the axis    Mass and Velocity of racquet will affect the momentum of swing and therefore accuracy. |

(8 Marks)

**Lab 3 - Task 2**

**Procedure**

* Study the following video of a volleyball player performing a spike and answer the following questions concerning the actions observed
* https://www.youtube.com/watch?v=FMtUqoxfR50

**Discussions Questions**

During the flight stage of a volleyball spike, the player’s body hyperextends and then flexes at the hip.

1. State and define which of Newton’s Laws of Motion best describes the body’s action represented in this flight stage of the spike

- State = 1 Mark, Define = 2 Marks  
- Newtons 2nd Law – Law of acceleration  
- Acceleration of an object is dependent upon the acting force and mass.  
- Generating force through acceleration: When flexing at the hip the volleyballer increases momentum (mass x velocity) to then generate greater force on the ball (impulse – change of momentum)

(3 Marks)

1. Using one of Newton’s Laws of Motion to assist, explain how the player can attain greater acceleration of the ball.

2nd Law of Motion

Force: F=ma   
  
Momentum: P=mv (mass x velocity)

Greater acceleration of the ball is attained by applying an external force hence increasing momentum  
  
Newtons 2nd law states that when a body is acted upon by a constant force, it’s resulting acceleration is proportional to the force and inversely proportional to the mass.  
This means that if a greater force is being acted upon the volleyball then the acceleration will be directly proportional to the force. Therefore the greater the force the greater the acceleration.

(3 Marks)

1. Which of Newton’s Laws of Motion best describes the change of direction of the ball after impact? Explain

- Newton’s 3rd law of Action/reaction best describes the change of direction of the ball after impact. The impact of the hand causes an equal and opposite reaction on the ball  
  
- Force applied to the ball, it’s momentum changes = impulse which therefore affects the direction/path the ball travels  
  
- Whilst momentum and speed are important it must be balanced by accuracy.

(1 Mark)

###### LABORATORY REPORT 4: SEQUENTIAL MOVEMENTS OF BODY PARTS

**Equipment**

* One softball and pair of catching gloves per student pair

**Procedure**

In pairs, sit opposite each other at a safe distance apart and throw the softball from the following positions, make a note of how far you are able to throw:

1. Sitting with legs crossed, using only your wrist to throw
2. Sitting with legs crossed, using wrist and elbow to throw
3. Kneeling, using shoulder, elbow and wrist to throw
4. Standing with feet together, using trunk, shoulder, elbow and wrist to throw
5. Standing, then stepping forward with one leg and using trunk, shoulder, elbow and wrist to throw

**Results**

|  |  |
| --- | --- |
|  | **Distance of Throw (m)** |
| **1** |  |
| **2** |  |
| **3** |  |
| **4** |  |
| **5** |  |

(3 Marks)

**Discussion Questions**

1. Which technique produced the best results for you and your partner? Why?

- Number 5 – sequential movement = Force summation

(1 Mark)

1. How can you explain these results in terms of force production and summation of momentum?

- F=ma   
- Force Summation  
- Large body parts produce large amounts of force which progresses onto smaller body parts increasing in velocity – this produces the greatest momentum and force

(4 Marks)

1. Describe another three skills where the correct sequencing of body parts helps to maximise technique.

- Shot put, Javelin, Golf Swing etc.   
- Explain that the correct sequence generates the greatest force for the greatest distance (Force Summation)

(3 Marks)

###### LABORATORY REPORT 5: FLATTENING THE ARC VERSUS ACCURACY

**Equipment**

* Hockey stick
* Tennis Ball
* Target (or chalk on wall of CASS 1m x 1m)
* Markers or set of goals

**Procedure**

Make five attempts at hitting the target by doing a:

* Hockey drive – into a 1m target (2 markers)
* Underhand softball pitch – into a 1m x 1m wall square/round target

**Trial 1:** Do not step forward, transfer your weight forward or follow through

**Trial 2:** Step forward or transfer your weight forward and follow through

**Trial 3:** Step forward or transfer your weight forward, but do not follow through

**Results**

Use the following table to represent your results: (give 1-point for hitting the target)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hockey Drive** | Attempt 1 | Attempt 2 | Attempt 3 | Attempt 4 | Attempt 5 | Overall Score |
| Trial 1 |  |  |  |  |  | / 5 |
| Trial 2 |  |  |  |  |  | / 5 |
| Trial 3 |  |  |  |  |  | / 5 |

(2 Marks)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Softball Pitch** | Attempt 1 | Attempt 2 | Attempt 3 | Attempt 4 | Attempt 5 | Overall Score |
| Trial 1 |  |  |  |  |  | / 5 |
| Trial 2 |  |  |  |  |  | / 5 |
| Trial 3 |  |  |  |  |  | / 5 |

(2 Marks)

**Discussion Questions**

1. How does stepping forward increase the accuracy of performance?

Page 139 Text  
Flattens the arc = Increases contact time/space on the hand and hockey stick and therefore there is a greater chance to influence accuracy.

(2 Marks)

1. How does the follow-through improve accuracy?

Following through increases the contact time, allows for a more precise point of release and therefore influences accuracy (shape of the arc produced)

(2 Marks)

1. How accurate was your performance of each of the tasks? Did your results differ between the three trials? Why?

Answer depends on results however:

- Trial 2 should be the most successful, followed by 3 and then 1  
  
The softball pitch should be easier (have more accuracy) than the hockey drive because the arc of the throw is aligned with the target. However the hockey drive is harder as the ball has to be exactly at the bottom of the swing arc (the stick) to be moving in the correct direction and be on the tight line of impact.

(3 Marks)

###### LABORATORY REPORT 6: BALANCE & STABILITY

The control that an athlete has over his or her balance and stability is vital in maximising performance. In some sports the emphasis is placed on increasing stability (eg. wrestling) whilst in others the athlete wishes to decrease stability to enhance performance (eg. sprint start).

**Equipment**

* Stop watches
* Tape measures

**Procedure**

**Task 1**

Have your partner try to push you off balance when you are in the following positions and rank them from most stable (1) to least stable (3). *Ensure that your feet are always in the same position.*

|  |  |
| --- | --- |
| **POSITION** | **RANK** |
| 1. Standing with your arms straight above your head. |  |
| 1. Standing with your arms at your sides. |  |
| 1. Standing in a crouched position (knees bent). |  |

(1 Mark)

**Task 2**

Have your partner push from the side to try and make you off balance when you are in the following positions and rank them from most stable (1) to least stable (3).

|  |  |
| --- | --- |
| **POSITION** | **RANK** |
| 1. Standing on tiptoes, with your feet as close together as possible. |  |
| 1. Standing with feet wide apart and flat footed. |  |
| 1. On all fours. |  |

(1 Mark)

**Task 3**

Have your partner push from the side to try make you off balance when you are in the following positions and rank them from most stable (1) to least stable (3).

|  |  |
| --- | --- |
| **POSITION** | **RANK** |
| 1. Standing with feet spread wide to the front/back. |  |
| 1. Standing with feet spread wide to the side. |  |
| 1. Standing with your feet together. |  |

(1 Mark)

**Task 4**

Have your partner time you for a 10m sprint from the following starting positions:

|  |  |
| --- | --- |
| **Starting Position** | **Time** |
| 1. Standing straight with arms by your side. |  |
| 1. Feet apart with a slight lean forward and arms in the ready position. |  |
| 1. Crouch start. |  |

(1 Mark)

**Discussion Questions**

1. What was the effect of the height of the centre of gravity on balance and stability? Why?

The higher the COG the less balance and stability as you are further away from the ground.

(2 Marks)

2. What was the effect of the area of the base of support on balance and stability? Why?

The greater the area of BOS the greater the balance and stability – weight is more evenly spread out and COG is in the middle of a larger area.

(2 Marks)

3. What was the effect on the alignment of the base of support on balance and stability? Why?

When alignment is outside the BOS then balance and stability decreases

(2 Marks)

4. In terms of balance and stability, which starting position was the fastest? Why?

The crouch start, as a lowered mass = lowered COG = Wide BOS = Stability  
Fastest because better balance can generate a greater force in one direction

(2 Marks)

1. Stand with your back and heels touching a wall. Slowly attempt to bend down and touch your toes, keeping your legs straight. Can you do it? Why or why not?

You can’t do it. This is because COG moves outside the BOS which leads to decreased stability and therefore the person overbalances.

(2 Marks)

1. Repeat the activity, this time standing away from the wall. Explain the differences you experience.

This time the lower body counter balances the upper body which keeps the COG over the BOS which gives more stability.

(2 Marks)

1. Now stand with your side against a wall and lift your outside foot to the side. What happens? How can you explain this?

Cog wants to move outside the BOS but the wall restricts movement and therefore stability decreases  
BOS has also decreased in size so this also causes decreased stability  
When COG moves outside the line of BOS – less stability

(2 Marks)

1. Stand facing a partner no more than 1 metre away. Place your palms together and move your feet into various positions to experiment with the base of support. Try applying gradual force from different directions. What determines maximum stability when trying to push each other off balance? Explain the differences noted.

Maximum stability is determined by the size of the BOS, how low the COG and Centre of Mass is and the mass of the individual. When these factors are affected/changed then so is balance and stability

(3 Marks)

1. Perform a regular push-up. Why is it easier to perform a push-up by using your knees as a point of support than using your toes as a point of support? What changes in positioning are necessary if you take one hand away and try to do a single-arm push-up? Explain any differences?

Greater mass is over the BOS whilst on knees, hence COG is in the middle  
When on toes COG moves to a place of decreased mass and therefore the arms have a tougher job moving the mass when COG is further away.  
Once handed push up – BOS has become a smaller area (triangle) and therefore it is harder to move the COG over the area and therefore less stable

(3 Marks)

1. Think of three sporting situations where it is advantageous to move the line of gravity close to or beyond the edge of the base of support.

Gynmastics, High Jump, Pole Vault, Sprint Start, etc

Mark for naming and explaining why

(3 Marks)