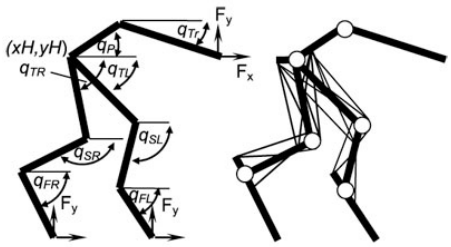


Using Biomechanical Formula to analyze "Real Life" sports

Name: _____

Using the text book as a resource work through this lab and assess the different activities and apply them to enhance your ability as a coach, therapist and personal trainer. The three activities that will be assess in this lab are: hitting a baseball, high jump and spinning like a ice dancer sitting in a chair.

Part A.

In order to for us to be able to assess and apply biomechanical principles in this lab we must be familiar with the 7 biomechanical principles

List the 7 biomechanical Principles (text, 231)

1.

2.

3.

4.

5.

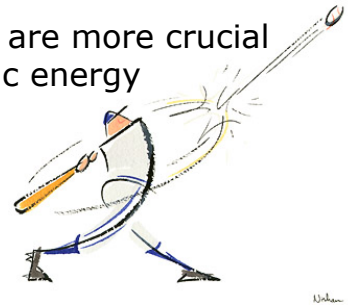
6.

7.

Part B.

Hitting a baseball and determining which variable is more important – bat speed or weight of the bat?

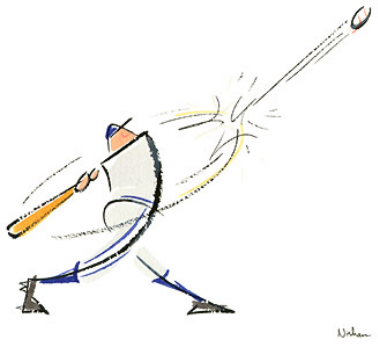
Since the properties of the ball don't change for both the heavy bat and the light bat this component of the may be treated as constant and taken out of our calculation. We'll assume that the ball speed is also a constant since the ball will start at rest for the light bat and heavier bat. Therefore the only two remaining variables that determine the final velocity of the ball and ultimately projectile distance are the mass of the bat, m and the speed of the bat swing, v. If we know these two parameters, we can predict the batted ball speed. As we will see, however, the problem is complicated somewhat by the fact that the speed with which a player can swing a bat depends on the weight of the bat and in this lab we are going to investigate which factor is more important.
The formula used to help investigate whether bat speed or bat weight are more crucial in determining the distance you hit a ball will be the formula for Kinetic energy



E_K = ½ mv2
With m – mass of bat
v – bat speed
E_K - Kinetic energy

Initially looking at the formula for Kinetic energy, before you do the experiment which variable do you believe is more important to produce the furthest homerun balls (Mass of bat or velocity of bat swing)?

1. Use the formula in your discussion to hypothesize why you think either bat speed or weight of the bat is more crucial for homerun hitters?



The Homerun hitters experiment

Step 1: Put the ball on the tee (orange cone)

Step 2: Hit the ball five times with the bat labeled light and using the tape measure record the distances the ball travelled in the air in the chart below

Step 3: Hit the ball five times with the bat labeled light and using the tape measure record the distances the ball travelled in the air in the chart below

Step 4: Calculate the average distances for the heavy bat and the light bat

Step 5: Do Biomechanical Applications for baseball swing

Trail Number	Heavy Bat Distance	Light Bat Distance
1		
2		
3		
4		
5		
Calculate the average distance the ball was hit		

Biomechanical Applications

1. Which bat did you swing faster – the light bat or the heavy bat? Is your assessment in line with your results?

2. Explain if the results from the table confirm your educated guesses from above concerning bat speed and bat weight?

3. Apply two biomechanical principles that would help you hit the ball further and explain why?

a. (Remember to explain why it would help hit the ball further)

b. (Remember to explain why it would help hit the ball further)

4. As a coach what knowledge can you gain from this experiment that would help you be a better batting coach for homerun hitters?

5. What are the three ultimate goals that can be attained by applying biomechanics to sport? (text 235)

a.

b.

c.

Part C - The Flosbury Flop

Prior to 1968, high jumpers traditionally cleared the bar by running, jumping and while remaining head up throwing over one leg and then another (straddle style). Dick Fosbury in 1968 twisted his body so that he went over head first with his back next to the bar.
With any projectile, which includes humans jumping, after takeoff the center of mass will follow a set path (ignoring aerodynamic forces). This old straddle technique meant that the center of mass must go over the top of the bar. The Fosbury Flop technique worked so well because he could arch his body so that his center of mass was outside his body and passed under the bar. This way a greater height can be cleared.

1. From the introduction to the flosbury flop above what is the correlation between center of gravity, flight path and how high you have to jump to clear the same height for the straddle and flosbury flop?

High Jump Experiment

In our investigation today we are going to take a picture of a group member do the flosbury flop and determining if their center of gravity does in fact go under the bar. Mission: to compute the position of the center of mass of the high jumper as they jump over the bar

Step 1: Take a picture of one of your biomechanical team assessment member's jumping over the high jump bar. It would be desirable if one of your group members had prior experience doing the flosbury flop. Make sure mats are all in correct position to ensure jumpers safety

Step 2: Print the picture and put an "X" and "Y" axis on the picture and draw straight lines over each of the following body segments: head (from vertex to chin), trunk (from neck to hip), thigh (from hip to knee), calf (from knee to knee), and foot (from ankle to toe) **Refer to pg. 164 in exercise science workbook for example.**

Step 3: Now using data from table #1 in the second column labeled "Center of Mass Position", identify the position on the straight line for the position of that segment's center of mass. For example, the position of the center of mass for the thigh segment is measured as 37% of the distance to the hip end. Mark this location on the picture.

Table #1

Segment	**Center of Mass Position**	**Length of Segment**	**Actual Distance to CoM up/down segment - plot on picture (%*segment length)**
Head	46% from vertex (top)		
Trunk	38% from neck		
Thigh	37% to hip		
Calf	37% to knee		
Foot	45% to heel		

Step 4: Once you have labeled the "center of mass" on each body segment straight line, then measure them from the "X" and "Y" axis to come up with an (X,Y) co-ordinate for each segment's center of mass. (Measure in millimeters). Then record these (x,y) co-ordinates in the table #2

Table #2

Segment	Segment center of mass conversion ratio	X co-ordinate	X co-ordinate conversion number = (X) multiply by (Center of mass ratio)	Y co-ordinate	Y co-ordinate conversion number = (Y) multiply by (Center of mass ratio)
Head	0.07				
Trunk	0.51				
Thigh	0.2				
Calf	0.08				
Foot	0.02				
Total (X,Y) co-ordinate		Sum of X conversion number →	(center of total body "X" coordinate)	Sum of Y conversion number →	(center of total body "Y" coordinate)

Step 5: Include picture with lab and record the "center of mass"of the body on the picture of the team member high jumping.

Step 6: Do Biomechanical Applications (next page)

Biomechanical Applications

1. Biomechanically speaking, as a coach of the high jumper on the picture how could you get your athlete to go over a higher height with out jumping any higher

2. Apply two biomechanical principles that would help your athlete jump higher and explain why? (text 231-234)

a. (Remember to explain why it would help the athlete jump higher)

b. (Remember to explain why it would help the athlete jump higher)

Part D - Figure Skating and angular Momentum

A key consideration in generating angular momentum is the object's moment of inertia. The larger an object's moment of inertia, the more angular momentum the object can obtain. For example, if a figure skater wants to generate a lot of angular momentum, they should have their arms spread wide, which increases their moment of inertia. In this position, while the skater will have to have a large torque to start rotating, his or angular momentum.
A skater who starts spinning with his arms at his side, with the same angular velocity will have a smaller angular momentum. Moreover, this skater will not be able to increase his speed in the spin, because he will not be able to reduce his moment of inertia to increase his angular velocity.

Some skaters reach rotation speeds of 7 rev/s during a jump. This corresponds to 420 rpm (revolutions per minute). This is as fast than the idling speed of the engine on some cars!!!!

Angular Momentum (L) = Mass (mass of person) X Radius (distance hands away from axis or center line) X Velocity (how fast you spin)
L =mvr

1. What is the definition of angular momentum? (text 234)

2. After considering the definition of angular momentum and looking at the formula, explain why the speed of the rotation can be manipulated by pulling your arms tight to your chest or by outstretching them far away from your body Use the formula in your discussion regarding angular momentum and rotational speed manipulation.

Part A. Spinning Like a Figure Skater Experiment

Step 1: Pick a team member to be the twirler ☺
Step 2: Have the twirler sit in spinning chair and have another team member create torque and turn the with the twirler's arms wide open and after one rotation have the pull their arms to their chest. Do 3 trials
Step 3: Repeat step 2, except have the twirler put 5-pound weights in their hands
Step 4: Repeat step 2, except have the twirler put 10-pound weights in their hands
Step 5: Complete chart # 3 after you have done all the trials. Check which trial was the slowest, the trial that spun next fastest and finally check
Step 6: Do biomechanical applications

Chart #3

Trial Type	Spin Speed - Slowest	Spin Speed – Fast	Spin Speed – Fastest
No weights in hands			
5 Pound weights in			

hands			
10 pounds weights in hands			

Part B. Walking on a Tight Rope

Step 1: Pick a team member to be the tight rope walker (Bench upside down) ☺
Step 2: Have the tight rope walker walk across upside bench with their arms close to their sides (Do 3 trials)
Step 3: Record in space below how hard it was to balance, walking across the upside down bench with your arms to your chest
Step 4: Repeat step 2, except have the tight rope walker this time walk across upside bench with a high jump pole in their hands to help balance them (Do 3 trials)
Step 5: Record in space below how hard it was to balance walking across the balance beam relative to walking across the upside down bench with your arms to your chest. From a scale from 1 – 10, 1 being way more difficult and 10 being way easier

Observations Part B

Step 3 (walking with arms close to sides)

Step 5 (Using a high jump pole to help balance)

Circle number that best describes difficulty of walking across balance beam with high jump pole verses no pole

1 2 3 4 5 6 7 8 9 10
most difficult with pole way easier with pole

Biomechanical Applications

1. Explain how and why added weight impacts the spin, use the formula in your discussion regarding angular momentum and rotational speed manipulation.

2. If you were a diving coach how could you use your results from this lab to help your diver do a 1080 off the 10 meter platform and be able to hit the water totally vertical to have a ripped entry

3. Apply two biomechanical principles that would help the athlete spin quicker or control speed of spin better) and explain why? (text 231-234)

a. (Remember to explain why it would help the athlete spin quicker or control speed of spin better)

b. (Remember to explain why it would help the athlete spin quicker or control speed of spin better)

4. With respect to the formula of angular momentum why would it be easier to walk across a balance beam with a high jump pole in your hands? Describe how changing the variables in the formula (L=mvr) gives you better balance?