

# LABORATORY 11

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## Kinetics

### Objectives

1. State Newton's laws as they apply to both linear and rotary motion.
2. Explain the cause and effect relationship between the forces responsible for linear motion and the objects experiencing the motion.
3. Explain the cause and effect relationship between the forces responsible for rotary motion and the objects experiencing the motion.
4. Explain the analogous kinetic relationships that exist between linear and rotary motion.

### Background

There is a relationship between linear and angular kinematics based on the length of the radius of a lever. The greater the distance from the axis to a point the greater will be the displacement of the point and the derivatives of displacement.

Newton's three laws govern motion in this universe. These three laws are:

1. *Law of Inertia* - a body at rest will remain at rest and a body in motion will remain in motion until acted upon by an outside force.
2. *Law of Acceleration* - acceleration of a body is directly proportional to force and indirectly proportional to mass ( $F = m a$ ).
3. *Law of Reaction* - for every action there is an equal and opposite reaction.

The quantity of motion which an object possesses is referred to as *momentum*. Momentum is a product of mass and velocity ( $mv$ ). Since a change in velocity is an acceleration and since acceleration requires the application of a force over some period of time, it requires a force over a period of time to change momentum. This is called *impulse* ( $Ft$ ). Momentum within a system, once established, remains constant until an impulse is applied.

When two objects collide the total momentum of the system will be the sum of the momentums imparted by each object.

### Equipment

Two balls of unequal mass  
push stick  
drawer with moving arm and 5 marbles  
smoothly rotating chair or platform  
block of wood  
plastic bat, batting tee, indoor ball  
weighted bags

## Laboratory Report - Kinetics

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

### Experiment 1

Equipment: two balls of unequal mass (e.g. golf ball and table tennis ball), push stick

1. Place the two balls against the stick. Applying even force along the length of the stick, push the two balls approximately 10 cm. Stop the stick suddenly and observe the action of the balls.

What type(s) of motion did you observe? \_\_\_\_\_

In what way did the balls exhibit the motion(s) observed?

Which ball travels farther? \_\_\_\_\_

Give a mechanical reason for this result:

2. Repeat the experiment, using the same force, but push for approximately 20 cm.

In which of the two trials did the balls travel farther? \_\_\_\_\_

Give a mechanical reason for this difference:

## Experiment 2

Equipment: Drawer or shallow box with rotating arm, 5 marbles

1. In the drawer, move the rotating arm back against the end of the drawer. Place the marbles against the edge of the arm about 2 cm apart. Gently push the stick forward until it hits the upright screw. Observe the action of the marbles.

Which marble traveled farthest? \_\_\_\_\_

Give a mechanical explanation for this result:

Which marble had the highest linear velocity? \_\_\_\_\_

Give a mechanical reason for this higher velocity:

Which marble had the highest angular velocity \_\_\_\_\_

Give a reason for this result:

### Experiment 3

Equipment: rotating platform or chair

1. Have a subject sit on the rotating platform in such a way that no part of the body is in contact with the floor. Start the platform spinning. As the platform spins have the subject suddenly abduct the arms.

What happens to the rotation when the arms are abducted?

Give a mechanical reason for your results:

2. Repeat the experiment. Immediately following the abduction of the arms have the subject quickly adduct again, bringing the arms in close to the body.

What happens to the rotation in this case?

Give a mechanical explanation for your results:

3. Have the subject attempt to start the platform rotating, with no contact with any outside surface by either the hands or the feet.

Is the subject successful in this attempt? \_\_\_\_\_

Give a mechanical explanation for this success or failure:

## Experiment 4

Equipment: wooden block, notebook

1. Put the block on top of the notebook which is flat on the floor. Quickly jerk the notebook towards you.

What happens to the block?

Give a mechanical reason for this result:

2. Now pull the notebook towards you slowly.

What happens to the block?

Give a mechanical reason for this result:

3. Now pull the notebook towards you smoothly but rapidly. Stop the notebook abruptly.

What happens to the block?

Give a mechanical reason for this result:

## Experiment 5

Equipment: plastic bat, batting tee, indoor ball

1. With the bat, hit the ball from the tee. Mark its landing point. Next, toss the ball up to yourself and hit it. Mark the landing. Finally, hit a ball that is pitched to you. Mark the landing. Use a consistent swing speed throughout the experiment.

Which ball went farther? \_\_\_\_\_

Give a mechanical reason for this result:

## Experiment 6

Equipment: weighted bags

1. Perform a standing long jump under each of the following conditions. Mark the distance jumped for each condition.
  - a. using no arm motion
  - b. using a swinging motion of the arms
  - c. same as b while holding a weight in each hand
  - d. again hold the weights. Swing the weights forward as you jump. At the peak of the jump throw the weights down and backward. This one may require some practice.

Which jump was the longest? \_\_\_\_\_

Give at least 2 mechanical reasons for this result:

## LABORATORY 12

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### Work, Power, Friction, Elasticity

#### Objectives

1. Explain the work-energy relationship as it applies to a body experiencing linear motion.
2. Define and use properly the terms work, power, kinetic energy, and potential energy.

#### Background

Work is defined as the product of force and the distance through which that force moves an object, in the direction in which the force is applied ( $W = F d$ ).

Power is the rate at which work is done ( $P = W / t$ ).

Energy is defined as the ability to do work. Potential energy (PE) is energy based on position. Kinetic energy (KE) is energy based on motion. Energy within a system is conserved. That is, the total energy is the sum of PE and KE.

Friction is the tangential component of force which acts between two surfaces to resist sliding or rolling. The coefficient of friction is determined by the nature of the two surfaces.

Elasticity is the ability of an object to resist deformation and to resume its' original shape once it has been deformed. Elasticity is described in terms of an object coefficient of restitution.

#### Equipment

assortment of surfaces  
assortment of balls  
board marked at 10 cm and 20 cm  
meter stick  
steel ball bearing or golf ball

spring scale  
stopwatch  
tape measure  
weight

# Laboratory Report - Work, Power, Friction, Elasticity

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

In all experiments, be careful to make sure that your units are consistent (you may not mix pounds with meters).

## Work & Power

Equipment: stopwatch, meter stick

You will need to record the following before you start:

Subject body weight (in Newtons) \_\_\_\_\_ N

Vertical height of stairs \_\_\_\_\_ m  
(hint - measure a single step and multiply)

1. Time the subject as they walk up the stairs. Time:

Calculate the work done:

$$W = F d; \quad W =$$

Calculate the power produced:

$$P = W / t; \quad P =$$

Briefly explain what these two quantities indicate in this experiment:

2. Repeat the experiment with the subject running up the stairs. Time:

Calculate the work done:  $W =$

How does this compare to the first trial?

Give a mechanical explanation for this comparison:

Calculate the power produced:  $P =$

How does this compare to the first trial?

Give a mechanical explanation for this comparison:

## Energy

Equipment: marked board, steel ball bearing or golf ball

3. Place the board on the floor with the 20 cm end propped up on some stable object (such as a book or a block). Start the bearing at the 10 cm mark on the board. Release the bearing and let it roll. Record the time it takes to travel the first meter after it leaves the board. Record the total distance the bearing travels. Record the height of the board at the 10 cm mark.

Mass of shot \_\_\_\_\_ kg

Height of 10 cm mark \_\_\_\_\_ m

Time for 1st meter \_\_\_\_\_ sec.

Total distance (d) \_\_\_\_\_ m

Calculate the potential energy possessed by the bearing before release:

PE = mgh; PE =

Calculate the kinetic energy possessed by the bearing in motion:

KE =  $\frac{1}{2} m v^2$ ; KE =

Are the potential energy and the kinetic energy approximately the same? \_\_\_\_\_

Give a mechanical explanation for this result:

Calculate the force which was applied to the bearing:

F = KE / d; F =

2. Repeat the experiment, but start the bearing from the 20 cm mark on the board. Record the time taken to cover the first meter, the total distance covered, and the height of the 20 cm mark.

Height of 20 cm mark \_\_\_\_\_ m

Time for 1st meter \_\_\_\_\_ sec.

Total distance (d) \_\_\_\_\_ m

Calculate the potential energy possessed before release:

PE = mgh; PE =

Calculate the kinetic energy possessed in motion:

KE =  $\frac{1}{2} m v^2$ ; KE =

Are the potential energy and the kinetic energy approximately the same? \_\_\_\_\_

Give a mechanical explanation for this result:

Calculate the force which was applied:

$$F = KE / d; \quad F =$$

4. Do the following comparisons between the two trials.

Which of the two trials possessed the greatest PE? \_\_\_\_\_

Why was this so?

Which of the two trials produced the greatest KE? \_\_\_\_\_

Give a mechanical explanation for this result:

In which trial was the greatest force generated? \_\_\_\_\_

Give a mechanical explanation for this result:

If you have time, repeat Experiment 2 with other balls. Record your results on a separate sheet of paper.

## Friction

Equipment: weighted shoe, spring scale, a variety of surfaces (suggest floor, a board, carpet, astroturf, artificial track, etc.)

5. Place the weight in the shoe. Attach the spring scale to the shoe and weight it ( $W$ ). Place the shoe on a wooden board. Pull horizontally on the spring scale just until the shoe starts to move. Make sure you do not exert any upward force on the shoe, as this will reduce friction. Read the pulling force ( $P$ ) from the scale and record it below.

$W =$  \_\_\_\_\_  $P =$  \_\_\_\_\_

Calculate the coefficient of friction ( $\mu$ ):

$\mu = P/W$        $\mu =$  \_\_\_\_\_

6. Repeat this experiment on as many different surfaces as you can find.

Surface	P	$\mu$
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Which of these surfaces produced the greatest coefficient of friction?

Give a mechanical explanation for this result:

7. Place the weighted shoe on the board. Now tilt the board until the shoe just barely begins to slide. Measure the angle between the board and the floor. The tangent of this angle will be the coefficient of friction:

$\mu = \tan \theta$        $\mu =$  \_\_\_\_\_

Does this agree with the  $\mu$  you found in trial #1 of this experiment?

Give a mechanical explanation for this result:

## Elasticity

Equipment: an assortment of balls

8. Fix a tape measure to a vertical surface. Drop each ball in turn from a height of 2 meters onto the floor. Measure the height of each rebound. Calculate the coefficient of elasticity for each ball.

Coefficient of elasticity:

$$e = \sqrt{\frac{\text{height of rebound}}{\text{height of drop}}}$$

Ball	Rebound height	e
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Which ball has the greatest observed elasticity? \_\_\_\_\_

Give a mechanical explanation for this result:

9. Repeat the experiment using as many different landing surfaces as you have time for. (Record your results on an additional piece of paper.)

What were the effects of the different surfaces on the elastic response of the balls?

## LABORATORY 13

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### Torque

#### Objectives

1. Solve simple lever and torque problems involving the human body and the implements it uses.
2. Evaluate the true muscular effort force required to support a given external resistance.
3. Enhance understanding of the nature of torque and the effects of torque on the body.

#### Background

The turning effect of an eccentric force is called torque or moment of force. The torque about any point equals the product of the force magnitude and the perpendicular distance from the line of force to the axis of rotation. The perpendicular distance between the force vector and the axis is called the moment arm or torque arm. In this text, the turning effect will be referred to as torque and the perpendicular distance as moment arm.

Since torque is the product of force and the length of the moment arm, it may be modified by changing either the force or the moment arm. Torque may be increased by increasing the magnitude of the force or by increasing the length of the moment arm. Decreasing either of these factors will produce a decrease in torque. In supporting a weight at the end of a fully extended arm for instance, if the magnitude of the weight were decreased, the torque would also decrease. Conversely, increasing the weight would increase the torque. If, however, the weight is increased but is moved closer to the axis (the elbow), the torque produced by the heavier weight would be reduced through reducing the length of the moment arm.

It is important to emphasize that the moment arm is the *perpendicular* distance from the direction of force to the axis of rotation. In the example just given, the moment arm length was the same as the length of the forearm because the horizontal forearm was perpendicular to the vertical direction of the force, and therefore the forearm length was equal to the perpendicular distance from the force direction to the axis. If the arm were in some position other than the horizontal, its length would no longer be equal to the moment arm distance between the force direction and axis. Only the rotary component (y component) of a force acts to produce torque. The x component will act either to stabilize or dislocate the joint.

Torque is a function of an applied force times the distance from the axis at which that force is applied ( $T = F \times d$ ).

Forces can be either effort or resistance forces. For a system or a lever to be in equilibrium these two types of forces must create equal and opposite torques ( $E \times EA = R \times RA$ ).

Torque acts at the joint. Force acts on a lever.

#### Equipment

Meter stick  
Load ( a book bag with books inside works well)  
Stopwatch  
Goniometer

## Procedures

1. On your subject locate the lateral femoral condyle and the lateral malleolus of the right leg. Measure the distance between the two landmarks and record this on your lab report as segment length.
2. Using the converted weight of the subject (see lab report) determine the weight of the lower leg. Use the data provided to find the location of the center of gravity of the lower leg, as measured from the knee.
3. Record the leg weight and the distance to the center of gravity on the free body diagrams (FBD) provided. This will represent  $R_1$  and  $RA_1$ .
4. Calculate the location of the attachment of the quadriceps muscle group to the tibia using the percentage given on the lab report. Record this on the free body diagram representing EA. Notice the muscle angle of pull given on each FBD.
5. Have the subject sit on a table. Fix equal loads to each ankle. Have the subject then extend the left leg as fully as possible (with the thigh fully supported). The right knee is extended to an angle of  $150^\circ$ , determined by goniometer.
6. Hold these positions as long as possible. Record the holding time for each leg.
7. Record the magnitudes of the external loads on the lab report form and on the two FBDs. These will represent  $R_2$ . Record the segment length on the two FBDs, representing  $RA_2$ .
8. Following the torque calculation techniques discussed in lecture, calculate the actual muscle force required by the quadriceps muscle group of each in order to support the external load.

## Laboratory Report - Torque

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

Record the following information and do the required calculations to produce the relevant data.

Body weight \_\_\_\_\_ lbs. X 4.45 = \_\_\_\_\_ N

Segment weight (R1) = body weight \_\_\_\_\_ N X 0.045 = \_\_\_\_\_ N

Segment length (RA2) = \_\_\_\_\_ meters

Center of gravity location (RA1):

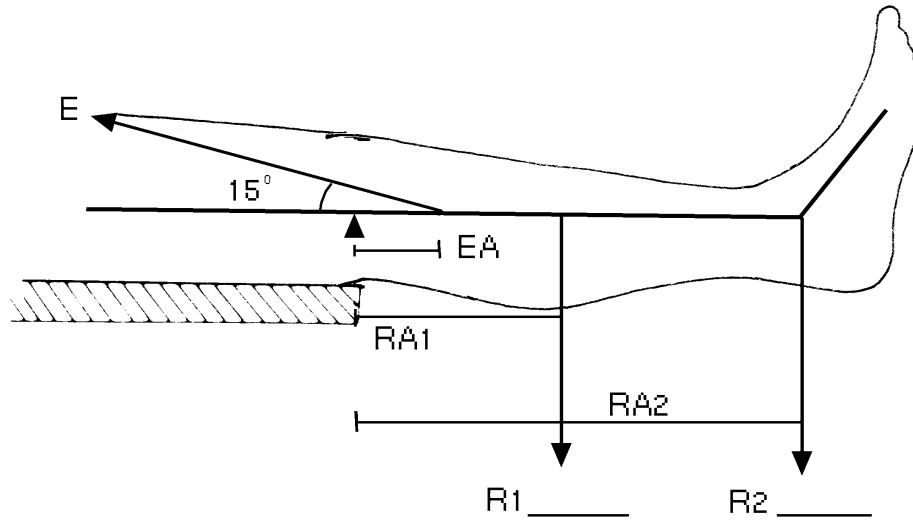
Segment length \_\_\_\_\_ meters X 0.433 = \_\_\_\_\_ meters

Muscle attachment (EA):

Segment length \_\_\_\_\_ meters X 0.12 = \_\_\_\_\_ meters

External load (R2) \_\_\_\_\_ lbs. X 4.45 = \_\_\_\_\_ N

Fill in the free body diagrams (FBDs) for both legs with this data.



Data to be used:

R1 (segment weight) = \_\_\_\_\_ N      RA1 (c of g) = \_\_\_\_\_ m

R2 (external load) = \_\_\_\_\_ N      RA2 (seg. length) = \_\_\_\_\_ m

EA (dist. to muscle attachment) = \_\_\_\_\_ m

Calculate torque produced by the resistance:

$$(R1 \times RA1) + (R2 \times RA2) = T_R$$

$$T_R = \text{_____ N}\cdot\text{m}$$

Calculate the rotary component of the muscle force required to produce an equal and opposite torque:

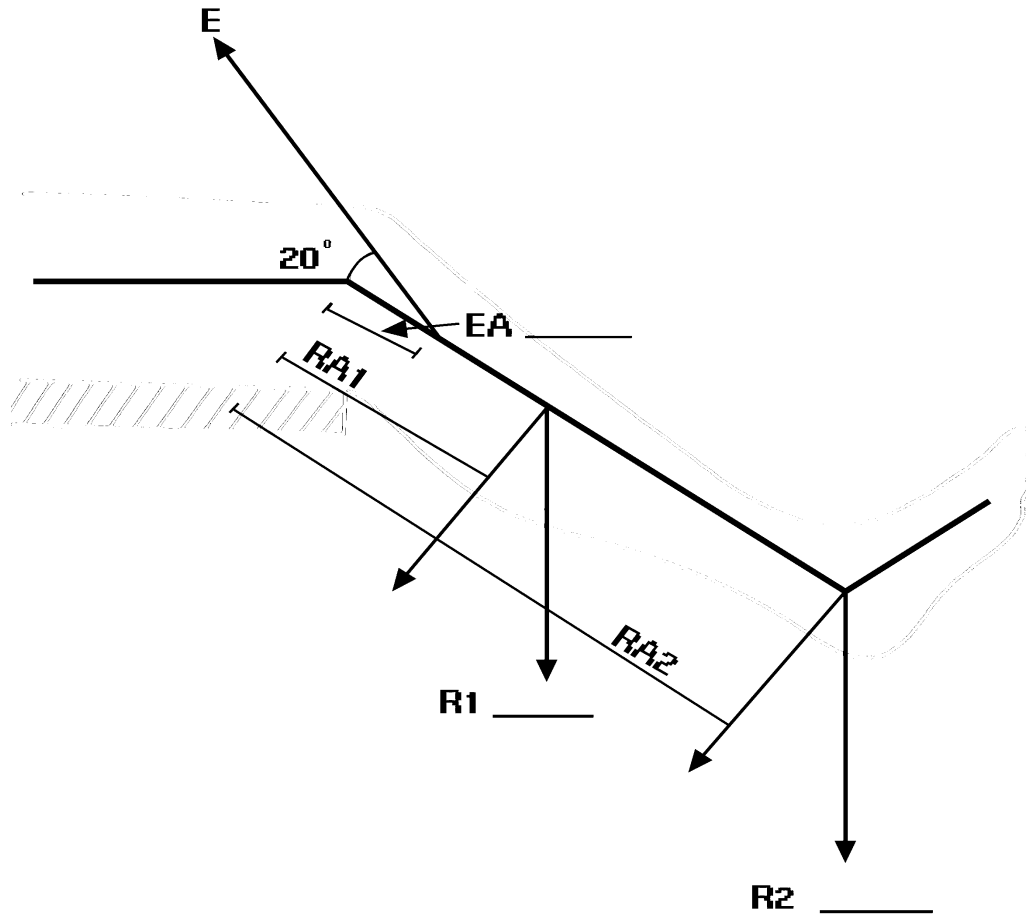
$$T_R = E_y \times EA, \text{ therefore, } E_y = T_R/EA$$

$$E_y = \text{_____ N}$$

Calculate the total muscle force:

$$E = E_y/\sin 15^\circ$$

$$E = \text{_____ N} \quad \text{Time held: _____ sec.}$$



Calculate the rotary components of the resistance forces:

$$R_{1y} = \text{_____ N}$$

$$R_{2y} = \text{_____ N}$$

Calculate the torque produced by the resistance:

$$(R_{1y} \times RA_1) + (R_{2y} \times RA_2) = T_R$$

$$T_R = \text{_____ N}\cdot\text{m}$$

Which of the two resistance torques is greater (straight leg or bent leg)? \_\_\_\_\_

What is the reason for this?:

Calculate the rotary component of the muscle force required:

$$T_R = E_y \times EA$$

$$E_y = \text{_____ N}$$

Calculate the total muscle force required to produce an equal and opposite torque:

$$E = E_y / \sin 20^\circ$$

$$E = \text{_____ N} \qquad \text{Time held: _____ sec.}$$

In which leg was the greatest muscle force required? \_\_\_\_\_

Using the concept of torque and the principle of levers in equilibrium, explain why this is so:

Which leg had the longest holding time? \_\_\_\_\_

Explain this result. Base your answer on the answer to the previous question.

## LABORATORY 14

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### Center of Gravity

#### Objectives

1. Define the term *center of gravity*, and explain the basis for its location in the human body.
2. Locate the center of gravity of an individual using either the reaction board or the segmental method.

#### Background

The center of gravity of a body is sometimes described as its balance point or that point about which a body would balance without a tendency to rotate. For this reason, the center of gravity is often identified as the point where all of the weight of the body or object is concentrated. More accurately, it is the point where the weight of the body may be said to act.

The ability to locate the center of gravity of a body is based on the knowledge of what it takes for a system to be balanced, or in equilibrium. There are two conditions that must be met:

1. All the linear forces acting on the body must be balanced.
2. All the rotary forces (torques) must be balanced.

Another way of expressing these necessary conditions for equilibrium is to say that the sum of all the forces acting on the body must equal zero. If there is a downward-directed linear force, there must be an equal upward force so that the vector sum of these forces equals zero. If there is a negative clockwise torque it must be canceled out by a positive counterclockwise torque of equal magnitude.

The location of the center of gravity of any object remains fixed as long as the body does not change shape. In rigid bodies of homogeneous mass, the center of gravity is at the geometric center. Where the density of a rigid body varies, the center of gravity is not at the geometric center but is shifted toward the more weighted section. If an object's shape or position changes, the location of the center of gravity will also change. This happens in the human body. It is a segmented structure, capable of numerous positions, and the location of its center of gravity changes accordingly. This is an important consideration in the execution of sports skills.

It has been estimated that the center of gravity of most individuals falls between 55% and 59% of the total body height. It has further been established that the center of gravity is usually located somewhat lower in women than in men.

#### Reaction Board Method

It is a fairly simple matter to find an estimate of the center of gravity of a motionless body using the *reaction board method*. Making use of the principle of moments, this procedure relies on the fact that the sum of the moments acting on a body in equilibrium is zero. Using this information the location of the gravitational line is found for each plane. The center of gravity of the body becomes the intersection of the values for each of these three planes. Directions for locating the center of gravity in three planes follow.

#### Equipment

Scales (the Toledo or the spring balance type).  
Block (same height as the platform of the scales)  
A board about 40 cm wide and 200 cm long with knife edge supports

## Procedures

1. Find the subject's total weight,  $W$ .
2. Put one knife edge of board on scale platform and the other edge on box platform. Use a spirit level to make sure board is horizontal. Note the reading on the scales. This is the partial weight of the board,  $B$ .
3. Have the subject lie supine on the board with the heels against the footrest at the end of the board away from the scales. The position the subject assumes should be as similar to the standing position as possible. Record the reading on the scales. This is the partial weight of the subject and scales,  $S$ .
4. For equilibrium to exist about the point  $P$ , the counterclockwise torques must equal the clockwise torques. If  $W$  is the total weight of the subject,  $B$  the partial weight of the board,  $S$  the partial weight of the subject and board,  $L$  the length of the board, and  $d$  the perpendicular distance from  $P$  to  $W$ , then

$$dXW=(S-B)L$$

(clockwise torques = counterclockwise torques)

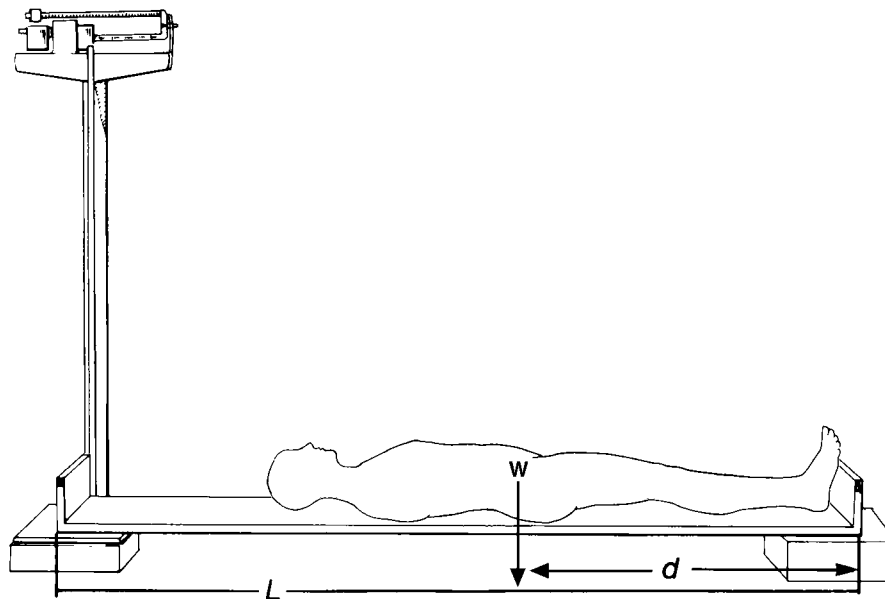
Rearranged,

$$d=\frac{(S-B)L}{W}$$

The distance between the subject's feet and center of gravity is  $d$ . This is comparable to the distance between the ground and the center of gravity when the subject is standing, but must be viewed as an estimate because of shifts in body organs and tissues when lying down.

5. The percentage height of the center of gravity with respect to the subject's total height is found by dividing the value of  $d$  in the transverse plane (supine lying position) by the subject's total height and multiplying by 100.

$$\text{percent}=\frac{d \text{ in transverse plane}}{\text{subjects height}} \times 100$$



## Segmental Method

With information on the proportionate mass of body segments and the location of the center of gravity of each segment, the center of gravity of the whole body in any plane may be determined by making use of the principle of torques. The sum of the torques of the individual segments about arbitrarily placed  $x$  and  $y$  axes will produce the location of the center of gravity of the whole body with respect to the  $x$  and  $y$  axes. This is because the total body weight acting at the center of mass is the resultant of the combined segment weights acting at their mass centers and the resultant moment of the total body weight about the  $x$ ,  $y$  axes is the sum of the individual segment torques about the same axes.

## Equipment

Line drawing on graph paper

## Procedures

1. Mark the locations of the extremities of the individual segments according to the link boundaries shown in Figure 14.18 (end of the second toe, ankle, knee, hip, knuckle III of the hand, wrist, shoulders, seventh cervical vertebra, midpoint of the transverse line joining the hips, and top of the head).
2. The extremity limits are joined to form a stick figure consisting of 14 segments.
3. The mass center location for each segment length is found using the data provided in Figure 14.18, where centers of gravity are located as a percentage of the distance between segment end points. The amount of the percentage distance from one segment end point is multiplied by the picture-length of the segment. The resulting product is the distance from the selected end point to the center of gravity of the segment. The distance is measured from the end point, and the center of gravity is marked by a short slash mark intersecting the segment line.
4. Draw  $x$  and  $y$  axes on the paper.
5. The  $x$ ,  $y$  coordinates for each of the 14 segment mass centers are determined and recorded on the diagram of the figure at the respective mass centers.
6. Record the  $x$ ,  $y$  coordinate values on the worksheet.
7. Multiply the  $x$  coordinate and the  $y$  coordinate each by the proportion of body weight listed in the second column. Record this result in the columns labeled  $x$  product and  $y$  product.
8. The algebraic sum of the  $x$  products represents the  $x$  coordinate of the total body's mass center, and the algebraic sum of the  $y$  products is the  $y$  coordinate. These values are located and marked on the tracing.

## Laboratory Report - Center of Gravity

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

### Reaction Board Method

Data to be used:

Subjects body weight ( $W$ ) \_\_\_\_\_ Length of the board ( $L$ ) \_\_\_\_\_

Weight of the board ( $B$ ) \_\_\_\_\_ Subject's height ( $H$ ) \_\_\_\_\_

Weight of the subject while lying on the board ( $S$ ) \_\_\_\_\_

1. Find height of the center of gravity measured from the feet:

$$d = \frac{(S - B)L}{W}$$

$d =$  \_\_\_\_\_

2. Find the location of the center of gravity as a percentage of the total height:

$$\text{percent} = \frac{d}{H} \times 100$$

percent of height = \_\_\_\_\_

3. How does the location of your center of gravity compare with that presented as average for your gender (higher, lower, same)?
4. Provide an anatomical explanation for the location of your center of gravity as compared to the average.

## Segmental Method

### Worksheet

Body Segment	Proportion of Body Weight	x value	x product	y value	y product
Trunk	.486				
Head & Neck	.079				
R. Thigh	.097				
R. Lower Leg	.045				
R. Foot	.014				
L. Thigh	.097				
L. Lower Leg	.045				
L. Foot	.014				
R. Upper Arm	.027				
R. Forearm	.014				
R. Hand	.006				
L. Upper Arm	.027				
L. Forearm	.014				
L. Hand	.006				
x-y Resultants (product total)					

# LABORATORY 15

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## Analysis of Posture

### Objectives

1. Identify and describe the skeletomuscular and neuromuscular antigravity mechanisms involved in the volitional standing position.
2. Summarize the similarities and differences that occur in the relation of the line of gravity to various body landmarks with good and poor anteroposterior segmental alignment.
3. Discuss the factors that affect the stability and energy cost of the erect posture.
4. Explain the effects that the variables of age, body build, strength, and flexibility have on the alignment of body segments in the standing posture.
5. Perform kinesiological analyses on the posture of individuals of different ages and body builds.

### Background

There are innumerable concepts of human posture and innumerable interpretations of its significance. Posture may well claim to be "all things to all people." To the physical anthropologist posture may be a racial characteristic, or it may be an indication of phylogenetic development; to the orthopedic surgeon it may be an indication of the soundness of the skeletal framework and muscular system; to an artist it may be an expression of the personality and the emotions; to the actor it serves as a tool for expressing mood or character; to the physician, biologist, fashion model, employer, sculptor, dancer, therapist, psychologist--to each of these, posture has a different significance. Each sees posture within the framework of his or her own profession and interest. This is no less true of kinesiologically oriented therapists and educators. To them, posture is a gauge of mechanical efficiency, kinesthetic sense, muscle balance, and neuromuscular coordination.

For all practical purposes no individual's posture can be described completely. Posture means position, and a multisegmented organism such as the human body cannot be said to have a single posture. It assumes many postures and seldom holds any of them for an appreciable time. Although characteristic patterns become apparent as we observe an individual over an extended period, it is difficult, if not impossible, to measure, or even record, these patterns. It would take a comprehensive series of motion pictures of an individual's varied stance and movement patterns to provide an adequate sample. Perhaps this is the reason why most posture research has been related to the volitional standing position.

### Procedures

Often an effective tool for the analysis of either static positions or dynamic movements of the body is a checklist. Checklists are derived from the principles which govern the human movement system. Each of the critical elements in a checklist has been placed there because it offers an opportunity to qualitatively determine the extent to which the observed action or position follows the principles established for a sound performance.

In this lab a checklist for posture has been provided. The student will provide the appropriate rationale for each of the critical elements utilized in the checklist.

Once the underlying basis for the postural checklist has been established, the student will apply the checklist in a qualitative analysis of the posture of several subjects with differing postures. Any notable deviations from expected posture will be described and discussed.

## Laboratory Report - Analysis of Posture

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

### *Checklist:*

1. The weight-bearing joints are in extension with no obvious strain or tension.

Rationale:

2. There is no evidence of excessive hip rotation.

Rationale:

3. The knees not hyperextended.

Rationale:

4. There is normal vertebral curvature in the sagittal plane; no obvious lordosis or kyphosis.

Rationale:

5. There is no lateral curvature of the vertebral column (scoliosis).

Rationale:

6. The head is balanced over trunk.

Rationale:

Subject 1 \_\_\_\_\_

		<i>Yes</i>	<i>No</i>
1.	The weight-bearing joints are in extension with no obvious strain or tension.	—	—
2.	There is no evidence of excessive hip rotation.	—	—
3.	The knees not hyperextended.	—	—
4.	There is normal vertebral curvature in the sagittal plane; no obvious lordosis or kyphosis.	—	—
5.	There is no lateral curvature of the vertebral column (scoliosis).	—	—
6.	The head is balanced over trunk.	—	—

Are there any noticeable deviations from the posture defined by the checklist? If so, describe each one:

What is the probable cause of each of these deviations?

In what way(s) will each of these deviations effect the rest of the system?

Subject 2 \_\_\_\_\_

		Yes	No
1.	The weight-bearing joints are in extension with no obvious strain or tension.	—	—
2.	There is no evidence of excessive hip rotation.	—	—
3.	The knees not hyperextended.	—	—
4.	There is normal vertebral curvature in the sagittal plane; no obvious lordosis or kyphosis.	—	—
5.	There is no lateral curvature of the vertebral column (scoliosis).	—	—
6.	The head is balanced over trunk.	—	—

Are there any noticeable deviations from the posture defined by the checklist? If so, describe each one:

What is the probable cause of each of these deviations?

In what way(s) will each of these deviations effect the rest of the system?

# LABORATORY 16

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## Exercise Evaluation

### Objectives

1. Identify the advantages and disadvantages of a selected exercise device or program.
2. Justify the selection of the exercise device using the outline for kinesiological analysis.

### Background

The objectives of exercise programs are to effect musculoskeletal, circulatory, and respiratory adaptations that will make possible increases in strength, flexibility, and work capacity for safer and more enjoyable motion in work, play, and activities of daily living.

Exercise instructors who have a good kinesiological background should be able to analyze and evaluate exercises, not only those with which they are already familiar but also those that are brought to their attention by their students or are seen on television or in popular magazines. They should be able to tell whether exercises are suitable for the inexperienced performer, a performer of moderate experience and ability, or an advanced performer. They should know whether the exercises have undesirable features such as the danger of straining ligaments, encouraging posture faults, or causing excessive tension. They should also recognize the mechanical problems that may be involved, such as problems of balance, leverage, or momentum. In brief, evaluation of exercises should be based on the answers to the following questions:

1. What is the purpose of the exercise or device?
2. How effectively does it accomplish its purpose?
3. Does it violate any principles of good mechanics?
4. What are the chief joint and muscular actions involved in it?
5. What are its intensity and difficulty? (Is it suitable for a beginner, a moderately experienced performer, or an advanced performer?)
6. Are there any elements of danger, injury, or strain against which precautions should be taken?
7. Is it likely to call forth any undesirable or harmful responses against which the performer should guard?
8. If the exercise is a difficult one, what preliminary exercise would serve to prepare the performer for it?

The uninformed consumer has become the primary target for disreputable manufacturers in many areas. The physical education, fitness, and rehabilitation areas are not immune from this trend. "Gimmick" exercise devices have appeared on the market in great numbers in recent years. These products are accompanied by claims which range from those based on logical, well founded scientific theory to gross exaggerations of the expected outcomes.

Within the realm of the movement professional should be the information necessary to make knowledgeable evaluations of the general and specific values of these devices. These evaluations will be requested and expected by your students and clients, and you should be able to provide this information.

### Procedures

Choose one of the exercise devices from a popular magazine or television advertisement. Choose one specific exercise which can be performed using this device.

Following the outline provided, completely analyze your chosen device.

When your analysis is complete, prepare a 90 second sales pitch for your device. Your group will attempt

to “sell” this device to the rest of the class. While your sales pitch may be less than accurate (without lying), you must answer all questions truthfully.

*(Warning - some devices are valid, some are not. Evaluate your device carefully !)*

## Laboratory Report - Exercise Evaluation

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

### Selected Device and/or Exercise

1. Name of device and exercise \_\_\_\_\_

Verbal description of exercise:

2. Suggested objectives of performing this exercise (those suggested by the sales information or producer):

3. Using appropriate kinesiological terminology describe the primary motion of the exercise. Include planes and axes, joint motions, and segments moved:

4. Prime movers for this exercise:

5. Are the antagonist muscle important in this exercise? \_\_\_\_\_

If so, explain their importance

6. What type of muscle action is required (isometric, isotonic, or isokinetic):

- Why is this muscle action required?
7. What muscle contraction type is required (concentric, eccentric, or static)?

Why is this contraction type required?

8. Does this exercise meet the suggested objectives better than any exercise using no external object or device?

Why or why not?

*Include the following ;*

1. What is the purpose of the exercise?
2. How effectively does it accomplish its purpose?
3. Does it violate any principles of good mechanics?
4. What are the chief joint and muscular actions involved in it?
5. What are its intensity and difficulty? (Is it suitable for a beginner, a moderately experienced performer, or an advanced performer?)
6. Are there any elements of danger, injury, or strain against which precautions should be taken?
7. Is it likely to call forth any undesirable or harmful responses against which the performer should be on guard?
8. If the exercise is a difficult one, what preliminary exercise would serve to prepare the performer for it?

## LABORATORY 17

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### Analysis of Push-Pull Motions

#### Objectives

1. Name and discuss anatomical and mechanical factors and principles that apply to representative push or pull activities.
2. Analyze the performance of someone performing a push-pull skill under each of these force application conditions: momentary contact, projection, or continuous application.

#### Background

In pushing and pulling patterns of motion, the basic joint actions are flexion and extension in one or more of the extremities. The joint actions in the upper extremities are characterized by flexion and extension in the elbow while the opposite movement is occurring in the shoulder. In the lower extremities, extension occurs simultaneously in the hip, knee, and ankle. This simultaneous and opposite joint action is a primary characteristic of push-pull patterns. All joint motions occur at the same time or very near the same time.

The simultaneous nature of the joint motions in push and pull patterns produces a rectilinear path of motion at the distal end point of the segments involved, as opposed to a curvilinear path. Such a rectilinear path means that all forces produced by segmental motion are applied directly to the object and that this force is applied in the direction of motion. Keeping this in mind makes it apparent that the primarily simultaneous push-pull patterns are of greatest value when it is important to apply a large force (overcome a large resistance) or to apply a force with maximum accuracy. All the forces involved are applied directly in line with the object being moved. There are no large-magnitude tangential forces.

A push, pull, or lift may be applied either directly or indirectly to an object. In the latter instance, the push or pull pattern is used for the purpose of developing potential energy in an elastic device such as a bow or slingshot. When the elastic structure is released, it imparts force to the movable object, causing the arrow or shot to be projected into the air.

#### Procedures

Working in a group of several students, select a simple push-pull skill.

From the movement principles listed on pages 488-489 in Luttgens & Hamilton *Kinesiology, 9th ed.*, derive a qualitative checklist for this skill. The checklist should include all of the critical elements necessary to insure that this skill is performed with optimum safety, effectiveness, and efficiency.

For each critical element included as part of the checklist, provide a rationale for inclusion.

Have one student act as a subject and perform the selected skill. Apply the checklist that has been developed to the performance. Based on the qualitative checklist evaluation, make suggestions for improvement of the skill performance, based on sound mechanical principles.

## Laboratory Report - Push-Pull Motions

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

*Checklist:*

1.

Rationale:

2.

Rationale:

3.

Rationale:

4.

Rationale:

5.

Rationale:

6.

Rationale:

7.

Rationale:

8.

Rationale:

9.

Rationale:

10.

Rationale:

Selected skill: \_\_\_\_\_

	<i>Yes</i>	<i>No</i>
1.	—	—
2.	—	—
3.	—	—
4.	—	—
5.	—	—
6.	—	—
7.	—	—
8.	—	—
9.	—	—
10.	—	—

Are there any noticeable deviations from the performance described by the checklist? If so, describe each one:

What is the probable cause of each of these deviations?

What specific suggestions would you make for the improvement of performance?

Rationale: