MECHAN1CAL CONCEPTS:

1. If the purpose of the projection is speed, rather than distance, the angle of projection should be as low as possible to carry it the required distance.

Applications:
a) Throw a baseball to a partner using maximum speed. Observe the angle required to complete the throw successfully.
b) Execute the tennis forehand observing the angle necessary to project the ball over the net using maximum speed.

2. To help achieve accuracy, eyes should be focused on the target or the object of focus.

Applications:
a) Attempt to hit a golf ball while focusing the eyes on the ball. Make a second attempt to hit the ball while focusing eye on, a target other than the ball. What are the differences?
b) In darts, attempt to hit vertical target while keeping the eyes on the dart board. Next attempt to throw darts at the dart board with the eyes closed.

3. If the line of gravity moves outside of the, base of support, a quick adjustment must be made in order to regain balance.

Applications:
a) Walk on a balance beam and attempt, to keep constant balance. Note the corrections needed in order to maintain balance on the beam.

4. When two or more forces act upon a body, or two or more forces act upon each other, the resulting movement is determined by the direction and magnitude of the acting forces.

Applications:
a) With a partner, face each other, lock hands and push against each other. One partner should change the direction the force is applied (i.e., move hands to the right or left). What is the result and why?

5. The smaller the vertical component of force, the greater the horizontal component.

Applications:
a) Throw a Frisbee to a maximum distance. Which is greater, the horizontal or the vertical component? Why?
b) Shoot a basketball and note the differences in the horizontal and vertical components.

6. Walking has been described as an alternating loss and recovery of balance.

Applications:

a) With a partner observe their gait and note their walking pattern. How does this relate to the above stated principle?

7. Stability of the body is directly related to the size of the base of support.

Applications:
a) Observe a partner jumping on one foot and then jumping on two feet. What are the differences in stability and why?

8. The path of motion of a body's COG in space is determined by the angle at which it is projected, speed of projection, height of COG at takeoff, and air resistance.

Applications:
a) Execute a jump ball with a basketball with two people of different heights. What are the differences in the angles of projection, the speed of projection, and the height of COG?
b) Execute a vertical jump with two people of similar heights. What are the differences, if any, in the angles of projection, the speed of projection, and the height of COG?

9. The time a body remains unsupported depends on the height of a projection which is governed by the vertical velocity of the projection.

Applications:
a) Execute a vertical jump with several subjects and record the height of projection of each subject and their time.

10. When a body is free in space, movement of a part in one direction results in the movement of the rest of the body in the opposite direction.

Applications:
a) When watching a high jump what occurs in regards to the placement of body segments as they pass over the bar?

11. Constant velocity is rarely present in human motion.

Applications:
a) Explain why running is an example of this principle?

12. Gravity has no effect on the horizontal component.

Applications:
a) Roll a ball down a flat, smooth surface. Next, toss the same ball int the air. What are the results? Why?

13. Linear motion consists of two types: rectilinear and curvilinear.

Applications:

a) Run on a track. 100m and 1lap. Observe and state the two components of motion that may occur.

14. With a horizontal target, a greater vertical component is required when seeking accuracy.

Applications:
a) Select two golf clubs: a putter and a 9-iron.Use the putter to putt the ball towards the hole.
Which component is greater? .
b) Use the9-iron to hit the ball up an embankment. Which component is greater?

15. Linear velocity and acceleration are derived from position and velocity, respectively.

Applications:
a) Observe a partner positioned in the starting blocks .on the tract. Note the differences in the technique when they run upright vs running with flexed trunk.

16. The flight of a projectile, its height and distance are affected by conditions at the
point of release; conditions being angle of projection, velocity of projection and relative height of projection.

Applications:
a) Throw a ball towards a target. Have a partner observe and discuss the three conditions associated with the throw.

17.The greater the distance between a takeoff and landing heights, the smaller the optimum angle of release, given equal projection velocities.

Applications:

a) Shoot two free throws. One should be shot from the free throw line and the other shot close to the basket. Adjust the angle of release accordingly to make a $1.1 successful shot each time.
Note the differences needed to make each shot.

18. There exists at each height and speed an optimum angle which gives the object the greatest horizontal distance.

Applications:
a) Have two people of different heights toss a water balloon at a target. Measure each subject's angle/point of release. What are the differences?
b) Two partners perform the following Jumping activity: Attempt to Jump 5 feet and record the approximate projection angle. Next, attempt to jump 7 feet and record the approximate projection angle. What are the differences?

19. When dealing with height, velocity and projection angle, it is beneficial to keep two of the factors constant.

Applications:
a) Have two people throw a ball at a target; one person should attempt to change their angle of release while the other person changes their velocity. Which ball goes farther and why?

20. The height of COG of a body relative to the ground should be maximized prior to the takeoff.

Applications:
a) Execute a volleyball spike. Attempt two trials. First, crouch in a stance to generate power. Spike the ball. Next stand upright and use the calves to generate all power for the spike (i.e. rise up on toes). Which is more effective and why?

21. Gravity reduces until vertical velocity reaches 0.

Applications:
a) Execute the tennis ball toss associated with tennis serve. Note the velocity of the ball at its highest point in the air prior to contact with the racquet.

22. The body should be projected upward rather than backward. Greater vertical velocity and force of gravity requires more time to bring the body to a halt and back down.

Applications:
a) Execute a high jump using a “dive method” {along head first over the bar). Make a second attempt using the flop method. What are the differences?

23. When projecting for accuracy and speed. One should decrease the vertical component.

Applications:
a) Toss a tennis ball lightly and throw it with great force. What occurs with the horizontal and vertical components?

24. The more vertical an object lands, the greater the chances of success with a horizontal target.

Applications:
a) Use a 9-iron a putter. Hit a golf ball with each club. Note the vertical and horizontal component. How does this relate to the above stated principle?

25. When projecting for accuracy, increasing vertical motion increases chances for error.

Applications:

a) Select either archery or darts to analyze. How do either of these activities relate to the above stated principle?

MORE **MECHANICAL CONCEPTS:**

1. The greater the range of movement over which the force is imparted, the greater the motion of the object.

Applications:

a) Take a basketball and throw it as hard as you can with forearm only. Next use the forearm and the upper arm.
b) Kick a soccer ball up the wall with just the leg segment, then with the leg and thigh segments.

2. A joint exhibits angular motion while the distal end of a limb may exhibit angular and/or linear motion.

Applications:

a) Observe a windmill softball pitch.
b) Kick a ball and watch the path.

3. When a lever moves about its axis, the distance that all points on the lever move and the speed at which they move is proportional to their distance from the axis (increases in length of the lever- more force).

Applications:

a) When hitting a baseball if contact occurs on the handle, the force is significantly lower than if contact occurred at the head of the bat.
b) Crack the whip on ice skates- the second person from the center will go slower than the sixth.

4. All moving segments the human body are levers.

Applications:
a) Observe a biceps curl.
b) Observe a person on the leg extension machine.

5. A moment of inertia is analogous to a lever. When the moment of inertia is lengthened, angular velocity decreases.

Applications:
a) Observe the difference when hitting a Koosh ball with a Koosh paddle, a Ping-Pong paddle and a tennis racquet.

6. Momentum can be transferred from a moving lever to an external object.

Applications:

a) Observe a baseball pitch.
b) Observe a person perform a rotational shot put.

7. It takes additional force to move a longer lever with the same angular velocity as a shorter lever.

Applications:
a) Swing a 35 cm bat, then a 20cm bat.
b) Observe a person cleaning a pool with a basket on a 10 foot pole, then a 6 foot pole.

8. The linear velocity at the end of a lever is directly proportional to its length provided the force moving the lever remains constant.

Applications:
a) Skullers use long oars to which propel them faster than using shorter oars like those used in a canoe.
b) In golf, the 2-Iron is longer than the 9-iron is providing the heads are the same, will produce a greater velocity.

9. An object moving in a circular path when released will go off in a straight line from the point of release.

Applications:
a) A windmill softball pitch produces a linear path, not taking into account gravity.
b) In crack the whip the last person in the line will travel in straight line when let go.

10. Since a long lever develops more linear speed at the end than does a short lever, the length of the leg during the driving phase of running should be as great as possible when speed is a consideration.

Applications:
a) Try running first with the knee at <90 degrees and then >110 degrees.
b) Observe two runners with different leg lengths.

11. Rotary motion may be accelerated by shortening the radius and decelerated by lengthening the radius.

Applications:
a) In diving the tuck somersault is less difficult than a lay out since it rotates faster. See how the speed of a ball on a string changes when you spin it and let it wrap around your finger or hand.

12. A long lever has greater linear velocity at the end than does a short lever moving at the same angular velocity.

Applications:
a) Observe the difference in speed of a tennis racquet when the swinging arm is straight and bent.

b) Observe 2 kids on a teeter totter. One at the end of the board and the other near the axis.

13. The momentum of any part of a body can be transferred to the rest of the body.

Applications:
a) Throw a ball with just the hand, the entire arm, then the arm and the upper body.

14. As a pendulum swings upward its speed decreases, until the Zero point is reached.

Applications:
a) Swing on a swing set and notice how you do not continue to rotate around the bar.
b) Using a ball on a string, move it like a pendulum and notice how the speed decreases as it moves against gravity.

15. Momentum developed in a body segment is transferred to the rest of the body only while the body is still in contact with the supporting surface.

Applications:
a) Once an ice skater leaves the ice to do a single axle, the skater has only imparted enough force to complete 360 degrees and will not be able to complete 720 degrees if changing mind just after takeoff.
b) Use the same concept with a ballet dancer preparing to do scissor Russian jump.

16. The longer the radius of rotation of a point on a rotating implement the faster the point will travel only if its angular velocity does not increase.

Applications:
a) Observe a 360 degree windmill pitch and a 180 degree pitch.
b) Notice the difference between a triple turn on the rotating shot-put and a single turn.

17. Using the same velocity, it is easier to go around a larger circular track versus a smaller track.

Applications:
a) Observe a Speed skater on a large oval track and a small oval track. Which is easier?
b) Run in a circle with a 10 ft radius. Next run in a circle with a 5 foot radius.

18. Along lever has greater velocity at the end than does a short lever moving at the same angular velocity.

Applications:

a) The head of a 1-iron moves faster than the head of a 9-iron.

b) Play crack the whip with 3 people than with 10 people.

19. The greater the angular velocity and/or the greater the radius of rotation, the greater the rotating point's linear speed or velocity.

Applications:

a) Observe the speed of a volleyball hit when the person stops contact with the ball and when using a follow through.
b) Use the same concept when kicking a ball.

20. The time taken by the pendulum to make a single round trip (period) is related to the length of the pendulum.

Applications:

a) Swing on a swing with a short chain, then on a long chain.
b) Compare a 4ft person and a 6 ft person swinging by their arms on a high bar.

21. When a pendulum reaches the end of its arc, just before it reverses its direction, it reaches a zero point in velocity.

Applications:

a) Observe the dragon ship ride, at the fair.
b) Swing on a swing set.

22. Rotary motion may be accelerated by shortening the radius and decelerated by lengthening the radius.

Applications:

a) Jump rope with a short rope, then with a long rope.
b) Observe a series of back handsprings performed by a 6 ft tall gymnast and a 5 ft tall gymnast.

23. The smaller the relative angles at the hip, knee and ankle, the more force can be exerted.

Applications:

a) Perform a vertical Jump with a straight body and legs. Next perform the jump with small relative angles at the hip, knee, and ankle.
b) Perform a standing long jump with the previous concept.

24. Sequential point action through out the body increases acceleration imparted to the object at the time of release.

Applications:

a) Throw a soft ball without using the lower body. Now, throw the ball using a step with the lower body then the upper body.
b) Hit a golf ball using only the arms. Now hit the ball using trunk rotation then the arms.

25. Linear velocity is imparted to external objects as a result of the angular velocity of the body segments.

Applications:
a) Kick a soccer ball.
b) Observe a person playing handball.

MECHANICAL CONCEPTS

1. Force of gravity limits movement as it pulls the weigh of the body or object downward toward the center of earth.

Applications:
a) An individual cannot maintain constant acceleration when walking and running due to force of gravity limiting movement as the downward heel strike creates deceleration.
b) If an object is projected with a large vertical component then COG acts against that component causing an object to have a shortened horizontal component as it falls.

2. When a body is acted upon by a force, the resulting acceleration and change of
Speed is proportional to the mass (Newton's 2nd Law).

Applications:
a) If you increase force when kicking ball then acceleration will be increased
b) If you kick a weighted ball vs. a non-weighted ball acceleration will be decreased.

3. External weights added to the body become a part of the total bodyweight and affect the location of the COG, displacing in the added weight.

Applications:
a) In performing the clean and jerk the external weight of the bar causing the shift of the COG toward the external weight of the bar.
b) In performing dips with the weighted belt, the COG shifts downward.

4. The location of the COG in the body shifts when the body parts move.

Applications:
a) When doing the Fosbury Flop the body's COG remains under the bar as the body, goes over the bar.
b) When testing for individual maximum vertical jump the COG shifts upward as arms elevate upward.

5. COG is located at the intersection of the lines of gravity determined by the 3 planes of movement, regardless of orientation of the body relative to the ground.

Applications:

a) A diver doing a 1 ½ twist goes through constant change in COG as the 3 planes of movement are offered during the twist.
b) A gymnast performing a back flip on a pommel horse changes COG as 3 planes of movement are altered.

6. Movement away from the midline of the body in one direction will cause the center of gravity to shift in that direction.

Applications:

a) A sprinter in the starting blocks will shift COG interiorly when exploding out of the blocks.
b) In the jump start in swimming, the swimmer's COG will shift anteriorly.

7. Once movement is started, it takes less force to maintain a given speed than to change speed, but several forces are applied in succession, each succeeding force must be applied at the point when the preceding one has made, its greatest contribution in the imparting of velocity.

Applications:

a) Once the race car driver has started motion it takes force to maintain speed than to change speed.
b) When biking in a straight path it is easier to bike with the wind than against the wind.

8. When two or more forces act upon a body or two or more forces act upon each other, the resulting movement is determined by the direction and the magnitude of the acting forces.

Applications:

a) In tug of war, there is more force applied at one end, and then the end applying more force will win.

9. When a force is applied to a stable source, a counter force is returned to the body from which the force came. The less the stable force, the less will be the counter force.

Applications:

a) If a long jumper jumps with a constant force with more of a horizontal component than vertical component, they will be less stable.

10. If a constant force is applied to a body the body develops greater velocity as the distance over which the force is applied increases.

Applications;
a) Two sprinters running a 100m and 200m respectively… the one running the 200m will develop greater velocity when the force is constant for the two (or two swimmers swimming 50 and 100meters).

11. Other things being equal, the greater the friction between the supporting surface and the parts of the body in contact with it, the more stable the body will be.

Applications:
a) The greater the friction between the feet and the ground, the greater the stability of the discus thrower.
b) A body standing on concrete is more stable than a body standing on ice.

12. The amount of force a striking implement imparts to an object depends upon the combined momentum of the implement and the amount of impact. Any give in the implement or object at impact reduces the propulsive force.

Applications:
a) A ball will lose its propulsive force as it is hit.
b) In a hockey strike, the puck will lose the propulsive force if the strike doesn't follow through.

13. If the force applied to a freely moveable object is not in line with the center of the, line of gravity, it will result in rotary motion of the object.

Applications:
a) In bowling the friction of the bowling surface will cause a change in its rotary motion.
b) In shooting pool the table's surface will cause a change in the rotary motion of the pool balls.

14. Sequential joint action throughout the body increases acceleration imparted to the object at the time of release.

Applications:
a) Due to the kinetic link principle a pitcher's angular velocity of the arm segments increases the acceleration of the object at the time of release.
b) When kicking a ball the sequential joint action (angular velocity) there is an increase in acceleration imparted to the ball at the time of contact.

15. The object will move only if the force is of sufficient magnitude to overcome the object's inertia.

Applications:
a) A person exerting a 5N force cannot push a box needing a force of 10N.
b) In tug of war, the side applying a force of 15N will overpower the side applying a force of 11N.

16. The pattern and range of joint movements depends upon the purpose of the movement.

Applications:
a) A sprinter must have a higher joint ROM to accommodate for a increased speed as opposed to a distance runner must maintain slower steady pace.
b) A person throwing a ball 5ft must have a smaller joint ROM. than a person throwing a ball 20ft.

17. Force exerted by the body will be transferred to an external object in proportion to the effectiveness of the counter force of the feet against the ground.

Applications:
a) A shot-putter throwing a rotational shot-put must transfer force from the ground to the put upon release.
b) A javelin thrower must transfer the forces from lower extremity to upper extremity and transfer force to the javelin being thrown.

18. Linear velocity is imparted to an external object as a result of the angular velocity of the body segments.

Applications:
a) Angular velocity results in distributing linear velocity to the basketball for the proper angle and force needed to shoot the ball.
b) An adjustment in angular position or of a person throwing horse shoes will increase linear velocity.

19. Optimum summation of internal force is needed if maximum force is to be applied to move an object.

Applications:
a) To bench press a 501lb 0r more pressure needs to be applied to move the weight.
b) To curl a 25 lb bar 26lb or more must be exerted to curl the weight.

20. For a change in momentum to occur, force is applied to move an object.

Applications:
a) In tug of war, the force must be applied over a given time to change the momentum.

21 The direction in which the object moves is determined by the direction of the force applied to it.

Applications:
a) Depending on which angle you throw a ball will depend on the direction to which the ball goes.
b) A field goal kicker kicking a field goal will move the ball toward the field.

22. If an object is free to move only along a predetermined pathway, any component of force not in the direction of this pathway is wasted and serves to increase friction.

Applications:
a) A force not parallel to a pendulum will be wasted energy to move the pendulum.

23. Force applied to freely moveable object not inline with the COG, will result in rotary motion of the object.

Applications:
a) In football when tackling, if you hit the ball carrier in line with the COG it will result in linear motion of that person.
b) In shooting the cue ball below the COG will result in rotary motion backwards after contact with another ball.

24. If the force applied to a freely movable object is not in line with the COG, it will result in rotary motion of that object.

Applications:
a) A runner on the standard 400m track will have a centripetal force when adjusting for the track's curves which will result in curvilinear motion.

25. If the free motion of an object is interfered with by friction or by presence of an obstacle, rotary motion may result, even though the force is applied in line with the object's COG.

Applications:
a) In baseball, a person catching a ball may result rotary motion.
b) A goalie deflecting a soccer kick will result in rotary motion.