HPER K530 Mechanical Analysis of Human Performance Fall, 2003

Dapena

FINAL EXAM

Equations:

$$S = S_0 + v\ t$$

$$S = S_0 + v_0\ t + 1/2\ a\ t^2$$

$$v = v_0 + a\ t$$

$$v^2 = v_0^2 + 2\ a\ (S-S_0)$$

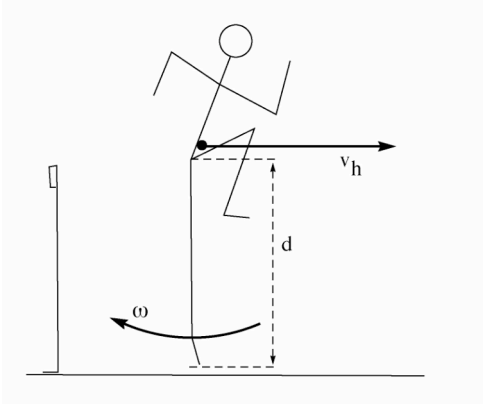
$$e = \sqrt{h_b / h_d}$$

$$F_{CP} = m\ v^2 / r$$

IMPORTANT **READ THIS FIRST:**

* Give each numerical answer correct to **two decimal places**, and make sure that the sign is correct.
* Give the correct **units** for each numerical answer.
* In multiple-choice questions, pick the **BEST** answer.
* Some questions may give you **more information than what you need** to solve them.

1. The horizontal velocity of an athlete's hip after it passed over a hurdle was $v_h = 8.6$ m/s. At the instant immediately before the hurdler's foot landed on the ground, her leg was straight and vertical, and it was rotating backward at the hip joint with an angular velocity $\omega = 425°/s$. If the length of the leg (from the hip joint to the foot) was $d = 0.92$ m, calculate the horizontal linear velocity of the foot **relative to the ground**. (If the foot was moving forward relative to the ground, you should report a positive velocity value; otherwise, a negative velocity value.)



(HINTS: You first need to figure out the linear velocity of the foot relative to the hip. Then, knowing the linear velocity of the hip relative to the ground and the linear velocity of the foot relative to the hip, you should be able to figure out the linear velocity of the foot relative to the ground.)

2. If a muscle is trying to shorten but it is forced to lengthen, the muscle is able to make:

   (a) the same force as in isometric conditions.
   (b) less force than in isometric conditions.
   (c) more force than in isometric conditions.

3. You are a diver. You are walking forward toward the edge of the platform, and you want to perform a forward somersault. To achieve this, you will generally push _____ on the platform during the takeoff phase:

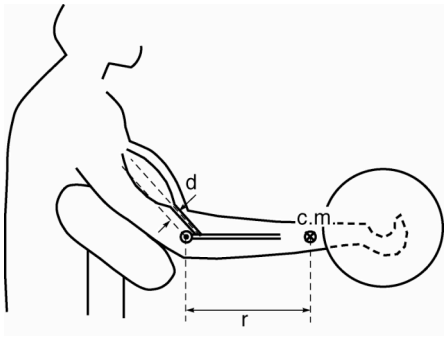
   (a) downward and forward.
   (b) directly downward.
   (c) downward and backward.

4. (HINT: Don't rush to answer this question. Use the information given in class to figure out the correct answer. Construct a rough sketch of horizontal velocity versus time for the whole period –from takeoff until the next takeoff – and then look at it closely to see how the average velocities for the airborne and ground-support phases compare with each other.)

   When a sprinter is running at maximum speed, the horizontal velocity of the c.m. actually varies somewhat within each running step. The **average** horizontal velocity during the ground-support phase is:

   (a) smaller than the corresponding value for the airborne phase.
   (b) larger than the corresponding value for the airborne phase.
   (c) the same as the corresponding value for the airborne phase.

5. A weight lifter is holding a barbell in a horizontal position with one hand (see drawing below). The center of mass of the barbell+forearm+hand system is at a distance r = 0.29 m from the elbow joint center. If the weight of the system is 326 N, and the moment arm of the muscle is d = 0.03 m, calculate the muscle tension necessary to maintain the forearm in this horizontal position.



6. If the spherical objects listed below were all moving in the air at the same speed, which one would experience the **smallest** drag force?

   (a) a basketball
   (b) a two-feet diameter balloon
   (c) a baseball
   (d) a table tennis ball

7. Which of the following statement is **FALSE**?

   (a) At the instant of the most backward position of the swinging foot in a kick, the hip flexor muscles of the swinging leg (the muscles that cross the front of the hip) are momentarily in isometric conditions.
   (b) In an arm wrestling contest, the active muscles of the winner are in eccentric conditions.
   (c) At the instant of the most backward position of the swinging foot in a kick, the hip flexor muscles of the swinging leg (the muscles that cross the front of the hip) are stretched.
   (d) In a back-and-forth motion, pre-tension allows a muscle to have a large tension at the beginning of the "forth" part of the motion.

8. The main purpose of the curve in the high jump run-up is to:

   (a) make the jumper lean toward the center of the curve during the run-up, which permits the athlete to be vertical by the end of the takeoff phase.
   (b) obtain a centrifugal force, because the impulse of this force helps to produce vertical velocity.
   (c) help the jumper to obtain angular momentum before the start of the takeoff phase.
   (d) obtain a centripetal force, because the impulse of this force helps to produce vertical velocity.

9. During the first half of the takeoff phase of a high jump, the quadriceps muscles of the takeoff leg are mostly in:

(a) isometric conditions.
(b) concentric conditions.
(c) eccentric conditions.

10. In the breaststroke technique, the propulsive force exerted on the swimmer is mainly a:

(a) drag force.
(b) roughly even combination of lift and drag forces.
(c) lift force.

11. In general, one should expect a body builder to float:

(a) better than most other people.
(b) worse than most other people.
(c) just as well as other people.

12. If the angular momentum vector of a diver is pointing toward you, you will see overall:

(a) a counterclockwise rotation.
(b) a clockwise rotation.
(c) neither clockwise nor counterclockwise rotation.

13. When the body is assumed to be composed of 14 segments, the local terms of angular momentum are usually _____the remote terms of angular momentum.

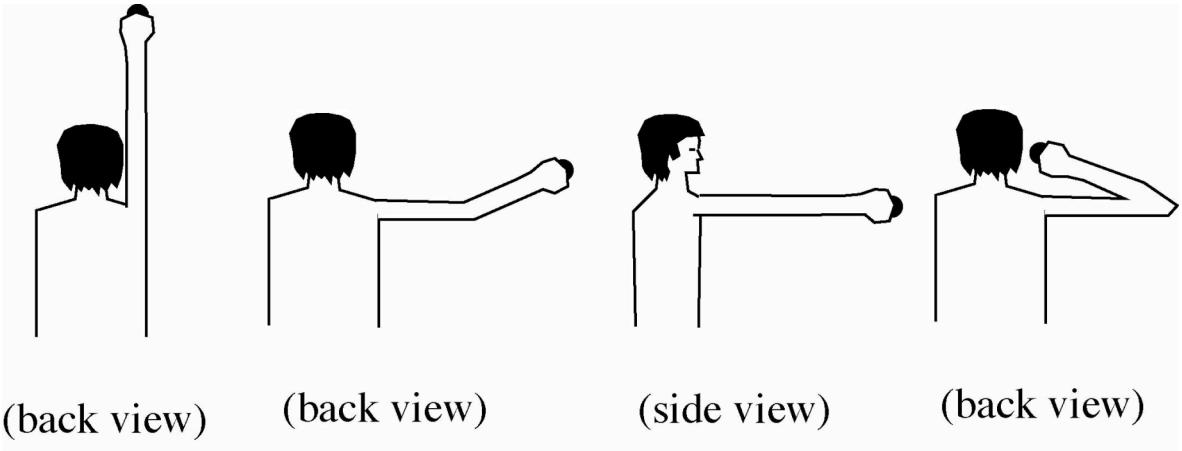
(a) larger than
(b) roughly equal in size to
(c) smaller than

14. In general, if a person gets into a horizontal position on the surface of the water in a swimming pool, with the arms along the sides of the trunk, the buoyancy force will:

(a) not exert any torque about the c.m.
(b) exert a torque about the c.m. that will tend to make the feet go up and the head go down.
(c) exert a torque about the c.m. that will tend to make the feet go down and the head go up.

15. In an "overarm" throw, the release of the ball takes place in one of the positions shown below. Indicate which one.

(a) (b) (c) (d)



16. After leaving the springboard, a diver changed her body configuration from a straight body position to a tuck. This:

(a) changed her total angular momentum.
(b) changed her angular velocity.
(c) changed her moment of inertia.
(d) both (b) and (c).
(e) both (a) and (c).

17. The peak height reached by the c.m. of a high jumper is completely determined by:

(a) the initial horizontal velocity of the c.m. at the start of the airborne phase.
(b) the initial vertical velocity of the c.m. at the start of the airborne phase.
(c) the initial height of the c.m. over the ground at the start of the airborne phase.
(d) both (a) and (c).
(e) both (b) and (c).

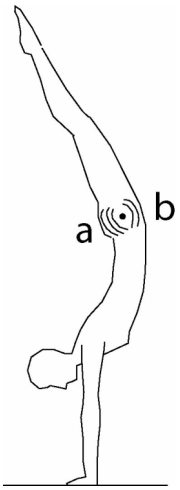
18. A ball is dropped from a height of 2.00 m, and it bounces back up to 1.04 m. Calculate the coefficient of elastic restitution of the impact of the ball against the ground.

19. A 74 Kg sprinter pushes **backward** on the ground with a 238 N horizontal force. Calculate the horizontal acceleration of the athlete. (The forward direction is designated as positive; the backward direction is designated as negative.)

20. A gymnast is making many consecutive bounces on a trampoline. At what instant of each complete jump cycle will his kinetic energy be largest?

(a) when his feet are barely off the surface of the trampoline
(b) when his c.g. is at the highest point of its motion
(c) when his c.g. is half-way between the lowest point of its motion and the highest point
(d) when his c.g. is at the lowest point of its motion

21. The gymnast in the drawing is maintaining her position without any motion at all. What muscles are acting at the hip joint while the gymnast maintains this position? (HINT: A free-body diagram of the legs should help you to decide.)



(a) the muscles marked as "a" in the drawing
(b) the muscles marked as "b" in the drawing
(c) neither the muscles marked as "a" nor as "b" in the drawing

22. A discus thrower made two practice throws, and neither one was an "all-out" effort. In the first throw, the athlete's elbow was kept straight throughout the throw. In the second throw, the elbow was kept at a somewhat flexed angle throughout the throw. If the discus had the same linear velocity at release in both throws, this implies that the active muscles of the shoulder:

(a) shortened faster in the first throw than in the second throw.
(b) shortened faster in the second throw than in the first throw.
(c) shortened at the same rate in both throws.

23. Which of the following is the most important as a technique objective for a right-handed discus thrower?

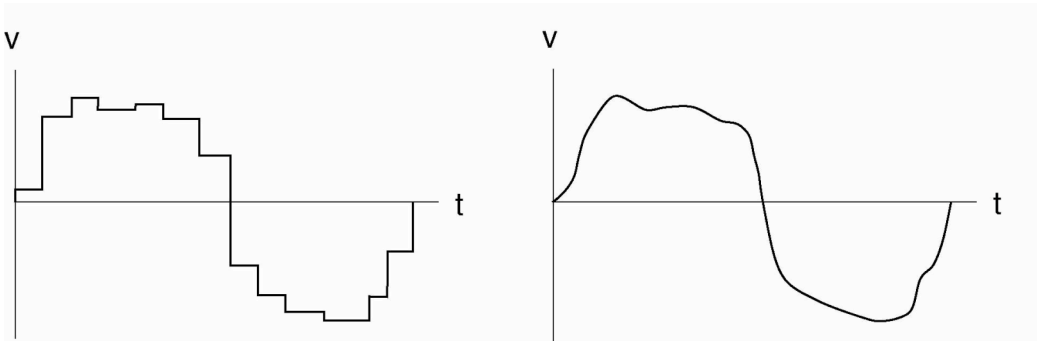
(a) to give the discus a large velocity by the end of the preparatory phase
(b) to have a long range of motion available for the discus during the double-support phase
(c) to use the muscles of the legs to slow down the counterclockwise rotation of the trunk during the double-support phase.

24. The angular momentum of a person can be changed while the person is free in the air.

(a) TRUE
(b) FALSE

25. Look at the graphs below, and indicate which statement is most likely to be true:

(a) The graph on the left shows average velocities vs. time, and the graph on the right shows instantaneous velocities vs. time.
(b) Both graphs show instantaneous velocities vs. time.
(c) The graph on the left shows instantaneous velocities vs. time, and the graph on the right shows average velocities vs. time.
(d) Both graphs show average velocities vs. time.



26. In the mechanical analysis of diving, "getting off the plane" or "getting back into the plane" usually refers to:

(a) a plane containing the total angular momentum vector.
(b) a plane perpendicular to the total angular momentum vector.
(c) a plane parallel to the total angular momentum vector, but which does not contain the vector itself.
(d) a plane set at an oblique (diagonal) angle with respect to the total angular momentum vector.

27. The velocity vector of a basketball at the instant of release was 7.8 m/s, pointing at a 17° angle with respect to the horizontal plane. Calculate the horizontal velocity component of the ball.

28. Good technique in the high jump event of track and field requires:

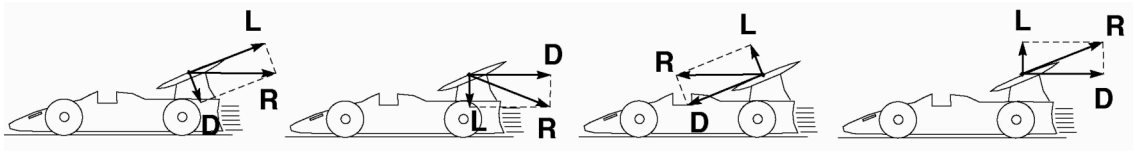
(a) a large vertical velocity at the end of the approach run.
(b) a small vertical velocity at the end of the takeoff phase.
(c) a small horizontal velocity at the end of the takeoff phase.
(d) a high c.m. position at the end of the approach run.
(e) a large horizontal velocity at the end of the approach run.

29. The amount of change in the velocity of an object is determined by:

(a) the mass of the object.
(b) the time during which force is exerted on the object.
(c) the force exerted on the object.
(d) both (a) and (c).
(e) all three: (a), (b) and (c).

30. The drawings below show the resultant aerodynamic force (R) exerted on the aerofoil of a Grand Prix racing car, and its lift (L) and drag (D) components. Which drawing is correct?

(a) (b) (c) (d)



31. In the front crawl technique, the trunk should be kept aligned with the direction of the race, in order to:

(a) minimize the resistive forces exerted on the trunk.
(b) maximize the propulsive forces exerted on the arms.
(c) minimize the resistive forces exerted on the head during breathing.
(d) maximize the propulsive forces exerted on the legs.

32. Which of the following is true?

(a) If acceleration is constant, velocity also has to be constant.
(b) If velocity is constant, acceleration has to change at a constant rate.
(c) If location is constant, velocity has to be zero.

33. Strong arm actions during the takeoff phase of high jumping:

(a) will help to produce a large peak height of the c.m., but can interfere with the generation of lateral somersaulting angular momentum.
(b) will not help to produce a large peak height of the c.m.
(c) will help to produce a large peak height of the c.m., but can interfere with the generation of forward somersaulting angular momentum.
(d) will help to produce a large peak height of the c.m., and will not interfere with the generation of angular momentum.

34. At the end of a high jump run-up, immediately before the takeoff foot is planted on the ground, the vertical velocity of the c.m. is usually:

(a) slightly negative.
(b) slightly positive.
(c) zero.

35. The remote term of angular momentum is the angular momentum associated with the motion of:

(a) the c.m. of the body with respect to the ground.
(b) the c.m. of a segment with respect to the c.m. of the whole body.
(c) a segment about its own c.m.

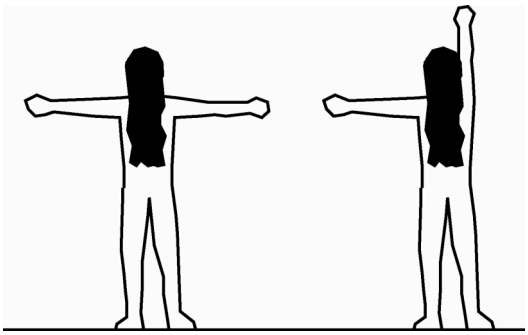
36. In most throwing activities, the speed increase of the projectile takes place primarily during the:

(a) preparatory phase.
(b) follow-through phase.
(c) double-support delivery phase.

37. A basketball player is trying to intercept a high-flying ball with his right hand. Which of the following will **NOT** help him to reach it:

(a) lifting his knees as his right hand gets near the ball
(b) making large downward forces on the ground with his feet during the takeoff phase
(c) lowering his head as his right hand gets near the ball
(d) obtaining, through his takeoff, a high parabola for the airborne path of his c.m.

38. A gymnast stands on the floor with her arms stretched out to the sides, forming a cross with the body. Then, the gymnast moves her right arm until it is pointing directly overhead. If the rest of the body does not move, what happens to the center of mass of the whole body as a result of this action?



(a) It moves up and to the left.
(b) It moves up and to the right.
(c) It moves down and to the left.
(d) It does not move.
(e) It moves down and to the right.

39. Which of the following statements is TRUE?

In the support phase of a running step at "full speed", a sprinter normally:

(a) exerts no horizontal forces on the ground,
(b) exerts first a forward force on the ground, then a backward force.
(c) exerts a backward force on the ground during the whole support phase.
(d) exerts a forward force on the ground during the whole support phase.
(e) exerts first a backward force on the ground, then a forward force.

40. The equation $E = 1/2\ m\ v^2$ expresses:

(a) rotational kinetic energy.
(b) chemical energy.
(c) elastic energy.
(d) potential energy.
(e) translational kinetic energy.

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Name: _____

ANSWERS

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