

THE TWENTY-FIRST ANNUAL SLAPT PHYSICS CONTEST
SOUTHERN ILLINOIS UNIVERSITY EDWARDSVILLE
APRIL 29, 2006

MECHANICS TEST

$$g=9.8 \text{ m/s}^2$$

Please answer the following questions on the supplied answer sheet. You may write on this test booklet, but only the answer sheet will be scored.

1. A car travels 1194 miles at an average speed of 60 mi/hr. How long did the trip take?
(a) 16 hours
(b) 20 hours
(c) 23 hours
(d) 28 hours
2. A runner runs a race around a circular track of circumference 1512 m in 530 s. What was the average speed of the runner?
(a) 0.0 m/s
(b) 2.9 m/s
(c) 4.9 m/s
(d) 6.5 m/s
3. A runner runs a race around a circular track of circumference 1512 m in 530 s. What was the magnitude of the average velocity of the runner?
(a) 0.0 m/s
(b) 2.9 m/s
(c) 4.9 m/s
(d) 6.5 m/s
4. A car accelerates from 8.0 m/s to 21 m/s at a rate of 3.0 m/s^2 . How far does it travel while accelerating?
(a) 38 m
(b) 63 m
(c) 107 m
(d) 189 m
5. How long would it take a car to come to a complete stop from 16.8 m/s if it undergoes a constant deceleration of magnitude 3.12 m/s^2 ?
(a) 2.94 s
(b) 5.38 s
(c) 5.83 s
(d) 9.83 s

6. A baseball thrown straight up in the air reaches a maximum height of 21 m. With what velocity was the ball thrown?

- (a) 14 m/s
- (b) 20 m/s
- (c) 24 m/s
- (d) 39 m/s

7. The vectors \vec{A} and \vec{B} have magnitudes A and B. What can be said with certainty about the magnitude of $\vec{A} + \vec{B}$?

- (a) It is equal to A+B
- (b) It is larger than A+B
- (c) It is smaller than A+B
- (d) It is equal to or larger than A+B
- (e) It is equal to or smaller than A+B

8. You walk 47 m to the north, then turn 60° to your right and walk another 45 m. How far are you from where you originally started?

- (a) 42 m
- (b) 65 m
- (c) 80 m
- (d) 92 m
- (e) 635 m

9. A car drives east at 15 m/s for 1080 s, and then turns directly southeast and travels 7.2 km in 600 s. Find the magnitude of the car's displacement.

- (a) 15 km
- (b) 18 km
- (c) 22 km
- (d) 28 km

10. If you forcefully throw an object upwards, its acceleration after it leaves your hand is

- (a) Greater than 9.8 m/s^2 and directed upwards
- (b) Greater than 9.8 m/s^2 and directed downwards
- (c) Equal to 9.8 m/s^2 and directed upwards
- (d) Equal to 9.8 m/s^2 and directed downwards
- (e) Less than 9.8 m/s^2 and directed downwards

11. If you are in an elevator moving down at a constant speed of 3.0 m/s, your acceleration is

- (a) Greater than 9.8 m/s^2
- (b) Equal to 9.8 m/s^2
- (c) Less than 9.8 m/s^2 , but greater than 0 m/s^2
- (d) 0 m/s^2

12. A person standing at the edge of a cliff throws one ball straight up and another ball straight down at the same initial speed. Neglecting air resistance, the ball to hit the ground below the cliff with the greater speed is the one initially thrown
- (a) Upward
 - (b) Downward
 - (c) Neither; they both hit the ground at the same speed.
13. A cat leaps to catch a bird. If the cat's jump was at 60.0° off the ground and its initial speed was 7.90 m/s , what is the highest point of its trajectory?
- (a) 0.796 m
 - (b) 2.39 m
 - (c) 4.78 m
 - (d) 31.6 m
14. A 27 kg object is accelerated at a rate of 2.5 m/s^2 . What net force does the object experience?
- (a) 11 N
 - (b) 68 N
 - (c) 93 N
 - (d) 98 N
15. A skydiver reaches a terminal velocity of 120 km/h . If the skydiver has a mass of 70.0 kg , what is the magnitude of the upward force on the skydiver due to wind resistance?
- (a) 6.43 N
 - (b) 7.13 N
 - (c) 686 N
 - (d) 755 N
 - (e) 8400 N
16. A person with a mass of 71 kg is riding in an elevator which is accelerating upward at 1.80 m/s^2 . What is the person's apparent weight?
- (a) 568 N
 - (b) 696 N
 - (c) 824 N
 - (d) 882 N
17. A force of 55 N stretches a spring 0.73 m from equilibrium. What is the value of the spring constant?
- (a) 75 N/m
 - (b) 40 N/m
 - (c) 62 N/m
 - (d) 84 N/m

18. A tightrope walker walks across a 30.0 m long wire tied between two poles. The center of the wire is displaced vertically downward by 1.0 m when he is halfway across. If the tension in both halves of the wire at this point is 6262 N, what is the mass of the tightrope walker? Neglect the mass of the wire.

- (a) 43 kg
- (b) 74 kg
- (c) 85 kg
- (d) 91 kg
- (e) 1280 kg

19. A 11 kg box must be slid across a level floor. If the coefficient of static friction between the box and the floor is 0.37, what is the minimum force needed to start the box moving from rest?

- (a) 28 N
- (b) 40 N
- (c) 56 N
- (d) 108 N

20. A driver in a 1000.0 kg car traveling at 35 m/s slams on the brakes and skids to a stop along a level road. If the coefficient of friction between the tires and the road is 0.80, how long will the skid marks be?

- (a) 62 m
- (b) 73 m
- (c) 78 m
- (d) 98 m

21. Astronauts on the Moon can jump so high because

- (a) They weigh less there than they do on Earth
- (b) Their mass there is less than it is on the Earth
- (c) Both (a) and (b)
- (d) There is no atmosphere on the Moon

22. An object is held in place by friction on an inclined surface. The angle of inclination is increased until the object starts moving. If the surface is kept at this angle, the object

- (a) slows down
- (b) moves at uniform speed
- (c) speeds up
- (d) none of the above

23. You are a passenger in a car and not wearing your seat belt. Without increasing or decreasing its speed, the car makes a sharp left turn, and you find yourself colliding with the right-hand door. Which is the correct analysis of the situation?

- (a) Before and after the collision, there is a rightward force pushing you into the door.
- (b) Starting at the time of the collision, the door exerts a leftward force on you
- (c) Both of the above
- (d) Neither of the above

24. In the absence of friction, how much work would a child do while pulling a 12 kg wagon a distance of 4.3 m with a 22 N force?

- (a) 52 J
- (b) 67 J
- (c) 80 J
- (d) 95 J

25. You carry a 7.0 kg bag of groceries 1.2 m above the ground at a constant velocity across a 6.8 m room. How much work do you do on the bag in the process?

- (a) 0.0 J
- (b) 82 J
- (c) 396 J
- (d) 466 J

26. A spring with a spring constant of 16 N/m is stretched from equilibrium to 2.9 m. How much work is done in the process?

- (a) 34 J
- (b) 67 J
- (c) 87 J
- (d) 134 J

27. Two marbles, one twice as heavy as the other, are dropped to the ground from the roof of a building. Just before hitting the ground, the heavier marble has

- (a) As much kinetic energy as the lighter one
- (b) Twice as much kinetic energy as the lighter one
- (c) Half as much kinetic energy as the lighter one
- (d) Four times as much kinetic energy as the lighter one
- (e) Impossible to determine from the information given

28. A block initially at rest is allowed to slide down a frictionless ramp and attains a speed v at the bottom. To achieve a speed $2v$ at the bottom, how many times as high must a new ramp be?

- (a) 1
- (b) 2
- (c) 3
- (d) 4
- (e) 5
- (f) 6

29. Suppose you drop a 1 kg rock from a height of 5 m above the ground. When it hits, how much force does the rock exert on the ground?

- (a) 0.2 N
- (b) 5 N
- (c) 50 N
- (d) 100 N
- (e) Impossible to determine from the information given

30. A spring has a spring constant of 1734 N/m and it moves horizontally in simple harmonic motion on a frictionless tabletop. If the mass attached to it is 756.7 g, what is the mass's speed as it passes through the equilibrium point? The spring's maximum extension is 31.02 cm.

- (a) 0 m/s
- (b) 0.5 m/s
- (c) 14.85 m/s
- (d) 46.4 m/s

31. A tennis ball bounces on the floor three times. If each time it loses 13.0% of its energy due to heating, how high does it bounce after the third time, provided we released it 2.4 m from the floor?

- (a) 160 cm
- (b) 16 cm
- (c) 160 mm
- (d) 180 cm

32. A 37 g bullet pierces a sand bag 41 cm thick. If the initial bullet velocity was 75 m/s and it emerged from the sandbag with 20 m/s, what is the total magnitude of the friction force the bullet experienced while it traveled through the bag?

- (a) 2.4 N
- (b) 24 N
- (c) 97 N
- (d) 240 N

33. The Moon does not fall to Earth because

- (a) It is in Earth's gravitational field
- (b) The net force on it is zero
- (c) It is beyond the main pull of Earth's gravity
- (d) It is being pulled by the Sun and planets as well as by Earth
- (e) None of the above

34. A car accelerates from rest. In doing so the absolute value of the car's momentum changes by a certain amount and that of the Earth changes by

- (a) A larger amount
- (b) The same amount
- (c) A smaller amount
- (d) The answer depends on the interaction between the two.

35. A car accelerates from rest. It gains a certain amount of kinetic energy and the Earth

- (a) Gains more kinetic energy
- (b) Gains the same amount of kinetic energy
- (c) Gains less kinetic energy
- (d) Loses kinetic energy as the car gains it

36. Suppose a ping-pong ball and a bowling ball are rolling toward you. Both have the same momentum, and you exert the same force to stop each. How do the distances needed to stop them compare?
- (a) It takes a shorter distance to stop the ping-pong ball
 - (b) Both take the same distance
 - (c) It takes a longer distance to stop the ping-pong ball
37. A compact car and a large truck collide head on and stick together. Which undergoes the larger momentum change?
- (a) The car
 - (b) The truck
 - (c) The momentum change is the same for both vehicles
 - (d) Can't tell without knowing the final velocity of the combined mass
38. Two vehicles approach a right angle intersection from different streets and then collide. After the collision they become entangled. If their mass ratios were 1:3 and their respective speeds as they approached were 14 m/s and 13 m/s, find the velocity of the wreck.
- (a) 9.1 m/s at 70°
 - (b) 10.4 m/s at 70°
 - (c) 12.1 m/s at 70°
 - (d) 13.8 m/s at 70°
39. A 0.24 kg blob of clay is thrown at a wall with an initial velocity of 20 m/s. If the clay comes to a stop in 91 ms, what is the average force experienced by the clay?
- (a) 33 N
 - (b) 45 N
 - (c) 53 N
 - (d) 64 N
40. A 1200 kg car moving at 19.7 m/s collides with a stationary car of mass 1500 kg. If the two vehicles lock together, what is their combined velocity immediately after the collision?
- (a) 7 m/s
 - (b) 8.8 m/s
 - (c) 10.9 m/s
 - (d) 15.2 m/s
41. A 1200 kg cannon fires a 100.0 kg cannonball at speed of 47 m/s (relative to the ground). What is the recoil velocity of the cannon? Assume that frictional forces are negligible and that the cannon is fired horizontally.
- (a) 3.9 m/s
 - (b) 4.3 m/s
 - (c) 4.7 m/s
 - (d) 47 m/s

42. Two cars, one twice as heavy as the other, are at rest on a horizontal track. A person pushes each car for 5 s. Ignoring friction and assuming equal force exerted on both cars, the momentum of the lighter car after the push is
- (a) Smaller than the momentum of the heavy car
 - (b) Equal to the momentum of the heavy car
 - (c) Larger than the momentum of the heavy car
43. You are trying to open a door that is stuck by pulling on the doorknob in a direction perpendicular to the door. If you instead tie a rope to the doorknob and pull with the same force, is the torque you exert increased?
- (a) yes
 - (b) no
44. Two wheels, A and B, have identical masses, but the mass of wheel A is spread uniformly over the disk of the wheel, while the mass of wheel B is concentrated on its rim. Which has the larger moment of inertia?
- (a) Wheel A
 - (b) Wheel B
 - (c) Both wheels have the same moment of inertia
45. A person sits on a swing. When the person sits still, the swing oscillates back and forth at its natural frequency. If, instead, two people sit on the swing, the new natural frequency of the swing is
- (a) Greater
 - (b) The same
 - (c) Smaller
46. What is the angular speed of a flywheel turning at 689.0 rpm?
- (a) 11.47 rad/s
 - (b) 54.10 rad/s
 - (c) 72.15 rad/s
 - (d) 80.79 rad/s
47. A force of 28.43 N is applied tangentially to a wheel of radius 0.340 m and gives rise to an angular acceleration of 1.20 rad/s^2 . Calculate the rotational inertia of the wheel.
- (a) $6.04 \text{ kg}\cdot\text{m}^2$
 - (b) $8.06 \text{ kg}\cdot\text{m}^2$
 - (c) $10.06 \text{ kg}\cdot\text{m}^2$
 - (d) $12.08 \text{ kg}\cdot\text{m}^2$
48. A bicycle is heading east at 4.4 m/s. Find the magnitude and direction of the angular velocity of one of its 0.75 m diameter wheels
- (a) 12 rad/s, north
 - (b) 12 rad/s, south
 - (c) 6.6 rad/s, north
 - (d) 6.6 rad/s, south

49. A child swings a 0.45 kg ball in a circle on a string that is 1.3 m long. If the ball makes 1.2 rev/s, what is the magnitude of the ball's angular momentum?

- (a) $0.9 \text{ kg}\cdot\text{m}^2/\text{s}$
- (b) $4.5 \text{ kg}\cdot\text{m}^2/\text{s}$
- (c) $5.7 \text{ kg}\cdot\text{m}^2/\text{s}$
- (d) $6.3 \text{ kg}\cdot\text{m}^2/\text{s}$

50. An ice skater with a moment of inertia of $70.0 \text{ kg}\cdot\text{m}^2$ is spinning at 41 rpm. If the skater pulls in her arms, her moment of inertia decreases to $50.0 \text{ kg}\cdot\text{m}^2$. What is the skater's resulting angular speed?

- (a) 21 rpm
- (b) 29 rpm
- (c) 49 rpm
- (d) 57 rpm