

The Thirty-First Annual SLAPT Physics Contest Mechanics Test

$$G = 6.673e-11 \text{ N}\cdot\text{m}^2/\text{kg}^2 \quad m_E = 5.972e24 \text{ kg} \quad r_E = 6.371e6 \text{ m} \quad g=9.8 \text{ m/s}^2$$

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 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
3. 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/s²?
 - (a) 2.94 s
 - (b) 5.38 s
 - (c) 5.83 s
 - (d) 9.83 s
4. 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
5. If you forcefully throw an object upwards, its acceleration after it leaves your hand is
 - (a) Greater than 9.8 m/s² and directed upwards
 - (b) Greater than 9.8 m/s² and directed downwards
 - (c) Equal to 9.8 m/s² and directed upwards
 - (d) Equal to 9.8 m/s² and directed downwards
 - (e) Less than 9.8 m/s² and directed downwards
6. 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.

7. A skydiver reaches a terminal velocity of 120 km/h. If the skydiver has a mass of 70.0kg, 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

8. 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

9. 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

10. 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

11. 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

12. 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

13. 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

14. 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

15. 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

16. 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

17. 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

18. 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

19. 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°

20. 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

21. 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

22. What is the angular speed of a flywheel turning at 689.0 rpm?

- (a) 11.48 rad/s
- (b) 54.10 rad/s
- (c) 72.15 rad/s
- (d) 80.79 rad/s

(e) 41340 rad/s

23. Complete the following statement: An inertial reference frame is one in which

- (a) Newton's first law of motion is valid.
- (b) The inertias of objects within the frame are zero.
- (c) The frame is accelerating.
- (d) The acceleration due to gravity is greater than zero m/s^2 .
- (e) Newton's third law of motion is not valid.

24. Two cars travel along a level highway in the same direction. It is observed that the distance between the cars is increasing. Which one of the following statements concerning this situation is necessarily true?

- (a) The velocity of each car is increasing.
- (b) At least one of the cars has a non-zero acceleration.
- (c) The leading car has the greater acceleration.
- (d) The trailing car has the smaller acceleration.
- (e) Both cars could be accelerating at the same rate

25. A sled of mass m is coasting on the icy surface of a frozen river. While it is passing under a bridge, a package of equal mass m is dropped straight down and lands on the sled (without causing any damage). The sled plus the added load then continue along the original line of motion. How does the kinetic energy of the sled + load compare with the original kinetic energy of the sled?

- (a) It is $1/4$ the original kinetic energy of the sled.
- (b) It is $1/2$ the original kinetic energy of the sled.
- (c) It is $3/4$ the original kinetic energy of the sled.
- (d) It is the same as the original kinetic energy of the sled
- (e) It is twice the original kinetic energy of the sled.

26. The side of a cube is increased by 5%. The percentage increase of the surface area of the cube is,

- (a) 5%
- (b) 10%
- (c) 12%
- (d) 16%
- (e) 25%

27. A 5.0 kg object has a moment of inertia of 1.2 kg m^2 . What torque is needed to give the object an angular acceleration of 2.0 rad/s^2 ?

- (a) 2.4 Nm
- (b) 2.6 Nm
- (c) 2.8 Nm
- (d) 3.2 Nm
- (e) 10 Nm

28. A ball collides with a second ball at rest. After the collision, the first ball comes to rest and the second ball moves off at the speed of the first ball. In this collision,

- (a) Total momentum is not conserved.
- (b) Total kinetic energy is not conserved.
- (c) Total momentum is conserved but total kinetic energy is not conserved.
- (d) Total momentum is not conserved but total kinetic energy is conserved.
- (e) Total momentum and total kinetic energy are conserved and the masses are equal.

29. A CD has a diameter of 12.0 cm. If the CD is rotating at a constant frequency of 6.0 cycles per second, then the angular velocity is,

- (a) 21.5 rad/s
- (b) 26.9 rad/s
- (c) 29.6 rad/s
- (d) 33.3 rad/s
- (e) 37.7 rad/s

30. Three objects experience interactions. Object A has mass, object B has electrical charge, and object C has both mass and electrical charge. Object A and object B have a rope connected between them. Which of the following statements are true?

- (a) The electrical force on C due to B is equal and opposite to the electrical force on C due to A.
- (b) The electrical force on A due to B is equal and opposite to the gravitational force on B due to A.
- (c) The rope force on A due to B is equal and opposite to the electrical force on B due to A
- (d) The gravitational force on C due to A is equal and opposite to the gravitational force on A due to C.
- (e) The rope force on B due to A is equal and opposite to the gravitational force on A due to C

31. A car starts from rest and travels a distance of 100 m in 10 seconds. The acceleration of the car is,

- (a) 1.0 m/s^2
- (b) 2.0 m/s^2
- (c) 2.5 m/s^2
- (d) 3.0 m/s^2
- (e) 10 m/s^2

32. A projectile is projected from the origin with a velocity of 30.0 m/s at an angle of 45 degrees above the horizontal. What is the velocity and time when the projectile hits the ground?

- (a) $V_x = 21.2 \text{ m/s}$, $V_y = 21.2 \text{ m/s}$ at $t = 4.33 \text{ s}$
- (b) $V_x = 16.7 \text{ m/s}$, $V_y = 16.7 \text{ m/s}$ at $t = 3.33 \text{ s}$
- (c) $V_x = 21.1 \text{ m/s}$, $V_y = 16.7 \text{ m/s}$ at $t = 2.83 \text{ s}$
- (d) $V_x = 16.7 \text{ m/s}$, $V_y = 21.2 \text{ m/s}$ at $t = 4.33 \text{ s}$
- (e) $V_x = 21.2 \text{ m/s}$, $V_y = 15.0 \text{ m/s}$ at $t = 3.33 \text{ s}$

33. A rocket is launched from the origin with an acceleration of 20.0 m/s^2 at an angle of 30 degrees above the horizontal. The launch acceleration lasts for 2.0 seconds at which time the fuel is exhausted. The rocket then falls with an acceleration of 9.8 m/s^2 downward. What is the maximum height?

- (a) 22.3 m
- (b) 27.5 m
- (c) 30.5 m
- (d) 36.7 m
- (e) 40.4 m

34. A projectile is projected from the origin with a velocity of 30.0 m/s at an angle of 40 degrees above the horizontal. What is the position vector when the projectile is at the maximum height?

- (a) $X = 45.2 \text{ m}$, $Y = 19.0 \text{ m}$
- (b) $X = 21.1 \text{ m}$, $Y = 19.0 \text{ m}$
- (c) $X = 51.1 \text{ m}$, $Y = 21.1 \text{ m}$
- (d) $X = 45.2 \text{ m}$, $Y = 21.1 \text{ m}$
- (e) $X = 19.0 \text{ m}$, $Y = 17.5 \text{ m}$

35. An airplane is flying in horizontal flight at a constant velocity. The weight of the airplane is 40,000 N. The wings produce a lift force that is perpendicular to the wings and a drag force that is parallel to the wing. The engine produces a forward thrust force of 2,000 N.

Which of the following statements is true?

- (a) The lift force on the airplane is zero.
- (b) The drag force on the airplane is zero.
- (c) The lift force on the airplane is 42,000 N upward.
- (d) The drag force on the airplane is 38,000 N downward.
- (e) The drag force on the airplane is 2,000 N backward.

36. A force of 100 N is applied to an object in a direction that is 60 degrees to the left of the Y axis. The X component and the Y component of the force vector are, in N

- (a) $F_x = -50, F_y = +87$
- (b) $F_x = +87, F_y = +87$
- (c) $F_x = -50, F_y = -50$
- (d) $F_x = -87, F_y = +50$
- (e) $F_x = +50, F_y = +87$

37. A certain spring produces a force F , in N, when it is stretched. The following values of the force F were measured when the spring has a length L , in cm. The force constant of the spring is, in N/cm

Force(N)	0	24	48	72	96	120
L(cm)	4	6	8	10	12	14

- a) 4.0
- b) 6.0
- c) 7.2
- d) 8.0
- e) 12.0

38. A 100 Newton box is sliding down an incline at a constant acceleration of 1.5 m/s^2 . The angle of the incline is 20 degrees. The tangential force of friction is,

- (a) 10.2 N
- (b) 18.9 N
- (c) 26.3 N
- (d) 34.8 N
- (e) 94.0 N

39. An object is moving in a circular path of radius 4.0 m. If the object moves through an angle of 30 degrees, then the tangential distance traveled by the object is,

- (a) 3.66 m
- (b) 3.21 m
- (c) 2.84 m
- (d) 2.09 m
- (e) 1.75 m

40. A 0.5 kg stone is moving in a circular path (path is perpendicular to the ground) attached to a string that is 75 cm long. The stone is moving around the path at a constant frequency of 2.2 rev/sec. At the moment the stone is at the highest point, the stone is released. The magnitude and direction of the velocity of the stone when it leaves the circular path is,

- (a) 10.4 m/s horizontal
- (b) 10.4 m/s vertical
- (c) 22.0 m/s horizontal
- (d) 22.0 m/s vertical
- (e) 31.4 m/s horizontal

41. A 2,000 kg car traveling at 30 mph skids to a stop in 60 meters. The coefficient of kinetic friction during the skid is, ($1.0 \text{ mi/h} = 0.447 \text{ m/s}$)

- (a) 0.15
- (b) 0.20
- (c) 0.25
- (d) 0.31
- (e) 0.39

42. A student lifts a weight of 10.0 N a distance of 0.5 meters. If this exercise is repeated 50 times in 100 seconds, then the power of this exercise is,

- (a) 2.5 Watts
- (b) 3.1 Watts
- (c) 3.6 Watts
- (d) 4.0 Watts
- (e) 4.8 Watts

43. The explosion in a cannon exerts an average force of 30,000 N for L meters, the length of the cannon. The length of the cannon to shoot a 2.0 kg projectile from the cannon on the earth to deep space is,

- (a) 2.75 km
- (b) 3.01 km
- (c) 3.98 km
- (d) 4.17 km
- (e) 5.02 km

44. Human reaction times are worsened by alcohol. How much farther would a drunk driver's car travel before he hits the brakes than a sober driver's car? Assume both cars are initially traveling at 49.0 mi/h, the sober driver takes .33 s and the drunk driver takes 1.0 s to hit the brakes in a crisis.

- (a) 34 ft
- (b) 40 ft
- (c) 45 ft
- (d) 48 ft

45. A fisherman casts his bait into the river at an angle of 25° . As the line unravels, he notices that the bait and hook reach a maximum height of 3.9 m. What was the initial velocity he launched the bait with?

- (a) 8.4 m/s
- (b) 9.2 m/s
- (c) 10 m/s
- (d) 21 m/s

46. A hobby rocket reaches a height of 72.3 m and lands 111 m from the launch point. What was the angle of launch?

- (a) 45°
- (b) 69°
- (c) 75°
- (d) 82°

47. Suppose you are playing hockey on a new-age ice surface in which there is no friction between the ice and the hockey puck. You wind up and hit the puck as hard as you can. Just after the puck loses contact with your stick, the puck

- (a) Will start to slow down
- (b) Will slow down a little then move at a constant rate
- (c) Will not slow down or speed up
- (d) Will speed up a little, then move at a constant rate

48. An object is moving to the right in a straight line. The net force acting on the object is also directed to the right, but the magnitude of the force is decreasing with time.

The object will

- (a) Continue to move to the right, with its speed increasing with time
- (b) Continue to move to the right, with its speed decreasing with time
- (c) Continue to move to the right, with a constant speed
- (d) Stop and start moving to the left

49. A 12 kg block on a table is connected by a string to a 26 kg mass, which is hanging over the edge of the table. If the 12 kg block is 3.1 m from the edge of the table, how much time will pass before the block falls off the table from when the other block is released? Assume that frictional forces may be neglected.

- (a) 0.96 s
- (b) 0.82 s
- (c) 0.68 s
- (d) 0.58 s

50. A large truck collides head-on with a cyclist. During the collision

- (a) The truck exerts a greater amount of force than the cyclist exerts on the truck
- (b) The truck exerts the same amount of force as the cyclist exerts on the truck
- (c) The truck exerts a lesser amount of force than the cyclist exerts on the truck
- (d) The truck exerts a force on the cyclist, but the cyclist exerts no force on the truck