

1. The topmost line on this page says
 - a. This is Version A of
 - b. This is Version B of

2. Which of the following statements about the moon is most correct?
 - a. The moon has a constant velocity around the earth.
 - b. There is a net force acting on the moon due to the sun, the earth and the other planets.
 - c. The earth exerts a stronger force on the moon than the moon exerts on the earth.
 - d. The moon experiences a centripetal acceleration which drives it forward.
 - e. All of the above statements about the moon are true.
 - f. None of the above statements is true.

3. Which of the following statements (a through e) about the moon is false?
 - a. The acceleration due to gravity at the moon's surface is smaller than that at the earth's.
 - b. The earth's gravitational pull on the moon is greater than the moon's gravitational pull on earth.
 - c. There is a net force acting on the moon.
 - d. The moon is accelerating.
 - e. The moon's rotation about the earth causes high tide to come later on successive days.

4. An astronaut weighs 900 N when measured on the surface of the earth. How large a force of gravity would act on him if he were in an earth satellite at an altitude equal to the earth's radius?
 - a. 100N
 - b. 225 N
 - c. 300 N
 - d. 450 N
 - e. 900 N
 - f. None of the above is correct within 10%.

5. A future space traveler, Skip Parsec, lands on the planet, Z, which has twice the mass of Earth and half its radius. If Skip weighs 400 Newtons on Earth's surface, how much does he weigh on Z's surface?
 - a. 3200 N
 - b. 1600 N
 - c. 800 N
 - d. 400 N
 - e. 200 N
 - f. 100N
 - g. 50 N
 - h. None of the above is correct within 10%.

6. What is the magnitude of the earth's gravitational field, F_G/m , at a height above the earth equal to twice the earth's radius?
- 160 N/kg
 - 90 N/kg
 - 30 N/kg
 - 10 N/kg
 - 3.3 N/kg
 - 1.1 N/kg
 - 0.62 N/kg
 - None of the above is correct within 10%.
7. During the Apollo flights to the moon a well-known TV newscaster made the following statement, "The Apollo space craft is now leaving the gravitational force of the earth." This statement is incorrect. He should have said that the space craft
- was now being attracted only by the moon.
 - was now being attracted only by the sun
 - was now attracted more by the sun than by the earth.
 - was now in a region of space where there no gravitational forces act upon it.
 - was no longer being attracted gravitationally by the earth.
 - None of the completions (a through e) above leads to a correct statement.
8. The numerical value of G , the gravitational constant, was first roughly estimated
- by Newton from a reasonable guess about the earth's mass density.
 - from the law of universal gravitation and the value of g .
 - from the value of the moon's acceleration.
 - by Cavendish' measuring the force between masses in the laboratory.
 - from the mass of the earth, which had been known from the Greeks..
 - None of the above completions yields a true statement.
9. Which of the following would cause the gravitational force on an object near the surface of the earth to be greater than its average value?
- a high density ore deposit just under the surface
 - a higher elevation of the earth's surface above the mean sea level
 - a horizontal velocity
 - A vertical upward velocity
 - None of the above would cause a greater gravitational force on the object.
 - All of the circumstances a) through d) above would cause a greater than average gravitational force.
10. In an orbiting satellite such as SkyLab , physical objects
- have mass but no weight.
 - have weight but no mass.
 - have mass but feel no force due to gravity.
 - have neither mass nor weight.
 - fall to the floor with an acceleration of 9.8 m/s/s.
 - conform to none of the above completions (a through e).

11. Geosynchronous communications satellites orbit the earth once every
 - a. 90 minutes
 - b. 24 hours
 - c. 28 days
 - d. 1 year
 - e. They don't orbit the earth; they just stay in one place.
 - f. None of the above completions yields a true statement.
12. Because the moon rotates about the earth (in the same direction as the earth rotates about its own axis) about once every 27.3 days, there will occur on earth during some, but not most, 24 hour intervals,
 - a. one high tide and one low tide;
 - b. one high tide and two low tides, or two high tides and one low tide;
 - c. two high tides and three low tides, or three high tides and two low tides.
 - d. two high tides and two low tides.
 - e. All of the above combinations occur in some, but not most, 24 hour intervals
 - f. None of the above completions yields a true statement.
13. Which of the following is true of the momenta of an 18-wheeler parked at the curb and a Volkswagen rolling down a hill?
 - a. The 18-wheeler has the greater momentum
 - b. The Volkswagen has the smaller momentum
 - c. The two momenta are equal.
 - d. Either could have the greater momentum.
 - e. The answer depends upon the ratio of the masses.
 - f. None of the above
14. How fast would you have to throw a baseball ($m = 150$ g) to give it the same momentum as a 3-g pellet traveling at 800 m/sec
 - a. 5.3 m/s
 - b. 16 m/s
 - c. 267 m/s
 - d. 2400 m/s
 - e. 40,000 m/s
 - f. None of the above is correct within 10%.
15. Newton's second law can be rearranged to show that the _____ is equal to the _____.
 - a. momentum ... impulse
 - b. change in momentum ... change in impulse
 - c. change in momentum ... impulse
 - d. momentum ... change in impulse
 - e. All of the above statements can be obtained by suitably rearranging Newton's second law.
 - f. None of the results a) through d) can be obtained from Newton's second law.
16. The acceleration due to gravity on Titan, Saturn's largest moon, is about 1.4 m/s^2 . What would a 600-kg scientific instrument weigh on Titan?
 - a. 4.28 N
 - b. 8.40 N
 - c. 42.8 N
 - d. 84 N
 - e. 428 N
 - f. 840 N
 - g. None of the above is within 10% of the correct answer.

17. An astronaut training at the Craters of the Moon in Idaho jumps off a platform in full space gear and hits the surface at 5 m/s. If later on the moon the astronaut jumps from the LEM and hits the moon's surface at the same speed, the impulse will be _____ that on earth.
- the same as
 - larger than
 - smaller than
 - larger or smaller depending upon the height of the jump.
 - It is not possible to compare the impulses.
18. We can explain the recoil that occurs when a rifle is fired by using
- conservation of momentum.
 - equal and opposite impulses.
 - equal and opposite changes in momentum.
 - Newton's third law.
 - Any or all of the above.
 - None of the items a) through d) suffices to explain the recoil of a fired rifle.
19. Which of the following will cause the largest change in the momentum of an object?
A force of _____ acting for _____.
- 9 N ... 8 s
 - 11 N ..7 s
 - 13 N ..6 s
 - 15N ...5 s
 - 17N ... 4 s
 - None of the above.
20. What average net force, most nearly, is required to stop a 150-kg football player running at 8 m/s in a time of 0.24 s?
- 5000 N
 - 2880 N
 - 500 N
 - 288 N
 - None of the above is within 10% of the correct answer.
21. If it takes 33s for a jet plane to go from rest to the takeoff speed of 100 mph (44.7 m/s), What is the average horizontal force that the seat exerts on the back of a 110-kg passenger during takeoff, most nearly ?
- 50 N
 - 150 N
 - 250 N
 - 350 N
 - 450 N
 - None of the above is within 10% of the correct answer.
22. A very hard rubber ball ($m = 0.4$ kg) is falling vertically at 6 m/s just before it strikes the floor. The ball rebounds back at essentially the same speed. If the collision with the floor lasts 0.06 s, what is the average force exerted by the floor on the ball?
- 8 N
 - 16 N
 - 80 N
 - 160 N
 - 800 N
 - None of the above is within 10% of the correct answer.

23. If we examine a ball in free fall, we find that the momentum of the ball is not constant. This is not a violation of the law of conservation of momentum because
- the force of gravity acts on the ball.
 - the ball experiences an external force.
 - the ball is not an isolated system.
 - All of the above reasons are valid.
 - None of the above statements is true.
24. If rockets are fired in the forward direction from a moving airplane, the momentum of the airplane will
- be unchanged, by conservation of momentum.
 - increase just enough to conserve the momentum of the plane plus rocket system
 - decrease, but not by an amount we can specify
 - increase, but not by an amount that we can specify.
 - decrease just enough to conserve the momentum of the plane plus rocket system
 - None of the above completions yields a true statement.
25. Sally is an astronaut who has a mass of 50 kg. Currently she is conducting experiments in a permanent space station that is orbiting the earth at an altitude equal to the earth's radius. What are Sally's mass and weight as measured in the space station?
- 0.00 kg and 0 N, respectively.
 - 50 kg and 500 N, respectively
 - 50 kg and 0.00 N, respectively
 - 0.00 kg and 500 N, respectively
 - 50 kg is her mass, but the weight cannot be specified from the data given.
 - None of the above.
26. Which of the following properties of a ball is conserved as it falls freely in a vacuum?
- kinetic energy
 - gravitational potential energy
 - momentum
 - mechanical energy
 - All of the above are conserved quantities, but only in the absence of non-conservative forces.
 - None of the above (a through e) yields a correct statement,
27. Under what conditions is the kinetic energy (KE) conserved, in the strict sense of the word, during a collision?
- It is always conserved.
 - When the collision is totally elastic.
 - When there is no net outside force.
 - When there is no friction.
 - When the forces involved are fundamental forces of nature.
 - KE is never conserved during a collision because its value does not remain constant.
 - None of the above.
28. A ball moving at 4 m/s toward the right has a head-on collision with stationary ball of twice its mass. Each of the following final velocity pairs satisfies the law of conservation of linear momentum. Which one also preserves kinetic energy? The lighter ball has a velocity of _____, while the heavier has a velocity of _____ to the right.
- 2 m/s to the left ... 3 m/s
 - zero ... 2 m/s
 - 2 m/s to the right ... 1 m/s
 - 4 m/s to the left ... 4 m/s
 - None of the above has a final kinetic energy equal to the initial value.

29. A 5-kg toy car with a speed of 4 m/s collides head-on with a stationary 1-kg car. After the collision, the cars are locked together with a speed of 3.16 m/s. How much kinetic energy is lost in the collision?
- 10 J
 - 20 J
 - 30 J
 - 40 J
 - None of the above is within 10% of the correct value.
30. In physics, **net work** is defined as the product of the
- net force and the time over which it is applied.
 - net force parallel to the motion and the distance traveled.
 - net force and the distance traveled..
 - applied force and the distance traveled.
 - net force parallel to the motion and the time over which it is applied.
 - None of the above correctly defines a physical work.
31. Two objects have different masses but equal kinetic energies. If you stop them with the same retarding force, which one will stop in the shorter time?
- The heavier one.
 - The lighter one.
 - The one with the larger momentum.
 - The one with the smaller ~~momentum~~ \rightarrow velocity (EC:ex post facto, Q. is poorly posed, Because, befor correction, both b) and d) are correct answers.)
 - Both stop in the same distance.
 - It is not possible to say from the data given.
32. Two objects have different masses but equal momenta. If you stop them with the same retarding force, which one will stop in the shorter distance?
- the heavier one.
 - the lighter one.
 - The one with the larger kinetic energy.
 - Both stop in the same time.
 - There is not enough information to say.
33. The kinetic energy of an object moving in a circle at a constant speed
- is continually changing as the force changes direction.
 - is equal to the force times the time for one revolution.
 - is equal to one-half of the potential energy.
 - is constant.
 - depends upon the radius of the circle.
 - None of the above completions yields a true statement.
34. Which of the following has the physical dimension of power?
- Newton-meter/sec
 - kilowatt
 - Joule/sec
 - $\text{kg}\cdot\text{m}^2/\text{sec}^3$
 - All of the above have the physical dimension of power.
 - None of the units a) through d) has the dimension of a physical power.

35. How much work is performed by the gravitational force F on a geosynchronous satellite during one day?
- Zero, because the gravity force is exactly cancelled by the centrifugal force.
 - Zero, because the force is perpendicular to the velocity.
 - $F \cdot C$, where C is the circumference of the satellite orbit.
 - $F \cdot r$, where r is the radius of the orbit.
 - Zero, because a geosynchronous satellite remains in a stationary position above the earth, and therefore suffers no displacement.
 - None of the above.
36. A bowler lifts a bowling ball from the floor and places it on a rack. If you know the weight of the ball, what else must you know in order to calculate the work she does on the ball?
- mass of the ball
 - the time required
 - nothing else
 - height of the rack above the floor
 - acceleration due to gravity
 - None of the above suffices to calculate the work done.
37. How much work does a 50-kg person do against gravity in walking up a trail that gains 700 m in elevation?
- 500 J
 - 7000 J
 - 35,000 J
 - 350,000 J
 - The answer can be calculated, but (EC:) ~~one~~ none of (a through d) above is within 10%. J
 - There is not enough information to say, because the work depends on the slope of the trail.
38. Imagine riding in a glass-walled elevator that goes up the outside of a tall building at a constant speed of 10 meters per second. Assuming that you drop a ball as you pass a window, a person looking out the window will see the ball
- fall starting from rest.
 - fall starting with an upward speed of 20 m/s.
 - fall starting with a downward speed of 10 m/s.
 - accelerate downward at 10 m/s^2 .
 - None of the above statements is true
39. While you are standing on the sidewalk, you observe your friends pass by in a van traveling at a constant velocity. They drop a ball and you all make measurements of the ball's motion. Which of the following quantities has the same value in both reference systems?
- velocities
 - total mechanical energies
 - individual momenta
 - total momentum
 - None of the above physical quantities has the same value in both reference systems.

40. Assume that you are riding in a windowless room on a perfectly smooth surface. (You can't feel any motion.) Imagine that you have a collection of objects and measuring devices in the room. Which of the following experiments could you do to prove that the room is moving horizontally at a constant velocity?
- Determining an object's mass by applying a net horizontal force.
 - Weighing an object and comparing it to its known weight.
 - Determining the force necessary for an object to move in a circle.
 - Measuring the verticality of a hanging object
 - None of the above experiments can provide the proof, although it is possible in principle to perform some set of experiments which would do so.
 - No experiment of any kind could possibly provide the proof sought.
41. You can throw a ball vertically upward in a car moving with a constant velocity and have it land back in your hand because
- there is a net horizontal force acting on the ball.
 - the reference system attached to the car is non-inertial.
 - there is a net force in the forward direction.
 - the force in the forward direction is canceled by the inertial force.
 - In fact the ball will not actually land in you hand, but will fall behind it, since the car is moving.
 - None of the above.
42. A person drops a ball in train traveling along a straight, horizontal track with a constant acceleration of 5 m/s^2 in the forward direction. What would the person in the train say about the horizontal forces acting on the ball?
- There are no horizontal forces acting on the ball.
 - There is a horizontal force acting forward of magnitude, $mg/2$
 - There is a horizontal force acting backward of magnitude, $mg/2$.
 - There is a horizontal force, but its magnitude cannot be stated in terms of mg .
 - There is a centrifugal force.
 - The person on the train would offer none of the above statements.
43. A rock is thrown horizontally at 40 m/s from the back of a flatbed truck that is moving with a constant velocity of 30 m/s . Relative to an observer on the ground, what is the horizontal speed of the rock when it is thrown in the forward direction?
- 10 m/s
 - 30 m/s
 - 40 m/s
 - 50 m/s
 - 70 m/s
 - None of the above speeds is within 10 % of the correct answer.
44. An aircraft carrier is moving to the south at a constant 20 mph on a windless day. A plane requires a speed relative to the air of 145 mph to take off. How fast must the plane be traveling relative to the deck of the aircraft carrier to take off if the plane is headed north?
- 20 mph
 - 72.5 mph
 - 125 mph
 - 145 mph
 - 165 mph
 - None of the above answers is within 10% of the correct value.

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45. A train is traveling along a straight, horizontal track with a constant acceleration in the forward direction. At the instant the speed is 40 mph, a ball is dropped by an observer in the train. A second observer on the train determines that the horizontal speed of the ball during the fall is
- decreasing
 - increasing
 - zero
 - constant and equal to 40 mph.
 - None of the above.
46. An observer drops a ball in a train traveling along a straight, horizontal track with a constant acceleration in the forward direction. What would an observer in the station say about the horizontal force acting on the ball?
- There is no horizontal force.
 - A force acts backward.
 - A force acts forward.
 - There is a centrifugal force.
 - None of the above
47. You and a friend are rolling marbles on a horizontal table in the back of a van traveling straight forward on a level section of interstate highway. You start the marble rolling directly toward the side of the truck and observe that it curves toward the front. You conclude, correctly, that the truck is
- not moving
 - moving at a constant velocity
 - speeding up
 - slowing down
 - Turning at constant speed
 - None of the above
48. An elevator is moving upward is slowing down with an acceleration equal in magnitude to three-quarters that of gravity (about 7.5 m/s^2). If a person who weighs 1000 N when at rest on Earth steps on a bathroom scale in this elevator, what will the scale read?
- 250 N
 - 500 N
 - 750 N
 - 1000 N
 - 1250 N
 - None of the above.
49. While driving to the movies you decide to take advantage of a sharp right-hand corner to slide your date over next to you by turning right sharply . (Assume that the seat is frictionless.) From your point of view your date experiences a net force to the left, while a person standing on the roadway says, correctly in his frame of reference, that your date experiences
- a net force to the right.
 - a net force to the left.
 - no net force.
 - a net force backward
 - a net force forward.
 - none of the above

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50. What would an observer measure for the magnitude of the free-fall acceleration in an elevator near the surface of Earth if the elevator accelerates downward at 4 m/s^2 ?
- a. 4 m/s^2
 - b. 6 m/s^2
 - c. 10 m/s^2
 - d. 14 m/s^2
 - e. 16 m/s^2
 - f. None of the above.
51. A room is being accelerated through space at 10 m/s^2 relative to the “fixed stars”, far away from any massive objects. If a man weighs 700 N when he is at rest on earth, how much will he weigh in the room?
- a. zero
 - b. 350 N
 - c. 700 N
 - d. 1400 N
 - e. 2100 N
 - f. None of the above is within 10 % of the correct answer.
52. If you look down on the earth from a satellite, you will see that hurricanes in the Northern hemisphere rotate in a direction which
- a. is consistently clockwise
 - b. is consistently counterclockwise
 - c. is consistently northerly
 - d. is consistently southerly
 - e. differs from hurricane to hurricane.
 - f. is well characterized by none of the above completions.

Note that the remaining eight problems (#53 through #60) may require more computation than average. You may wish to allocate your effort accordingly.

53. A solid lead sphere of radius 10 m (about 66 ft across!) has a mass of about 57 million kg. If two of these spheres are floating in deep space with their centers 400 m apart, the gravitational attraction between the spheres is only 120 N. How large, most nearly, would this gravitational force be if the distance between the centers of the two spheres were reduced to 200 m?
- a. 15 N
 - b. 30 N
 - c. 60 N
 - d. 120 N
 - e. 240 N
 - f. 480 N
 - g. None of the above factors is correct within 10%.

54. A 800-kg frictionless roller coaster starts from rest at a height of 36 m. It travels 500 m under a frictional force of 224 N to the crest of a hill that is 22 m high. What is its kinetic energy at the top of the (EC) ~~12-m~~ 22m hill, most nearly? (1 kJ = 10^3 J.)

- a. 0 kJ
- b. 48 kJ
- c. 96 kJ
- d. 112 kJ
- e. 144 kJ J
- f. 288 kJ

55. A block weighing 30 N is falling with a kinetic energy of 85 J at time, $t = 0$, when a constant upward force of 45 N is applied. At a particular later time, $t = t_1$ the block has been lifted 4 m above the point where it was at $t = 0$. What is its kinetic energy at time t_1 , most nearly?

- a. 145 J
- b. 115 J
- c. 85 J
- d. 55 J
- e. 30 J
- f. 25 J
- g. 0 J

56. What average power is required to accelerate a 1300-kg car from rest to 10 m/s in 8 s, most nearly? (Note: 1 kW = 1000 watts = 1000 J/sec.)

- a. 0 kW
- b. 8 kW
- c. 12 kW
- d. 15 kW
- e. 18 kW
- f. 24 kW
- g. None of the above is within 10% of the correct answer.

57. An 90-kg satellite orbits a distant planet with a radius of 4000 km and a period of 280 min. From the radius and period, you calculate the satellite's acceleration to be about 0.55 m/s^2 . What is the gravitational force on the satellite, most nearly?

- a. 50 N
- b. 100 N
- c. 500 N
- d. 1,000 N
- e. None of the above is within 10% of the correct answer.

58. A person who weighs 320 N when at rest is riding in the rotating cylinder ride. The cylinder rotates fast enough to create a horizontal centrifugal pseudo-force in the rotating frame of magnitude 320 N. What is the magnitude of the person's weight in the rotating reference frame, most nearly?

- a. 450 N
- b. 650 N
- c. 850 N
- d. 1050 N
- e. 1250 N
- f. 1450 N

59. An observer drops a ball in a train traveling along a straight, horizontal track with a constant acceleration of 5 m/sec^2 in the forward direction. The observer is unaware of the acceleration and notices that the ball falls in a straight line that is slanted toward the back of the train. The angle of this line (measured from the vertical) is _____, most nearly.

- a. 6° .
- b. 13° .
- c. 26°
- d. 39°
- e. 52°
- f. None of the above is within 10 %.

60. A cylindrical space habitat with a 4,000-m radius is rotating so that a person standing on the inside surface feels a centripetal acceleration equal to $g = 10 \text{ m/sec}^2$. What is the tangential speed of a point just inside the cylinder, most nearly?

- a. 100 m/s
- b. 200m/s
- c. 4, 000 m/s
- d. 20,000 m/s
- e. 40,000 m/s

.....End of Exam