CPS lesson
Forces
ANSWER KEY

1. A constant force is briefly exerted on a cart initially at rest on an air track, giving it some speed. To achieve the same speed with half the force, it must be exerted for a time interval:

   A. four times as long
   * B. twice as long
   C. equally long
   D. half as long
   E. a quarter as long

2. A constant force is briefly exerted on a cart initially at rest on an air track. If the cart's mass is doubled and the same force is exerted for the same time, the final speed will be:

   A. a quarter of what it was before
   * B. half
   C. the same as
   D. double
3. A constant force is briefly exerted on a cart initially at rest, giving it speed $v$. If we now re-exert the same force on it for the same time interval, the cart's speed will increase to:

   - A. $2v$
   - B. $v^2$
   - C. $4v$
   - D. its speed won't change
   - E. more information is needed

4. A person is standing in an elevator accelerating upward. The normal force exerted on the person by the floor of the elevator is:

   - A. larger than her weight
   - B. equal to her weight
   - C. smaller than her weight
   - D. the answer depends on whether the elevator is traveling upward or downward

5. A train engine pulls a series of wagon cars along a level track.
Which of the following is true?

A. The engine constantly pulls slightly harder on the cars than the cars pull backward on the engine.

B. Since action equals reaction, the engine pulls forward just as hard as the cars pull backward, and there is no net force on the train.

C. The engine exerts a forward tug which is momentarily greater than the backward pull of the cars, in order to get them moving.

* D. The frictional force forward on the train engine is larger than the backward frictional force on the wagon cars.

E. The engine can only pull a wagon car if the engine weighs more than the car.

6. A car rounds a horizontal curve at constant speed.

Is there a net force on the car?

A. No.

* B. Yes.

C. It depends on other factors.

7. Von Guricke in Magdeburg butted two bronze hemispheres together and removed the air between them. Two 8-horse teams could not pull them apart. If von Guricke had instead coupled all 16 horses to one side and tied the other side to a rigid tree, the tension pulling the hemispheres apart would have:

* A. doubled
8. You push a crate across a rough floor at constant speed. If you turn the box onto another face having half the surface area, the force you will now have to apply to move it at the same constant speed is:

A. about 4 times bigger
B. twice as great
* C. about the same as before
D. half as great
E. only a quarter as large

9. A box is on an incline. The angle of inclination is slowly increased until the object just starts to slide. If the surface is now kept at this angle, the box will:

A. gradually slow down
B. slide at approximately constant speed
* C. gradually speed up
10. You are a passenger in a car not wearing your seatbelt. The car makes a sharp left turn at constant speed. Why do you feel the right-hand car door pressing against you?

A. Because there is a rightward force on you.

*B. Because there is a leftward force on you.

C. Both of the above.

D. None of the above.

11. A car is at rest on level ground. The downward gravitational pull of the earth on the car and the upward contact force of the earth on the car are equal and opposite because:

A. the two forces are an action-reaction pair

*B. the net force on the car is zero

C. neither of the above statements explains it

12. Can astronauts jump higher on the moon than on the earth if they exert the same muscular force in both cases?

*A. Yes because they weigh less.

B. Yes because their mass has decreased.

C. No because the net force is the same.

13. If the Atwood machine has a massless rope and pulley, the upward acceleration of m is:
14. The system shown is in static equilibrium.

What is the frictional force \( f \)?

A. \( g \)  
B. \( g/2 \)  
* C. \( g/3 \)  
D. \( g/4 \)  
E. zero
15. Which of the following statements is ALWAYS true in an inertial frame of reference?

A. Any object in equilibrium must be at rest.

B. Any object whose velocity is zero must be in equilibrium.

* C. An object moving with constant velocity must be in equilibrium.

16. A bucket of water is swung in a vertical circle. Its acceleration just reaches g at the topmost point of the circle.

What happens?
A. The water falls straight down out of the bucket.
B. The water sloshes sideways out of the bucket.
* C. The water stays in the bucket.

17. A hockey puck shot along the ice eventually comes to rest because:
   A. gravity stopped it
   B. no forces were keeping the puck going
   * C. there is friction between the ice and the puck
   D. the puck returns to its natural state of rest

18. An object on the moon has less:
   A. mass
   * B. weight
   C. inertia
   D. more than one of the above

19. A small car and a large truck are both traveling down a level road at 55 mph.
   * A. Less braking force is required to stop the car because it has less inertia than the truck.
   B. Less braking force is required to stop the truck because it is heavier and thus gravity helps stop it.
C. Equal braking force is needed to stop both vehicles.

20. A one-newton apple rests on a table.

Which statement is true?

A. The apple exerts a force on the table but not on the earth.

* B. The apple pulls up on the earth with one newton of force.

C. The apple pushes on the earth.

D. None of the above.

21. The diagram shows the forces on an apple at rest on a table.

Which statement is true?
22. You hoist a sail on a knockabout by pulling on the line with 6 N of force. Which statement is true?

* A. The line pulls back on you with 6 N of force.

B. The line pulls back on you with slightly less than 6 N.

C. Inanimate objects cannot pull on you.

23. Why are many racetrack corners banked?

A. To reduce the frictional forces slowing down a race car.

B. To reduce the force of gravity by the sine of the banking angle.

* C. So that the normal force can contribute to the centripetal acceleration.
24. The earth's orbit about the sun is approximately circular.

What provides the centripetal force on the earth?

   A. Nothing: the earth is moving through empty space.
   B. Gravity.
   C. The centripetal acceleration.
   D. Inertia.
   E. The centrifugal effect.

25. A mass on a string revolves in a horizontal plane. If the string is lengthened but the centripetal force is unchanged, the speed of the mass will:

   A. increase
   B. decrease
   C. remain the same

26. A rock is swung in a horizontal circle. Which path shows its motion if the string is released?
27. Force F pushes on a block but the block doesn't move because:

* A. F is equal to the static frictional force
B. F is less than the weight of the block
C. F is less than the static frictional force

28. A car making a turn on ice will slip if the following force is too small:
1. kinetic friction  2. static friction  3. normal force

A. 1 only
* B. 2 only
C. 3 only
D. 1 and 2
E. 1, 2, and 3

29. A complete free body diagram must show:

A. all of the action-reaction pairs of forces.
* B. all of the forces acting on a body.
C. all of the forces exerted by the body.
30. Which of the following statements is false?

A. Tension is a scalar.

B. The tension must be the same at both ends of a straight massless rope.

C. A rope exerts a pull directed tangentially to its length.

D. The tension must be the same on both sides of a rope passing over a massless, frictionless pulley.

31. Which of the following is false?

A. The net force must be zero in equilibrium.

B. Acceleration must be zero in equilibrium.

C. Velocity must be zero in equilibrium.

D. If there is a net force, the acceleration cannot be zero.

E. All of the above statements are true.

32. If an object is in equilibrium, not only must the net force be zero, each component of the net force must also be zero.

A. True

B. False
33. An anvil is suspended from the ceiling by a rope. You shake the anvil from side to side vigorously. You then repeat this experiment aboard the space shuttle.

You discover that:

A. it requires no effort because the anvil is now weightless.

B. it requires some effort because there is still some gravity in orbit.

* C. it is about as hard to shake as it was on earth.

34. Which of the following depends only on the inertial (rather than the gravitational) mass of an object?

A. the time the object takes to falls a certain height

B. the weight of the object on a bathroom scale

* C. the acceleration of the object fired horizontally by a spring-loaded gun

D. the weight of the object on a pan balance

35. Two equal-mass satellites A and B circle the earth. The distance of B from earth's center is twice that of A. What is the ratio of the centripetal force on B to that on A?

A. 1/8

* B. 1/4

C. 1/2

D. 1/\sqrt{2}

E. 1

36. Two equal-mass satellites A and B circle the earth. The distance of B from
earth's center is twice that of A. What is the ratio of the tangential speed of B to that of A?

A. 1/2  

* B. 1/21/2  

C. 1  

D. 21/2  

E. 2

37. Suppose earth had no atmosphere and a ball were fired tangential to the ground from atop Mt. Everest with a launch speed to cause it to circle the earth. Its acceleration would be:

A. much less than g  

* B. approximately g  

C. need more information to answer

38. A rock initially at rest and located infinitely far away from earth is released. An observation tower with its base on earth's surface is 3 earth radii high. Neglecting air drag, its speed when it hits ground is:

* A. twice as large as its speed at the top of the tower
39. The moon does not fall onto the earth because:

A. the net force on the moon is zero
B. it is beyond the main pull of earth's gravity
C. it is being pulled by the sun and other planets and not just by the earth
* D. the earth's surface curves out of the way just as fast as the moon falls toward it

40. A plumb bob is hanging freely at rest in the northern hemisphere. The combination of gravity and earth's rotation causes the bob to:
A. point toward earth's center
B. deviate eastward
C. deviate westward
D. deviate northward
E. deviate southward

41. Which statement describes the acceleration of the pendulum bob at position 5?

A. It is not accelerating.
* B. Its acceleration is toward 4.
C. Its acceleration is away from 4.
D. Its acceleration is toward the suspension point.
E. Its acceleration is away from the suspension point.

42. An object is initially traveling 25 m/s. It is brought to rest in 62.5 m by a net 15 N force. What is its mass?
43. A tomcat fighter is powered by two engines with 27,000 lb of thrust each. The plane can fly a maximum of 1544 mph at 35,000 ft level altitude. What is the drag force on the plane at this velocity?

A. less than 27,000 lb
B. 27,000 lb
* C. 54,000 lb
D. greater than 54,000 lb
E. need more information

44. What is the acceleration of an (unpropelled) meteor when it is 3 earth radii above earth's surface?

A. 0
45. What minimum launch speed is needed for an object to get arbitrarily far away from the surface of a planet of mass $M$ and radius $R$?

A. $\frac{GM}{R}$
B. $(\frac{GM}{R})^{1/2}$
C. $\frac{2GM}{R}$
* D. $(\frac{2GM}{R})^{1/2}$
E. $\frac{3GM}{R}$

46. Which fundamental force holds your body together (so that it doesn't dissociate into individual atoms)?

A. nuclear
* B. electromagnetic
C. weak
D. gravitational

47. Which statement about black holes is false?

A. An object will speed up as it falls into the hole.
B. Any nearby object must quickly fall into the hole.

C. Its Schwarzschild radius increases linearly with its mass.

D. Every other particle in the universe is gravitationally attracted to the hole.

48. Which of the following is NOT one of Kepler's laws?

A. Planetary orbits are elliptical with the sun at a focus.

B. A line connecting the sun to a planet sweeps out equal areas in equal times.

* C. The gravitational force between a planet and the sun is proportional to their masses divided by the distance squared.

D. The average distance cubed from a planet to the sun is proportional to its orbital period squared.

49. Which of the following is NOT a possible planetary orbit?

* A.
50.
Which planet has the shortest period?
51. Consider the planetary orbit below. The red areas are equal. If it takes 6 years for the planet to get from A to B, how long does it take to get from B to C?

* A. 1
B. 2
C. 3
D. need more info
52. Which of the following statements is false?

A. Gravity is weaker than the weak force.
B. Gravity is always attractive.
C. The electrostatic force can be repulsive.
* D. The strong force is long range.
E. All of these statements are true.

53. Which of the following statements is false?

A. The gravitational field is a scalar.
B. The gravitational field has units of N/m.
C. The gravitational field is always 9.8 m/s².
D. Exactly two of these statements are false.
* E. All three of them are false.

54. Does the escape speed of an object from some unknown planet depend on the mass of the object?
55. The Schwarzschild radius is the distance from the center of a black hole at which light is just barely unable to escape.

* A. True

B. False

56. Which statement about the gravitational force between two particles is true?

A. It can be shielded by an intervening mass.

B. It is proportional to the distance squared between the particles.

* C. It adds vectorially to the gravitational forces due to any other masses.

D. It does not depend on the distance between the particles.

57. The gravitational constant G:

A. is equal to g at earth's surface

B. has a different value on the moon than on the earth

C. can be directly determined by timing the freefall of an object from a known height

* D. none of the above
58. The terminal speed of an object depends on both the geometry of the object and the nature of the fluid through which it falls.

* A. True

B. False

59. A feather is dropped from the ceiling of a room with no air currents. It quickly reaches terminal speed. From then on it:

* A. stops accelerating

B. accelerates at a much lower rate than g

C. accelerates at g downward

60. Which of the following statements about the drag on an object traveling through a fluid is false?

A. The drag force depends on the shape of the object.

B. The drag force depends on the viscosity of the fluid.

C. The drag force increases when the object moves faster.

D. The drag force is always opposite to the object's velocity.

* E. All of these statements are true.

61. Two skydivers have the same total mass. The first skydiver has a parachute with twice the area as the second skydiver. What is the ratio of the first diver's terminal speed to that of the second?

A. 2
B. 21/2
C. 1
D. 1/2
* E. 1/21/2

62. A popcorn kernel is dropped into oil. Which plot shows its acceleration vs time in the oil?
63. An object falls and reaches terminal speed. A graph of the drag force on it versus time is:

* * A. 

B. 

D. 

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* *
64. A solid styrofoam ball is dropped in air. If a styrofoam ball with one-quarter the radius is dropped, its terminal speed will be:

A. one sixteenth of what it was originally

B. a quarter of what it was

* C. half of what it was

D. the same as it was before

E. double what it was

65. An astronaut orbiting the earth in a space shuttle experiences weightlessness because:

A. gravity is negligible up there

B. the centripetal force acting on her is zero
C. she is in free fall
D. the propulsion force of the engines balances gravity
E. there is no air resistance in space

66. To escape from the solar system, an object must climb totally out of the gravitational well of the earth and partly out of sun's well. The escape speed from the earth if the sun were absent is 11.2 km/s. But because of the sun, the total escape speed is:
   A. slightly bigger than 11.2 km/s
   B. made up of comparable contributions from the earth and sun
   * C. dominated by the sun

67. A rider in a barrel of fun finds herself stuck to the wall after the floor drops away. Which is the correct free-body diagram?

* A.
68. Two blocks connected by a cord which does not stretch slide on a frictionless level surface.

The net force on block B is:

A. 2 N
B. 3 N
* C. 6 N
D. 60 N

69. A satellite revolves around earth in the circular orbit. It fires a thruster backward to move into the elliptical orbit. Its average speed in the new orbit is:
A. bigger than in the circular orbit

B. equal to what is was before

* C. smaller than in the circular orbit

D. more information is needed

70. The block has a weight of 100 N. The frictional coefficients are $m_s = 0.4$ and $m_k = 0.3$.

If the block is at rest and a force of $F = 35$ N is then applied to it, the frictional force will settle down to:
71. The block has a weight of 100 N. The frictional coefficients are $m_s = 0.4$ and $m_k = 0.3$.

If the block is at rest and a force of $F = 50$ N is then applied to it, the frictional force will settle down to:

A. 30 N
B. 35 N
C. 40 N
D. 100 N