NATIONAL SCIENCE LEAGUE – 2015

PHYSICS CONTEST

SAMPLE

– ANSWER KEY –

1. **(d)**
2. **(b)**
3. **(a)**
4. **(b)**
5. **(c)**
6. **(c)**
7. **(a)**
8. **(b)**
9. **(c)**
10. **(b)**
11. **(a)**
12. **(d)**
13. **(c)**
14. **(b)**
15. **(d)**
16. **(d)**
17. **(a)**
18. **(a)**
19. **(c)**
20. **(c)**
21. **(c)**
22. **(d)**
23. **(d)**
24. **(a)**
25. **(a)**
26. **(b)**
27. **(a)**
28. **(a)**
29. **(c)**
30. **(d)**
31. **(b)**
32. **(c)**
33. **(b)**
34. **(d)**
35. **(a)**
36. **(d)**
37. **(d)**
38. **(c)**
39. **(b)**
40. **(b)**

1. A boy and a girl begin at the same position in the center of a large flat field. The boy walks in a straight line 50 meters due north from the starting position and stops. The girl walks in a straight line 30 meters due south from the starting position and stops. What is the position of the girl relative to the boy?
   (a) She is 20 meters north of the boy.
   (b) She is 20 meters south of the boy.
   (c) She is 80 meters north of the boy.
   (d) She is 80 meters south of the boy.

2. A boy and a girl begin at the same position in the center of a large flat field. The boy walks in a straight line 50 meters due north from the starting position and stops. The girl walks in a straight line 30 meters from the starting position and stops. How far is the girl from the boy?
   (a) She must be 20 meters from the boy.
   (b) She must be at least 20 meters but no more than 80 meters from the boy.
   (c) She must be 80 meters from the boy.
   (d) She must be more than 80 meters from the boy.

3. Below are four statements about objects. Of the statements, which is correct?
   (a) An object in equilibrium may be at rest.
   (b) An object in equilibrium must be at rest.
   (c) An object in equilibrium may be moving with uniform (non-zero) acceleration.
   (d) An object in equilibrium must be moving with uniform (non-zero) acceleration.

4. It takes a runner 12.5 seconds to run a straight-line distance of 100 meters. What is her average speed for the 100 meter run?
   (a) 0.125 meter per second
   (b) 8.0 meters per second
   (c) 112.5 meters per second
   (d) 1250 meters per second

Base your answers to questions 5 through 7 on the following information.

A box is sitting on a long, horizontal floor. The box is kicked, giving it an initial velocity of 12 meters per second. The box undergoes uniform acceleration as it slides to a stop in 3.0 seconds.

5. What is the average speed of the box as it slides?
   (a) 3.0 meters per second
   (b) 4.0 meters per second
   (c) 6.0 meters per second
   (d) 12 meters per second

6. How far does the box move during its 3.0 second slide?
   (a) 3.0 meters
   (b) 4.0 meters
   (c) 18 meters
   (d) 36 meters

7. What is the magnitude of the acceleration of the box during its 3.0 second slide?
   (a) 4.0 meters per second^2
   (b) 18 meters per second^2
   (c) 36 meters per second^2
   (d) 72 meters per second^2

8. A car moving on a straight road increases its speed uniformly from 30. meters per second to 40. meters per second in 4.0 seconds. What is the average acceleration of the car?
   (a) 0.25 meter per second^2
   (b) 2.5 meters per second^2
   (c) 10. meters per second^2
   (d) 40. meters per second^2

9. A ball is thrown upward with an initial speed of 20. meters per second. If it is caught at the same height from which it was thrown, what is its velocity just before it is caught? [Ignore air friction.]
   (a) 4.0 meters per second downward
   (b) 10. meters per second downward
   (c) 20. meters per second downward
   (d) 40. meters per second downward

10. An arrow is shot directly upward at a speed of 40. meters per second. How long after it is shot will it reach its maximum height? [Assume g = 10. meters per second^2 and ignore air friction.]
   (a) 2.0 seconds
   (b) 4.0 seconds
   (c) 10. seconds
   (d) 40. seconds

11. A rock is thrown directly downward from a bridge toward the water below. Of the following statements about the rock's speed, which is correct? [Ignore air friction.]
   (a) The rock's speed increases during the trip.
   (b) The rock's speed first increases, then decreases during the trip.
   (c) The rock's speed first decreases, then increases during the trip.
   (d) The rock's speed remains constant throughout the trip.

12. A rock is thrown directly downward from a bridge toward the water below. Of the following statements about the rock's acceleration, which is correct? [Ignore air friction.]
   (a) The rock's acceleration increases during the trip.
   (b) The rock's acceleration first increases, then decreases during the trip.
   (c) The rock's acceleration first decreases, then increases during the trip.
   (d) The rock's acceleration remains constant throughout the trip.

13. A net force of 24 newtons is acting on a block of wood of mass 3.0 kilograms resting on a horizontal frictionless surface. What will be the acceleration of the block?
   (a) zero
   (b) 0.125 meter per second^2
   (c) 8.0 meters per second^2
   (d) 72 meters per second^2

14. A force of 30. newtons is applied to a 3.0 kilogram box resting on a horizontal **frictional** floor. The box accelerates in the direction of the applied force at 8.0 meters per second^2. What is the force of friction acting on the box?
   (a) 2.0 newtons
   (b) 6.0 newtons
   (c) 24 newtons
   (d) 30. newtons

15. A book has a mass of 2.0 kilograms. What is its weight in a location where g = 10. meters per second^2?
   (a) 0.2 newton
   (b) 2.0 newtons
   (c) 5.0 newtons
   (d) 20. newtons

Base your answers to questions 16 through 18 on the following information. Ignore friction.

Toy train **Car A**, which has a mass of 2.0 kilograms, is coasting along a straight, level track at a speed of 10. meters per second when it collides with **Car B**, which has a mass of 3.0 kilograms, and is initially at rest. When the two cars collide they hook together and move as one unit.

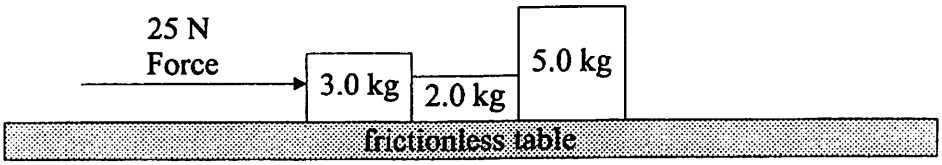
16. What is the momentum of **Car A** before it collided with **Car B**?
    (a) zero
    (b) 0.20 kilogram·meter/second
    (c) 5.0 kilogram·meters/second
    (d) 20. kilogram·meters/second

17. What is the momentum of **Car B** before it is hit by **Car A**?
    (a) zero
    (b) 0.20 kilogram·meter/second
    (c) 5.0 kilogram·meters/second
    (d) 20. kilogram·meters/second

18. What is the speed of the two cars after the collision?
    (a) 4.0 meters per second
    (b) 5.0 meters per second
    (c) 6.7 meters per second
    (d) 10. meters per second

Base your answers to questions 19 through 21 on the following information.

Three blocks are placed on a frictionless table as shown in the diagram below. The masses of the blocks are indicated on the diagram. A 25 newton force acts on the blocks in the direction shown.



19. What is the acceleration of the set of blocks?
    (a) 0.2 meter per second^2 to the right
    (b) 0.4 meter per second^2 to the right
    (c) 2.5 meters per second^2 to the right
    (d) 250 meters per second^2 to the right

20. What is the ***net*** force acting on the 5.0 kg block?
    (a) 2.0 newtons
    (b) 5.0 newtons
    (c) 12.5 newtons
    (d) 25 newtons

21. What force is the 3.0 kg block exerting on the 2.0 kg block?
    (a) 8.3 newtons
    (b) 10. newtons
    (c) 17.5 newtons
    (d) 25 newtons

Base your answers to questions 22 through 24 on the following information. Assume that the acceleration due to gravity is 10. meters per second^2 downward, and that friction can be ignored.

An athlete lifts a 50. kilogram mass from the floor to a height of 2.0 meters above the floor in 0.50 seconds. He then holds the mass still in the same position for 5.0 seconds.

22. What is the change in potential energy of the mass during the lift?
    (a) zero joules
    (b) 50 joules
    (c) 100 joules
    (d) 1000 joules

23. What is the average power exerted by the athlete during the lift?
    (a) 50 watts
    (b) 500 watts
    (c) 1000 watts
    (d) 2000 watts

24. How much work is done by the athlete during the 5.0 seconds when he was supporting the mass?
    (a) no work is done
    (b) 100 joules
    (c) 1000 joules
    (d) 5000 joules

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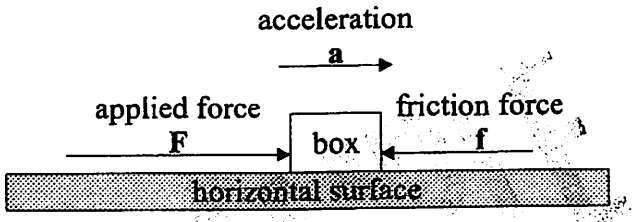
25. An object slides down a frictionless inclined plane. Of the following statements about the energies associated with the object, which is correct?
    (a) The object's kinetic energy will increase as its potential energy decreases.
    (b) The object's kinetic energy will increase as its potential energy increases.
    (c) The object's kinetic energy will decrease as its potential energy decreases.
    (d) The object's kinetic energy will decrease as its potential energy increases.

26. Two balls are moving with the same speed. Ball A has a mass of 1.0 kilogram and Ball B has a mass of 2.0 kilograms. Which statement about the kinetic energies of the two balls is correct?
    (a) Ball A has one-fourth the kinetic energy of Ball B.
    (b) Ball A has one-half the kinetic energy of Ball B.
    (c) Ball A has twice the kinetic energy of Ball B.
    (d) Ball A has four times the kinetic energy of Ball B.

27. Two balls have the same mass but are moving at different speeds. Ball A moves with a speed of 1.0 meter per second and Ball B moves with a speed of 2.0 meters per second. Which statement about the kinetic energies of the two balls is correct?
    (a) Ball A has one-fourth the kinetic energy of Ball B.
    (b) Ball A has one-half the kinetic energy of Ball B.
    (c) Ball A has twice the kinetic energy of Ball B.
    (d) Ball A has four times the kinetic energy of Ball B.

28. The diagram below shows two forces (an applied force and a friction force) acting on a box that is on a horizontal surface. The box is accelerating in the direction shown. Of the following statements about the forces acting on the box, which is correct?



(a) The applied force must be greater than the friction force.
(b) The applied force must be equal to the friction force.
(c) The applied force must be less than the friction force.
(d) The friction force must be zero for any acceleration to be possible.

Base your answers to questions 29 and 30 on the following information.

The specific heat of aluminum is twice as great as the specific heat of iron. Equal masses of hot aluminum and cold iron are placed in contact in an insulated container.

29. Of the following statements about the temperature change of the two metals, which is correct?
(a) The temperature change of the aluminum is four times as great as the temperature change of the iron.
(b) The temperature change of the aluminum is twice as great as the temperature change of the iron.
(c) The temperature change of the aluminum is one-half as great as the temperature change of the iron.
(d) The temperature change of the aluminum is equal to the temperature change of the iron.

30. Of the following statements about the heat energy exchanged between the two metals, which is correct?
(a) The heat energy lost by the aluminum is four times as great as the heat energy gained by the iron.
(b) The heat energy lost by the aluminum is twice as great as the heat energy gained by the iron.
(c) The heat energy lost by the aluminum is one-half as great as the heat energy gained by the iron.
(d) The heat energy lost by the aluminum is equal to the heat energy gained by the iron.

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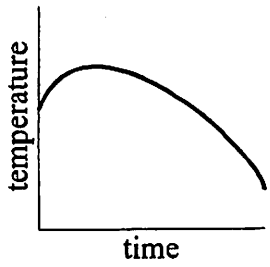
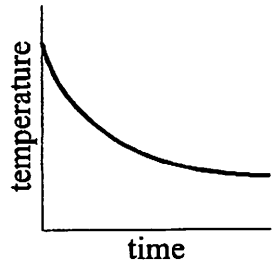
31. When a liquid freezes
(a) heat energy enters the liquid.
(b) heat energy leaves the liquid.
(c) the temperature of the liquid increases.
(d) the temperature of the liquid decreases.

32. Of the following temperature - time graphs, which best represents the graph of the temperature of a cup of boiling water allowed to sit at room temperature for a long time?

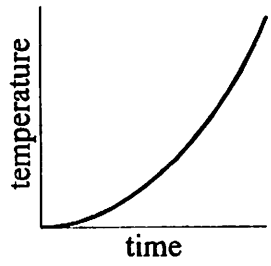
(a)



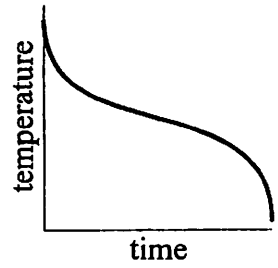
(c)



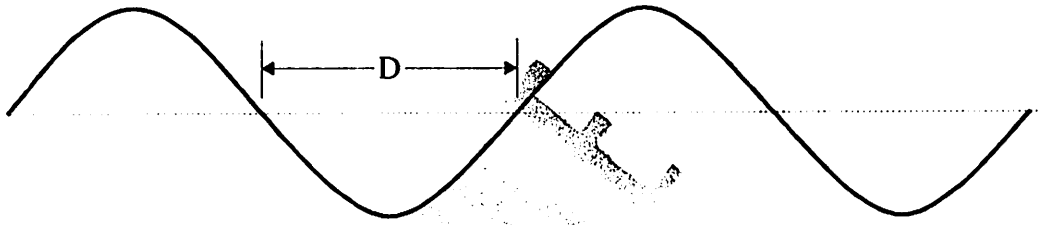
(b)



(d)



33. The diagram below shows a transverse wave moving to the right. What is the size of the distance marked "D" in the diagram?



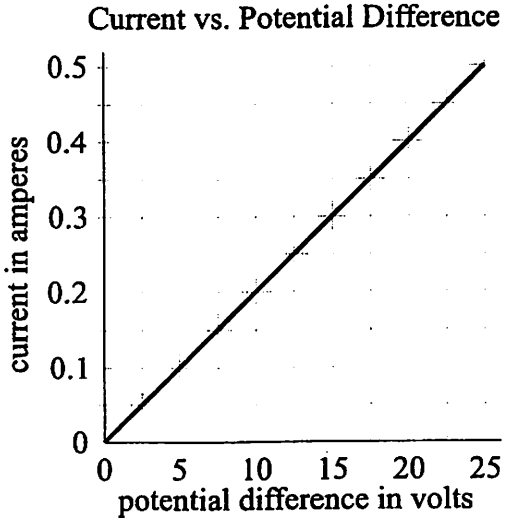
(a) one-fourth wavelength
(b) one-half wavelength
(c) one wavelength
(d) one amplitude

34. A sound wave has a frequency of 85 Hertz. If the sound is traveling at a speed of 340 meters per second, what is the wavelength of the sound wave?
(a) 0.25 meter
(b) 1.0 meter
(c) 2.0 meters
(d) 4.0 meters

35. A student is listening to a sound wave produced by a tuning fork. What will she hear if the amplitude of the wave is increased?
(a) The sound will become louder.
(b) The sound will become quieter.
(c) The pitch (note) of the sound will become higher.
(d) The pitch (note) of the sound will become lower.

36. A 12-volt battery is used to light a light bulb. If the current in the bulb is 3.0 amperes, how much power is being converted in the bulb?
(a) 0.25 watt
(b) 4.0 watts
(c) 15 watts
(d) 36 watts

37. A student measures the current in a piece of metal wire as he varies the potential difference (voltage) across the wire. A graph of his results is shown below. What is the resistance of this piece of wire?



(a) 0.020 ohm
(b) 0.080 ohm
(c) 12.5 ohms
(d) 50. ohms

38. Two resistors with resistances of 3.0 ohms and 12 ohms are connected in **series**. What is the combined (equivalent) resistance of this combination?
(a) 0.42 ohm
(b) 2.4 ohms
(c) 15 ohms
(d) 36 ohms

39. Two resistors with resistances of 3.0 ohms and 12 ohms are connected in **parallel**. What is the combined (equivalent) resistance of this combination?
(a) 0.42 ohm
(b) 2.4 ohms
(c) 15 ohms
(d) 36 ohms

40. Two wires are made of the same metal and are kept at the same temperature. One wire is thinner and longer than the other. Of the following statements about the resistances of the wires, which is correct?
(a) Both wires have the same resistance.
(b) The longer, thinner wire has a higher resistance than the shorter, thicker wire.
(c) The longer, thinner wire has a lower resistance than the shorter, thicker wire.
(d) Neither wire will have any resistance at all.