NATIONAL SCIENCE LEAGUE – 2015

JUNIOR HIGH PHYSICAL SCIENCE CONTEST

– ANSWER KEY –

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

1. Of the following, which would be correctly expressed in square meters (m^2)?
   (a) the length of a piece of wire
   (b) the mass of a book
   (c) the volume of milk in a drinking glass
   (d) the area of a floor tile

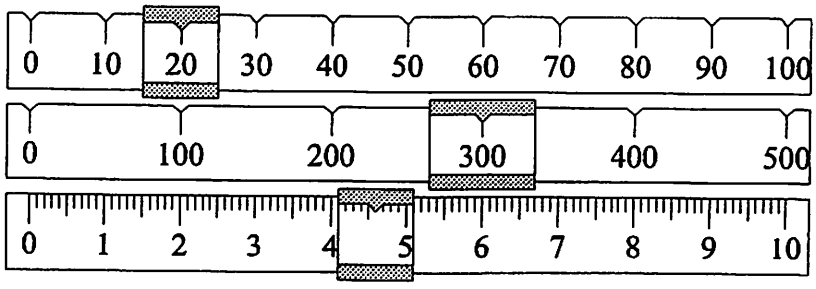
2. Of the following measuring instruments, which would be used to correctly measure the volume of water in a beaker?
   (a) a graduated cylinder
   (b) a meter stick
   (c) a thermometer
   (d) a triple-beam balance

3. What is the approximate mass of a small cat?
   (a) 1 milligram
   (b) 1 gram
   (c) 1 kilogram
   (d) 1000 kilograms

4. The mass of 50 identical nails is measured to be 122.5 grams. What is the mass of one nail?
   (a) 0.41 gram
   (b) 2.45 grams
   (c) 12.25 grams
   (d) 24.5 grams

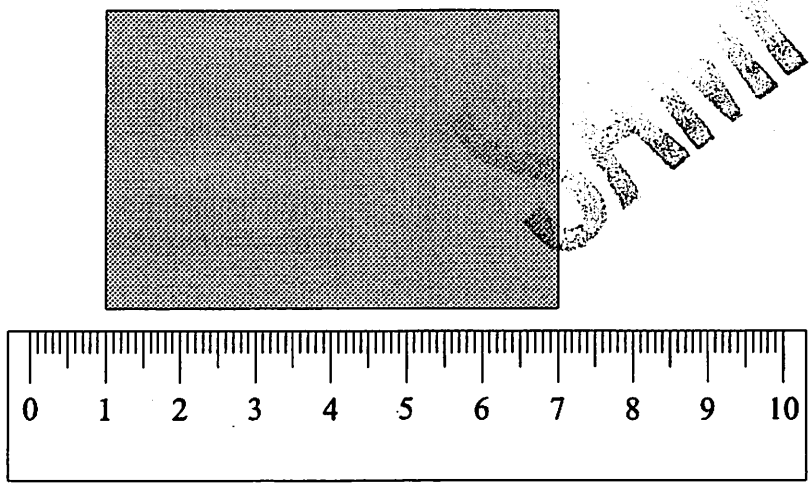
5. A can contains 355 milliliters of soda. What is this volume in liters?
   (a) 0.355 liter
   (b) 3.55 liters
   (c) 35.5 liters
   (d) 355,000 liters

6. The riders on the beams of a triple-beam balance are shown in the diagram below. What mass is the balance measuring?



   (a) 4.623 grams
   (b) 234.6 grams
   (c) 324.6 grams
   (d) 203004.6 grams

Use the full-size metric ruler in the diagram below to answer questions 7 and 8.



7. What is the width of the shaded rectangle?
   (a) 6.0 centimeters
   (b) 7.0 centimeters
   (c) 60. centimeters
   (d) 70. centimeters

8. What is the area of the shaded rectangle?
   (a) 0.24 square centimeter (cm^2)
   (b) 24 square centimeters (cm^2)
   (c) 240 square centimeters (cm^2)
   (d) 2400 square centimeters (cm^2)

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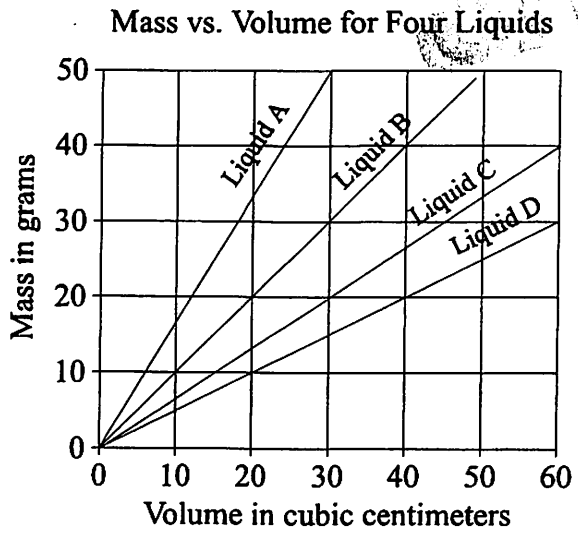
9. Students collected cans of food during a food drive. They collected 84 cans during the 6 day drive. What was the average rate of collection of cans?
   (a) 0.071 can per day
   (b) 14 cans per day
   (c) 90 cans per day
   (d) 504 cans per day

10. Of the following, which is an example of a **physical** change?
    (a) Salt water evaporates leaving solid salt crystals.
    (b) Gasoline burns in air.
    (c) Aluminum corrodes when exposed to air and water.
    (d) Starch is digested into sugar.

11. Of the following, which is an example of a **chemical** change?
    (a) Water is boiled to produce steam.
    (b) Iron rusts.
    (c) Sugar dissolves in water.
    (d) Chalk is ground into a fine powder.

Base your answers to questions 12 through 15 on the graph below which is a graph of the mass-volume relationships for four liquids.



12. Which liquid on the graph has the greatest density?
    (a) Liquid A
    (b) Liquid B
    (c) Liquid C
    (d) Liquid D

13. What is the density of Liquid D?
    (a) 0.5 gram per cubic centimeter
    (b) 2.0 grams per cubic centimeter
    (c) 30. gram per cubic centimeter
    (d) 60. gram per cubic centimeter

14. Which liquid on the graph is most likely water?
    (a) Liquid A
    (b) Liquid B
    (c) Liquid C
    (d) Liquid D

15. A certain material is placed in each liquid in turn. It sinks in some liquids and floats in others. Of the following statements about this material, which ***could*** be correct?
    (a) The material sinks in Liquid B and floats in Liquid C.
    (b) The material sinks in Liquid B and floats in Liquid D.
    (c) The material floats in Liquid B and sinks in Liquid A.
    (d) The material floats in Liquid B and sinks in Liquid C.

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16. Of the following, which is an example of a mixture?
    (a) salt water
    (b) water
    (c) gold
    (d) carbon dioxide

17. Of the following, which is an example of an element?
    (a) air
    (b) lemon juice
    (c) iron
    (d) table salt (NaCl)

18. Of the following, which is an example of a compound?
    (a) oxygen
    (b) milk
    (c) carbon
    (d) table sugar ($C_{12}H_{22}O_{11}$)

19. Of the following, which statement best describes the physical characteristics of a solid?
    (a) A solid has no definite shape and no definite volume.
    (b) A solid has a definite shape but no definite volume.
    (c) A solid has a definite volume but no definite shape.
    (d) A solid has a definite shape and a definite volume.

20. A student examines a rock collected from a field near her home. Of the following statements, which is an inference (interpretation)?
    (a) The rock is 4.3 centimeters along its longest length.
    (b) The rock has no odor.
    (c) The rock contains flecks of a silvery, shiny material.
    (d) The rock was deposited by a glacier during the last Ice Age.

21. A student observes a feather as it falls from the ceiling to the floor. Of the following statements, which is a direct observation?
    (a) The feather is a chicken feather.
    (b) The feather would fall faster if the room were warmer.
    (c) The feather would develop an odor if it were heated.
    (d) The feather is white.

22. A neutral atom of boron is composed of 5 protons, 6 neutrons and 5 electrons. What is the atomic number of boron?
    (a) 5
    (b) 6
    (c) 11
    (d) 16

23. A neutral atom of boron is composed of 5 protons, 6 neutrons and 5 electrons. What is the mass number (atomic weight) of boron?
    (a) 5
    (b) 6
    (c) 11
    (d) 16

24. Of the following atomic particles, which has a negative electrical charge?
(a) electron
(b) neutron
(c) proton
(d) alpha particle

25. A neutral atom of fluorine is composed of 9 protons, 10 neutrons and 9 electrons. This atom can gain one extra electron and become a fluoride ion. What would be the charge on the fluoride ion?
(a) -9
(b) -1
(c) +1
(d) +9

26. A neutral atom of potassium is composed of 19 protons, 20 neutrons, and 19 electrons. Of the following atomic structures, which represents an isotope of potassium?
(a) 21 protons, 21 neutrons, and 21 electrons
(b) 20 protons, 19 neutrons, and 20 electrons
(c) 19 protons, 21 neutrons, and 19 electrons
(d) 18 protons, 20 neutrons, and 18 electrons

27. The structures of four atoms or ions are listed below. Of the four, which has an overall positive charge?
(a) 17 protons, 16 neutrons, and 18 electrons
(b) 17 protons, 17 neutrons, and 17 electrons
(c) 17 protons, 18 neutrons, and 17 electrons
(d) 17 protons, 19 neutrons, and 16 electrons

28. How many atoms are there in each molecule of C_2H_5OH?
(a) 4
(b) 7
(c) 9
(d) 13

29. One molecule of sulfuric acid [H_2SO_4] and two molecules of ammonium hydroxide [NH_4OH] can combine to produce one molecule of ammonium sulfate [$(NH_4)_2SO_4$] and two molecules of another compound [X]. The balanced chemical equation is:

$$H_2SO_4 + 2\,NH_4OH \rightarrow (NH_4)_2SO_4 + 2\,X$$

What is the unknown compound X?
(a) H_2NH_4
(b) SO_4OH
(c) H_2O
(d) NH_4SO_4

30. A small rock taken from a refrigerator has a starting temperature of 10°C. It is placed in an insulated container of water that has a starting temperature of 60°C. Of the following statements about energy flow between the rock and the water, which is correct?
    (a) Energy will flow from the water to the rock until the temperatures are equal.
    (b) Energy will flow from the rock to the water until the temperatures are equal.
    (c) Energy will flow from the rock to the water until all of the water has boiled away.
    (d) No energy will flow between the rock and the water.

31. A student mixes 100 grams of water at a temperature of 10°C with 100 grams of water at a temperature of 50°C. What will be the final temperature of the mixture?
    (a) 10°C
    (b) 30°C
    (c) 40°C
    (d) 70°C

32. A student mixes 200 grams of water at a temperature of 10°C with 100 grams of water at a temperature of 50°C. What will be the final temperature of the mixture?
    (a) The final temperature will be 10°C.
    (b) The final temperature will be between 10°C and 30°C.
    (c) The final temperature will be between 30°C and 50°C.
    (d) The final temperature will be greater than 50°C.

33. A student places a 100 gram block of aluminum with a temperature of 10°C into an insulated container with 100 grams of water at a temperature of 50°C. What will be the final temperature of the block in the water?
    (a) The final temperature will be less than 10°C.
    (b) The final temperature will be between 10°C and 50°C.
    (c) The final temperature will be between 50°C and 60°C.
    (d) The final temperature will be 60°C.

34. Two plastic spheres, labeled Sphere A and Sphere B, are hanging from thin threads. Each is rubbed with a wool cloth. The spheres are now found to repel each other. Of the following statements about the static electric charge on the spheres, which is correct?
    (a) Sphere A must have a negative charge and Sphere B must have a positive charge.
    (b) Sphere A must have a positive charge and Sphere B must have a negative charge.
    (c) Sphere A and Sphere B must both be electrically neutral.
    (d) Sphere A and Sphere B must both have charge with the same sign.

35. A student combs her hair with a hard rubber comb. The comb is then found to have a negative static electric charge. Of the following statements, which correctly explains what has happened?
(a) The comb gains electrons from the hair.
(b) The comb loses electrons to the hair.
(c) The comb gains protons from the hair.
(d) The comb gains neutrons from the hair.

36. A student watches a small robot move on a classroom floor. From its starting position, the robot first walks 5.0 meters due east. It then turns and walks 8.0 meters due west. Of the following statements about the location of the robot, which is correct?
(a) The robot is 3.0 meters west of its original position.
(b) The robot is 3.0 meters east of its original position.
(c) The robot is 13 meters west of its original position.
(d) The robot is 13 meters east of its original position.

37. A student programs a small robot to move across a classroom floor. The robot first moves 5.0 meters in a straight line. It then moves 12 meters in a straight line. How far from its original position is the robot?
(a) The robot must be less than 7.0 meters from its original position.
(b) The robot must be 7.0 meters from its original position.
(c) The robot must be at least 7.0 meters but no more than 17 meters from its original position.
(d) The robot must be more than 17 meters from its original position.

38. A toy car moves in a straight line a distance of 16 meters in 4.0 seconds. What is the average speed of the car during the 4.0 seconds?
(a) 0.25 meter per second
(b) 4.0 meters per second
(c) 20. meters per second
(d) 64 meters per second

39. A student walks in a straight line at a constant speed of 2.0 meters per second. If he maintains this speed for 30. seconds, how far will he travel?
(a) 0.07 meter
(b) 15 meters
(c) 32 meters
(d) 60. meters

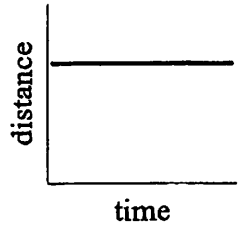
40. A student pulls a textbook across a level desktop at a steady speed in a straight line. She exerts a force of 5.0 newtons to do this. What is the force of friction between the textbook and the desktop?
(a) zero
(b) less than 5.0 newtons
(c) 5.0 newtons
(d) more than 5.0 newtons

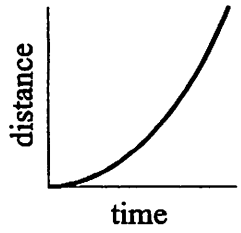
Base your answers to questions 41 through 43 on the following information.

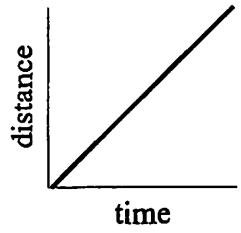
A ball is released at the top of a 6.0 meter long ramp made of a flat board tilted at an angle. The ball takes 4.0 seconds to get to the bottom giving it an average speed of 1.5 meters per second.

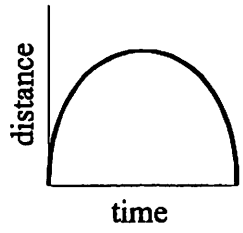
41. How fast is the ball traveling just as it reaches the bottom of the ramp?
(a) there is no way to tell
(b) less than 1.5 meters per second
(c) 1.5 meters per second
(d) more than 1.5 meters per second

42. Of the following **distance** versus **time** graphs, which best represents the motion of the ball?

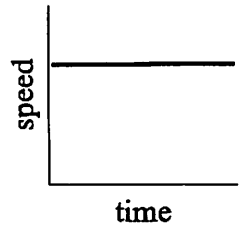
(a)


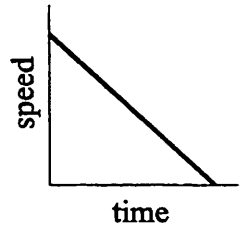
(c)


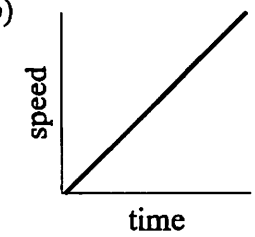
(b)


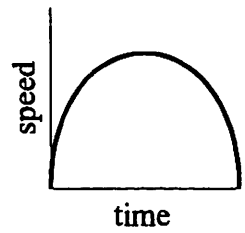
(d)


43. Of the following **speed** versus **time** graphs, which best represents the motion of the ball?

(a)


(c)


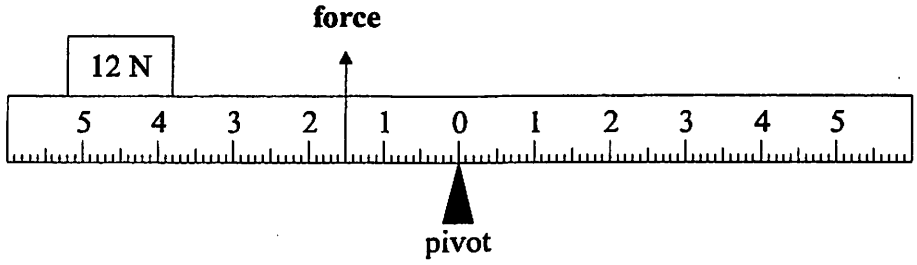
(b)


(d)


44. A student pulls a textbook across a level desktop at a steady speed in a straight line. He exerts a force of 5.0 newtons to do this. He repeats the experiment a second time with one exception. In the second experiment he puts a second textbook on top of the first. What force must he exert on the two textbooks to keep them moving at a steady speed in a straight line?
    (a) zero
    (b) less than 5.0 newtons
    (c) 5.0 newtons
    (d) more than 5.0 newtons

45. A man stands on a small stool. The man weighs 1000 newtons. Of the following statements about the force exerted by the stool on the man, which is correct?
    (a) The stool is exerting no force on the man.
    (b) The stool is exerting an upward force of 1000 newtons on the man.
    (c) The stool is exerting a downward force of 1000 newtons on the man.
    (d) The stool is exerting an upward force of more than 1000 newtons on the man.

46. The diagram below shows a lever. The center of a box weighing 12 newtons (N) is 4.5 meters from the pivot.

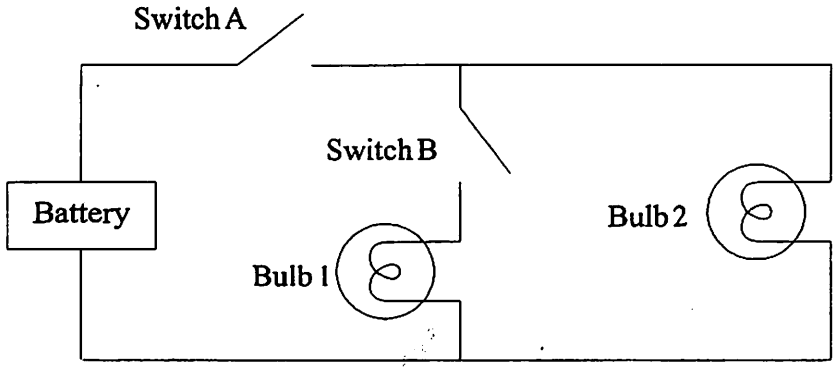


    What upward force must be exerted at a point 1.5 meters from the pivot, as shown above, in order to just support the box?
    (a) 4.0 newtons
    (b) 8.0 newtons
    (c) 12 newtons
    (d) 36 newtons

47. The four diagrams below show a magnetic compass placed between the poles of two permanent magnets. Which diagram is correct?

    (a) North ↑ South
    (b) North ↓ South
    (c) North → South
    (d) North ← South

Base your answers to questions 48 through 50 on the diagram below which shows a battery connected to two bulbs and two switches.



48. Which bulb(s) will be lit when both Switch A and Switch B are open (as shown)?
    (a) Neither Bulb 1 nor Bulb 2 will be lit.
    (b) Only Bulb 1 will be lit.
    (c) Only Bulb 2 will be lit.
    (d) Both Bulb 1 and Bulb 2 will be lit.

49. Which bulb(s) will be lit when Switch A is open and Switch B is closed?
    (a) Neither Bulb 1 nor Bulb 2 will be lit.
    (b) Only Bulb 1 will be lit.
    (c) Only Bulb 2 will be lit.
    (d) Both Bulb 1 and Bulb 2 will be lit.

50. Which bulb(s) will be lit when Switch A is closed and Switch B is open?
    (a) Neither Bulb 1 nor Bulb 2 will be lit.
    (b) Only Bulb 1 will be lit.
    (c) Only Bulb 2 will be lit.
    (d) Both Bulb 1 and Bulb 2 will be lit.