1. In addition to being an organized body of knowledge about nature, science is also a
   a. guide to improving human behavior.    c. study of nature’s rules.
   b. recipe for avoiding conflicts.         d. handbook for establishing truth.

2. Great advances in science occurred with the invention of
   a. paper.
   b. the printing press.
   c. devices of torture to encourage truth.
   d. religious ways of looking at things.

3. Which of these is a scientific hypothesis?
   a. Atoms in proper proportions make us feel good.
   b. Atoms are every star in the universe.
   c. An atom is the smallest bit of matter in a material.
   d. Distant galaxies have atoms not found on Earth.

4. Galileo said that if you rolled a ball along a level surface it would
   a. soon slow down due to its natural tendency to come to rest.
   b. keep rolling without slowing if no friction acted upon it.
   c. roll as long as its inertia nudged it along.
   d. soon roll in the opposite direction.

5. Nellie runs the length of a 100-yard football field in a time of 20 seconds. Her average running speed is
   a. 1/2 yard/s.
   b. 5 yards/s.
   c. 50 yards/s.
   d. no way to say.

6. The Earth moves about 30 km/s relative to the Sun. When you jump upward in front of a wall, the wall
   a. has too little gravity to influence you.
   b. moves in an opposite direction to you.
   c. and you are moving at the same horizontal speed, before, during, and after your jump.
   d. has negligible inertia compared with the Sun.

7. A motor scooter undergoes acceleration when it
   a. gains speed.
   b. decreases speed.
   c. changes direction.
   d. all of these.

8. The acceleration of a rain drop that falls at constant velocity
   a. is zero.
   b. is directed downward.
   c. decreases over time.
   d. increases over time.

9. If a falling object gains 10 m/s each second it falls, its acceleration is
   a. 10 m/s.
   b. 10 m/s².
   c. directed upward.
   d. steadily increasing.

10. A heavy rock and a light rock in free fall have the same acceleration. The reason the heavy rock does not
    have more acceleration is because
     a. the force of gravity on each is the same.
     b. there is no air resistance.
11. A fish is propelled in water directly by force provided by the
   a. fish itself.  c. water drag.
   b. water.  d. food the fish eats.

12. When you hold a heavy ball in your hand at rest, the forces on the ball
   a. are mainly those due to gravity.
   b. are mainly due to the upward push of your hand.
   c. don’t act unless the rock is dropped.
   d. cancel to zero.

13. Two identical carts have a compressed spring between them. When the spring is released, the carts recoil from
   each other with oppositely-directed accelerations that are
   a. almost equal.  c. unequal
   b. equal  d. zero

14. A grasshopper has a collision with the windshield of a massive high-speed truck. The force of impact on the grasshopper is
   a. less than the impact force on the truck.
   b. the same as the impact force on the truck.
   c. more than the impact force on the truck.
   d. actually zero.

15. A soccer ball is kicked to a 20-m/s speed. While being kicked, the amount of force exerted by the player’s
   foot on the ball is
   a. less than the amount of force on the foot.
   b. the same as the amount of force on the foot.
   c. more than the amount of force on the foot.
   d. none of these.

16. A lunar vehicle is tested on Earth at a speed of 10 km/h. When it travels at the same speed on the Moon, its
   momentum is
   a. the same.  c. more.
   b. less.  d. zero.

17. In hitting something, follow-through is important. This increases the impulse by increasing the
   a. time of contact.  c. momentum.
   b. force of contact.  d. change in momentum.

18. Which of the following equations most directly illustrates the safety value of automobile airbags?
   a. $F = ma$.  c. $d = 1/2 at^2$.
   b. $Ft = \Delta (mv)$.  d. $v = gt$.

19. When you try jumping from a rowboat to the dock, you may fall in the water because
   a. momentum is not always conserved.
   b. you’ll make the boat recoil and underestimate your jump.
   c. you’ll get less impulse.
   d. the boat is more massive than you.

20. A pair of spiral galaxies collide and merge to form one larger elliptical galaxy. Astronomers assume that the
   momentum of the new elliptical galaxy is
21. The kinetic theory of matter states that atoms and molecules are
   a. particles of all matter.
   b. always in random motion.
   c. what compose solids, liquids, and gases.
   d. always emitting energy of some form.

22. The temperature of absolute zero is
   a. 0°C.
   b. 273°C.
   c. 0 kelvin.
   d. -273 kelvin.

23. Hot sand cools off faster at night than plants and vegetation. This indicated that the specific heat capacity for sand is
   a. less than that of plants.
   b. more than that of plants.
   c. likely the same as that of plants.
   d. not enough information to answer.

24. When a liquid is changed to a gas, the liquid
   a. releases energy.
   b. absorbs energy.
   c. neither of the above.

25. When a gas turns to a liquid, the gas
   a. releases energy.
   b. absorbs energy.
   c. neither of the above.

26. When you brush a cat and scrape electrons from its fur, the charge of the cat’s fur becomes
   a. positive.
   b. negative.
   c. actually both of these.
   d. actually neither of these.

27. As a pair of charged particles are brought closer together, the force between them
   a. decreases.
   b. increases.
   c. increases only if the charges are of the same sign.
   d. increases only if the charges are of opposite signs.

28. To increase the electric potential energy of a charged object
   a. lift it higher against the force of gravity.
   b. let it fall to a lower gravitational potential energy.
   c. do work by pushing it against an electric force.
   d. release it in any electric field.

29. The amount of current in the battery that connects a circuit depends on the
   a. resistance in the circuit.
   b. charges present in the circuit.
   c. whether it is ac or dc.
   d. surrounding electric fields.

30. A 5-ohm resistor carries 5 amperes. The voltage across the resistor is
   a. zero.
   b. more than zero but less than 5 V.
   c. 5 V.
   d. more than 5 V.
31. To receive an electric shock there must be
   a. current in one direction.
   b. moisture in an electrical device being used.
   c. a difference in voltage across part or all of your body.
   d. electrical contact between your body and the floor.

32. The vibrations along a transverse wave move in a direction
   a. parallel to the wave direction.
   b. perpendicular to the wave direction.
   c. both of these.
   d. neither of these.

33. The number of different elements known to humankind is
   a. somewhat more than 100.
   b. somewhat more than 1000 or so.
   c. in the millions.
   d. in the millions of billions.

34. An element is a substance consisting of
   a. atoms of the same kind.
   b. atoms or molecules of the same kind.
   c. only protons.
   d. protons and electrons in balance.

35. The mass of an atom is mostly in its
   a. nucleus.
   b. electrons.
   c. protons.
   d. neutrons.

36. Protons in an atom attract
   a. other protons.
   b. neutrons.
   c. electrons.
   d. positive ions.

37. When an atom undergoes alpha or beta decay, it
   a. becomes an ion of the same element.
   b. becomes an isotope of the same element.
   c. turns into a completely different element.
   d. may or may not turn into a completely different element.

38. The half-life of uranium-238 is 4.5 billion years. Compared with the amount of uranium-238 in the Earth today, only half that amount will exist in
   a. less than 4.5 billion years.
   b. 4.5 billion years.
   c. more than 4.5 billion years.
   d. a time that even science experts can’t predict.

39. Carbon dating is best used for dating once-living things
   a. for all times.
   b. going back thousands but not millions of years.
   c. going back millions of years.
   d. that had brief lifetimes.

40. When energy is released by the process of fission, the total mass of the material after the event is
   a. less.
   b. the same.
   c. more.
   d. zero.

41. A group of nucleons has the greatest total mass when
   a. inside an iron nucleus.
   b. inside a uranium nucleus.
   c. outside any nucleus.
   d. formed into alpha particles.

42. Which would have the most kinetic energy?
43. If all of the above images represents the same material, which has the highest temperature?

a. A  
b. B  
c. C  
d. All have same temperature.  
e. temperature cannot be determined

44. Which of the following is an example of a physical change?

a. a candy bar being digested by a student  
b. charcoal being converted into ash  
c. water being electrolyzed and being converted into hydrogen and oxygen  
d. water boiling and being converted into steam  
e. iron metal reacting with oxygen to form rust

45. Which of the following is an example of a chemical change?

a. gasoline being used in the engine of a car producing exhaust  
b. water freezing into ice crystals  
c. aftershave or perfume on your skin generating a smell  
d. breaking a glass window  
e. a piece of metal expanding when heated, but returning to original size when cooled

46. Which of the following is not a chemical change?

a. grass growing  
b. a rock being crushed to powder  
c. a loaf of bread growing mold  
d. grape juice turning into wine  
e. wood burning to ash

47. Which of the following elements has six valence electrons?

a. Be  
b. N  
c. O  
d. C  
e. B

48. Which should be larger, the potassium atom, K, or the potassium ion, K⁺?

a. The potassium ion, K⁺ is larger since charging an atom always makes it larger.  
b. The potassium atom and the potassium ion are exactly the same size and only differ in charge.  
c. The potassium atom, K, with an additional shell of electrons is larger.  
d. The potassium ion, K⁺ is larger since it has an extra electron which increases its size.

49. If you filter sea water to remove all of the particles you would be left with a clear _____.
a. heterogeneous mixture called a solution  
b. heterogeneous mixture called a suspension  
c. pure liquid  
d. homogeneous mixture called a suspension  
e. homogenous mixture called a solution

50. Given the following generic chemical reaction, which is the product?

\[ X \rightarrow Y \]

a. \( \rightarrow \) is the product.  
d. Both X and Y are the products.  
b. Y is the product.  
e. Both X and Y are the reactants.  
c. X is the product.

51. Balance the following chemical equation.

\[ \_\_\_\_\_\_N_2 + \_\_\_\_\_\_H_2 \rightarrow \_\_\_\_\_\_NH_3 \]

a. 1, 3, 2  
d. 1, 2, 3  
b. 1/2, 3/2, 1  
e. 3, 2, 1  
c. 2, 6, 4

52. The reactants shown schematically below represent iron oxide, \( Fe_2O_3 \), and carbon monoxide, CO. Which of the following is the correct full balanced chemical equation for what is depicted?

\[ Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2 \]
\[ Fe_2O_3 + 3\ CO \rightarrow 3\ FeO + 2\ C \]
\[ Fe_2O_3 + 3\ CO \rightarrow 3\ FeO_2 + 2C \]

53. A refrigerator delays the spoilage of food by  
a. slowing down the rate of chemical reactions within microorganisms.  
b. expanding the water found within microorganisms.  
c. diminishing the supply of oxygen to microorganisms.  
d. killing microorganisms.

54. Some reactions are more sluggish than others. To speed up these reactions and save energy a(n) _____ is sometimes added.

a. reaction profile  
d. activator  
b. catalyst  
e. heat source  
c. exotherm

55. How many bonds between nitrogen and hydrogen are formed if you react nitrogen with hydrogen according to the following reaction?

\[ N_2 + 3H_2 \rightarrow 2\ NH_3 \]

a. 2  
d. 6  
b. 3  
e. 8
56. Is the synthesis of ozone, $O_3$, from oxygen, $O_2$, an example of an exothermic or endothermic reaction?
   a. exothermic because ultraviolet light is emitted during its formation
   b. exothermic because ultraviolet light is absorbed during its formation
   c. endothermic because ultraviolet light is absorbed during its formation
   d. endothermic because ultraviolet light is emitted during its formation

57. Entropy is the tendency of
   a. energy to disperse.
   b. matter to become neatly ordered.
   c. energy to become concentrated.
   d. matter to become all cluttered.

58. How do you make a proton out of a hydrogen atom?
   a. remove a proton from a helium nucleus
   b. let the hydrogen atoms undergo fusion
   c. let the hydrogen atoms combine to form a hydrogen molecule and eject an electron
   d. let the hydrogen atoms combine to form a hydrogen molecule and eject a proton
   e. remove an electron from a hydrogen atom

59. According to the following reaction, which molecule is acting as an acid?

$$H_2O + NH_3 \rightarrow OH^- + NH_4^+$$
   a. $H_2O$
   b. $NH_4^+$
   c. $OH^-$
   d. $NH_3$
   e. none of the above

60. Arrange the following images of an aqueous base solution in order of increasing base strength:

   a. C, B, A
   b. B, C, A
   c. A, B, C
   d. A, C, B
   e. All are equally strong.

61. Why do we use the pH scale to indicate the acidity of a solution rather than simply stating the concentration of hydronium ions?
   a. It is more accurate to use the pH scale.
   b. It includes the concentration of hydronium and hydroxide ions.
   c. It is used because the general public understands it.
   d. It is more convenient, since the concentration of hydronium ions is so small.

62. What happens to the pH of an acidic solution as water is added?
   a. The pH will decrease as the solution becomes more dilute.
   b. The pH is not influenced by the addition of water.
   c. The pH will decrease since more hydronium ions are produced from the water.
   d. The pH will increase as the solution becomes more dilute.
63. What is a reduction?
   a. the reaction of oxygen with a reductant
   b. the loss of an electron from the valence shell
   c. the reduction of the number of electrons
   d. the gain of electrons
   e. the formation of red compounds in the presence of an oxidant

64. Water is 88.88 percent oxygen by mass. Oxygen is exactly what a fire needs to grow brighter and stronger. So why doesn't a fire grow brighter and stronger when water is added to it?
   a. Oxygen in water is completely different from oxygen \( O_2 \), which is what is required for combustion.
   b. The oxygen is chemically bound to hydrogen atoms.
   c. Oxygen in water is already "reduced" from the hydrogen atoms, so this oxygen atom no longer has a great attraction for additional electrons.
   d. all of the above
MULTIPLE CHOICE

1. ANS: C  PTS: 1  DIF: 1  TOP: History of Science
2. ANS: B  PTS: 1  DIF: 1  TOP: History of Science
3. ANS: C  PTS: 1  DIF: 2  TOP: Scientific Hypotheses
4. ANS: B  PTS: 1  DIF: 1  TOP: Galileo and Inertia
5. ANS: C  PTS: 1  DIF: 1  TOP: Speed and Velocity
6. ANS: C  PTS: 1  DIF: 2  TOP: Earth Moves Around the Sun
7. ANS: D  PTS: 1  DIF: 1  TOP: Acceleration
8. ANS: A  PTS: 1  DIF: 1  TOP: Acceleration
9. ANS: B  PTS: 1  DIF: 1  TOP: Free Fall
10. ANS: D  PTS: 1  DIF: 2  TOP: Free Fall
11. ANS: B  PTS: 1  DIF: 2  TOP: Force and Interaction
12. ANS: D  PTS: 1  DIF: 1  TOP: Newton’s Third Law
13. ANS: B  PTS: 1  DIF: 1  TOP: Rule to Identify Action and Reaction
14. ANS: A  PTS: 1  DIF: 1  TOP: Action Equals Reaction
15. ANS: B  PTS: 1  DIF: 1  TOP: Momentum
16. ANS: A  PTS: 1  DIF: 1  TOP: Impulse and Momentum
17. ANS: A  PTS: 1  DIF: 2  TOP: Impulse and Momentum
18. ANS: B  PTS: 1  DIF: 1  TOP: Conservation of Momentum
19. ANS: B  PTS: 1  DIF: 2  TOP: Conservation of Momentum
20. ANS: A  PTS: 1  DIF: 1  TOP: Thermal Energy
21. ANS: B  PTS: 1  DIF: 1  TOP: Absolute Zero
22. ANS: C  PTS: 1  DIF: 1  TOP: Specific Heat Capacity
23. ANS: A  PTS: 1  DIF: 2  TOP: Energy and Change of Phase
24. ANS: B  PTS: 1  DIF: 1  TOP: Energy and Change of Phase
25. ANS: A  PTS: 1  DIF: 1  TOP: Electric Charge
26. ANS: B  PTS: 1  DIF: 1  TOP: Coulomb’s Law
27. ANS: C  PTS: 1  DIF: 1  TOP: Voltage
28. ANS: A  PTS: 1  DIF: 2  TOP: Ohm’s Law
29. ANS: D  PTS: 1  DIF: 2  TOP: Ohm’s Law
30. ANS: C  PTS: 1  DIF: 1  TOP: Electric Shock
31. ANS: B  PTS: 1  DIF: 1  TOP: Transverse and Longitudinal Waves
32. ANS: A  PTS: 1  DIF: 1  TOP: Discovering the Invisible Atom
33. ANS: A  PTS: 1  DIF: 1  TOP: Discovering the Invisible Atom
34. ANS: A  PTS: 1  DIF: 1  TOP: Atomic Nucleus Consists of Protons and Neutrons
35. ANS: C  PTS: 1  DIF: 1  TOP: Isotopes and Atomic Mass
36. ANS: C  PTS: 1  DIF: 1  TOP: Transmutation of the Elements
37. ANS: B  PTS: 1  DIF: 1  TOP: Radioactive Half-Life
39. ANS: B  PTS: 1  DIF: 2  TOP: Isotopic Dating
40. ANS: A  PTS: 1  DIF: 1  TOP: Nuclear Fission
41. ANS: C  PTS: 1  DIF: 1  TOP: Nuclear Fusion
42. ANS: E  PTS: 1  DIF: 2
   TOP: The Submicroscopic World Is Super-Small
43. ANS: B  PTS: 1  DIF: 2  TOP: The Phase of Matter Can Change
44. ANS: D  PTS: 1  DIF: 1  TOP: Matter Has Physical and Chemical Properties
45. ANS: A  PTS: 1  DIF: 1  TOP: Matter Has Physical and Chemical Properties
46. ANS: B  PTS: 1  DIF: 1  TOP: Determining Physical and Chemical Changes Can Be Difficult
47. ANS: C  PTS: 1  DIF: 1  TOP: Electron-Dot Structures Help Us to Understand Bonding
48. ANS: C  PTS: 1  DIF: 1  TOP: Atoms Can Lose or Gain Electrons to Become Ions
49. ANS: E  PTS: 1  DIF: 2  TOP: The Chemist’s Classification of Matter
50. ANS: B  PTS: 1  DIF: 1  TOP: Chemical Reactions Are Represented By Chemical Equations
51. ANS: A  PTS: 1  DIF: 2  TOP: Chemical Reactions Are Represented By Chemical Equations
52. ANS: A  PTS: 1  DIF: 2  TOP: Chemical Reactions Are Represented By Chemical Equations
53. ANS: A  PTS: 1  DIF: 1  TOP: Chemical Reactions Can Be Slow or Fast
54. ANS: B  PTS: 1  DIF: 1  TOP: Catalysts Speed Up Chemical Reactions
55. ANS: D  PTS: 1  DIF: 1  TOP: Chemical Reactions Can Be Either Exothermic or Endothermic
56. ANS: C  PTS: 1  DIF: 1  TOP: Chemical Reactions Can Be Either Exothermic or Endothermic
57. ANS: A  PTS: 1  DIF: 1  TOP: Chemical Reactions Are Driven By Entropy
58. ANS: E  PTS: 1  DIF: 1  TOP: Acids Donate and Bases Accept Hydrogen Ions
59. ANS: A  PTS: 1  DIF: 1  TOP: Acids Donate and Bases Accept Hydrogen Ions
60. ANS: C  PTS: 1  DIF: 3  TOP: Some Acids and Bases Are Stronger Than Others
61. ANS: D  PTS: 1  DIF: 1  TOP: Solutions Can Be Acidic, Basic, or Neutral
62. ANS: D  PTS: 1  DIF: 2  TOP: Solutions Can Be Acidic, Basic, or Neutral
63. ANS: D  PTS: 1  DIF: 1  TOP: Oxidation Is the Loss of Electrons and Reduction Is the Gain of Electrons
64. ANS: D  PTS: 1  DIF: 2  TOP: Oxygen Is Responsible for Corrosion and Combustion