1. What is a scientific theory?
A) It is a collection of experimental data.
B) It is an assertion of scientific fact.
C) It is a guess or conjecture about natural phenomena.
D) It is a fundamental relationship of nature.
E) It is an explanation of natural phenomena that has undergone significant testing.
ANS: E

2. An untested explanation of a series of experimental observations is called _______.
A) a hypothesis
B) a theory
C) a law
D) an experiment
E) the scientific method
ANS: A

3. Which of the following statements concerning experiment and explanation is/are true?

1. A law is always given in the form of a mathematical expression.
2. Once a hypothesis passes one or two tests it is considered a theory.
3. Observation is a key component of the scientific method.

A) 1 only
B) 2 only
C) 3 only
D) 1 and 2
E) 1, 2, and 3
ANS: C

4. A saline solution similar to that used for intravenous drips is made by dissolving 0.45 g sodium chloride in 50.00 g water. Which of the following statements concerning the saline solution and the law of conservation of mass is/are correct?

1. The mass of the saline solution is greater than the mass of water.
2. The mass of the saline solution is equal to the combined mass of sodium chloride and water.
3. The mass of the saline solution is greater than the mass of the sodium chloride.

A) 1 only
B) 2 only
C) 3 only
D) 1 and 2
E) 1, 2, and 3
ANS: D

5. A sample of silicon is burned in oxygen to form silicon dioxide. What mass of oxygen is consumed if 57.76 g silicon dioxide is formed from 27.00 g silicon?

A) 30.76 g
B) 84.76 g
C) 1559.59 g
D) 0.47 g
E) none of the above.
ANS: A
6. In a certain chemical reaction, 7.29 g of compound A is added to 5.70 g of compound B. Once the reaction is complete, 3.60 g of compound A and 1.17 g of compound B remain. What mass of products was produced?
   A) 17.76 g  
   B) 4.53 g  
   C) 8.22 g  
   D) 3.69 g  
   E) 4.77 g  
   ANS:  C

7. Sodium oxide reacts with water to produce sodium hydroxide. Suppose 18.6 g of sodium oxide is combined with 33.7 g of water. When the reaction is complete, all the sodium oxide has been consumed. According to the law of conservation of mass, which is a true statement?
   A) The mass of sodium hydroxide produced must equal 52.3 g.  
   B) The mass of unreacted water must equal 15.1 g.  
   C) The mass of sodium hydroxide produced must equal 18.6 g.  
   D) The mass of water consumed must equal 18.6 g.  
   E) The mass of sodium hydroxide produced plus the mass of unreacted water must equal 52.3 g.  
   ANS:  E

8. The state of matter for an object that has both definite volume and definite shape is the
   A) gaseous state.  
   B) solid state.  
   C) mixed state.  
   D) elemental state.  
   E) liquid state.  
   ANS:  B

9. The state of matter for an object that has a definite volume but not a definite shape is the
   A) elemental state.  
   B) gaseous state.  
   C) mixed state.  
   D) liquid state.  
   E) solid state.  
   ANS:  D

10. Two types of pure substances are
    A) compounds and heterogeneous solutions.  
    B) compounds and elements.  
    C) elements and homogeneous solutions.  
    D) compounds and homogeneous solutions.  
    E) elements and heterogeneous solutions.  
    ANS:  B

11. A sample that cannot be separated into two or more substances by physical means is
    A) a heterogeneous mixture.  
    B) a compound.  
    C) either a compound or an element.  
    D) an element.  
    E) a homogeneous mixture.  
    ANS:  C
12. All of the following are homogeneous mixtures except
A) sodium chloride and potassium chloride.
B) hydrogen gas and chlorine gas.
C) sodium chloride and potassium chloride solution.
D) mercury-zinc solution.
E) hydrochloric acid solution.
ANS: A

13. Which of the following is a homogeneous mixture?
A) gasoline
B) vegetable oil and water
C) sugar dissolved in water
D) A and C
E) A, B, and C
ANS: D

14. All the following are examples of chemical changes except
A) aging.
B) photosynthesis.
C) fermentation.
D) perspiration.
E) respiration.
ANS: D

15. Which of the following is an example of a chemical change?
A) alcohol evaporating
B) water boiling
C) skin burning in the sun
D) iodine vaporizing
E) ice melting
ANS: C

16. Which of the following is a chemical property of tin?
A) It is easily malleable.
B) It melts at 232°C.
C) It conducts electricity.
D) Its density is 7.31 g/cm³.
E) It dissolves in certain acids.
ANS: E

17. All the following are characteristic properties of phosphorus. Which one is a chemical property?
A) When exposed to air, white phosphorus will burn spontaneously, but red phosphorus will not.
B) Red phosphorus and white phosphorus are solid allotrope forms.
C) The white form is soluble in liquid carbon disulfide but is insoluble in water.
D) The red form of phosphorus is insoluble in both water and carbon disulfide.
E) The red form melts at about 600°C, and the white form melts at 44°C.
ANS: A

18. Which of the following statements concerning accuracy and precision is/are correct?

1. It is possible for a series of measurements to be both precise and inaccurate.
2. Accuracy is a measure of how close multiple measurements are to each other.
3. The more significant figures in a measurement the more accurate the measurement.

A) 1 only
B) 2 only
C) 1 and 2
D) 2 and 3
E) 1, 2, and 3

ANS: A

19. Two students determined the volume of a glass container three separate times (see table below). The true volume of the container is 24.20 mL. Which statement correctly describes the students’ results?

<table>
<thead>
<tr>
<th>Student A</th>
<th>Student B</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.3 mL</td>
<td>24.89 mL</td>
</tr>
<tr>
<td>24.4 mL</td>
<td>24.87 mL</td>
</tr>
<tr>
<td>24.5 mL</td>
<td>24.88 mL</td>
</tr>
</tbody>
</table>

A) Student A’s results are the most accurate. Student B’s results are the most precise.
B) Student A’s results are the most accurate and precise.
C) Student B’s results are the most accurate and precise.
D) Student A’s results are the most precise. Student B’s results are the most accurate.
E) The precision and accuracy of the two data sets are identical.

ANS: A

20. The number of significant figures in $1.9124 \times 10^{-1}$ dm is

A) 5.
B) 6.
C) 3.
D) 7.
E) 4.

ANS: A

21. How many significant figures are there in the value 0.0863 m?

A) 4
B) 3
C) 2
D) 5
E) 6

ANS: B

22. How many significant figures are there in the number 8.400?

A) 1
B) 5
C) 3
D) 4
E) 2

ANS: D

23. How many significant figures are there in the number 0.04560700?

A) 4
B) 9
C) 8
24. Express the number 0.000460 in scientific notation.
   A) \(0.460 \times 10^{-3}\)
   B) \(4.60 \times 10^{-4}\)
   C) \(4.60 \times 10^{-2}\)
   D) \(4.60 \times 10^{-4}\)
   E) \(460 \times 10^{-6}\)
   ANS: D

25. What is the best answer to the following expression?
   \((55.78 \text{ cm} + 0.829 \text{ cm} + 4.6666 \text{ cm} - 52.4 \text{ cm})\)
   A) 9 cm
   B) 8.8756 cm
   C) 8.876 cm
   D) 8.88 cm
   E) 8.9 cm
   ANS: E

26. How many significant figures should be reported for the difference between 235.6708 mL and 235.57 mL?
   A) 7
   B) 1
   C) 2
   D) 3
   E) 5
   ANS: C

27. What is the best answer to the following expression involving a sum of measurements?
   \((85.430 \text{ cm} + 0.400 \text{ cm} + 31.3 \text{ cm})\)
   A) 117 cm
   B) 117.1300 cm
   C) 117.13 cm
   D) 117.130 cm
   E) 117.1 cm
   ANS: E

28. What is the correct answer to the following expression?
   \(5.45 \times 10^{-10} + 5.74 \times 10^{-12}\)
   A) \(5.5074 \times 10^{-10}\)
   B) \(5.507 \times 10^{-10}\)
   C) \(6 \times 10^{-10}\)
   D) \(5.5 \times 10^{-10}\)
   E) \(5.51 \times 10^{-10}\)
   ANS: E
29. Four samples were weighed using three different balances. (All are as accurate as the precision indicates.) The masses are 0.94 kg, 58.2 g, 1.55 g, and 250 mg. The total mass should be reported as
A) 1.000 kg.
B) 1.0000 kg.
C) 1.00 kg.
D) 1.00000 kg.
E) 1.0 kg.
ANS: C

30. The mass of 59 kg equals
A) 590 g.
B) 5900 g.
C) $5.9 \times 10^4$ g.
D) 0.059 g.
E) 0.59 g.
ANS: C

31. The boiling point of chlorine is 172 K. This temperature corresponds to
A) $-82^\circ$C.
B) 101$^\circ$C.
C) 172$^\circ$C.
D) $-172^\circ$C.
E) $-101^\circ$C.
ANS: E

32. The melting point of nitrogen is 63 K. What is this temperature in degrees Celsius?
A) 63°C
B) $-336^\circ$C
C) $-63^\circ$C
D) $-210^\circ$C
E) 483°C
ANS: D

33. The melting point of a solid is 39°F. This corresponds to
A) 295 K.
B) 312 K.
C) 286 K.
D) 277 K.
E) 312 K.
ANS: D

34. A particular liquid boils at $-287^\circ$F. What is its boiling point on the Kelvin scale?
A) 131 K
B) 114 K
C) 96 K
D) 146 K
E) 214 K
ANS: C

35. The melting point of a certain solid is $-25^\circ$C. This corresponds to
A) 13°F.
B) $-32^\circ$F.
C) $-13^\circ$F.
D) $-103^\circ$F.
E) 18°F.
ANS: C

36. The melting point of a particular solid is 2923 K. This corresponds to
A) 4802°F.
B) 3196°C.
C) 2589°C.
D) 4738°F.
E) 1504°F.
ANS: A

37. A piece of metal (mass = 17.676 g) is placed in 11.00 mL of chloroform ($d = 1.498$ g/mL) in a 
25-mL graduated cylinder. The chloroform level increases to 15.46 mL. The best value for density of 
this metal from these data is
A) 1.14 g/mL.
B) 2.65 g/mL.
C) 3.963 g/mL.
D) 5.94 g/mL.
E) 3.96 g/mL.
ANS: E

Review/Chapter 2

1. Which of the following lists gives the atomic symbols for potassium, magnesium, beryllium, and 
sodium?
A) Po, Mn, Br, Na
B) P, Mn, Be, Se
C) K, Mg, Be, Na
D) Pt, Mg, Be, Sc
E) K, Mn, Br, Na
ANS: C

2. The names of the elements whose symbols are Si, P, Mn, and S are, respectively,
A) silicon, phosphorus, manganese, and sulfur.
B) silicon, potassium, magnesium, and sulfur.
C) silver, phosphorus, magnesium, and sodium.
D) silver, potassium, manganese, and sodium.
E) silicon, potassium, manganese, and sulfur.
ANS: A

3. Which of the following is the atomic symbol for the element cobalt?
A) CO
B) Co
C) C
D) co
E) All of the above
ANS: B

4. According to the law of multiple proportions:
A) the total mass is the same after a chemical change as before the change.
B) it is not possible for the same two elements to form more than one compound.
C) the ratio of the masses of the elements in a compound is always the same.
D) if the same two elements form two different compounds, they do so in the same ratio.
E) none of these
ANS: E
5. Which of the following pairs of compounds can be used to illustrate the law of multiple proportions?
   A) H₂O and HCl
   B) NO and NO₂
   C) NH₃ and NH₄Cl
   D) ZnO₂ and ZnCl₂
   E) CH₄ and CO₂
   ANS: B

6. The nucleus of a ²⁰⁸Pb nuclide contains
   A) 208 neutrons and 290 electrons.
   B) 82 protons and 208 neutrons.
   C) 208 protons and 126 electrons.
   D) 208 protons, 82 neutrons, and 208 electrons.
   E) 82 protons and 126 neutrons.
   ANS: E

7. If two different nuclides have the same atomic number, it must mean that
   A) they have the same atomic mass.
   B) they have the same mass number.
   C) they have the same number of protons.
   D) they have the same number of electrons.
   E) they have the same number of neutrons.
   ANS: C

8. The number of protons in a given nucleus determines the
   A) mass number.
   B) atomic number.
   C) number of electrons.
   D) number of protons.
   E) number of isotopes.
   ANS: C

9. Which nuclide has the same number of protons as ¹⁴N?
   A) ¹⁹F
   B) ¹⁵O
   C) ¹²C
   D) ³¹P
   E) ¹⁵N
   ANS: E

10. How many electrons does the ion ¹⁷Cl⁻ have?
    A) 18
    B) 36
    C) 16
    D) 34
11. How many protons are there in the chromium-52 nuclide?
A) 29  
B) 76  
C) 23  
D) 24  
E) 28
ANS: D

12. How many neutrons are there in the cobalt-59 nuclide?
A) 27  
B) 2  
C) 86  
D) 59  
E) 32
ANS: E

13. An atom that has the same number of neutrons as \( ^{59} \text{Ni} \) is
A) \( ^{38} \text{Zn} \).  
B) \( ^{57} \text{Fe} \).  
C) \( ^{57} \text{Cr} \).  
D) \( ^{58} \text{Mn} \).  
E) \( ^{59} \text{Co} \).
ANS: B

14. Which combination of protons, neutrons, and electrons correctly represents a \( ^{56} \text{Fe} \) nuclide?
A) 26 protons, 30 neutrons, 56 electrons  
B) 26 protons, 30 neutrons, 30 electrons  
C) 26 protons, 30 neutrons, 26 electrons  
D) 56 protons, 26 neutrons, 56 electrons  
E) 56 protons, 26 neutrons, 26 electrons
ANS: C

15. The species that has the same number of neutrons as \( ^{37} \text{Cl} \) is
A) \( ^{36} \text{S} \).  
B) \( ^{35} \text{Cl} \).  
C) \( ^{40} \text{Ar} \).  
D) \( ^{32} \text{S} \).  
E) \( ^{31} \text{P} \).
ANS: A

16. Which of the following nuclides contains more protons than neutrons?
A) \( ^{1} \text{H} \)
B) \( ^{19}_{9} \text{F} \)  
C) \( ^{34}_{16} \text{S} \)  
D) \( ^{24}_{12} \text{Mg} \)  
E) \( ^{4}_{2} \text{He} \)

ANS: A

17. How many neutrons are there in 6 molecules of \( ^{33}_{16} \text{S}_2 \)?  
A) 204  
B) 102  
C) 6  
D) 396  
E) 192  
ANS: A

18. Suppose atom 1 has the same number of protons as atom 2, and atom 2 has the same number of neutrons as atom 3. Atom 1 does not have the same number of neutrons as atom 3. Which of the following statements is true?  
A) Atom 3 must have the same number of protons as atom 2.  
B) Atoms 1 and 2 must be isotopes.  
C) Atoms 1 and 3 must be isotopes.  
D) Atom 2 must have the same number of neutrons as atom 1.  
E) Atom 3 must have the same number of protons as atom 1.  
ANS: B

19. Which of the following statements is true concerning the two nuclides \( ^{3}_{1} \text{He} \) and \( ^{4}_{1} \text{He} \)?  
A) They have the same number of neutrons.  
B) They are isotopes.  
C) They have the same relative atomic mass.  
D) They have the same mass number.  
E) They have different chemical properties.  
ANS: B

20. Which of the following represents a pair of isotopes?  

<table>
<thead>
<tr>
<th>Atomic Number</th>
<th>Mass Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) I 17</td>
<td>36</td>
</tr>
<tr>
<td>II 18</td>
<td>36</td>
</tr>
<tr>
<td>B) I 7</td>
<td>15</td>
</tr>
<tr>
<td>II 8</td>
<td>15</td>
</tr>
<tr>
<td>C) I 17</td>
<td>35</td>
</tr>
<tr>
<td>II 17</td>
<td>37</td>
</tr>
<tr>
<td>D) I 17</td>
<td>37</td>
</tr>
<tr>
<td>II 18</td>
<td>38</td>
</tr>
<tr>
<td>E) I 7</td>
<td>16</td>
</tr>
<tr>
<td>II 8</td>
<td>17</td>
</tr>
</tbody>
</table>

ANS: C

21. There are three isotopes of carbon differing with respect to  
A) electron configuration.  
B) nuclear charge.
C) number of neutrons.
D) number of protons.
E) atomic number.
ANS: C

22. Which of the following about the isotopes of a particular element is not true?
A) Each unique isotope has a different atomic mass.
B) Each unique isotope has a different atomic number.
C) Each unique isotope has a different number of neutrons.
D) Each unique isotope has the same number of protons.
E) In neutral atoms of each unique isotope, the number of electrons equals the number of protons.
ANS: B

23. The neutral atoms of all the isotopes of the same element have
A) different numbers of protons.
B) the same number of neutrons.
C) the same number of electrons.
D) the same mass.
E) the same mass number.
ANS: C

24. The elements in a row of the periodic table are known as
A) metals.
B) a period.
C) metalloids.
D) a family.
E) a group.
ANS: B

26. Which of the following statements about different elements is incorrect?
A) Potassium is an alkali metal.
B) Fluorine is a halogen.
C) Aluminum is a transition element.
D) Barium is an alkaline earth metal.
E) Helium is a noble gas.
ANS: C

27. Which element belongs to the transition metals?
A) palladium
B) sodium
C) calcium
D) iodine
E) helium
ANS: A

28. Which of the following statements about different elements is/are true?

1. As is a metalloid and Se is a nonmetal.
2. Cu is a transition element and Ge is a metalloid.
3. Both F and I are halogens.
A) 1 only
B) 2 only
29. Which of the following is a metalloid?
A) oxygen
B) hydrogen
C) silicon
D) carbon
E) copper
ANS: C

30. An ion is formed
A) by either adding electrons to or subtracting electrons from the atom.
B) by either adding protons to or subtracting protons from the atom.
C) by either adding neutrons to or subtracting neutrons from the atom.
D) All of the above are true.
E) Two of the above are true.
ANS: A

31. The species Au\(^+\), Mg\(^{2+}\), and V\(^{3+}\) are all
A) anions.
B) isotopes.
C) isoelectronic.
D) allotropes.
E) cations.
ANS: E

32. The species that is formed when a molecule gains or loses an electron is called
A) an ion.
B) a metalloid.
C) an isotope.
D) an atom.
E) a metal.
ANS: A

33. Which of the following statements is true about one formula unit of SrBr\(_2\)?
A) It is composed of one Sr atom and one Br\(_2\) molecule.
B) It is composed of one Sr atom and two Br atoms.
C) It is composed of one Sr\(^{2+}\) ion and one Br\(_2\)\(^{2-}\) ion.
D) It is composed of one SrBr\(_2\) molecule.
E) It is composed of one Sr\(^{2+}\) ion and two Br\(^{-}\) ions.
ANS: E

34. Chemical reactions between nonmetals and nonmetals primarily involve
A) sharing of electrons.
B) interactions between protons.
C) transfer of electrons.
D) interactions among protons, electrons, and neutrons.
E) interactions between protons and electrons.
ANS: A

35. Which statement is incorrect concerning the formation of ionic compounds?
A) Halogens tend to form anions with a charge of \(-1\).
B) Alkali metals tend to form cations with a charge of \(+1\).
C) Metals tend to form cations, while nonmetals tend to form anions.
D) Transition metals tend to form cations with a charge of +3.
E) Noble gases tend not to form ionic compounds.

ANS: D

36. When the equation

\[ \underline{\text{C}_3\text{H}_7\text{N}_2\text{OS}}(s) + \underline{\text{O}_2(g)} \rightarrow \underline{\text{CO}_2(g)} + \underline{\text{H}_2\text{O(l)}} + \underline{\text{N}_2(g)} + \underline{\text{SO}_2(g)} \]

is balanced, the sum of all the coefficients (simplest whole number) is

A) 19.
B) 20.
C) 24.
D) 18.
E) 21.

ANS: D