

**ANSWERS ARE IN RED**

1. Copper has two naturally occurring isotopes,  $^{63}\text{Cu}$  (isotopic mass = 62.9296 amu) and  $^{65}\text{Cu}$  (isotopic mass = 64.9278 amu). Copper has an atomic mass of 63.546 amu. What is the percent abundance of copper-63?

- (A) 30.85 %
- (B) 99.03 %
- (C) 69.15 %
- (D) 62.93 %
- (E) 14.46 %

2. Select the answer that expresses the result of this calculation with the correct number of significant figures.

$$\frac{15.785 \times 2.75 \times 1.01}{3.7 \times 1.2702}$$

- (A) 9
- (B) 9.3
- (C) 9.33
- (D) 9.329
- (E) 9.3288

3. A scientist must determine the density of a mineral sample. His four trials yield densities of  $4.77 \text{ g/cm}^3$ ,  $4.69 \text{ g/cm}^3$ ,  $4.67 \text{ g/cm}^3$ , and  $4.81 \text{ g/cm}^3$ . Independent studies found the correct density to be  $4.75 \text{ g/cm}^3$ . Which of the following statements represents the best analysis of the data?

- (A) The scientist's results have much greater precision than accuracy.
- (B) The scientist's results have much greater accuracy than precision.
- (C) The scientist's results have high accuracy and high precision.
- (D) The scientist's results have low accuracy and low precision.

4. A flask has a mass of 65.40 g when empty and 586.63 g when filled with water. When the same flask is filled with concentrated sulfuric acid,  $\text{H}_2\text{SO}_4$ , its mass is 1023.74 g. What is the density of concentrated sulfuric acid? (Assume that water has a density of  $1.00 \text{ g/cm}^3$  at the temperature of the measurement.)

- (A)  $1.523 \text{ g/cm}^3$
- (B)  $0.543 \text{ g/cm}^3$
- (C)  $1.992 \text{ g/cm}^3$
- (D)  $1.635 \text{ g/cm}^3$
- (E)  $1.840 \text{ g/cm}^3$

5. Atoms Q, X, Y and Z have the following nuclear compositions:



Which two are isotopes?

- (A) Y & Z
- (B) Q & Y
- (C) Q & X
- (D) X & Z
- (E) Q & Z

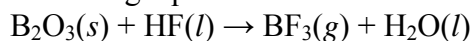
6. A sample of argon gas is confined to an 12.3 L container at 0.365 atm and 34.7°C. How many moles of argon are in the container? ( $R = 8.2058 \times 10^{-2} \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$ )

- (A) 0.179 mol
- (B) 0.0624 mol
- (C) 1.58 mol
- (D) 0.634 mol
- (E) 5.62 mol

7. Glucose has the molecular formula  $\text{C}_6\text{H}_{12}\text{O}_6$ . What is the percent of carbon in sucrose by mass?

- (A) 25.0%
- (B) 6.70 %
- (C) 40.0 %
- (D) 60.0 %
- (E) 53.3 %

8. Balance the following equation:



- (A)  $\text{B}_2\text{O}_3(s) + 6\text{HF}(l) \rightarrow 2\text{BF}_3(g) + 3\text{H}_2\text{O}(l)$
- (B)  $\text{B}_2\text{O}_3(s) + \text{H}_6\text{F}_6(l) \rightarrow \text{B}_2\text{F}_6(g) + \text{H}_6\text{O}_3(l)$
- (C)  $\text{B}_2\text{O}_3(s) + 2\text{HF}(l) \rightarrow 2\text{BF}_3(g) + \text{H}_2\text{O}(l)$
- (D)  $\text{B}_2\text{O}_3(s) + 3\text{HF}(l) \rightarrow 2\text{BF}_3(g) + 3\text{H}_2\text{O}(l)$
- (E)  $\text{B}_2\text{O}_3(s) + 6\text{HF}(l) \rightarrow 2\text{BF}_3(g) + 6\text{H}_2\text{O}(l)$

9. The chemical equation  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$  informs us that
- (A)  $\text{NH}_3$  is formed, but the relative amounts of  $\text{N}_2$ ,  $\text{H}_2$  and  $\text{NH}_3$  involved in the reaction are a function of reaction conditions.
  - (B) only under special conditions will 1 mole of  $\text{N}_2$  and 3 moles of  $\text{H}_2$  yield 2 moles of  $\text{NH}_3$ .
  - (C) the tendency of  $\text{N}_2$  and  $\text{H}_2$  to combine is equal to the tendency of  $\text{NH}_3$  to decompose.
  - (D) regardless of conditions, 1 mole of  $\text{NH}_3$  is formed by the combination of 1/2 mole of  $\text{N}_2$  and 3/2 mole of  $\text{H}_2$ .
  - (E) less than 2 moles of  $\text{NH}_3$  will form from the combination of 1 mole of  $\text{N}_2$  and 3 moles of  $\text{H}_2$ .
10. Which of the following elements are the least reactive?
- (A) alkaline earth metals
  - (B) halogens
  - (C) alkali metals
  - (D) noble gases
  - (E) metalloids
11. An enclosed mixture has a mass of  $7.50396 \pm 0.00002$  g, and after a chemical change occurs the mixture has a mass of  $7.50397 \pm 0.00002$  g. These results show that
- (A) the law of conservation of matter is not always true.
  - (B) the mass of the enclosed mixture remains constant within the experimental error of the measurement.
  - (C) the mass of the enclosed mixture increased.
  - (D) the mass of the enclosed mixture does not change
  - (E) the law of conservation of mass is not always true.
12. What mass of nitrogen gas occupies 26.4 L at 448 °C and 1.80 atm?  
( $R = 8.2058 \times 10^{-2}$  L·atm/mol·K)
- (A) 22.5 g
  - (B) 0.0287 g
  - (C) 36.2 g
  - (D) 11.2 g
  - (E) 0.0462 g
13. All neutral atoms of iron have 26 protons and 26 electrons.
- (A) True
  - (B) False

14. Which of the following compounds is ionic?

- (A) HBr
- (B)  $\text{Cs}_2\text{S}$
- (C)  $\text{CS}_2$
- (D)  $\text{CO}_2$
- (E)  $\text{SF}_4$

15. Which of the following properties of oxygen gas is not an intensive property?

- (A) Temperature
- (B) Density
- (C) The number of molecules present
- (D) The average speed of a molecule in the sample
- (E) All of the above are intensive properties

16. The appropriate number of significant figures in the result of  $15.727 - 15.587$

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

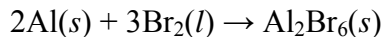
17. Which of the following compounds is covalent?

- (A) KCl
- (B)  $\text{CaBr}_2$
- (C) MgO
- (D) RbF
- (E)  $\text{PF}_3$

18. Select the best statement.

- (A) Physical properties are mostly extensive in nature.
- (B) Physical changes alter the composition of the substances involved.
- (C) Physical changes may be reversed by changing the temperature.
- (D) Physical changes are usually accompanied by chemical changes.
- (E) Physical properties are not valid characteristics for identifying a substance.

19. Aluminum will react with bromine to form aluminum bromide.



How many moles of Al are needed to form 2.43 mol of  $\text{Al}_2\text{Br}_6$ ?

- (A) 7.29 mol
- (B) 4.86 mol
- (C) 2.43 mol
- (D) 1.62 mol
- (E) 1.22 mol

20. What volume will 4.25 g of sulfuryl fluoride,  $\text{SO}_2\text{F}_2$ , occupy at STP?  
( $R = 8.2058 \times 10^{-2} \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$ )

- (A) 0.933 L
- (B) 22.4 L
- (C) 1.02 L
- (D) 95.3 L
- (E) 0.0417 L

21. Which assumptions of Dalton's atomic theory had to be revised or discarded because of the discovery of radioactivity?

Dalton's Original Atomic Theory

1. The ultimate particles of matter are the atoms of elements, which are indivisible and indestructible.
2. All the atoms of a given element are alike in all respects.
3. The atoms of different elements differ in one or more properties.
4. Compounds are formed by combination of different kinds of atoms.

- (A) 1                      (B) 2                      (C) 3                      (D) 4

22. Chemical reactions occur through the tendency of elements with less stable electronic structure to attain a more stable structure by the gain, loss, or sharing of electrons. This statement is

- (A) a false statement of a law, theory, or definition.
- (B) a correct definition of a chemical term or expression, either in terms of experimental behavior or of sound scientific theory.
- (C) a scientific law expressing the directly observable results of many different experiments.
- (D) a specific experimental fact that is not related to any scientific law.
- (E) a scientific theory, which while it cannot be directly measured or observed, is in accord with and explains the results of experiments.

23. The mass of a neutron is equal to the mass of a proton minus the mass of an electron.

- (A) True
- (B) False

24. A sample of ammonia gas at 65.5 °C and 0.689 atm has a volume of 15.31 L. What is its volume when the temperature is -15.8 °C and its pressure is 0.689 atm?  
( $R = 8.2058 \times 10^{-2} \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$ )

- (A) 63.5 L
- (B) 20.2 L
- (C) 3.69 L
- (D) 11.6 L
- (E) not possible, since the volume would have to be negative

25. Consider the isotope bromine-81,  ${}^{81}_{35}\text{Br}$ . Select the combination which lists the correct atomic number, neutron number, and mass number, respectively.

- (A) 35, 46, 81
- (B) 35, 81, 46
- (C) 81, 46, 35
- (D) 46, 81, 35
- (E) 35, 81, 116