Knowledge/Understanding

Multiple Choice

In your notebook, write the letter for the best answer to each question.

1. Which statement is the best scientific description (based on observations) of a car?
   (a) It is red, and it goes fast.
   (b) It was made in Detroit by unionized workers, using metal and fibreglass.
   (c) It has chrome bumpers, a red fibreglass body, and wheels made of a magnesium alloy. It has been tested on a straight road and found to be able to accelerate from 0 to 60 km/h in 4.9 s.
   (d) It is owned by my cousin.
   (e) My cousin bought it at the car dealership down the street. She got a good deal on it.

2. An ocean is not a solution because
   (a) solutions cannot contain salt
   (b) solutions cannot be blue
   (c) solutions should not have particles that can be seen
   (d) solutions should not be clear enough to see through them
   (e) a whale could not breathe through a solution

3. Which mass is expressed to four significant digits?
   (a) 0.0027 g   (c) 0.270 g   (e) 2.700 g
   (b) 0.027 g   (d) 2.70 g

4. Suppose that you multiply a density of 13.6 g/cm^3 by a volume of 2.0 cm^3. How many significant digits does the resulting mass have?
   (a) five, because you add the total number of significant digits in the question
   (b) three, because you use the greatest number of significant digits in the numbers in the question
   (c) six, because you multiply the significant digits in the question when you multiply the numbers
   (d) two, because you use the least number of significant digits in the numbers in the question
   (e) as many as you like, because both of the given quantities are exact numbers

5. Now suppose that you measure the mass of a chemical on a filter paper. The mass of the filter paper is 1.6 g. The mass of the chemical and the filter paper, together, is 14.168 g. How many significant digits should the final mass of the chemical have?
   (a) three, because you subtract to determine the number of significant digits
   (b) three, because you use the least number of significant digits after the decimal place (the tenths place in this question)
   (c) five, because you measured the chemical and filter paper very accurately and you want your answer to be as precise as possible
   (d) two, because you should use the least number of significant digits in the numbers in the question
   (e) as many as you like, because both of the given quantities are exact numbers

6. Rust is an example of
   (a) a compound
   (b) an element
   (c) a homogeneous mixture
   (d) a heterogeneous mixture
   (e) a solution

7. Which statement contains only qualitative observations about a copper sulfate solution?
   (a) The solution fills a 250 mL beaker, and the solution is clear.
   (b) The solution has not evaporated more than 0.5 mL overnight, and the temperature is 23°C.
   (c) The solution is clear and is a pale blue colour.
   (d) 4.6 g of copper sulfate was added to 249 mL of water to produce the solution.
   (e) The solution easily conducts about 3 V of electricity between two probes.

8. Which of the following chemical groups are least likely to react with other elements?
   (a) the halogen gases
   (b) the noble gases
   (c) the transition metals
   (d) the alkaline earth metals
   (e) the alkali metals

9. Periodic trends are linked to
   (a) the number of electrons in an atom and the way they are arranged
   (b) the atomic mass of the atoms
   (c) the number of neutrons that an atom has
   (d) the temperature of the elements
   (e) the arrangement of the protons

10. Blake measured a piece of steel three times using Vernier calipers. He recorded values of 13.62 mm, 13.53 mm, and 13.55 mm. His lab partner Ayako measured the same piece of steel. She recorded values of 13.45 mm, 13.33 mm, and 13.56 mm. Which of the following statements are true?
    (a) Blake's results were more precise than Ayako's.
    (b) Ayako's results were more precise than Blake's.
    (c) Blake's results were more accurate than Ayako's.
    (d) Ayako's results were more accurate than Blake's.
    (e) Blake's results and Ayako's results were equally accurate and precise.

11. Which of the following represent polar covalent bonds?
    (i) Na–Cl; (ii) N–O; (iii) Hg–O; (iv) Ag–S
    (a) (i), (iii), and (iv) only
    (b) (ii) and (iii) only
    (c) (iii) and (iv) only
    (d) (iii) only
    (e) (i) only

12. Which equation most accurately represents the following reaction:
    iron metal + copper(II) sulfate solution →
    copper metal + iron(II) sulfate solution
    (a) $Fe_{(s)} + Cu(SO_4)_{2(aq)} \rightarrow Cu_{(s)} + Fe(SO_4)_{2(aq)}$
    (b) $Fe_{(aq)} + Cu(SO_4)_{(aq)} \rightarrow Cu_{(aq)} + Fe(SO_4)_{(aq)}$
    (c) $2Fe_{(s)} + Cu_2(SO_4)_{(aq)} \rightarrow 2Cu_{(s)} + Fe_2(SO_4)_{(aq)}$
    (d) $Fe_{(s)} + Cu(SO_4)_{(aq)} \rightarrow Cu_{(s)} + Fe(SO_4)_{(aq)}$
    (e) $Fe_{(s)} + CuS_{(aq)} \rightarrow Cu_{(s)} + FeS_{(aq)}$

True/False

In your notebook, indicate whether each statement is true or false. If a statement is false, rewrite it to make it true.

13. Masses of 3.9 g, 4.1 g, and 4.0 g were obtained on a scale for a brass 5 g weight. This scale is accurate but not precise.

14. The measurement 4.90 m has three significant figures.

15. Matter is anything that has a weight and a density.

16. The three standard states of matter that exist at room temperature are liquid, solid, and plasma.

17. When iron rusts, a compound becomes an element. This is a physical change.

18. Acid rain is a pure liquid.

19. When water melts, a quantitative chemical change occurs.

20. To change water from ice to liquid, energy must be removed from the water.

21. A gold ring is an example of a heterogeneous mixture.

22. Water is an example of an element.

23. When the atoms of two elements are not significantly different in size, the element with the larger atomic radius has a smaller electronegativity.

24. Nitric oxide, NO, is a non-polar molecule.

25. In a balanced chemical equation, the number of particles of products is always equal to the number of particles of reactants.

Short Answer

26. Name four chemical processes that occur in everyday life.

27. How many different types of atoms would you expect to find in a cylinder of pure nitrogen gas?

28. Using only a periodic table, rank the atoms in each set in order of decreasing size. Explain your ranking.
    (a) Na, K, H
    (b) Mg, S, Si
    (c) Cl, K, Ar

29. Using only a periodic table, rank the elements in each set in order of increasing ionization energy. Explain your ranking.
    (a) B, N, F
    (b) F, Cl, Br
    (c) Na, Cs, K

30. Using only a periodic table, rank the elements in each set in order of increasing electron affinity. Explain your ranking.

(a) Be, Ca, Mg
(b) Kr, Se, Br
(c) Na, Cs, K

31. Write the chemical name for each compound.
(a) NH_4NO_3 **(d)** $Ba(NO_2)_2$
(b) $Pb(C_2H_3O_2)_4$ **(e)** P_4O_{10}
(c) S_2Cl_2 **(f)** Mn_2O_3

32. Write the chemical formula of each compound.
(a) strontium chloride
(b) lead(II) sulfite
(c) chromium(III) acetate
(d) hydrogen sulfide
(e) iodine heptafluoride

33. Explain why it is useful to classify reactions.

34. Balance each chemical equation, if necessary. State which class it belongs to.
(a) $Zn_{(s)} + AgNO_{3(aq)} \rightarrow Zn(NO_3)_{2(aq)} + Ag_{(s)}$
(b) $Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)}$
(c) $KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$
(d) $NaCO_{3(aq)} + MgSO_{4(aq)} \rightarrow MgCO_{3(s)} + Na_2SO_{4(aq)}$
(e) $C_2H_6O_{(\ell)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$

35. Predict the products of each reaction. Then write a balanced chemical equation, and state which class the reaction belongs to.
(a) $Mg_{(s)} + HCl_{(aq)} \rightarrow$
(b) $HgO_{(s)} \rightarrow$
(c) $Al_{(s)} + O_{2(g)} \rightarrow$
(d) $C_6H_{12}O_{6(s)} + O_{2(g)} \rightarrow$
(e) $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow$

Inquiry

36. Describe an experimental procedure to test three qualitative properties and two quantitative properties of lead.

37. Design an experiment that uses acids to test the reactivities of one metal from each of the following groups: alkali metals, alkaline earth metals, and transition metals.

38. Raja weighed calcium sulfate on filter papers for an experiment that he performed three times. His data are shown below.

	Mass of filter paper	Mass of paper + powder	Mass of calcium sulfate
Trial # 1	4.13 g	13.6 g	9.47 g
Trial # 2	4.2 g	12.81 g	8.51 g
Trial # 3	4.12 g	10.96 g	6.8 g

What errors did Raja make in his reporting and calculations?

39. What kinds of tests could be used to differentiate between unknown metal and non-metal samples in a laboratory? Design an experiment that includes these tests.

40. You are given a substance. You must decide whether it is an ionic compound or a covalent compound. The substance has roughly cube-shaped granules, which are translucent and colourless.
(a) Predict whether the compound is ionic or covalent.
(b) Explain your prediction.
(c) Design an experiment to collect data that will support your prediction.

41. A student drops a coil of metal wire, $X_{(s)}$, into a water solution of a metal sulfate, $ZSO_{4(aq)}$. The student observes that the colour of the solution changes, and that a metallic-looking substance appears to be forming on the metal wire. Based on these observations, answer the following questions.
(a) Has a reaction taken place? If so, what kind of reaction has taken place? Explain your answer.
(b) Which metal is more reactive, metal X or metal Z in compound ZSO_4? Explain your answer.
(c) Write the names of a real metal and a metal sulfate that you predict would behave this way in a laboratory.

Communication

42. Perform each calculation. Express the answer to the correct number of significant digits.
(a) 19.3 g + 2.22 g
(b) 14.2 cm $\times$ 1.1 cm $\times$ 3.69 cm
(c) 57.9 kg $\div$ 3.000 dm^3
(d) 18.76 g $-$ 1.3 g
(e) 25.2 + 273°C

43. Name four groups in the periodic table. Give characteristics of each group, and list three members of each group.

44. Copy the following table into your notebook, and fill in the missing information. If isotopic data are not given, use the atomic mass from the periodic table to find the number of neutrons.

Atom or ion with mass number	Number of protons	Number of neutrons	Number of electrons
$^{14}N^{3-}$			
	16		18
		2	2
$^{7}Li^{+}$	3		
		20	16

45. Draw a Lewis structure for each element.
   (a) argon, Ar
   (b) sodium, Na
   (c) aluminum, Al
   (d) boron, B

46. Draw a Lewis structure for each element. Explain the two patterns that appear.
   (a) carbon, C
   (b) neon, N
   (c) oxygen, O
   (d) fluorine, F
   (e) chlorine, Cl
   (f) bromine, Br

47. Describe three periodic trends. Explain how these trends change across and down the periodic table.

48. Arrange the following quantities in a table to show which are physical and chemical properties, which are qualitative, and which are quantitative: melting point, colour, density, reactivity with acids, flammability, malleability, electrical conductivity, boiling point, reactivity with air, hardness, toxicity, brittleness.

49. Draw a Lewis structure for each compound.
   (a) $CrBr_2$
   (b) H_2S
   (c) CCl_4
   (d) AsH_3
   (e) CS_2

50. Draw diagrams to represent each class of reaction below. Use symbols or drawings to represent different kinds of atoms.
   (a) synthesis
   (b) decomposition
   (c) combustion
   (d) single displacement
   (e) double displacement

51. Compare the boiling points of ammonia, NH_3, phosphorus trihydride, PH_3, and arsenic trihydride, AsH_3. Use the periodic table and the concept of molecular shape and polarity.

52. The molecule BF_3 contains polar covalent bonds, yet the molecule is not polar. Explain why. Include a diagram with your explanation.

Making Connections

53. What effects do accuracy, precision, and margin of error have in courts of law? Consider court cases that involve forensic analysis. What are the implications of inaccurate science in the courts?

54. Some metals (such as gold, lead, and silver) were known and widely used in ancient times. Other metals have only been discovered relatively recently. For example, both sodium and potassium were discovered in the early nineteenth century by Sir Humphrey Davy. Explain why ancient cultures knew about some metals, while other metals remained unknown for thousands of years.

COURSE CHALLENGE

Planet Unknown

Consider the following as you continue to plan for your Chemistry Course Challenge:

- How did chemists use trends of physical and chemical properties to arrange elements in a periodic table?
- What are several ways of comparing the reactivity of metals?
- How can you use the physical and chemical properties of elements to help identify them?