1. Which two states of matter are the least compressible?
   Ans. solids and liquids

2. What device is used to measure atmospheric pressure?
   Ans. barometer

3. The pascal (Pa) is a unit for expressing what quantity?
   Ans. pressure

4. What experimental quantity measures force per unit area?
   Ans. pressure

5. State Boyle's Law.
   Ans. The volume of a gas is inversely proportional to the pressure, if the number of moles (or mass) and the temperature of the gas are kept constant.

   Ans. The volume of a gas is directly proportional to the absolute temperature, if the number of moles (or mass) and the pressure of the gas are kept constant.

7. State Avogadro's Law.
   Ans. Equal volumes of any ideal gas, at the same temperature and pressure, contain the same number of moles.

8. What law predicts the expansion of a balloon when helium is added?
   Ans. Avogadro's

9. Consider 1.00 L of air in a patient's lungs at 37.0°C and 1.00 atm pressure. What volume would this air occupy if it were at 25.0°C under a pressure of 5.00 × 10² atm (a typical pressure in a compressed air cylinder)?
   Ans. 19.2 × 10⁻³ L

10. If a gas sample is at STP (Standard Temperature and Pressure), what are its temperature and pressure?
   Ans. temperature = 0.0°C or 273 K, pressure = 1.00 atm.

11. Calculate the density of oxygen gas (O₂) at STP, in g/L. [Use molar mass: O₂, 32.0 g/mol]
   Ans. 1.43 g/L

12. What is the volume (L) occupied by a mole of an ideal gas, if the pressure is 626 mmHg and the temperature is 25.0°C?
   Ans. 29.7 L

13. Who found that a mixture of gases exerts a total pressure that is the sum of the pressures that each gas would exert if each were present alone under similar conditions?
   Ans. Dalton
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14. An gas sample is prepared in which the components have the following partial pressures: nitrogen, 555 mmHg; oxygen, 149 mmHg; water vapor, 13 mmHg; argon, 7 mmHg. What is the total pressure of this mixture?

Ans. 724 mmHg

15. What is the name of the theory which deals with particle behavior in the gas phase?

Ans. kinetic molecular theory

16. Choose the best one from each pair in the following sentence: The closest approach to ideal gas behavior will be shown by (NH$_3$ or H$_2$?) at (low or high?) pressure and (low or high?) temperature.

Ans. H$_2$, low, high

17. What is meant by viscosity?

Ans. It is the resistance of a liquid to flow.

18. What experimental quantity is a measure of the attractive forces between molecules at the surface of a liquid?

Ans. surface tension

19. What process is responsible for the formation of dew on the grass early in the morning?

Ans. condensation

20. How can pure water be made to boil at a temperature above 100°C?

Ans. by raising the pressure to more than one atmosphere

21. Who postulated the existence of temporary dipole attraction among nonpolar molecules?

Ans. Fritz London

22. What are the general structural requirements for a compound to display hydrogen bonding?

Ans. It must have hydrogen atoms bonded to small, electronegative atoms such as N, O or F.

23. Why is hydrogen bonding more extensive in water than in hydrogen fluoride?

Ans. Each water molecule has two $\delta^+$ sites and two $\delta^-$ sites, all of which can be used for hydrogen bonding. The hydrogen fluoride has three $\delta^-$ sites but only one $\delta^+$ site, and the shortage of the latter limits the number of hydrogen bonds which can form per molecule to half the number in water.

24. Name the four main types of crystalline solid, and give an example of each.

Ans. ionic solid, NaCl; covalent solid, diamond; molecular solid, ice; metallic solid, iron.
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25. A barometer measures

A. the pressure of a gas sample in a container
B. the difference in pressure between two gas samples
C. the difference in pressure between a gas sample and atmospheric pressure
D. atmospheric pressure
E. the pressure of an ideal gas

Ans. D

26. Who invented the first barometer?

A. Boyle
B. Charles
C. Dalton
D. Gay-Lussac
E. Torricelli

Ans. E

27. Express one standard atmosphere of pressure in units of mm Hg.

A. 14.7 mm Hg
B. 380 mm Hg
C. 760 mm Hg
D. 0.333 mm Hg
E. 30 mm Hg

Ans. C

28. Which one of the following pressures is NOT equal to one atmosphere?

A. 76 cm Hg
B. 14.7 lb/in²
C. 30 inches of Hg
D. 101 kPa
E. 76 torr

Ans. E
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29.

In the graph shown above, which line is the best representation of Boyle's Law behavior of a gas?

A. A  B. B  C. C  D. D  E. E

Ans. E

30. Who formulated the relationship between the volume and the pressure of a gas?

A. Boyle  B. Charles  C. Dalton  D. Gay-Lussac  E. Torricelli

Ans. A

31. A sample of oxygen occupies 1.00 L. If the temperature remains constant, and the pressure on the oxygen is tripled, what is the new volume?

A. 3.00 L  B. 1.50 L  C. 0.667 L  D. 0.500 L  E. 0.333 L

Ans. E

32. A given mass of oxygen at room temperature occupies a volume of 500.0 mL at 1.50 atm pressure. What pressure must be applied to compress the gas to a volume of only 150.0 mL?

A. 500 atm  B. 150 atm  C. 5.00 atm  D. 1.50 atm  E. 0.500 atm

Ans. C
33. Who formulated the relationship between the volume and temperature of a gas?

A. Boyle  
B. Charles  
C. Dalton  
D. Gay-Lussac  
E. Torricelli

Ans. B

34. A balloon filled with helium has a volume of $1.00 \times 10^3$ L at $20^\circ$C. What would be the balloon's volume at $30^\circ$C, if the pressure surrounding the balloon remains constant?

A. $6.7 \times 10^2$ L  
B. $9.70 \times 10^2$ L  
C. $1.03 \times 10^3$ L  
D. $1.11 \times 10^3$ L  
E. $1.50 \times 10^3$ L

Ans. C

35. Who discovered the gas law represented in the figure above?

A. Boyle  
B. Charles  
C. Dalton  
D. Gay-Lussac  
E. Torricelli

Ans. B

36. What is the volume occupied by one mole of helium at $0^\circ$C and 1 atm pressure?

A. 1.0 L  
B. 22.4 L  
C. 4.0 L  
D. 40.0 L  
E. 12.2 L

Ans. B
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37. A helium-filled weather balloon is launched from the ground where the pressure is 752 mmHg and the temperature is 21°C. Under these conditions its volume is 75.0 L. When it has climbed to an altitude where the pressure is 89 mmHg and the temperature is 0°C, what is its volume?

A. 0.00 L  
B. 8.24 L  
C. 9.56 L  
D. 588 L  
E. 682 L

Ans. D

38. How many moles of gas are there in a gas-filled balloon which has a volume of 67.0 L at a pressure of 742 mmHg and a temperature of 25.0°C?

A. 2.24 mol  
B. 2.67 mol  
C. 2.81 mol  
D. 31.9 mol  
E. 1.71 \times 10^3 mol

Ans. B

39. Carbon dioxide acts as a greenhouse gas by

A. absorbing visible radiation  
B. absorbing ultraviolet radiation  
C. absorbing infrared radiation  
D. storing solar energy  
E. trapping sunlight during photosynthesis

Ans. C

40. Which of the following statements conflicts with the kinetic molecular theory of gases?

A. There are no forces between gas particles.  
B. Gas particles occupy a negligible volume compared with the volume of their container.  
C. The average kinetic energy of the gas particles is proportional to the absolute temperature.  
D. Gas particles lose energy only when they collide with the walls of the container.  
E. Gas particles are in constant, random motion.

Ans. D

41. What quantity is directly proportional to the kinetic energy of the particles in a gas?

A. distance between molecules  
B. absolute temperature  
C. atomic mass  
D. formula mass  
E. volume of the individual particles.

Ans. B
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42. Of the following gases, which will behave most like an ideal gas?
   A. H₂      B. HF      C. NH₃      D. CH₃Cl      E. CO
   Ans. A

43. What is the experimental quantity that serves as a measure of resistance to flow of a liquid?
   A. vapor pressure
   B. surface tension
   C. resistivity
   D. viscosity
   E. compressibility
   Ans. D

44. At the membrane barrier in lung tissue between the blood and the surrounding atmosphere, what is the relationship between the partial pressure of atmospheric oxygen to that of the oxygen present in the blood?
   A. equal
   B. proportional
   C. zero
   D. lower
   E. higher
   Ans. E

45. Surface tension
   A. increases with increasing temperature
   B. is unaffected by temperature
   C. is higher for nonpolar substances than for polar ones
   D. is lowered by surfactants
   E. is the same as viscosity
   Ans. D

46. What is the term that describes a liquid changing to a vapor at a temperature less than its boiling point?
   A. evaporation
   B. sublimation
   C. dissociation
   D. condensation
   E. supercooling
   Ans. A
47. Which one of the following substances with their structures shown, will NOT display hydrogen bonding?

- A. NH₃
- B. HF
- C. H₂O
- D. ethanol
- E. diethyl ether

A. A    B. B    C. C    D. D    E. E

Ans. E

48. T F Gases and liquids are both highly compressible.

Ans. F

49. T F The density of a gas is proportional to its molecular weight.

Ans. T

50. T F Dalton's Law states that the volume of a gas varies directly with the absolute temperature.

Ans. F

51. T F Approximately 99% of the total pressure of dry air is due to molecules of N₂ and O₂.

Ans. T

52. T F The average energy of an ideal gas molecule depends on the molecular weight of the gas.

Ans. F

53. T F Polar gases are more ideal than nonpolar ones.

Ans. F

54. T F As temperature increases, so does viscosity.

Ans. F

55. T F Glycerol has a lower viscosity than ethanol.

Ans. F

56. T F The surface tension of water is reduced by the addition of soap.

Ans. T

57. T F The boiling point of a liquid is dependent on the atmospheric pressure.

Ans. T

58. T F The boiling point of a liquid increases with increasing altitude.

Ans. F
59. T F Polar compounds generally have higher boiling points than nonpolar compounds of similar molecular weight.
   Ans. T

60. T F All compounds containing both oxygen and hydrogen will exhibit hydrogen bonding.
   Ans. F

61. T F Ionic compounds tend to have higher melting points than molecular compounds.
   Ans. T

62. T F Covalent solids are soft and readily soluble in many solvents.
   Ans. F

63. T F Metals conduct electricity well due to the mobility of the metal ions in the solid.
   Ans. F
Chapter 7, Reactions and Solutions

1. Classify the following reaction as precipitation, acid-base or oxidation-reduction:
   \[ \text{Ce}^{4+}(aq) + \text{Fe}^{2+}(aq) \rightarrow \text{Ce}^{3+}(aq) + \text{Fe}^{3+}(aq) \]
   Ans. oxidation-reduction

2. Classify the following reaction as precipitation, acid-base or oxidation-reduction:
   \[ \text{H}_2\text{SO}_4(aq) + 2\text{KOH}(aq) \rightarrow \text{K}_2\text{SO}_4(aq) + 2\text{H}_2\text{O}(aq) \]
   Ans. acid-base

3. Classify the following reaction as precipitation, acid-base or oxidation-reduction:
   \[ \text{Na}_2\text{S}(aq) + \text{CuSO}_4(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + \text{CuS}(s) \]
   Ans. precipitation

4. Complete the products and balance the following equation for an acid-base reaction:
   \[ \text{HCl}(aq) + \text{KOH}(aq) \]
   Ans. \[ \text{HCl}(aq) + \text{KOH}(aq) \rightarrow \text{KCl}(aq) + \text{H}_2\text{O}(l) \]

5. Complete the products and balance the following equation for a precipitation reaction:
   \[ \text{FeSO}_4(aq) + \text{NaOH}(aq) \]
   Ans. \[ \text{FeSO}_4(aq) + 2\text{NaOH}(aq) \rightarrow \text{Fe(OH)}_2(s) + \text{Na}_2\text{SO}_4(aq) \]

6. Write a balanced equation for the reaction between zinc metal and iron(III) ions to form zinc(II) ions and iron(II) ions (Symbols: zinc = Zn; iron = Fe).
   Ans. \[ \text{Zn}(s) + 2\text{Fe}^{3+}(aq) \rightarrow \text{Zn}^{2+}(aq) + 2\text{Fe}^{2+}(aq) \]

7. Name the two products formed when octane \((\text{C}_8\text{H}_{18})\) burns completely in excess oxygen gas.
   Ans. carbon dioxide and water

8. Classify the following reaction as decomposition, combination, single-replacement or double-replacement:
   \[ 2\text{H}_2\text{O}(l) \rightarrow 2\text{H}_2(g) + \text{O}_2(g) \]
   Ans. decomposition

9. Classify the following reaction as decomposition, combination, single-replacement or double-replacement:
   \[ \text{H}_2\text{SO}_4(aq) \rightarrow \text{Ba(OH)}_2(aq) \rightarrow \text{BaSO}_4(s) + 2\text{H}_2\text{O}(g) \]
   Ans. double-replacement

10. Classify the following reaction as decomposition, combination, single-replacement or double-replacement:
    \[ \text{Mg}(s) + 2\text{HCl}(aq) \rightarrow \text{MgCl}_2(g) + \text{H}_2(g) \]
    Ans. single-replacement