1. Which of the following compounds is a strong electrolyte?
   A) H₂O   B) CH₃OH   C) CH₃CH₂OH   D) HF   E) NaF
   Ans: E

2. Which of the following compounds is a nonelectrolyte?
   A) NaOH   B) HNO₃   C) C₂H₆O (ethanol)   D) KF   E) CH₃COOH (acetic acid)
   Ans: C

3. Based on the solubility rules, which one of the following compounds should be insoluble in water?
   A) NaCl   B) MgBr₂   C) FeCl₂   D) AgBr   E) ZnCl₂
   Ans: D

4. Which of the following will occur when solutions of CuSO₄(aq) and BaCl₂(aq) are mixed?
   A) A precipitate of CuCl₂ will form; Ba²⁺ and SO₄²⁻ are spectator ions.
   B) A precipitate of CuSO₄ will form; Ba²⁺ and Cl⁻ are spectator ions.
   C) A precipitate of BaSO₄ will form; Cu²⁺ and Cl⁻ are spectator ions.
   D) A precipitate of BaCl₂ will form; Cu²⁺ and SO₄²⁻ are spectator ions.
   E) No precipitate will form.
   Ans: C

5. Identify the precipitate(s) formed when solutions of Pb(NO₃)₂(aq), Mg(ClO₄)₂(aq), and (NH₄)₂SO₄(aq) are mixed.
   A) PbSO₄   B) MgSO₄   C) NH₄ClO₄   D) NH₄NO₃ and NH₄ClO₄   E) PbSO₄ and MgSO₄
   Ans: A

6. Identify the correct net ionic equation for the reaction that occurs when solutions of AgNO₃ and NH₄Cl are mixed.
   A) AgNO₃(aq) + NH₄Cl(aq) → AgCl(s) + NH₄Cl(aq)
   B) NH₄⁺(aq) + NO₃⁻(aq) → NH₄NO₃(s)
   C) AgNO₃(aq) + NH₄Cl(aq) → AgCl(s) + NH₄Cl(s)
   D) Ag⁺(aq) + Cl⁻(aq) → AgCl(s)
   E) AgNO₃(aq) + NH₄⁺(aq) → NH₄AgNO₃(s)
   Ans: D     Category: Medium
7. Which of the following compounds is a *weak acid*?
   A) HF  B) HCl  C) HBr  D) HI  E) HClO₄
   Ans: A

8. Identify the major ions present in an aqueous LiOH solution.
   A) Li⁺, O²⁻, H⁻  B) Li⁺, OH⁻  C) LiO⁻, H⁺  D) Li⁺, O²⁻, H⁺  E) Li⁻, OH⁺
   Ans: B

9. Identify the correct net ionic equation for the reaction that occurs when solutions of HF and KOH are mixed.
   A) H⁺(aq) + OH⁻(aq) → H₂O(l)
   B) HF(aq) + OH⁻(aq) → H₂O(l) + F⁻(aq)
   C) H⁺(aq) + KOH(aq) → H₂O(l) + K⁺(aq)
   D) HF(aq) + KOH(aq) → H₂O(l) + KF(s)
   E) HF(aq) + KOH(s) → H₂O(l) + KF(aq)
   Ans: B

10. The oxidation number of Mn in KMnO₄ is
    A) +8  B) +7  C) +5  D) −7  E) −8
    Ans: B

11. For the chlorate ion, ClO₃⁻, what are the oxidation states of the Cl and O, respectively?
    A) −1, −2  B) +5, −2  C) +6, −2  D) +7, −2  E) +2, −1
    Ans: B

12. Determine the correct oxidation numbers for all three elements in Ca(ClO)₂ in the order that the elements are shown in the formula?
    A) +2, +1, −2  B) +2, −2, +1  C) +2, −3, +2  D) −2, +2, −1  E) −2, +3, −2
    Ans: A

13. How many total electrons are transferred in the following reaction?
    2Na(s) + Cl₂(g) → 2NaCl(s)
    A) 1  B) 2  C) 3  D) 4  E) 5
    Ans: B
14. Which one of the following is a redox reaction?

A) \(2\text{Al}(s) + 3\text{H}_2\text{SO}_4(aq) \rightarrow \text{Al}_2(\text{SO}_4)_3(aq) + 3\text{H}_2(g)\)
B) \(2\text{KBr}(aq) + \text{Pb(NO}_3)_2(aq) \rightarrow 2\text{KNO}_3(aq) + \text{PbBr}_2(s)\)
C) \(\text{CaBr}_2(aq) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{CaSO}_4(s) + 2\text{HBr}(g)\)
D) \(\text{H}^+(aq) + \text{OH}^-(aq) \rightarrow \text{H}_2\text{O}(l)\)
E) \(\text{CO}_3^{2-}(aq) + \text{HSO}_4^-(aq) \rightarrow \text{HCO}_3^-(aq) + \text{SO}_4^{2-}(aq)\)

Ans: A

15. Identify the oxidizing agent in the following chemical reaction.

\(2\text{MnO}_4^- + 5\text{H}_2\text{SO}_3 \rightarrow 2\text{Mn}^{2+} + 5\text{SO}_4^{2-} + 4\text{H}^+ + 3\text{H}_2\text{O}\)

A) \(\text{MnO}_4^-\)  B) \(\text{H}_2\text{SO}_3\)  C) \(\text{Mn}^{2+}\)  D) \(\text{SO}_4^{2-}\)  E) \(\text{H}^+\)

Ans: A

16. Identify the reducing agent in the following chemical reaction.

\(\text{Cd} + \text{NiO}_2 + 2\text{H}_2\text{O} \rightarrow \text{Cd(OH)}_2 + \text{Ni(OH)}_2\)

A) \(\text{Cd}\)  B) \(\text{NiO}_2\)  C) \(\text{H}_2\text{O}\)  D) \(\text{Cd(OH)}_2\)  E) \(\text{Ni(OH)}_2\)

Ans: A

17. Predict the products of the following single replacement reaction.

\(\text{Fe(s)} + \text{CuSO}_4(aq) \rightarrow\)

A) \(\text{Cu(s)} + \text{FeSO}_4(aq)\)  D) \(\text{FeCuSO}_4(aq)\)
B) \(\text{Fe(s)} + \text{Cu(s)} + \text{SO}_4(aq)\)  E) \(\text{FeO(s)} + \text{CuSO}_4(aq)\)
C) \(\text{CuS(s)} + \text{Fe}_2\text{SO}_4(aq)\)

Ans: A

18. Which of the following represents a hydrogen displacement reaction?

A) \(2\text{C}_2\text{H}_6(g) + 7\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 6\text{H}_2\text{O}(l)\)
B) \(2\text{KBr}(aq) + \text{Cl}_2(g) \rightarrow 2\text{KCl(aq)} + \text{Br}_2(l)\)
C) \(\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)\)
D) \(\text{CaBr}_2(aq) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{CaSO}_4(s) + 2\text{HBr}(g)\)
E) \(2\text{Al}(s) + 3\text{H}_2\text{SO}_4(aq) \rightarrow \text{Al}_2(\text{SO}_4)_3(aq) + 3\text{H}_2(g)\)

Ans: E
18. The reaction below can be classified as which type of reaction?

\[ 2 \text{NO}_2(g) + \text{H}_2\text{O}(l) \rightarrow \text{HNO}_2(aq) + \text{HNO}_3(aq) \]

A) Combination reaction   D) Disproportionation reaction
B) Acid-base neutralization reaction   E) Combustion reaction
C) Hydrogen displacement reaction

Ans: D

19. What type of reaction is the following?

\[ \text{Ca(OH)}_2(s) + 2 \text{HNO}_3(aq) \rightarrow \text{Ca(NO}_3)_2(aq) + 2 \text{H}_2\text{O}(l) \]

A) Combination reaction   D) Disproportionation reaction
B) Acid-base neutralization reaction   E) Combustion reaction
C) Hydrogen displacement reaction

Ans: B

20. Categorize the following reaction as an acid-base neutralization, precipitation, combination, decomposition, combustion, displacement, or disproportionation reaction.

\[ \text{Ba(C}_2\text{H}_3\text{O}_2)_2(aq) + \text{Na}_2\text{CO}_3(aq) \rightarrow \text{BaCO}_3(s) + 2 \text{NaC}_2\text{H}_3\text{O}_2(aq) \]

Ans: Precipitation

21. Describe the procedure used to make 3.0 liters of a 2.0 M KCl solution, starting with solid KCl and water.

Ans: Determine the molar mass of KCl, which is 74.55 g/mol; weigh out 447.3 grams (6 mol) of KCl; dissolve the KCl in enough water to form exactly 3 liters of solution.

22. The solubility of Ba(NO\textsubscript{3})\textsubscript{2} is 130.5 grams per liter at 0°C. How many moles of dissolved salt are present in 4.0 liters of a saturated solution of Ba(NO\textsubscript{3})\textsubscript{2} at 0°C?

Ans: 2.0 moles
23. During a titration the following data were collected. A 10. mL portion of an unknown monoprotic acid solution was titrated with 1.0 M NaOH; 40. mL of the base were required to neutralize the sample. How many moles of acid are present in 2.0 liters of this unknown solution?

Ans: 8.0 moles

24. Identify the Brønsted acid in the following reaction.

\[
\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^- \]

Ans: \( \text{H}_2\text{O} \)

25. Write the balanced molecular and net ionic equations for the reaction that would occur between \( \text{CuCl}_2(\text{aq}) \) and \( \text{Pb}(\text{s}) \). Be sure to include the correct states in your final equations. If no reaction is expected, write “no reaction.”

Ans: Molecular equation: \( \text{CuCl}_2(\text{aq}) + \text{Pb}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{PbCl}_2(\text{s}) \)
Net ionic equation: \( \text{Cu}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) + \text{Pb}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{PbCl}_2(\text{s}) \)

26. TRUE/FALSE: The following equation is an example of a net ionic equation.

\[
\text{Na}^+(\text{aq}) + \text{Br}^-(\text{aq}) + \text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{AgBr(s)} + \text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq})
\]

Ans: False

27. TRUE/FALSE: Hydrogen is oxidized in the following chemical reaction.

\[
\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}
\]

Ans: True
28. TRUE/FALSE: The following reaction is a redox reaction.

\[
\text{CaC}_2(s) + \text{H}_2\text{O}(l) \rightarrow \text{HCCH}(g) + \text{CaO}(s)
\]

**Ans:** False

29. What will happen to the height (h) of the mercury column in the manometer shown below if the stopcock is opened, given that the atmospheric pressure is 755 mmHg?

A) h will decrease  
B) h will not change  
C) h will increase  
D) not enough information given to answer the question

**Ans:** A
30. The pressure of a gas sample was measured to be 654 mmHg. What is the pressure in kPa? (1 atm = 1.01325 \times 10^5 \text{ Pa})
A) 87.2 kPa
B) 118 kPa
C) 6.63 \times 10^4 \text{ kPa}
D) 8.72 \times 10^4 \text{ kPa}
E) 8.72 \times 10^7 \text{ kPa}
Ans: A

31. Which of the following statements is consistent with Boyle's Law concerning an ideal gas?
A) At constant temperature and moles, a plot of volume versus pressure is linear.
B) At constant pressure and volume, a plot of temperature versus moles is linear.
C) At constant pressure and moles, a plot of temperature versus volume is linear.
D) At constant temperature and moles, a plot of pressure versus the inverse of volume is linear.
E) At constant temperature and pressure, a plot of moles versus volume is linear.
Ans: D

32. A 45 mL sample of nitrogen gas is cooled from 135°C to 15°C in a container that can contract or expand at constant pressure, what is the new volume of the nitrogen gas?
A) 64 mL
B) 5.0 mL
C) 410 mL
D) 32 mL
E) 41 mL
Ans: D

33. If the pressure on a gas sample is tripled and the absolute temperature is quadrupled, by what factor will the volume of the sample change?
A) 12
B) 4/3
C) 3/4
D) 1/3
E) 4
Ans: B

34. Calculate the number of moles of gas contained in a 10.0 L tank at 22°C and 105 atm. (R = 0.08206 L·atm/K·mol)
A) 1.71 \times 10^{-3} \text{ mol}
B) 0.0231 \text{ mol}
C) 1.03 \text{ mol}
D) 43.4 \text{ mol}
E) 582 \text{ mol}
Ans: D
35. How many atoms of He gas are present in a 450 mL container at 35°C and 740 mmHg?
   A) 0.017 He atoms  
   B) 0.068 He atoms  
   C) 1.2 x 10^5 He atoms  
   D) 1.0 x 10^{22} He atoms  
   E) 7.9 x 10^{24} He atoms
   Ans: D

36. Calculate the density, in g/L, of SF₆ gas at 27°C and 0.500 atm pressure.
   A) 3.38 × 10^{-3} g/L  
   B) 2.96 g/L  
   C) 22.4 g/L  
   D) 32.9 g/L  
   E) 3.38 kg/L
   Ans: B

37. A 0.271 g sample of an unknown vapor occupies 294 mL at 140.°C and 847 mmHg. The empirical formula of the compound is CH₂. What is the molecular formula of the compound?
   A) CH₂  
   B) C₂H₄  
   C) C₃H₆  
   D) C₄H₈  
   E) C₆H₁₂
   Ans: B

38. What volume of sulfur dioxide gas at 45 °C and 723 mmHg will react completely with 0.870 L of oxygen gas at constant temperature and pressure?
   2 SO₂(g) + O₂(g) → 2SO₃(g)
   A) 0.0317 L  
   B) 0.0634 L  
   C) 0.870 L  
   D) 1.74 L  
   E) 3.48 L
   Ans: D

39. How many liters of chlorine gas at 25°C and 0.950 atm can be produced by the reaction of 12.0 g of MnO₂ with excess HCl(aq) according to the following chemical equation?
   MnO₂(s) + 4HCl(aq) → MnCl₂(aq) + 2H₂O(l) + Cl₂(g)
   A) 5.36 × 10^{-3} L  
   B) 0.138 L  
   C) 0.282 L  
   D) 3.09 L  
   E) 3.55 L
   Ans: E

40. If equal masses of O₂(g) and HBr(g) are in separate containers of equal volume and temperature, which one of these statements is true?
   A) The pressure in the O₂ container is greater than that in the HBr container.  
   B) There are more HBr molecules than O₂ molecules.  
   C) The average velocity of the O₂ molecules is less than that of the HBr molecules.  
   D) The average kinetic energy of HBr molecules is greater than that of O₂ molecules.  
   E) The pressures of both gases are the same.
   Ans: A
41. A sample of mercury(II) oxide is placed in a 5.00 L evacuated container and heated until it decomposes entirely to mercury metal and oxygen gas. The container is then cooled to 25°C. One now finds that the gas pressure inside the container is 1.73 atm. What mass of mercury(II) oxide was originally placed into the container?
   A) 1.51 g  B) 45.6g  C) 76.6 g  D) 913 g  E) 153 g
   Ans: E

42. What is the pressure (mmHg) of the sample of gas trapped in the closed-tube mercury manometer shown below if atmospheric pressure is 751 mmHg and \( h = 17.3 \) cm?
   Ans: 173 mmHg

43. Define *Avogadro’s Law*
   Ans: At constant pressure and temperature, the volume of a gas is directly proportional to the number of moles of the gas present.

44. The following data describes an initial and final state for an ideal gas. Given that the amount of gas does not change in the process, what is the final volume (mL) of the gas?

   \[
   \begin{array}{ccc}
   P & V & T \\
   \text{initial:} & 720 \text{ mmHg} & 235 \text{ mL} & 25^\circ\text{C} \\
   \text{final:} & 860 \text{ mmHg} & ? & 15^\circ\text{C} \\
   \end{array}
   \]
   Ans: 190. mL
45. *Heat* is
   A) a measure of temperature.
   B) a measure of the change in temperature.
   C) a measure of thermal energy.
   D) a measure of thermal energy transferred between two bodies at different temperature.

   Ans: D

46. An endothermic reaction causes the surroundings to
   A) warm up.
   B) become acidic.
   C) condense.
   D) decrease in temperature.
   E) release CO$_2$.

   Ans: D

47. An endothermic reaction causes the surroundings to
   A) warm up.
   B) become acidic.
   C) condense.
   D) decrease in temperature.
   E) release CO$_2$.

   Ans: D

48. Aluminum metal has a specific heat of 0.900 J/g·°C. Calculate the amount of heat required to raise the temperature of 10.5 moles of Al from 30.5 °C to 225°C.
   A) 1.84 kJ  B) 2.41 kJ  C) 65.1 kJ  D) 49.6 kJ  E) 57.3 kJ

   Ans: D
49. Three separate 3.5g blocks of Al, Cu, and Fe at 25 °C each absorb 0.505 kJ of heat. Which block reaches the highest temperature? The specific heats of Al, Cu, and Fe are 0.900 J/g·°C, 0.385J/g·°C, and 0.444 J/g·°C, respectively.
   A) Al    B) Cu    C) Fe    D) Al and Cu    E) Fe and Cu
   Ans: B

50. If 10.6 moles of water at 35°C absorbs 12.30 kJ, what is the final temperature of the water? The specific heat of water is 4.184 J/g·°C.
   A) 15°C    B) 20°C    C) 35°C    D) 50.°C    E) 312°C
   Ans: D

51. Which of the following processes is endothermic?
   A) O₂(g) + 2H₂(g) → 2H₂O(g)
   B) H₂O(g) → H₂O(l)
   C) 3O₂(g) + 2CH₃OH(g) → 2CO₂(g) + 2H₂O(g)
   D) H₂O(s) → H₂O(l)
   Ans: D

52. The reaction that represents the standard enthalpy of formation for acetone (CH₃COCH₃), a common ingredient in nail polish remover is:
   A) 3 C(graphite) + 3 H₂(g) + ½ O₂(g) → CH₃COCH₃(l)
   B) 6 C(diamond) + 6 H₂(g) + O₂(g) → 2 CH₃COCH₃(l)
   C) 3 C(diamond) + 3 H₂(g) + ½ O₂(g) → CH₃COCH₃(l)
   D) CH₃COCH₃(l) → 3 C(graphite) + 3 H₂(g) + ½ O₂(g)
   E) CH₃COCH₃(l) + 4 O₂(g) → 3 CO₂(g) + 3 H₂O(g)
   Ans: A

53. When 0.560 g of Na(s) reacts with excess F₂(g) to form NaF(s), 13.8 kJ of heat is evolved at standard-state conditions. What is the standard enthalpy of formation (ΔH°f) of NaF(s)?
   A) -570 kJ/mol    D) 24.8 kJ/mol
   B) -24.8 kJ/mol    E) 570 kJ/mol
   C) -7.8 kJ/mol
   Ans: A
54. Octane (C\textsubscript{8}H\textsubscript{18}) undergoes combustion according to the following thermochemical equation:

\[ 2\text{C}_8\text{H}_{18}(l) + 25\text{O}_2(g) \rightarrow 16\text{CO}_2(g) + 18\text{H}_2\text{O}(l) \quad \Delta H^\circ_{\text{rxn}} = -11,020 \text{ kJ/mol}. \]

Given that \( \Delta H^\circ_{f}[\text{CO}_2(g)] = -393.5 \text{ kJ/mol} \) and \( \Delta H^\circ_{f}[\text{H}_2\text{O}(l)] = -285.8 \text{ kJ/mol} \), calculate the standard enthalpy of formation of octane.

A) \(-210 \text{ kJ/mol}\)  
B) \(-11,230 \text{ kJ/mol}\)  
C) \(22,040 \text{ kJ/mol}\)  
D) \(-420 \text{ kJ/mol}\)  
E) \(420 \text{ kJ/mol}\)  

Ans: A

55. Glycine, C\textsubscript{2}H\textsubscript{5}O\textsubscript{2}N, is important for biological energy. The combustion reaction of glycine is given by the equation

\[ 4\text{C}_2\text{H}_5\text{O}_2\text{N}(s) + 9\text{O}_2(g) \rightarrow 8\text{CO}_2(g) + 10\text{H}_2\text{O}(l) + 2\text{N}_2(g) \quad \Delta H^\circ_{\text{rxn}} = -3857 \text{ kJ/mol} \]

Given that \( \Delta H^\circ_{f}[\text{CO}_2(g)] = -393.5 \text{ kJ/mol} \) and \( \Delta H^\circ_{f}[\text{H}_2\text{O}(l)] = -285.8 \text{ kJ/mol} \), calculate the enthalpy of formation of glycine.

A) \(-3,178 \text{ kJ/mol}\)  
B) \(-964 \text{ kJ/mol}\)  
C) \(-537.2 \text{ kJ/mol}\)  
D) \(-268.2 \text{ kJ/mol}\)  
E) \(2,149 \text{ kJ/mol}\)  

Ans: C

56. During volcanic eruptions, hydrogen sulfide gas is given off and oxidized by air according to the following chemical equation:

\[ 2\text{H}_2\text{S}(g) + 3\text{O}_2(g) \rightarrow 2\text{SO}_2(g) + 2\text{H}_2\text{O}(g) \]

Calculate the standard enthalpy change for the above reaction given:

\[ 3\text{S}(s) + 2\text{H}_2\text{O}(g) \rightarrow 2\text{H}_2\text{S}(g) + \text{SO}_2(g) \quad \Delta H^\circ = 146.9 \text{ kJ/mol} \]
\[ \text{S}(s) + \text{O}_2(g) \rightarrow \text{SO}_2(g) \quad \Delta H^\circ = -296.4 \text{ kJ/mol} \]

A) \(-1036.1 \text{ kJ/mol}\)  
B) \(-742.3 \text{ kJ/mol}\)  
C) \(-149.5 \text{ kJ/mol}\)  
D) \(443.3 \text{ kJ/mol}\)  
E) \(742.3 \text{ kJ/mol}\)  

Ans: A
57. Calculate the standard enthalpy change for the reaction

\[2A + 2A_2 + 4AB + B \rightarrow 5A_2B\]

Given:
\[2A + B \rightarrow A_2B \quad \Delta H^\circ = -25.0 \text{ kJ/mol}\]
\[2A_2B \rightarrow 2AB + A_2 \quad \Delta H^\circ = 35.0 \text{ kJ/mol}\]

A) \(-95.0 \text{ kJ/mol}\)  D) \(10.0 \text{ kJ/mol}\)
B) \(-60.0 \text{ kJ/mol}\)  E) \(45.0 \text{ kJ/mol}\)
C) \(-15.0 \text{ kJ/mol}\)

Ans: A

58. An average home in Colorado requires 20. GJ of heat per month. How many grams of natural gas (methane) must be burned to supply this energy?

\[\text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(l) \quad \Delta H^\circ_{\text{rxn}} = -890.4 \text{ kJ/mol}\]

A) \(7.1 \times 10^{-4} \text{ g}\)  D) \(2.2 \times 10^4 \text{ g}\)
B) \(1.4 \times 10^3 \text{ g}\)  E) \(3.6 \times 10^5 \text{ g}\)
C) \(1.4 \times 10^4 \text{ g}\)

Ans: E

59. A gas is compressed in a cylinder from a volume of 20.0 L to 2.0 L by a constant pressure of 10.0 atm. Calculate the amount of work done on the system.

A) \(-1.81 \times 10^4 \text{ J}\)  B) \(-180 \text{ J}\)  C) \(180 \text{ J}\)  D) \(1.01 \times 10^4 \text{ J}\)  E) \(1.81 \times 10^4 \text{ J}\)

Ans: E

60. The bond enthalpy of the Br–Cl bond is equal to \(\Delta H^\circ\) for the reaction

\[\text{BrCl}(g) \rightarrow \text{Br}(g) + \text{Cl}(g)\]

Use the following data to find the bond enthalpy of the Br–Cl bond.

\[\text{Br}_2(l) \rightarrow \text{Br}_2(g) \quad \Delta H^\circ = 30.91 \text{ kJ/mol}\]
\[\text{Br}_2(g) \rightarrow 2\text{Br}(g) \quad \Delta H^\circ = 192.9 \text{ kJ/mol}\]
\[\text{Cl}_2(g) \rightarrow 2\text{Cl}(g) \quad \Delta H^\circ = 243.4 \text{ kJ/mol}\]
\[\text{Br}_2(l) + \text{Cl}_2(g) \rightarrow 2\text{BrCl}(g) \quad \Delta H^\circ = 29.2 \text{ kJ/mol}\]

A) \(14.6 \text{ kJ/mol}\)  D) \(438.0 \text{ kJ/mol}\)
B) \(203.5 \text{ kJ/mol}\)  E) \(407.0 \text{ kJ/mol}\)
C) \(219.0 \text{ kJ/mol}\)

Ans: C
61. Given the following ΔH° values,

\[ \text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H°_f = -285.8 \text{ kJ/mol} \]
\[ \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \quad \Delta H°_{\text{rxn}} = 187.6 \text{ kJ/mol} \]

calculate ΔH°rxn for the reaction \( \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \).

Ans: \(-98.2 \text{ kJ/mol}\)

62. A 0.3423 g sample of pentane, \( \text{C}_5\text{H}_{12} \), was burned in a bomb calorimeter. The temperature of the calorimeter and the 1.000 kg of water contained therein rose from 20.22°C to 22.82°C. The heat capacity of the calorimeter is 2.21 kJ/°C. The heat capacity of water = 4.184 J/g·°C. What is the heat of combustion, in kilojoules, per gram of pentane?

Ans: \(48.6 \text{ kJ/g}\)

63. TRUE/FALSE: If \( 2\text{Mg}(s) + \text{O}_2(\text{g}) \rightarrow 2\text{MgO}(s), \Delta H° = -1203.6 \text{ kJ/mol} \).

For \( \text{Mg}(s) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{MgO}(s) \), the enthalpy change is \( \Delta H = -601.8 \text{ kJ/mol} \).

Ans: True
CHEM 1411 Formulas and Constants

<table>
<thead>
<tr>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass of proton</td>
<td>1.00728 amu</td>
</tr>
<tr>
<td>mass of neutron</td>
<td>1.00866 amu</td>
</tr>
<tr>
<td>c</td>
<td>$3.00 \times 10^8$ m/s</td>
</tr>
<tr>
<td>F</td>
<td>96500 C/(mol of e⁻) = 96500 J/(V mol of e⁻)</td>
</tr>
<tr>
<td>K</td>
<td>0°C + 273.15</td>
</tr>
<tr>
<td>R</td>
<td>0.08206 (L atm)/(mol K) = 8.314 J/(mol K)</td>
</tr>
<tr>
<td>1 g</td>
<td>$6.022 \times 10^{23}$ amu</td>
</tr>
<tr>
<td>1 atm</td>
<td>760 mm Hg</td>
</tr>
<tr>
<td>1 mL</td>
<td>1 cm³</td>
</tr>
</tbody>
</table>

Temperature scales/Conversion:

- $T_K = T_C + 273$ (Celsius to Kelvin)
- $T_C = T_K - 273$ (Kelvin to Celsius)
- $T_F = (1.8 \times T_C) + 32$ (Celsius to Fahrenheit)
- $T_C = (T_F - 32) / 1.8$ (Fahrenheit to Celsius)

Percent by mass = \( \frac{\text{mass of solute}}{\text{[mass of solute + mass of solvent]}} \times 100\% \)

Two-component solution:
Mole fraction of solute A: \( X_A = \frac{\text{moles of solute A}}{\text{moles of solute A + moles of solvent B}} \)

Molarity = number of moles of solute in 1 L of solution:

Molarity = \( \frac{\text{moles of solute}}{\text{Liters of solution}} \)

Molality = number of moles of solute dissolved in 1 kg (1000 g) of solvent:

Molality = \( \frac{\text{moles of solute}}{\text{Mass of solvent (1 kg)}} \)

Density = Mass / Volume.