Part I. Circle your answers for multiple choice questions

1. 550 nm electromagnetic radiation is in what region of the electromagnetic spectrum?
   A) Ultraviolet
   B) Visible
   C) Infrared
   D) Microwave
   E) X-ray

2. Which of the following choices is false regarding the wave amplitude of electromagnetic radiation? (Circle all that apply. There may be more than one answer)
   A) For visible light, a larger wave amplitude correlates with a brighter light
   B) A larger wave amplitude correlates with higher energy photons
   C) A larger wave amplitude correlates with a larger number of photons
   D) A larger wave amplitude correlates with a longer wavelength
   E) A larger wave amplitude correlates with increased wave speed

3. Which of the following compounds will not undergo an acid-base (neutralization) reaction with HClO₄?
   A) NaOH
   B) Sr(OH)₂
   C) NH₃
   D) Na₂CO₃
   E) H₂SO₄

4. If the ΔH° for the reaction, 2 Mg(s) + 2 Cl₂(g) → 2 MgCl₂(g), is -1283.6 kJ, what is the standard enthalpy of formation of magnesium chloride?
   A) 0 kJ/mol
   B) -320.9 kJ/mol
   C) -641.8 kJ/mol
   D) 1283.6 kJ/mol
   E) -1283.6 kJ/mol

5. Assign the proper oxidation state for the sulfur atom in each of the following species.
   a) H₂S
      b) Na₂SO₄

6. In one sentence, clearly explain why only some wavelengths of light are absorbed when a white light source is directed through a sample of He gas.
   Light is absorbed only if the photon energy matches the energy gap between atomic orbitals on He.
Part II. Show All Your Work!

7. You place 2.80 g of phosphoric acid (H₃PO₄) into 150.0 mL of a 1.00 M sodium hydroxide solution. If the total volume remains constant, identify the following:

a) The concentration of sodium ion at the completion of the reaction: 1.00 M

b) The concentration of phosphate ion at the completion of the reaction: 0.190 M

c) The concentration of hydroxide ion at the completion of the reaction: 0.428 M

\[ \frac{2.80 \, \text{g} \, \text{H}_3\text{PO}_4}{97.99 \, \text{g/mol}} = 0.0286 \, \text{mol} \, \text{H}_3\text{PO}_4 \quad \text{Limiting} \]

\[ \text{H}_3\text{PO}_4 + 3 \text{NaOH} \rightarrow 3\text{H}_2\text{O} + \text{Na}_3\text{PO}_4 \]

\[ [\text{PO}_4^{3-}] = \frac{0.0286 \, \text{mol}}{0.150 \, \text{L}} = 0.190 \quad [\text{OH}^-] = \frac{1.50 - 3(0.0286)}{0.150 \, \text{L}} = 0.428 \]

8. According to De Broglie’s theory, an electron moving at 12.5% the speed of light will display wave behavior at what wavelength?

\[ \lambda = \frac{h}{mu} = \frac{6.626 \times 10^{-34} \text{J} \cdot \text{s}}{(9.109 \times 10^{-31} \text{kg})(125)(3.00 \times 10^8 \text{m/s})} \]

\[ \lambda = 1.94 \times 10^{-11} \text{m} \quad \text{or} \quad 19.4 \text{pm} \]

Note: \( 1 \, \text{J} = 1 \, \text{Kg m}^2 \text{ s}^{-2} \)

9. What is the energy of one mole of radio wave photons with a wavelength of 95.6 meters?

\[ E_{\text{photon}} = \frac{h \lambda c}{\lambda} = \frac{(6.626 \times 10^{-34} \text{J} \cdot \text{s}) (3.00 \times 10^9 \text{m/s})}{95.6 \, \text{m}} = 2.08 \times 10^{-27} \text{J} \]

\[ E_{\text{mol}} = N_A E_{\text{photon}} = (6.022 \times 10^{23})(2.08 \times 10^{-27} \text{J}) = 1.25 \times 10^3 \text{ J/mol} \]
10. Balance the following redox reaction (in either acidic or basic solution — your choice).

\[ I^- (aq) + ClO^- (aq) \rightarrow I_2 (aq) + Cl^- (aq) \]

\[ \text{Ox:} \quad 2I^- \rightarrow I_2 + 2e^- \]
\[ \text{red:} \quad 2H^+ + ClO^- + 2e^- \rightarrow Cl^- + H_2O \]

\[ 2H^+ + ClO^- + 2I^- \rightarrow Cl^- + I_2 + H_2O \]

11. You measure 48.0 mL of a solution of sulfuric acid with an unknown concentration, and carefully titrate this solution using a 1.500 M solution of KOH and a phenolphthalein indicator. You measure that 34.7 mL of the KOH solution is required to reach the equivalence point. What is the concentration of the sulfuric acid solution?

\[ H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O \]

\[ 0.347 \text{ L KOH soln} = 1.500 \text{ mol KOH} \]
\[ 12 \text{ soln} = 2 \text{ mol KOH} \]
\[ 0.0478 \text{ L soln} \]

\[ 0.542 \text{ M H}_2\text{SO}_4 (aq) \]
12. Complete combustion of 1.00 mol of acetone (C₃H₆O) liberates 1790. kJ of heat (the reaction is shown below). Given that \( \Delta H^\circ_r (\text{CO}_2) = -393.5 \) kJ/mol and \( \Delta H^\circ_r (\text{H}_2\text{O}) = -285.8 \) kJ/mol, calculate the standard enthalpy of formation of acetone. *Make sure to balance the reaction!*

\[
\text{C}_3\text{H}_6\text{O}(l) + 4\text{O}_2(g) \rightarrow 3\text{H}_2\text{O}(l) + 3\text{CO}_2(g)
\]

\[
\Delta H_{\text{rxn}} = \sum \Delta H_f^{\text{prod.}} - \sum \Delta H_f^{\text{reactants}}
\]

\[
-1790 = \left[3(-285.8) + 3(-393.5)\right] - \left[\Delta H_f^{\text{C}_3\text{H}_6\text{O}} + 0\right]
\]

\[
\Delta H_f^{\text{C}_3\text{H}_6\text{O}} = -248 \text{ kJ/mol}
\]