1. A car is advertised as having a gasoline mileage of 15 km/L. Convert this rating to miles per gallon of gasoline? (1 m = 1.094 yd, 1 km = 0.621 miles, 1 gallon = 4 qt, 1 qt = 0.946 L) (5%) 

2. Give the (English and Chinese) names of the metals that correspond to the following symbols: Sn, Pt, Co, Ni, Mg, Ba, K, Na, H, O? (10%) 

3. Briefly describe two methods one might use to find the molar mass of a newly synthesized gas for which a molecular formula was not known? (5%) 

4. Given the following data:
   \[ \text{H}_2(g) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{H}_2\text{O}(l), \quad \Delta H = -285.8 \text{ kJ} \]
   \[ \text{NO}_2(g) + \text{H}_2\text{O}(l) \rightarrow 2 \text{HNO}_3(l), \quad \Delta H = -76.6 \text{ kJ} \]
   \[ \frac{1}{2} \text{N}_2(g) + \frac{3}{2} \text{O}_2(g) + \frac{1}{2} \text{H}_2(g) \rightarrow \text{HNO}_3(l), \quad \Delta H = -174.1 \text{ kJ} \]
   Calculate the \( \Delta H \) for the reaction: \( 2 \text{N}_2(g) + 5 \text{O}_2(g) \rightarrow 2 \text{NO}_3(g) \)? (10%) 

5. (1) Explain why the first ionization energies tend to increase as one proceeds from left to right across a period in the chemical periodic table? (10%) 

6. Why is the first ionization energy of aluminum lower than that of magnesium? (10%) 

7. Consider the following reaction: \( \text{H}_2(g) + \text{O}_2(g) \rightarrow \text{H}_2\text{O}(g), \quad \Delta H = -153 \text{ kJ} \)
   Given that the H–O bond energy is 432 kJ/mol, the O–O bond energy is 495 kJ/mol, and the OH bond energy is 467 kJ/mol, estimate the bond energy for the \( \text{O} \equiv \text{O} \) (oxygen-oxygen) single bond? (5%) 

8. Which one of the following groups is predicted by the molecular orbital model to be the most stable diatomic species? (a) \( \text{H}_2^+, \text{H}_2, \text{H}_2^-, \) (b) \( \text{He}_2^+, \text{He}_2, \text{He}_2^- \) (5%) 

9. Calcium has a cubic closest packed structure as a solid. Assuming that calcium has an atomic radius of 197 pm, calculate the density of solid calcium. (Ca = 40.08 g/mol) (10%) 

10. In lab you need to prepare at least 100 ml of each of the following solutions. Explain how you would proceed using the given information. (10%) 
   (a) 2.0 M KCl in water (density of water = 1.00 g/cm³; K = 39.1 g/mol, Cl = 36.5 g/mol) 
   (b) 25% NaOH by mass in CH₃OH (density of CH₃OH = 0.79 g/cm³; Na = 23 g/mol) 

11. A first order reaction \( A \rightarrow P \) (rate = \(-d[A]/dt = k[A]\)) is 38.5% complete in 480 s. 
   (seconds) (a) Calculate the rate constant \( k = ? \) (10%) 
   (b) What is the value of the half-life \( t_{1/2} = ? \) (10%) 

12. What is the partial pressure of NO in equilibrium with N₂ and O₂ that were placed in a constant volume flask at initial pressures of 0.80 atm and 0.20 atm, respectively? (10%) 

13. Calculate the pH values of the following solutions: 
   (a) 0.10 M HNO₃(aq)?; (b) 1.0 \times 10^{-6} \text{ M} \text{HCl(aq)?}; (c) 0.010 \text{ M} \text{H}_2\text{SO}_4(aq)? (For H₂SO₄: \( K_a = \infty \), \( K_a = 1.2 \times 10^{-2} \)) (10%)