1. For a particular process \( q = -10 \text{ kJ} \) and \( w = 25 \text{ kJ} \). Which of the following statements is true?
   a. Heat flows from the surroundings to the system.
   b. The system does work on the surroundings.
   c. \( \Delta E = -15 \text{ kJ} \)
   d. All of these are true.
   e. None of these is true.

2. A gas absorbs 4.8 J of heat and then performs 13.0 J of work. What is the change in internal energy of the gas?

3. Which of the following statements is correct?
   a. The internal energy of a system increases when more work is done by the system than heat is flowing into the system.
   b. The internal energy of a system decreases when work is done on the system and heat is flowing into the system.
   c. The system does work on the surroundings when an ideal gas expands against a constant external pressure.
   d. All the statements are true.
   e. All the statements are false.

4. Which of the following are always exothermic?
   a. Breaking bonds
   b. Melting
   c. Combustion
   d. Condensation
   e. Sublimation

5. The following reaction occurs at constant temperature and pressure. Which of the following statements is true?

   \[
   4 \text{NH}_3 (g) + 5 \text{O}_2 (g) \rightarrow 4 \text{NO} (g) + 6 \text{H}_2\text{O} (g)
   \]
   a. The system does work on the surroundings and \( w < 0 \)
   b. The surroundings do work on the system and \( w < 0 \)
   c. The system does work on the surroundings and \( w > 0 \)
   d. The surroundings do work on the system and \( w > 0 \)
   e. No work is done, \( w = 0 \)
6. Calculate the value of $q$, $w$, $\Delta E$ and $\Delta H$ for the following:

a. heating 500 g of nitrogen gas from 50.0 °C to 75.0 °C in a rigid container
(for $N_2$, $C_v = 20.71 \text{ J/K mol}$ and $C_p = 29.03 \text{ J/K mol}$)

b. cooling 500 g of nitrogen gas from 75.0 °C to 50.0 °C at a constant pressure of 1.00 atm
7. For every gas, why is the value of $C_p$ greater than $C_v$? By what constant are they related?

8. Consider 2.00 mol of a monatomic ideal gas that is taken from state A (2.0 atm, 10.0 L) to state B (1.00 atm, 30.0 L) by two different pathways:

   Path 1: State A (2.0 atm, 10. L) $\rightarrow$ State C (2.0 atm, 30. L) $\rightarrow$ State B (1.0 atm, 30. L)

   Path 2: State A (2.0 atm, 10. L) $\rightarrow$ State D (1.0 atm, 10. L) $\rightarrow$ State B (1.0 atm, 30. L)

   Calculate $q$, $w$, $\Delta E$ and $\Delta H$ for both pathways.
9. Consider the reaction: \(4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O} \quad \Delta H = -338 \text{ kJ}\)

a. True or False: the products have more energy than the reactants.
b. Calculate the heat released when 12 g of ammonia reacts with 25 g of oxygen.

10. For different objects with the same mass, subjected to the same amount of heat,…

   the one with ____________ heat capacity will experience a ______________ temperature change.

11. The heat capacity of a bomb calorimeter was determined by burning 4.20 g of methane (energy of combustion = -802 kJ/mol) in the bomb. The bomb increased in temperature by 12.6 °C. Calculate the heat capacity (in kJ/°C) of the calorimeter.

12. If a 50.0 g sample of copper is heated to 85.0 °C and placed in 100 mL of water initially at 25.0 °C, what will be the final temperature of the water assuming no heat is lost to the surroundings? 
   \((C_{Cu} = 0.20 \text{ J/g °C}, \ C_{water} = 4.18 \text{ J/g °C})\)
13. Consider the dissolution reaction: \( \text{CaCl}_2(s) \rightarrow \text{Ca}^{2+}(aq) + 2\text{Cl}^- (aq) \) \( \Delta H = -81.5 \text{ kJ} \)
If 20.0 g of calcium chloride are dissolved in 150. mL of water at 25.0 °C, what will be the final temperature of the solution assuming no heat loss to surroundings? (heat capacity of solution is 4.18 J/g °C)

14. Given the following:
- \( \text{P}_4(s) + 6\text{Cl}_2(g) \rightarrow 4\text{PCl}_3(g) \) \( \Delta H = -1226 \text{ kJ} \)
- \( \text{P}_4(s) + 5\text{O}_2(g) \rightarrow \text{P}_4\text{O}_{10}(s) \) \( \Delta H = -2967 \text{ kJ} \)
- \( \text{PCl}_3(g) + \text{Cl}_2(g) \rightarrow \text{PCl}_5(g) \) \( \Delta H = -84 \text{ kJ} \)
- \( \text{PCl}_3(g) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{Cl}_3\text{PO}(g) \) \( \Delta H = -286 \text{ kJ} \)

Calculate \( \Delta H \) for the reaction: \( \text{P}_4\text{O}_{10}(s) + 6 \text{PCl}_5(g) \rightarrow 10 \text{Cl}_3\text{PO}(g) \)

15. Write the reaction that corresponds to the enthalpy of formation of \( \text{CH}_3\text{OH} \) (l)

16. Use the following data:
- \( \Delta H_f^\circ \)
  - \( \text{C}_3\text{H}_8 \) (g) \( -104 \text{ kJ/mol} \)
  - \( \text{CO}_2 \) (g) \( -394 \text{ kJ/mol} \)
  - \( \text{H}_2\text{O} \) (g) \( -242 \text{ kJ/mol} \)

  a. Calculate the heat released when 1 mol of propane, \( \text{C}_3\text{H}_8 \), is burned.

  b. Calculate \( \Delta E \) for the combustion of propane at 25 °C.
Equations

\[ q = nC\Delta T \quad q = mC\Delta T \quad q = C\Delta T \]

\[ q = n\Delta H \quad q = m\Delta H \]

\[ w = -P_{\text{ext}}\Delta V \]

\[ \Delta E = q + w \quad \Delta E = q_v = nC_v\Delta T \]

\[ \Delta H = \Delta E + \Delta(PV) \quad \Delta H = q_p = nC_p\Delta T \]

Constants

\[ R = 0.08206 \frac{\text{Latm}}{\text{mol K}} \quad R = 8.3145 \frac{\text{J}}{\text{mol K}} \quad 1 \text{ L atm} = 101.3 \text{ J} \]