

CH301H – Principles of Chemistry I: Honors
Fall 2017, Unique 50135
Homework, Weeks 14-15

1. Nitrogen gas (N_2) is heated slowly at a constant pressure of 50.0 atm from an initial volume of 540 L to a final volume of 975 L. Determine the work performed by the system.
2. Calculate the work done for each of the following examples:
 - a) Our textbook (1.8 kg) is carried up three flights of stairs with a horizontal displacement of 10 m.
 - b) An ideal gas expands isothermally from 1.0 L to 1.9 L at 25°C against a constant external pressure of 1.0 atm.
3. If you were on the surface of the moon you would need to wear a space suit with thermal insulation. In exploring the moon you might generate 4 kJ of heat per kg of mass per hour. If your body retains all of this heat because the insulation, how much would your temperature change per hour during this activity? How long would you recommend for such a moon walk? Assume your body mass is 65 kg and that your heat capacity is approximately that of water ($C_{p,m}(\text{H}_2\text{O}_{(l)}) = 75.29 \text{ J K}^{-1} \text{ mol}^{-1}$).
4. A gas at room temperature is sealed in a container with strong rigid walls. It is then heated vigorously.
 - a) Determine whether ΔU , q , and w of the system are positive, negative, or zero during the heating.
 - b) The container is then cooled to its original temperature. Determine whether ΔU , q , and w of the system are positive, negative, or zero during the cooling.
 - c) If the heating is step 1 and the cooling is step 2, determine the signs of $(\Delta U_1 + \Delta U_2)$, $(q_1 + q_2)$, and $(w_1 + w_2)$.
5. 0.500 mole of $\text{N}_2(\text{g})$ at 1.00 atm and 273 K is expanded against a constant external pressure of 0.100 atm until the gas pressure reached 0.200 atm, at a temperature of 210 K. Determine the work done by the system, the change in internal energy, and heat absorbed by the system.
6. A chemical reaction takes place in a container with a cross-sectional area of 1 m^2 . As a result of this reaction, a piston is pushed out 500 cm against an external pressure of 1.0 atm. Calculate the work done by the system.
7. The standard enthalpy of combustion of cyclopropane is $-2091 \text{ kJ mol}^{-1}$ at 25°C . From this information and the enthalpy of formation for $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{g})$, calculate the enthalpy of formation of cyclopropane. The enthalpy of formation of propene is $+20.4 \text{ kJ mol}^{-1}$. Calculate the enthalpy of isomerization of cyclopropane to propene.

8. For each of the following transformations, determine whether q , w , ΔU , and ΔH of the system are greater than zero, less than zero, or equal to zero.

- a) Air is sealed in a container with rigid walls and then heated from room temperature to 90°C .
- b) Gas in a cylinder 5.0 L in volume is compressed by a constant external pressure of 4.0 atm to a final volume of 1.0 L.
- c) Water is heated in an open beaker in a laboratory from room temperature to 100°C .
- d) The battery of your laptop discharges completely, performing 100 J of electrical work and releasing 25 J of heat into the room.

9. A 1 L sample of 2.00 mol Ar gas is expanded isothermally at 0°C to a final volume of 5 L a) against a constant external pressure equal to the final pressure of the gas, and b) freely (against no external pressure). Determine q , w , ΔU , and ΔH for these three processes.

10. Calculate the standard enthalpy of solution of $\text{AgCl}(\text{s})$ in water from the enthalpies of formation of the solid and aqueous ions.

11. Consider a system composed of 14 g of $\text{N}_2(\text{g})$ at 298 K and 1.0 atm. Determine the change in entropy of this system, the surroundings, and the total change in entropy when the system is expanded to twice its original volume a) isothermally and against a constant external pressure of 0, and c) adiabatically and reversibly.

12. A 500 g block of copper ($C_{p,m} = 24.4 \text{ J K}^{-1} \text{ mol}^{-1}$) initially at 293 K is in thermal equilibrium with an electric heater of resistance 1.0 k Ω and negligible mass. A current of 1.0 A is passed for 15.0 s. Determine the change in entropy of the copper block. The experiment is then repeated with the copper immersed in a stream of water that maintains its temperature at 293 K. Determine the change in entropy of the copper and the water.

13. Which is greater, the entropy of a cylinder containing 1.0 mol of $\text{N}_2(\text{g})$ or a cylinder containing 1.0 mol of gas that is 50% $\text{N}_2(\text{g})$ and 50% $\text{H}_2(\text{g})$? Justify your answer.