

Exam #1 for Physical Chemistry for Energy Science
Department of Nuclear Engineering, Seoul National University

4/16/2007 Monday PM 2:00-3:30

90 minutes, closed book

One spike sheet and calculator are allowed.

1. (15) One may define that future nuclear energy must satisfy the following criteria; a) Proliferation-resistance, b) Environment-friendliness, c) Accident-tolerance, d) Continuity, e) Economical competitiveness
Give one example of problem for each of the five criteria with nuclear energy we use today. Do not exceed ONE LINE for EACH.

2. (20) Explain the following words, in ONE LINE for EACH.;

- Kinetic properties
- Thermodynamic properties
- Thermodynamic state
- Equilibrium
- Law of corresponding states
- The first law
- The second law
- The third law
- Equation of state
- Standard state

$$PV = N/m^2 \cdot m^3 = J$$

$$nRT$$

$$N/m^2 \cdot K$$

$$\frac{kg \cdot m^2/s^2}{mol}$$

3. (20) Hydrogen gas is widely used for cooling the rotating magnet (rotor) in an electric generator.

- Compare the molar weight and specific heat of hydrogen gas and helium at room temperature $M =$
- Explain why hydrogen is preferred despite of fire risk.
- What is the most probable speed of helium molecule at room temperature?
- Why is the RMS energy of helium greater than the most probable energy?

$$\sqrt{\frac{2RT}{M}}$$

$$\frac{R}{M}$$

$$10^{10}$$

$$0.0831$$

4. (10) In a tokamak-based nuclear fusion concept that has been studied over past fifty years, deuterium-ion ($D^+ = {}_1H^2$) and Tritium-ion ($T^+ = {}_1H^3$) react to form He -ion and one neutron.



- a) If you can assume that the equi-partition principle is applicable to each element including neutron, predict how will the specific heat of mixture before the reaction be different from that after the reaction.
- b) Assuming an ideal gas behavior, show that the mean gas molecular speed is $u = (3RT/M)^{1/2}$.

5. (20) A mole of an ideal gas in a piston was expanded from V_1 to V_2 in an isothermal process at T_1 . ANSWER in TWO LINES.

- a) What are the requirements to be a reversible process?
- b) What is the change in entropy due to the volume increase in a reversible process?
- c) What is the change in entropy due to the volume increase in an irreversible process
- d) What is the physical meaning of the entropy change by the volume increase?

$$S = \frac{dq}{T} = \frac{-dw}{T} =$$



$$\frac{1}{T} = \frac{nR}{PV}$$

6. (15) Assuming that the internal energy, U , is given, answer in TWO LINES that:

- a) Explain the physical meaning of Helmholtz free energy $A = U - TS$
- b) Explain the physical meaning of Gibbs free energy $G = H - TS$?
- c) What is the physical meaning of NON-EXPANSIVE WORK?

END.

$$H = U + PV$$

$$dA = dU - TdS - SdT$$

$$= dq - PdV - TdS - SdT$$

$$dG = dH - TdS - SdT$$

$$= dU + PdV + VdP - TdS - SdT$$

$$= dq + dw + PdV + VdP - TdS - SdT$$

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