

**KABARAK**



**UNIVERSITY**

**UNIVERSITY EXAMINATIONS**

**2008/2009 ACADEMIC YEAR**

**FOR THE DEGREE OF BACHELOR OF EDUCATION  
SCIENCE**

**COURSE CODE: CHEM 311**

**COURSE TITLE: ORGANIC CHEMISTRY IV**

**STREAM: SESSION VI**

**DAY: THURSDAY**

**TIME: 2.00 – 4.00 P.M.**

**DATE: 13/08/2009**

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**INSTRUCTIONS TO CANDIDATES:**

*Attempt all questions*

**PLEASE TURN OVER**

## QUESTION ONE (20MARKS)

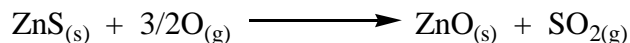
- a) Define the following terms:
- Internal energy
  - Work
  - Heat (6marks)
- b) State and explain the different types of thermodynamic systems. (6marks)
- c) Calculate the work done by an expansion of 1 mol of an ideal gas from  $V_2 0.01\text{m}^3$  to  $0.1\text{m}^3$  at  $25^\circ\text{C}$  by the following processes;
- Against a constant external pressure of 0.1 bar. (2marks)
  - From  $0.01\text{m}^3$  to  $0.025\text{m}^3$  against a constant external pressure of 0.33bar, followed by a second expansion from  $0.025\text{m}^3$  to  $0.05\text{m}^3$  against a constant external pressure of 0.2bar, followed by a third expansion from  $0.05\text{m}^3$  to  $0.1\text{m}^3$  against a constant external pressure of 0.1 bar. (4marks)
  - A reversible expansion. (2marks)

## QUESTION TWO (20MARKS)

- a) Show that the mean energy of an atom in three dimensional motion can be given by  $3/2nRT$ . (4marks)
- b) State the second law of thermodynamics and define all terms there in. (4marks)
- c) What is entropy? Hence explain the effect of temperature change on the entropy of a system. (4marks)
- d) A system at  $25^\circ\text{C}$  absorbed  $6.2 \times 10^6\text{J}$  from its surroundings without undergoing a temperature change. Calculate  $\Delta S_{(\text{system})}$ . Is this an increase or a decrease in entropy for the system? (4marks)
- e) Consider a reversible isothermal expansion of 1.00 mol of an ideal gas from  $0.01\text{m}^3$  to  $0.1\text{m}^3$  at 298K. Calculate  $\Delta S_{(\text{system})}$  for this process. (4marks)

### QUESTION THREE (15MARKS)

- a) One of the first steps involved in refining sulfide ore is the process of roasting ZnS (sphalerite) as shown in the equation below.

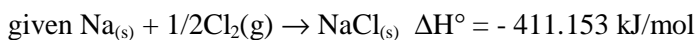


Given that the  $\Delta_f H^\circ_{298}$  in kJ/mol of  $\text{ZnS}_{(s)}$ ,  $\text{ZnO}_{(s)}$  and  $\text{SO}_{2(g)}$  are -205.98, -348.28 and -296.3 respectively. Calculate the  $\Delta_r H^\circ_{298}$  in kJ/mol for roasting sphalerite. (6marks)

- b) Given that  $\Delta S^\circ_{\text{rxn}}$  in J/mol.K for  $\text{CO}_{2(g)}$ ,  $\text{H}_2\text{O}_{(l)}$ ,  $\text{C}_3\text{H}_8$  and  $\text{O}_{2(g)}$  are 21.7, 69.9, 26.99 and 205 respectively. Calculate  $\Delta S^\circ_{\text{rxn}}$  in J/mol.K for the combustion of propane. (6marks)

- c) Given that  $\Delta_f H^\circ$  in kJ/mol of  $\text{Cl}^-_{(g)}$  and  $\text{Na}^+_{(g)}$  are -233.13 and 609.358 and respectively.

Calculate the lattice energy of  $\text{NaCl}_{(s)}$ . (3marks)



### QUESTION FOUR (15MARKS)

- a) Define the following terms:

- i. Critical point (2marks)
- ii. Triple point (2marks)
- iii. Supercritical fluid (2marks)
- iv. Phases (2marks)
- v. Equilibrium (2marks)

- b) Consider a process of water vapour condensation from vapour into liquid. What are the signs of  $\Delta H$  and  $\Delta S$  for this reaction? Give an explanation for each case, and hence comment on the spontaneity of this reaction. (5marks)