



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SECOND SEMESTER SUPPLEMENTARY EXAMINATION FOR
BACHELOR OF EDUCATION SCIENCE

BACHELOR OF EDUCATION (SPECIAL NEEDS)

SCH 201: CHEMICAL THERMODYNAMICS

DATE: 25/9/2019

TIME: 2:00 – 4:00 PM

INSTRUCTIONS:

1. Question number one is **compulsory**
2. Choose any other two questions.

Useful constants

$R=8.314\text{J/mol K}$ or $R=0.08206\text{L.atm/mol K}$

$C_p=\frac{5}{2}R$ $C_v=\frac{3}{2}R$ (monoatomic ideal gases)

$C_p=\frac{7}{2}R$ $C_v=\frac{5}{2}R$ (Diatomic ideal gases)

STP ($T=273.15\text{K}$, $1\text{atm}=101325\text{Nm}^{-2}$, $V=22.415\text{dm}^3$)

$\Delta U=nC_vdT$

$\Delta H=nC_pdT$

QUESTION ONE (30 MARKS)

- a) State and give a mathematical expression for the first law of thermodynamics (3 marks)
- b) Differentiate between intensive and extensive property of matter and classify the following properties as either extensive or intensive (3 marks)
- i) Density
 - ii) Pressure
- c) Explain why $C_p > C_v$ (3 marks)
- d) Give an expression for the change in internal energy of the system as it expands by volume ΔV against an external pressure P_{ext} on absorbing q joules of heat (3 marks)
- e) A sample of gas changes in volume from 4L to 6L against an external pressure of 1.5 atm and simultaneously absorbs 1000J of heat. What is the change in the internal energy of the system (4 marks)
- f) Classify the following as isolated, closed or open system (3 marks)
- i) Nitrogen and hydrogen reacting in a sealed tube to form ammonia
 - ii) A glass vial containing Sulphuric acid is broken inside water in a beaker
 - iii) Thermos flask
- g) A certain gas expands from 250mL to 750mL very slowly at 25°C. If there is one mole of the gas in the chamber, calculate the work involved when the gas behaves ideally (3 marks)
- h) Critical temperature of methane and carbon dioxide are -81.9°C and 31.1°C. which of these gases has stronger intermolecular forces and why (3 marks)
- i) Determine the entropy of the following reaction using information below (3 marks)
- | Substance | $S^\circ (\text{Jmol}^{-1}\text{K}^{-1})$ |
|----------------------------------|---|
| $\text{C}_2\text{H}_2(\text{g})$ | 200.82 |
| $\text{H}_2(\text{g})$ | 130.59 |
| $\text{C}_2\text{H}_4(\text{g})$ | 219.45 |
- $\text{C}_2\text{H}_2(\text{g}) + \text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_4(\text{g})$
- j) State and give mathematical expression for the third law of thermodynamics (2 marks)

QUESTION (20 MARKS)

A 4L sample of hydrogen gas at 15atm and 25°C is allowed to expand to a final pressure of 1atm. calculate q , w , ΔU and ΔH if the gas expands

- i) Adiabatically and reversibly (10 marks)
- ii) Adiabatically and irreversibly (10 marks)

QUESTION THREE (20 MARKS)

- a) Define standard enthalpy of formation (2 marks)
- b) Given the following standard enthalpies of formation, calculate the $\Delta H^\circ_{\text{Combustion}}$ of benzene. Calculate $\Delta U_{\text{combustion}}$ at 298.15K (10 marks)

Compound	$\Delta H^\circ_f(\text{kJ/mol})$
$\text{CO}_2(\text{g})$	-393.51
$\text{C}_6\text{H}_6(\text{l})$	+48.7
$\text{H}_2\text{O}(\text{l})$	-285.83

- c) Two Carnot engines operate with a temperature difference of 250K between their hot and cold reservoirs. If engine A's hot reservoir is maintained at 1000K, while that of engine B is maintained at 750K, which is the more efficient engine? (6 marks)
- d) Define heat capacity (3 marks)

QUESTION FOUR (20 MARKS)

- a) State Hess's law (2 marks)
- b) What is the heat required to vaporize 1 mole of $\text{H}_2\text{O}(\text{l})$ at 25°C (1 atm). given $\Delta H^\circ_{\text{vap}}=40.66\text{kJ/mol}\cdot\text{K}$, C_p of $\text{H}_2\text{O}(\text{l})=75.4\text{kJ/Mol}\cdot\text{K}$ and C_p of $\text{H}_2\text{O}(\text{g})=33.76\text{kJ/Mol}\cdot\text{K}$ (7 marks)
- c) By giving two examples for each differentiate between state and non-state functions (6 marks)
- d) Calculate the change in free energy when 11.21dm³ of a perfect gas at 0°C and 760mmHg pressure expands isothermally until its pressure is 190mmHg (5 marks)

QUESTION FIVE (20 MARKS)

- a) Sample of 1 mole of silver at 150°C is placed in contact with 1mole of silver at 0°C forming an isolated system at constant pressure. Given that the constant heat capacity of silver is 25.75J/mol K, calculate the
- i)The final temperature of both the silver samples (5 marks)
 - ii)Calculate ΔS for the hot silver (3 marks)
 - iii)Calculate ΔS for the cold silver (3 marks)
 - iv)The total ΔS of the system (2 marks)
 - v) Is the process spontaneous (2 marks)
- b) State the physical concept of entropy and its variation with temperature (5 marks)