THE OPEN UNIVERSITY OF SRI LANKA
B. Sc. Degree Programme — Level 4
Assignment III (Test)— 2006/2007
[Part I -thermo(1-7)and Part III- Mol. Spec(1-6)]
CHU 2124/CHE 4124 — Physical Chemistry I

$\left(1\frac{1}{2}\text{ hours}\right)$

5th Sept. 2006 — 3.30 p.m. — 5.00 p.m.

Gas constant (R)	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
Avogadro constant (N_A)	=	$6.023\times10^{23}\ \text{mol}^{-1}$
Faraday constant (F)	=	$96{,}500\ \text{C mol}^{-1}$
Planck constant (h)	=	$6.63\times10^{-34}\ \text{J s}$
Velocity of light (c)	=	$3.0\times10^{8}\ \text{m s}^{-1}$
Standard atmospheric pressure	=	$10^{5}\ \text{Pa}\left(\text{N m}^{-2}\right)$
$\text{Log}_e(X)$	=	$2.303\ \text{Log}_{10}(X)$

- Please write your **Registration number, Name, and Address** clearly in the space provided; see **last page** of this question paper.

- The paper has **two** parts, A and B.
- There are 20 (twelve) Multiple Choice Questions in **PART – A** and 02 (two) Structured Questions in **PART – B.**
- Use a **PEN** (not a PENCIL) in answering.
- The use of a *non-programmable* electronic calculator is permitted.
- Logarithm tables will be provided if desired.

PART – A, Multiple Choice Questions.

- In answering, choose the most correct answer to each of the questions and mark this answer with an "X" on the answer script for PART – A, in the appropriate box.
- Any answer with more than **one** "X" marked will be considered as an *incorrect* answer.
- Each correct answer will score 05 marks.
- Marks will be deducted for incorrect answers ($\frac{5}{6}$ per answer).

PART – B, Structured Questions.

- Write down your answers in the spaces provided in PART – B of this question paper itself.

1. What is the special term used to identify radiation with a single frequency?

(a) Electromagnetic radiation

(b) Microwaves

(c) X-rays

(d) γ-rays

(e) Monochromatic radiation

2. The energy **(in kJ)** corresponding to a photon of light of wavelength 300 nm is, approximately, of the order

(a) 10^{-31} (b) 10^{-29} (c) 10^{-24} (d) 10^{-22} (e) 10^{-19}

3. The unit of intensity of a beam of electromagnetic radiation is W m^{-2}. This unit, expressed in **fundamental SI units**, is equivalent to

(a) kg m^{-2} s^{-1} (b) kg m^{-1} s^{-3} (c) kg m^{-2} s^{-2} (d) kg m^{2} s^{-1} (e) kg s^{-3}

4. The order of decreasing wavelength of radiation is

(a) microwave > UV-visible > radio wave

(b) radio wave > microwave >UV-visible

(c) radio wave > UV – visible> microwave

(d) UV-visible> radio wave>microwave

(e) microwave > radio wave >UV-visible

5. The expression that represents "wave number" ($\bar{\nu}$) with the correct units is

(symbols used have their usual meanings)

(a) $\bar{\nu} = \frac{1}{\lambda}$ m (b) $\bar{\nu} = \frac{1}{c}$ m^{-1} s (c) $\bar{\nu} = \frac{1}{\nu}$ s

(d) $\bar{\nu} = \frac{2}{\lambda}$ m^{-1} (e) $\bar{\nu} = \frac{1}{\lambda}$ m^{-1}

6. The frequency of two different electromagnetic waves, A and B, is 25 Hz and 22.5 Hz respectively. Which of the following statements is true in this regard?

(a) Velocity of A is greater than that of B

(b) Velocity of B is greater than that of A

(c) Both waves have the same velocity.

(d) Both waves have the same wavelength.

(e) Wavelength of A is greater than that of B

7. The absorbance of a sample depends on

(i) the path length of the radiation through it

(ii) wavelength of radiation used

(iii) its concentration

The correct choice/s is/are

(a) (i) and (ii) only (b) (i) and (iii) only

(c) (ii) and (iii) only (d) all of (i), (ii) and (iii) (e) none of (i), (ii) , (ii) are correct

Answer to questions 8 and 9 are based on the following.

A chlorophyll solution at 25 ^{0}C is placed in a cell having a path length 1.0 cm. The measured absorbance at a wavelength of 580 μm is 2.00.

8. The corresponding transmittance due to this solution is

(a) 0.01 (b) 0.1 (c) 0.5 (d) 1 (e) 10

9. The percentage absorption of radiation is

(a) 10 % (b) 20 % (c) 30 % (d) 90% (e) 99%

10. A hypothetical molecule has two energy levels, one at 2.5 x 10^{-23} J and the other at 3.5 x 10^{-23} J. The frequency and wavelength of light that must be absorbed for the excitation of this molecule (respectively) are, approximately,

(a) 1.5 x 10^{10} s^{-1}, 2.0 x 10^7 nm (b) 1.5 x 10^{12} s^{-1}, 2.0 x 10^7 nm (c) 1.5 x 10^{10} s^{-1}, 2.0 x 10^5 nm

(d) 1.5 x 10^{10} s^{-1}, 2.0 x 10^7 m (e) 1.5 x 10^{11} s^{-1}, 2.0 x 10^7 nm

11. (i) Dipole moment has both direction and magnitude.

(ii) Dipole moment is a vector quantity.

(iii) The SI unit of dipole moment is C m

Of these statements,

(a) only (i) and (ii) are correct (b) only (ii) and (iii) are correct (c) only (iii) and (i) are correct

(d) all of (i), (ii) and (iii) are correct (e) none of (i), (ii) and (iii) are correct

12. An absorption experiment is performed with an incident radiation of intensity, R_o. The absorbance is expected to

(i) increase with increase in the molar extinction coefficient of the absorbing species

(ii) increase with increase in the concentration of the absorbing species

(iii) to be independent of the intensity of the transmitted radiation

Of these

(a) only (i) and (ii) are correct (b) only (ii) and (iii) are correct (c) only (iii) and (i) are correct

(d) all of (i), (ii) and (iii) are correct (e) none of (i), (ii) and (iii) are correct

13. When compared with a higher resolution spectrum, a spectrum of a molecule recorded at a lower resolution, may appear to have

(i) less number of peaks than expected.

(ii) broader peaks

(iii) lesser number of peaks at higher frequencies and more number of peaks at lower frequencies.

Of these statements,

(a) only (i) and (ii) are correct (b) only (ii) and (iii) are correct (c) only (iii) and (i) are correct

(d) all of (i), (ii) and (iii) are correct (e) none of (i), (ii) and (iii) are correct

14. Pick the molecules which have a zero dipole moment

(i) o – dichloro benzene (ii) p – dichloro benzene (iii) water (iv) carbon disulphide

(a) only (i) and (ii) (b) only (ii) and (iii) (c) only (ii) and (iv)

(d) only (i) and (iv) (e) only (iii) and (iv)

15. The approximate bond distance (**in nm**) of a diatomic molecule having dipole moment of 4.802 D and partial charge of 0.1602×10^{-19} C is

(a) 3.33×10^{-29} (b) 2.99×10^{29} (c) 9.98×10^{-1}

(d) 9.98×10^{-10} (e) 9.98×10^{-2}

16. The expression for the ratio between Einstein A-coefficient and B-coefficient with respect to a photon of frequency ν is

(a) $\frac{A}{B}=\frac{8\pi}{c^2\nu}$ (b) $\frac{A}{B}=\frac{8\pi\nu}{c^3}$ (c) $\frac{B}{A}=\frac{8\pi\nu^2}{c^3}$

(d) $\frac{A}{B}=\frac{c^3\nu^2}{8\pi}$ (e) $\frac{A}{B}=\frac{8\pi\nu^2}{c^3}$

17. Which one of the following represents the process of stimulated emission?

(a) $M + h\upsilon \rightarrow M^*$

(b) $M^* \rightarrow M + h\upsilon$

(c) $M^* + h\upsilon \rightarrow M + 2h\upsilon$

(d) $M \rightarrow M^* + h\upsilon$

(e) $M^* + h\upsilon \rightarrow M$

18. A transition takes place between hypothetical energy levels E_1 and E_2 ($E_2 > E_1$). The expression for the frequency υ of the resulting peak in the absorption spectrum ("h" is the Planck constant) is

(a) $\upsilon=\frac{E_1-E_2}{h}$ (b) $\upsilon=\frac{E_2-E_1}{h}$ (c) $\upsilon=\frac{h}{E_1-E_2}$ (d) $\upsilon=\frac{h}{E_2-E_1}$ (e) $\upsilon=\frac{E_2+E_1}{h}$

19 The decreasing order of energy out of the following energy components

$E_{nuclear}$, $E_{electronic}$, $E_{vibrational}$, $E_{rotational}$ is

(a) $E_{nuclear} > E_{electronic} > E_{vibrational} > E_{rotational}$

(b) $E_{electronic} > E_{vibrational} > E_{rotational} > E_{nuclear}$

(c) $E_{rotational} > E_{vibrational} > E_{vibrational} > E_{nuclear}$

(d) $E_{vibrational} > E_{rotational} > E_{nuclear} > E_{electronic}$

(e) $E_{electronic} > E_{nuclear} > E_{vibrational} > E_{rotational}$

20 In a vibrational spectrum, the transitions that are **not expected** are

(i) Rotational transitions
(ii) Nuclear transitions
(iii) Electronic transitions

The correct chioces out of (i), (ii) & (iii) above are;

(a) Only (i) & (ii) (b) Only (i) & (iii) (c) Only (ii) & (iii)

(d) All of (i), (ii) & (iii) (e) None of (i), (ii) and (iii)

THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME 2006/2007
CHU 2124/CHE 4124 - PHYSICAL CHEMISTRY - LEVEL 4
ASSIGNMENT TEST - MCQ TEST (III)

MCQ ANSWER SHEET: Mark a cross (x) over the most suitable answer.

Reg.No.

FOR EXAMINERS ONLY	
Correct Answers	
Wrong Answers	
Marks	

1.	a	b	c	d	**e**	2.	a	b	c	**d**	e	3.	a	b	c	d	**e**
4.	a	**b**	c	d	e	5.	a	b	c	d	**e**	6.	a	b	**c**	d	e
7.	a	b	c	**d**	e	8.	**a**	b	c	d	e	9.	a	b	c	d	**e**
10.	**a**	b	c	d	e	11.	a	b	c	**d**	e	12.	a	b	c	**d**	e
13.	**a**	b	c	d	e	14.	a	b	**c**	d	e	15.	a	b	**c**	d	e
16.	a	b	c	d	**e**	17.	a	b	**c**	d	e	18.	a	**b**	c	d	e
19.	**a**	b	c	d	e	20.	a	b	**c**	d	e						

Part B (30%)

1.(a) What is meant by Joule Thompson effect?

(10 marks)

(b) Write down the expression for the Joule Thompson coefficient, $\mu_{J,T}$?

(05 marks)

(c) Given that H = f(P,T), write down the general expression for the total differential, dH (the symbols used have the usual meanings)

(10 marks)

(d) Show that $\mu_{J,T} = -\frac{1}{Cp}\left(\frac{\partial H}{\partial P}\right)_T$

(15 marks)

(e) It is said that for an ideal gas $\mu_{J,T} = 0$. Why?

(05 marks)

2. According to the Clapeyron equation $\frac{dp}{dT} = \frac{\Delta H}{T\Delta V}$

(i) To what kind of system is this equation applied?

(10 marks)

(ii)Transform this equation into the integrated form of the Clausious Clapeyron equation

$\ln\frac{P_2}{P_1} = \frac{\Delta H}{nR}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$ where (P_1, T_1) and (P_2, T_2) represent the initial and final states.

State all the assumptions made in obtaining this equation.

(25 marks)

(iii) The vapour pressure of toluene is 0.15 Pa at 27 °C and 0.60 Pa at 77 °C. Making use of the appropriate assumptions and applying the Clausius Clapeyron equation you derived in (ii) above, calculate the mean molar enthalpy change of toluene in the above temperature range.

(20 marks)

Answer Guide to Assignment Test III PART – B (30%)

(Pages referred to corresponds to the study material - Themodynamics-Part I)

1. (a) The cooling (due to change of temperature) as a result of adiabatic expansion of a real gas is called the Joule Thompson effect

(b) $\mu_{JT} = \left(\frac{\partial T}{\partial P}\right)_H$

(c) $dH = \left(\frac{\partial H}{\partial P}\right)_T dP + \left(\frac{\partial H}{\partial T}\right)_P dT$

(d) Refer Page 102 to show that $\mu_{JT} = -\frac{1}{Cp}\left(\frac{\partial H}{\partial P}\right)_T$

(e) Since $\left(\frac{\partial H}{\partial P}\right)_T = 0$ for an ideal gas

2. (i) System undergoing Univariant Phase Transformation
(Two phase, one component system/ Univariant System)

(ii) Refer page 81 and 82
One phase is vapor;
Volume of vapor phase is very large compared to the other phase.
Vapor behaves ideally.
ΔH is independent of temperature

(iii) Refer similar worked example on page 83

Answer = 24.203 kJ mol^{-1}