ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE
FACULTY: BASIC AND APPLIED SCIENCES
DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
SECOND SEMESTER EXAMINATIONS: 2015/2016 ACADEMIC SESSION
COURSE CODE: CHM 204 COURSE TITLE: PHYSICAL CHEMISTRY I
DURATION: 2.5 HOURS HOD's SIGNATURE

TABLE OF CONSTANTS:
Speed of light c, 2.997 x10^{8}m/s
Faraday constant F, 96500 C/mol
Gas constant R, 8.314JK^{-1}mol^{-1}
Gas constant R, 8.314 x 10^{-2}Lbar K^{-1}mol^{-1}
Avogadro's constant Na, 6.022 x10^{23} mol^{-1}
Elementary charge e, 1.602 x 10^{-19}C
Boltzmann constant k , 1.38 x10^{-23}J/K
Planck's constant h, 6.626 x10^{-34}Js,
Atomic mass unit u, 1,661 x10^{-27}kg

INSTRUCTIONS: ATTEMPT QUESTION ONE AND ANY OTHER THREE QUESTIONS

QUESTION ONE IS COMPULSORY

1. **QUESTION ONE**
   a. State the van der Waals equation for pressure and explain the physical meaning of the parameters in terms of the pressure and volume of a gas. [4marks]
   b. Define the following thermodynamic quantities [6marks]
      i. Open, Isolated, and Closed Systems
      ii. Surrounding
      iii. Reversible and irreversible changes
   c. Explain concisely how the body utilizes its internal energy [3marks]
   d. State the Zeroth, first and second laws of thermodynamics. [3marks]
   e. Calculate the diffusion coefficient of haemoglobin in water at 298K (approximated as spherical), of viscosity η is 0.891kgm^{-1}s^{-1}and radius 3.55nm. [3marks]
   f. State the Ostwald dilution law [2marks]
   g. State the assumptions of the kinetic theory of gases [3marks]
   h. State the conditions under which ΔH and ΔU for a reaction involving gases and/or liquids or solids identical [3marks]
   i. State the factors that affect rates of reaction [3marks]
   j. Given the table below, Determine with respective to A and B the order of reaction and the rate constant of the reaction. [3marks]

[A]m	[B]M	Initial rate Ms^{-1}
2.30x10^{-4}	3.10x10^{-5}	5.25x10^{-4}
4.60x10^{-4}	6.20x10^{-5}	4.20x10^{-3}
9.20x10^{-4}	6.20x10^{-5}	1.70x10^{-2}

2. **QUESTION TWO**
   a. Explain why the heat capacity a body at constant pressure is greater than its heat capacity at constant volume. [1mark]
   b. Predict the following heat changes
   i. Isothermal heat [1mark]
   ii. Isobaric heat [1mark]
   iii. Isochoric heat [1mark]

iv. Adiabatic heat [1mark]

c. Calculate the change in entropy of the surrounding, total entropy and entropy of the system for one mole of an ideal gas isothermally compressed at 300K from a volume of 25L to 10L. [5marks]

3. QUESTION THREE

The evolution of life requires the organization of a very large number of molecules into biological cells. Does THE FORMATION OF LIVING ORGANISMS violate the second law of thermodynamics? Present detailed arguments to support your clearly stated conclusions. [10marks]

4. QUESTION FOUR

a. Calculate the work each of the processes when 3.00mol an ideal gas expands isothermally along three different paths, [6marks]

i. Reversible expansion from $P_i = 35.0$bar, $V_i = 6.50$L to $P_f = 10.50$bar

ii. A single-step expansion against a constant external pressure of 10.50bar

iii. A two-step expansion consisting initially of an expansion against constant external pressure of 22.0bar, $P=P_{external}$, followed by an expansion against a constant external pressure of 10.50 until $P=P_{external}$

b. For which of the irreversible process in (a) is the magnitude of work greater [1mark]

c. Discuss the molecular interpretation of Trouton's rules. [3marks]

5. QUESTION FIVE

a. The standard reduction potential of cytochrome c which carries an electron from Q – cytochrome c oxidoreductase to cytochrome c oxidase is 0.15V and free energy of the reducing oxygen to carbondioxide is -30kJ/mol. If the overall equation of this redox reaction is written as [4marks]

$$QH_2 + Fe^{3+}(Cyt\ c) \rightarrow Q + Fe^{2+}(Cyt\ c) + H^+$$

i. how many electrons are involved in the redox reaction

ii. balance the equation for the reaction

iii. Write a shorthand notation for the cell reaction

b. The half-life of decomposition of N_2O_5 is 4.05×10^{-4}s. How long will it take for N_2O_5 to decay to75% of its initial value? [3marks]

c. Define the following

i. quantum yield for a photochemical reaction [1mark]

ii. enzyme turnover number [1mark]

d. Write an expression for the rate of the shown in the equation below [1mark]

$$2NO_{(g)} + O_{2\,(g)} \rightarrow 2NO_{2(g)}$$

6. QUESTION SIX

a. Explain with equations the different steps involved in this photochemical reaction.

$HI + h\upsilon \rightarrow H^{\cdot} + I^{\cdot}$ and deduce its stoichiometric quantum yield. [4marks]

b. The kinetic data of an enzyme catalysed reaction is given in the table below. Determine Michaelis constant 'K_m', catalytic constant K_2 and the catalytic efficiency ε for the enzyme at 0.5^0C given that the initial enzyme concentration is 2 nM. [6marks]

Rate($mmoldm^{-3}s^{-1}$)	2.78×10^{-5}	5.00×10^{-5}	8.33×10^{-5}	1.67×10^{-5}
[S] ($mmoldm^{-3}$)	1.25	2.5	5.0	20.0