

MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING
CHEMICAL AND PROCESSING ENGINEERING
PHYSICAL CHEMISTRY FOR ENGINEERS/ PHYSICAL CHEMISRY
CODE: ENGT 104/HCHE112
SESSIONAL EXAMINATIONS
MARCH 2021

DURATION: 3 HOURS

LECTURER: MR M MAPOSA

INSTRUCTIONS

- 1. Answer all questions*
- 2. Each question carries 25 marks*
- 3. Total marks 100*

ADDITIONAL MATERIAL

Periodic table
Graph page

QUESTION 1

- (a) Define the following terms as used in quantum chemistry
- (i) Photon
 - (ii) Work function
 - (iii) Quanta
 - (iv) Wave function
 - (v) Photoelectric effect [5 marks]
- (b) A photoelectric experiment showed that 5.8 eV of energy are required to remove an electron from metal X
- (i) Describe any two applications of the concept of photoelectric effect
 - (ii) Explain why electrons ejected from the same metal surface possess different values of kinetic energy
 - (iii) What is the maximum wavelength of light that will eject an electron from metal X?
 - (iv) If light of 200 nm wavelength were used, what is the velocity of the emitted electron? [16 marks]
- (c) State any **two** observations in support of the
- (i) Wave nature of radiation
 - (ii) Particle nature of radiation [4 marks]

QUESTION 2

- a) Write brief notes on each of the following terms with regard to reaction kinetics
- (i) Order of reaction
 - (ii) Reaction rate
 - (iii) Arrhenius equation
 - (iv) Activation energy
 - (v) Rate constant
 - (vi) Mechanism of reaction
 - (vii) Rate determining step
 - (viii) Reaction intermediate
 - (ix) Transition state
 - (x) Quenching [10 marks]
- (b) **Table 1** shows data obtained from experiment when the decomposition of N_2O_5 was followed at 350 K. The equation of reaction is:

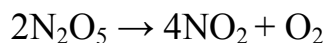


Table 1

[N ₂ O ₅]/ M	1.00	0.71	0.50	0.35	0.25	0.17
Time/min	0	1	2	3	4	5

Deduce the order of reaction, rate equation, half-life and rate constant of the reaction [12 marks]

- b) Calculate the rate constant, for the radioactive decomposition of an isotope of uranium which has a half-life of 1570 years [3 marks]

QUESTION 3

- (a) State **three** modes of vibrations shown by molecules which are dipolar [3 marks]
- (b) Briefly explain what is meant by ir active molecules [3 marks]
- (c) Using CO₂ and SO₂ as examples, illustrate those modes of vibration [6 marks]
- (d) Calculate the degrees of freedom of vibrational modes in
i. Carbon dioxide
ii. Sulphur dioxide
iii. Water [9 marks]
- e) Briefly outline any **two** strengths and two limitations of Raman spectroscopy when compared to other molecular spectroscopic techniques [4 marks]

QUESTION 4

- a) Write brief notes on each of the following terms:
i. Complex reaction
ii. Chain reaction
iii. Unimolecular elementary step
iv. Bimolecular elementary step
v. Steady state approximation [10 marks]
- b) Compare and contrast the Lindeman theory and the RRKM theory in the kinetics of gaseous reactions. [5 marks]
- c) In terms of internal degrees of freedom in the RRKM theory, explain **adiabatic modes** and **active modes** of reactants. [4 marks]
- d) Describe any two limitations associated with classical mechanics which necessitated the development of quantum mechanics. [4 marks]
- e) State the first two postulates of quantum mechanics [2 marks]

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