

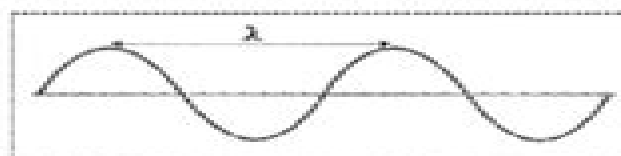


5: Flame Tests and Atomic Spectra (Experiment)

Objectives

- To perform flame tests of metal cations in order to observe their characteristic colors.
- To perform calculations to determine the frequency and energy of the emitted photons.
- To relate these results to the types of electronic transitions occurring in these elements.
- To observe and understand line emission spectra of atoms using gas-discharge tubes.
- To practice writing electron configurations for these (and other) elements.

Electromagnetic radiation is energy in the form of waves. Waves are characterized by their wavelength (λ) and frequency (ν). Wavelength is defined as the distance between successive crests (or troughs) on a wave, and is measured in meters. Frequency is defined as the number of waves that pass a given point every second, and is measured in 1/seconds ($1/s$ or s^{-1}), or Hertz (Hz).



All electromagnetic waves travel at the speed of light (c), or $3.0 \times 10^8 \text{ m/s}$. The relationship between the wavelength, frequency and speed of a wave is given by the equation:

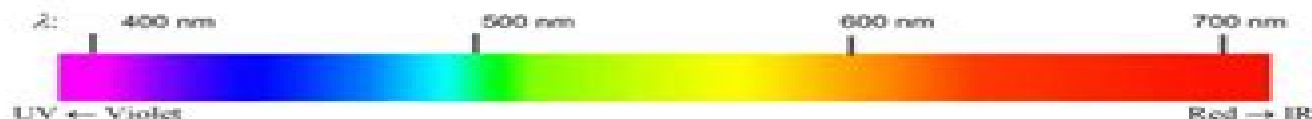
$$c = \lambda \times \nu \quad (5.1)$$

Electromagnetic radiation also occurs as discrete "packets" called *photons*. The energy (E) of a photon (in Joules, J) is given by the equation:

$$E_{\text{photon}} = h \times \nu \quad (5.2)$$

Here, h is Planck's constant, which has a value of $6.63 \times 10^{-34} \text{ J} \cdot \text{s}$.

Visible light is the most familiar example of electromagnetic radiation. Differences in the wavelengths of visible light are manifested as different colors, shown in the color spectrum below (colors can be seen in the PDF document on-line). Other examples of electromagnetic radiation include X-rays, ultraviolet light, infrared light, microwaves and radio waves.



So, how does electromagnetic radiation relate to flame tests? Well, when an atom or ion absorbs energy, its electrons can make transitions from lower energy levels to higher energy levels. The energy absorbed could be in the form of heat (as in flame tests), or electrical energy, or electromagnetic radiation. However, when electrons subsequently return from higher energy levels to lower energy levels, energy is released predominantly in the form of *electromagnetic radiation*.

The spacing between energy levels in an atom determines the sizes of the transitions that occur, and thus the energy and wavelengths of the collection of photons emitted.

Lab Manual Pavia Spectra

**Pankaj Shrivastava, Jose Antonio
Lorente, Ankit Srivastava, Ashish
Badiye, Neeti Kapoor**



Lab Manual Pavia Spectra:

Undergraduate Instrumental Analysis, Sixth Edition James W. Robinson, Eileen M. Skelly Frame, George M. Frame II, 2004-12-02 Completely rewritten revised and updated this Sixth Edition reflects the latest technologies and applications in spectroscopy mass spectrometry and chromatography It illustrates practices and methods specific to each major chemical analytical technique while showcasing innovations and trends currently impacting the field Many of the chapters have been individually reviewed by teaching professors and include descriptions of the fundamental principles underlying each technique demonstrations of the instrumentation and new problem sets and suggested experiments appropriate to the topic About the authors JAMES W ROBINSON is Professor Emeritus of Chemistry Louisiana State University Baton Rouge A Fellow of the Royal Chemical Society he is the author of over 200 professional papers and book chapters and several books including Atomic Absorption Spectroscopy and Atomic Spectroscopy He was Executive Editor of Spectroscopy Letters and the Journal of Environmental Science and Health both titles Marcel Dekker Inc and the Handbook of Spectroscopy and the Practical Handbook of Spectroscopy both titles CRC Press He received the B Sc 1949 Ph D 1952 and D Sc 1978 degrees from the University of Birmingham England EILEEN M SKELLY FRAME recently was Clinical Assistant Professor and Visiting Research Professor Rensselaer Polytechnic Institute Troy New York Dr Skelly Frame has extensive practical experience in the use of instrumental analysis to characterize a wide variety of substances from biological samples and cosmetics to high temperature superconductors polymers metals and alloys Her industrial career includes supervisory roles at GE Corporate Research and Development Stauffer Chemical Corporate R D and the Research Triangle Institute She is a member of the American Chemical Society the Society for Applied Spectroscopy and the American Society for Testing and Materials Dr Skelly Frame received the B S degree in chemistry from Drexel University Philadelphia Pennsylvania and the Ph D in analytical chemistry from Louisiana State University Baton Rouge GEORGE M FRAME II is Scientific Director Chemical Biomonitoring Section of the Wadsworth Laboratory New York State Department of Health Albany He has a wide range of experience in the field and has worked at the GE Corporate R D Center Pfizer Central Research the U S Coast Guard R D Center the Maine Medical Center and the USAF Biomedical Sciences Corps He is an American Chemical Society member Dr Frame received the B A degree in chemistry from Harvard College Cambridge Massachusetts and the Ph D degree in analytical chemistry from Rutgers University New Brunswick New Jersey

The Forensic Laboratory Handbook Ashraf Mozayani, Carla Noziglia, 2007-11-08 A comprehensive and easy to read introduction to the work of the modern forensic laboratory The authors explain in simple language the capabilities and limitations of modern forensic laboratory procedures techniques analyses and interpretations Here the interested reader will find an understandable and fascinating introduction to the complex worlds of forensic serology DNA chemistry crime reconstruction digital evidence explosives arson fingerprints firearms tool marks odontology and pathology Additional chapters address the problems of assuring quality and seeking trace

evidence in the forensic laboratory Nielsen's Food Analysis B. Pam Ismail, S. Suzanne Nielsen, 2024-06-24 This sixth edition provides information on techniques needed to analyze foods for chemical and physical properties The book is ideal for undergraduate courses in food analysis and it is also an invaluable reference for professionals in the food industry General information chapters on regulations labeling sampling and data handling provide background information for chapters on specific methods to determine chemical composition and characteristics physical properties and constituents of concern Methods of analysis cover information on the basic principles advantages limitations and applications The information on food analysis applications has been expanded in a number of chapters that cover basic analytical techniques Instructors who adopt the textbook can contact B Ismail for access to a website with related teaching materials **Organic Analytical Chemistry** Jag Mohan, 2003 Rapid developments in analytical techniques and the use of modern reagents in organic synthesis during the last two decades have revolutionized the approach to organic structure determination As advanced topics in organic analysis such as spectroscopic methods are being introduced postgraduate students majoring in organic chemistry have been feeling handicapped by the non availability of a book that could uncover various aspects of qualitative and quantitative organic analysis This book is written primarily to stimulate the interest of students of organic chemistry and pharmaceutical sciences in organic analytical chemistry Key features Identification and characterization of organic compounds by classical methods Mechanism of various reactions involved in the detection of functional groups and their derivatization Functional groups interfering with a given test procedure Identification of organic compounds by spectral methods IR UV NMR and Mass Spectrometry Chemical analysis by other instrumental techniques Atomic emission spectroscopy Electron spin resonance spectroscopy Atomic absorption spectroscopy fluorimetry Phosphorimetry Flame photometry and X ray methods General techniques for separation and purification including Gas Chromatography and HPLC Preparation of organic compounds based on important name reactions and pharmaceutical properties Mechanism of the reactions involved in the synthesis Simple analytical techniques and specific methods of quantitative elemental functional groups and biochemical estimations Composite spectral problems Incorporating ample modern techniques of organic analysis this book will be of great value to graduate postgraduate students teachers and researchers in the field of organic chemistry and pharmaceutical sciences Introduction to Organic Laboratory Techniques Donald L. Pavia, 1999 This edition features the successful format that has characterized the previous editions It includes essays that add relevance and interest to the experiments and emphasis on the development of the important laboratory techniques the use of spectroscopy and instrumental methods of analysis a section featuring conventional scale experiments and methods and a wide selection of well tested and well written experiments **Introduction to Spectroscopy** Donald L. Pavia, Gary M. Lampman, George S. Kriz, 1979 This text covers spectroscopic techniques used in the study of organic chemistry The level at which these topics are treated is designed to make the material accessible to typical undergraduate chemistry biology environmental science

pre medicine pre dentistry pre pharmacy and other science majors

Subject Guide to Books in Print ,1991

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Operational Organic Chemistry John W.

Lehman,1999 For sophomore level organic lab courses This text lab manual helps students master the fundamental laboratory operations of organic chemistry and develop critical thinking skills through scientific problem solving

Textbook of Forensic Science Pankaj Shrivastava,Jose Antonio Lorente,Ankit Srivastava,Ashish Badiye,Neeti

Kapoor,2023-10-28 This textbook provides essential and fundamental information to modern forensics investigations It discusses criminalistics and crime scene aspects including investigation management collecting and packaging various types of physical evidence forwarding and chain of custody It presents fundamental principles ethics challenges and criticism of forensic sciences and reviews the crime typologies the correlates of crime criminology penology and victimology It provides a viewpoint on legal aspects including types of evidence the procedure in the court and scrutiny of the evidence and experts The book summarizes forensic serological evidences such as blood semen saliva milk tears sweat vaginal fluids urine and sweat It also provides an overview of forensic examination of different types of evidence and also includes comprehensive detailing of forensic ballistics including firearm classification bullet comparison and matching Further it explores the examinations of drugs chemicals explosives and petroleum products It focuses on the various aspects of forensic toxicology including the study of various poisons toxins associated signs and symptoms a fatal dose fatal period of poisons The book also emphasizes digital and cyber forensics including classification data recovery tools encryption and decryption methods image and video forensics It is a useful resource for graduate and post graduate students in the field of Forensic Science

Handbook of Vibrational Spectroscopy John M. Chalmers,Peter R. Griffiths,2002 *Scientific and Technical Books and Serials in Print* ,1989 **Student Guide and Solutions Manual to Accompany Ternay's Contemporary Organic**

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Catalog Library of Congress, *Introduction to Organic Laboratory Techniques* Donald L. Pavia,Gary M. Lampman,George S. Kriz,Randall G. Engel,2005 Featuring 66 experiments detailing 29 techniques and including several explicating essays this lab manual covers basic lab techniques molecular modeling properties and reactions of organic compounds the identification of organic substances project based experiments and each step of the various techniques The authors teach at Western Washington University and North Seattle Community College Annotation 2004 Book News Inc Portland OR booknews com

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