

## Lesson 2. Nuclear Chemistry & Energy

### Outline

- 2.1 Nuclear Reactions and Radioactivity
- 2.2 Nuclear Stability
- 2.3 Kinetics of Radioactive Decay
- 2.4 Energetics of Nuclear Reactions
- 2.5 Fusion, Transmutation, Fission
- 2.6 Interaction of Radiation and Matter

### Nuclear Chemistry

**Nuclear chemistry is a study of nuclear reactions.** Nuclear reactions are changes in matter originating in the nucleus of an atom. When a nuclei change spontaneously, it emits radiation and that said is for radioactivity. Radioactive elements are widely used in medicine, diagnostic tools and as a means of treatment especially for cancer. They are also used as test substances to determine the mechanisms of chemical reactions, to trace the movement of atoms in biological systems, and as date important historical artifacts. Nuclear reactions are also used both to generate electricity and to create weapons of massive destruction.

This lesson discussed nuclear reactions and its applications.

### 2.1 Nuclear Reactions and Radioactivity

#### Nuclear Reactions

One of the nuclear reactions in the universe is the formation of carbon-14, which is a result of collision of gas molecules in the atmosphere with cosmic rays. Cosmic rays are particles travelling at high speeds. Majority of cosmic rays are atomic nuclei. Roughly, 80% of cosmic rays are hydrogen nuclei and about 10% are helium nuclei. Some cosmic rays emanate from the sun and others originate outside the solar system. The energies of cosmic rays are far higher than chemical energies. Chemical energies are usually expressed in kilojoules per mole (kJ/mol) but all cosmic rays are expressed in electron-volts (eV). One eV is equal to  $(1.6 \times 10^{-19})$  kJ/mol.

As cosmic rays enter the atmosphere, it collided with gas molecules. These collisions initiate nuclear reactions in the atmosphere. One of this nuclear reactions leads to the formation of the radioactive carbon-14. Carbon-14 is unstable isotope of carbon. It undergoes spontaneous radioactive decay or disintegration, spitting particles from the nucleus. Carbon-14 is formed when a free neutron is absorbed by nitrogen nucleus resulting to carbon nucleus and proton. Nitrogen nucleus and neutron are the reactants and carbon nucleus and proton are the products. The nuclear reaction is summarized



Note that the reactants and products of a nuclear reaction are summarized above as atomic notation,  ${}^A_Z\text{X}$ , where **X** is the symbol of the atom, **A** is the mass number and **Z** is the atomic number or nuclear charge. Similar notation is used for subatomic particles, neutrons ( ${}^1_0\text{n}$ ), protons ( ${}^1_1\text{p}$ ), and electrons ( ${}^0_{-1}\text{e}$ ).

Nuclear reactions also obey conservation rules, hence, nuclear reactions are balanced. Balancing nuclear equation is with respect to both mass number and nuclear charge. For the nuclear equation to form carbon-14, the sum of the mass numbers for each side of the equation is 14, and the sum of the nuclear charges on each side of the equation is 7, therefore the nuclear equation is balanced.

# Review Section 2 Nuclear Chemistry

**A Loxley**



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**Radiochemistry** G W A Newton, 2007-10-31 Specialist Periodical Reports provide systematic and detailed review coverage of progress in the major areas of chemical research Written by experts in their specialist fields the series creates a unique service for the active research chemist supplying regular critical in depth accounts of progress in particular areas of chemistry For over 90 years The Royal Society of chemistry and its predecessor the Chemical Society have been publishing reports charting developments in chemistry which originally took the form of Annual Reports However by 1967 the whole spectrum of chemistry could no longer be contained within one volume and the series Specialist Periodical Reports was born The Annual Reports themselves still existed but were divided into two and subsequently three volumes covering Inorganic Organic and Physical Chemistry For more general coverage of the highlights in chemistry they remain a must Since that time the SPR series has altered according to the fluctuating degree of activity in various fields of chemistry Some titles have remained unchanged while others have altered their emphasis along with their titles some have been combined under a new name whereas others have had to be discontinued The current list of Specialist Periodical Reports can be seen on the inside flap of this volume **Nuclear Magnetic Resonance I.**

Barsukov, 2000 For those wanting to become rapidly acquainted with specific areas of NMR this title provides unrivalled scope of coverage AEC Authorizing Legislation, Fiscal Year 1967: Biology and medicine; isotopes development;

communities; training, education, and information; security; program direction and administration; physical research;

Plowshare United States. Congress. Joint Committee on Atomic Energy, 1966 Reviews costs and benefits of nuclear programs involving Defense Dept and nuclear industries *Proceedings of the Third LAMPF II Workshop* LAMPF II Workshop, 1983

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**Monthly Catalog of United States Government Publications** United States. Superintendent of Documents,1982

**ERDA Energy Research Abstracts** United States. Energy Research and Development Administration,1977      **Nuclear Science Abstracts** ,1975      **CliffsNotes AP Chemistry** Bobrow Test Preparation Services,2009-02-09 The book itself contains chapter length subject reviews on every subject tested on the AP Chemistry exam as well as both sample multiple choice and free response questions at each chapter s end Two full length practice tests with detailed answer explanations are included in the book      **Femtochemistry: Ultrafast Dynamics Of The Chemical Bond (In 2 Volumes) - Volume 1** Ahmed H Zewail,1994-09-12 These two volumes on Femtochemistry present a timely contribution to a field central to the

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Basic Concepts of Chemistry, Study Guide Leo J. Malone, 1989-02-21 This Third Edition revised to provide smoother transitions between topics employs a concise yet informal approach to basic chemistry organized to help students employ basic math skills and problem solving strategies Writing style is straightforward and presentation incorporates many concrete analogies to clarify new concepts Includes many illustrative worked examples

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## **Table of Contents Review Section 2 Nuclear Chemistry**

1. Understanding the eBook Review Section 2 Nuclear Chemistry
  - The Rise of Digital Reading Review Section 2 Nuclear Chemistry
  - Advantages of eBooks Over Traditional Books
2. Identifying Review Section 2 Nuclear Chemistry
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Review Section 2 Nuclear Chemistry
  - User-Friendly Interface
4. Exploring eBook Recommendations from Review Section 2 Nuclear Chemistry
  - Personalized Recommendations
  - Review Section 2 Nuclear Chemistry User Reviews and Ratings

- Review Section 2 Nuclear Chemistry and Bestseller Lists
- 5. Accessing Review Section 2 Nuclear Chemistry Free and Paid eBooks
  - Review Section 2 Nuclear Chemistry Public Domain eBooks
  - Review Section 2 Nuclear Chemistry eBook Subscription Services
  - Review Section 2 Nuclear Chemistry Budget-Friendly Options
- 6. Navigating Review Section 2 Nuclear Chemistry eBook Formats
  - ePub, PDF, MOBI, and More
  - Review Section 2 Nuclear Chemistry Compatibility with Devices
  - Review Section 2 Nuclear Chemistry Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Review Section 2 Nuclear Chemistry
  - Highlighting and Note-Taking Review Section 2 Nuclear Chemistry
  - Interactive Elements Review Section 2 Nuclear Chemistry
- 8. Staying Engaged with Review Section 2 Nuclear Chemistry
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Review Section 2 Nuclear Chemistry
- 9. Balancing eBooks and Physical Books Review Section 2 Nuclear Chemistry
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Review Section 2 Nuclear Chemistry
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Review Section 2 Nuclear Chemistry
  - Setting Reading Goals Review Section 2 Nuclear Chemistry
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Review Section 2 Nuclear Chemistry
  - Fact-Checking eBook Content of Review Section 2 Nuclear Chemistry
  - Distinguishing Credible Sources



- 
13. Promoting Lifelong Learning
    - Utilizing eBooks for Skill Development
    - Exploring Educational eBooks
  14. Embracing eBook Trends
    - Integration of Multimedia Elements
    - Interactive and Gamified eBooks

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