

## Practice Problems: Quantum Theory

CHEM 1A

1. Hydrogen has a red emission line at 656.3 nm, what is the energy and frequency of a photon of this light? Note: Planck's constant =  $6.626 \times 10^{-34}$  J·s, speed of light =  $2.998 \times 10^8$  m/s

$$E_{\text{photon}} = h\nu = \frac{hc}{\lambda}$$

$$E_{\text{photon}} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s}) (2.998 \times 10^8 \text{ m/s})}{656.3 \text{ nm} \left( \frac{10^{-9} \text{ m}}{1 \text{ nm}} \right)}$$

$$E_{\text{photon}} = \underline{3.02677861 \times 10^{-19} \text{ J}}$$

$$\nu = \frac{c}{\lambda}$$

$$\nu = \frac{(2.998 \times 10^8 \text{ m/s})}{656.3 \text{ nm} \left( \frac{10^{-9} \text{ m}}{1 \text{ nm}} \right)}$$

$$\nu = \underline{4.568032912 \times 10^{14} \text{ s}^{-1}}$$

Answer (E):  $3.027 \times 10^{-19} \text{ J}$ Answer ( $\nu$ ):  $4.568 \times 10^{14} \text{ s}^{-1}$  or Hz

2. What is the de Broglie wavelength for an electron moving at  $2.42 \times 10^6$  m/s?  
Note:  $m_e = 9.109 \times 10^{-31}$  kg

$$\lambda = \left( \frac{h}{mv} \right)$$

$$\lambda = \left( \frac{6.626 \times 10^{-34} \text{ J}\cdot\text{s}}{(9.109 \times 10^{-31} \text{ kg}) (2.42 \times 10^6 \text{ m/s})} \right) = \underline{3.00583657 \times 10^{-10} \text{ m}}$$

Answer:  $3.01 \times 10^{-10} \text{ m}$   $\longleftarrow$  many orders of magnitude larger than the diameter of an electron

3. Using the Bohr equation, calculate is the change in energy when an electron transitions from  $n = 3$  to  $n = 2$  in a hydrogen atom.

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left( \frac{Z^2}{n_{\text{final}}^2} - \frac{Z^2}{n_{\text{initial}}^2} \right)$$

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left( \frac{1^2}{2^2} - \frac{1^2}{3^2} \right)$$

$$\Delta E = \underline{-3.02777778 \times 10^{-19} \text{ J}}$$

Answer:  $-3.03 \times 10^{-19} \text{ J}$

# Quantum Theory Study Guide Answers

**SA Adler**



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## **Table of Contents Quantum Theory Study Guide Answers**

1. Understanding the eBook Quantum Theory Study Guide Answers
  - The Rise of Digital Reading Quantum Theory Study Guide Answers
  - Advantages of eBooks Over Traditional Books
2. Identifying Quantum Theory Study Guide Answers
  - 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 Quantum Theory Study Guide Answers
  - User-Friendly Interface
4. Exploring eBook Recommendations from Quantum Theory Study Guide Answers
  - Personalized Recommendations
  - Quantum Theory Study Guide Answers User Reviews and Ratings
  - Quantum Theory Study Guide Answers and Bestseller Lists
5. Accessing Quantum Theory Study Guide Answers Free and Paid eBooks
  - Quantum Theory Study Guide Answers Public Domain eBooks
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6. Navigating Quantum Theory Study Guide Answers eBook Formats

- ePub, PDF, MOBI, and More
- Quantum Theory Study Guide Answers Compatibility with Devices
- Quantum Theory Study Guide Answers Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Quantum Theory Study Guide Answers
  - Highlighting and Note-Taking Quantum Theory Study Guide Answers
  - Interactive Elements Quantum Theory Study Guide Answers
- 8. Staying Engaged with Quantum Theory Study Guide Answers
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Quantum Theory Study Guide Answers
- 9. Balancing eBooks and Physical Books Quantum Theory Study Guide Answers
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Quantum Theory Study Guide Answers
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Quantum Theory Study Guide Answers
  - Setting Reading Goals Quantum Theory Study Guide Answers
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Quantum Theory Study Guide Answers
  - Fact-Checking eBook Content of Quantum Theory Study Guide Answers
  - 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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