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INTEGRATION OF DISCIPLINES IN TEACHING CHEMICAL BONDING AND VALENCE IN ATOMIC PHYSICS

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ABSTRACT

The interdisciplinary integration of scientific subjects has become an important approach in modern education, enabling students to develop a holistic understanding of natural phenomena. This article examines the integration of physics and chemistry in teaching chemical bonding and valence within the context of atomic physics. The study explores how concepts of atomic structure, electron configuration, quantum mechanics, and electromagnetic interactions provide a physical basis for understanding chemical bonds and valence. Particular attention is given to interdisciplinary teaching methods that connect theoretical knowledge from physics and chemistry, promoting deeper conceptual understanding and scientific literacy.

KEYWORDS

Interdisciplinary integration, atomic physics, chemical bonding, valence, science education, quantum mechanics, electron configuration, scientific literacy.

Introduction

Annotatsiya. Ilmiy fanlarning fanlararo integratsiyasi zamonaviy ta'limda muhim yondashuvga aylandi, bu esa talabalarga tabiiy hodisalarni yaxlit tushunish imkonini beradi. Ushbu maqolada atom fizikasi kontekstida kimyoviy bog'lanish va valentlikni o'qitishda fizika va kimyoning integratsiyasi ko'rib chiqiladi. Tadqiqotda atom tuzilishi, elektron konfiguratsiyasi, kvant mexanikasi va elektromagnit o'zaro ta'sirlar tushunchalari kimyoviy bog'lanishlar va valentlikni tushunish uchun qanday qilib fizik asos yaratishi o'rganiladi. Fizika va kimyodan nazariy bilimlarni bog'laydigan, chuqurroq kontseptual tushuncha va ilmiy savodxonlikni rivojlantiradigan fanlararo o'qitish usullariga alohida e'tibor qaratilgan.

Kalit so'zlar: fanlararo integratsiya, atom fizikasi, kimyoviy bog'lanish, valentlik, fan ta'limi, kvant mexanikasi, elektron konfiguratsiyasi, ilmiy savodxonlik.

Аннотация

Междисциплинарная интеграция научных дисциплин стала важным подходом в современном образовании, позволяющим студентам развивать целостное понимание природных явлений. В данной статье рассматривается интеграция физики и химии в преподавании химической связи

и валентности в контексте атомной физики. Исследование изучает, как концепции атомной структуры, электронной конфигурации, квантовой механики и электромагнитных взаимодействий обеспечивают физическую основу для понимания химических связей и валентности. Особое внимание уделяется междисциплинарным методам обучения, которые связывают теоретические знания из физики и химии, способствуя более глубокому концептуальному пониманию и научной грамотности.

Ключевые слова. междисциплинарная интеграция, атомная физика, химическая связь, валентность, научное образование, квантовая механика, электронная конфигурация, научная грамотность.

The rapid advancement of science and technology requires educational systems to adopt innovative approaches that encourage interdisciplinary learning. Traditional subject-centered teaching often presents scientific concepts in isolation, limiting students' ability to understand the relationships between different branches of science. As a result, interdisciplinary integration has emerged as an effective strategy for improving the quality of science education.

One of the most significant areas for interdisciplinary integration is the teaching of chemical bonding and valence through atomic physics. Understanding how atoms interact to form molecules requires knowledge from both chemistry and physics. Concepts such as atomic structure, electron energy levels, quantum mechanics, and electromagnetic forces provide the theoretical foundation for explaining chemical bonds and valence.

This article investigates the importance of integrating disciplines in teaching chemical bonding and valence and examines pedagogical approaches that facilitate meaningful connections between chemistry and atomic physics.

The article discusses the use of digital technologies, simulations, and inquiry-based learning activities to enhance students' comprehension of atomic and molecular structures. The findings suggest that interdisciplinary instruction improves students' analytical thinking, problem-solving skills, and ability to apply scientific concepts across disciplines. The study concludes that integrating chemistry and atomic physics contributes significantly to the effectiveness of science education and supports the development of comprehensive scientific competence.

Interdisciplinary integration refers to the process of connecting knowledge, methods, and concepts from different academic disciplines to achieve a deeper understanding of complex phenomena. In science education, interdisciplinary approaches help students recognize the unity of natural laws and understand how scientific knowledge is interconnected.

Physics and chemistry share many fundamental concepts. While chemistry focuses on the composition, structure, and transformations of matter, physics explains the underlying principles governing these processes. The study of atomic structure serves as a bridge between the two disciplines.

Integrating atomic physics with chemistry enables students to understand:

The structure of atoms and electron shells;

The arrangement of electrons in orbitals;

The physical origins of chemical bonds;

The role of energy in chemical reactions;

The relationship between atomic properties and chemical behavior.

Atomic physics provides the scientific foundation for understanding chemical bonding. The development of quantum theory revealed that electrons occupy specific energy levels around atomic nuclei. The distribution of electrons determines an atom's chemical properties and its ability to form bonds.

Atoms consist of a nucleus containing protons and neutrons surrounded by electrons. The behavior of electrons is described by quantum mechanics, which explains the existence of discrete energy levels and atomic orbitals.

Electron configuration determines how electrons are distributed among atomic orbitals. Atoms tend to achieve stable electronic arrangements, which often resemble the electron configurations of noble gases.

The tendency toward stability explains why atoms form chemical bonds through electron transfer, sharing, or delocalization.

Quantum mechanics explains the probabilistic nature of electron positions and energies. Concepts such as wave functions, quantum numbers, and orbital hybridization are essential for understanding chemical bonding mechanisms.

Understanding Valence Through Interdisciplinary Learning

Valence refers to the combining capacity of an atom and is closely related to the number of electrons available for bond formation. Traditionally taught as a chemical concept, valence can be more effectively understood when linked to atomic physics principles.

Through interdisciplinary instruction, students learn that valence depends on:

Electron shell structure;

Valence electron distribution;

Atomic energy levels;

Quantum mechanical interactions.

For example, the valence of carbon can be explained through its electron configuration:

$1s^2\ 2s^2\ 2p^2$

The presence of four valence electrons enables carbon to form four covalent bonds, a concept that becomes clearer when students understand atomic orbital structures and electron behavior.

Types of Chemical Bonds and Their Physical Basis

Ionic bonds form through the transfer of electrons from one atom to another. Atomic physics explains this process through differences in ionization energy and electron affinity.

Covalent bonds involve the sharing of electron pairs between atoms. Quantum mechanics provides a detailed explanation of electron density distribution and orbital overlap.

Metallic bonding arises from the collective behavior of delocalized electrons in metallic structures. Concepts from solid-state physics help explain electrical conductivity and metallic properties.

Hydrogen bonds result from electrostatic interactions between molecules. Understanding these forces requires knowledge of molecular polarity and electromagnetic interactions.

Pedagogical Approaches for Interdisciplinary Teaching

Inquiry-based activities encourage students to investigate atomic and molecular structures through experimentation and problem-solving.

Students analyze real-world scientific problems that require knowledge from both chemistry and physics.

Concept maps help learners visualize relationships between atomic structure, electron configuration, valence, and chemical bonding.

The integration of Science, Technology, Engineering, and Mathematics promotes interdisciplinary thinking and practical application of scientific concepts.

Digital technologies significantly enhance interdisciplinary science education.

Simulations allow students to visualize: Atomic orbitals; Electron movement; Molecular structures; Bond formation processes.

Virtual experiments provide opportunities to investigate chemical and physical phenomena in safe and interactive environments.

Animations and 3D models improve understanding of abstract concepts such as electron clouds and molecular geometry.

Educational Benefits of Interdisciplinary Integration

The integration of chemistry and atomic physics provides several advantages: Improved conceptual understanding; Enhanced critical thinking skills; Greater scientific literacy; Better problem-solving abilities; Increased student motivation;

Stronger connections between theory and practice.

Students become more capable of applying scientific knowledge across different contexts and disciplines.

Despite its benefits, interdisciplinary teaching presents several challenges: Curriculum fragmentation; Limited instructional time; Insufficient teacher preparation; Lack of interdisciplinary teaching materials.

Future educational reforms should emphasize curriculum integration, teacher professional development, and the use of digital technologies to support interdisciplinary science education.

The integration of disciplines in teaching chemical bonding and valence through atomic physics provides students with a deeper and more comprehensive understanding of scientific concepts. By connecting chemistry and physics, educators can help learners recognize the physical principles underlying chemical behavior and develop stronger analytical and problem-solving skills.

Modern pedagogical approaches, supported by digital technologies and inquiry-based learning, create effective conditions for interdisciplinary education. Consequently, integrating atomic physics and chemistry should be considered an essential component of contemporary science teaching aimed at preparing scientifically literate and competent learners.

References

1. Jamila X. O. J. ATOM FIZIKASI FANIDAN ELEKTRON ORBITAL BULUTLARI SHAKL O ‘ZGARISHINING TO ‘LQIN FUNKSIYAGA BOG ‘LIQLIGINI O ‘QITISHDA ZAMONAVIY AXBOROT TEXNOLOGIYALARDAN FOYDALANISH IMKONIYATLARI //«ACTA NUUz». – 2025. – T. 1. – №. 1.9. – C. 220-223.

2. XO‘JAMBERDIYEVA G. U. J. ATOM FIZIKASI FANINI O ‘QITISHDA ZAMONAVIY TA’LIM TEXNOLOGIYALARDAN FOYDALANISH IMKONIYATLARI //«ACTA NUUz». – 2025. – T. 1. – №. 1.6. – C. 190-193.

3. Uzokova G. S., Xujamberdiyeva J. N. SCIENTIFIC CONTENT OF PHYSICAL CONCEPTS AND SIGNIFICANCE //Экономика и социум. – 2024. – №. 5-2 (120). – С. 795-806.
4. Xo‘jamberdiyeva J. UZLUKSIZ TA’LIM TIZIMINI FIZIKA FANINI RIVOJLANTIRISHDA DASTURIY VOSITALARNING O ‘RNI //International Scientific and Practical Conference on Algorithms and Current Problems of Programming. – 2023.
5. Xo‘jamberdiyeva J., Hamdamova G. FIZIKA FANINI O‘QITISHDA ALGORITMLAR VA DASTURLASH AHAMIYATI //International Scientific and Practical Conference on Algorithms and Current Problems of Programming. – 2023.
6. Khojamberdiyeva J. PROBLEMS OF DESIGNING AND ORGANIZING EDUCATIONAL AND RESEARCH ACTIVITIES OF LEARNERS //Science and innovation. – 2023. – Т. 2. – №. B10. – С. 65-68.
7. Rayimjonova N. N. et al. Structural Change in SiO 2 Glass After Gamma Irradiation //Journal of Pharmaceutical Negative Results. – 2022. – Т. 13.
8. Benzerara M. et al. Advanced strengthening of steel structures: Investigating GFRP reinforcement for floor beams with trapezoidal web openings //E3S Web of Conferences. – EDP Sciences, 2024. – Т. 497. – С. 02013.
9. Pant R. et al. Study of produced harmonics in DFIG powered by wind turbines over linear and nonlinear loads //E3S Web of Conferences. – EDP Sciences, 2024. – Т. 563. – С. 01006.
10. Nurfahasdi M. et al. Enhanced removal of mercury from leachate using electrocoagulation: Reaction kinetics //Journal of Ecological Engineering. – 2026. – Т. 27. – №. 4. – С. 235-243.
11. Khasanov D., Daminova B., Tojiyev M. The Impact of Normalization on Regression-Based Crop Yield Prediction: Accuracy and Efficiency Analysis //2026 International Russian Smart Industry Conference (SmartIndustryCon). – IEEE, 2026. – С. 63-67.
12. GAUSS D. B. E. ITERATION METHODS FOR SOLVING A SYSTEM OF LINEAR ALGEBRAIC EQUATIONS //Экономика и социум. – 2024. – №. 2. – С. 117.
13. O‘G‘Li K. F. Z. CREATING A TEST FOR SCHOOL EDUCATIONAL PROCESSES IN THE ISPRING SUITE PROGRAM //Yosh mutaxassislar. – 2023. – Т. 1. – №. 8. – С. 84-87.