THE PHYSICS TUTOR

May 31, 2025

Hello Friends,

When I set out to design my series of practice tests, I wanted to create something that didn't just assess knowledge—it built it. My goal was to make each test a stepping stone that prepared students for the next level, creating a clear and deliberate progression in both content and difficulty. I wanted students to feel like they were not just being tested, but guided.

I started by outlining the fundamental concepts and problem types that should appear early on. Test I includes straightforward, foundational questions that build confidence and ensure a solid grasp of the basics. Then, with each successive test, I carefully layered in more complex topics, integrated multiple concepts into single problems, and introduced trickier or more abstract formats. The result is a progression where each test feels like a logical next challenge—not just harder for the sake of difficulty, but more demanding in a way that reflects deeper thinking and application.

I also paid close attention to the types of mistakes students are likely to make. Early tests help identify common misunderstandings, while later ones push students to apply their knowledge in less familiar contexts. By the time a student reaches the most advanced tests, they've encountered nearly every major topic and problem structure, giving them the confidence and skill to tackle even the toughest competitions.

This progression wasn't accidental—it was intentional. Every problem, every format, and every test was designed with purpose, making the series not just a set of exams, but a roadmap for growth.

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BIOLOGY

All of the biology questions will come from the following topics, with each test increasing in difficulty to reflect a logical progression of knowledge and reasoning skills.

Topics from Dr. Michelle McGehee:

1. **Relationship Between Structure and Function**
    - Basic biochemistry, cell biology, biological membranes, membrane transport, structure and function of organic macromolecules
2. **Cellular and Acellular Replication**
    - Cell cycle, regulation of the cell cycle, DNA replication, genome structure, meiosis and sexual reproduction, viral replication
3. **Energy Transformations**
    - Metabolism, cellular respiration, photosynthesis, enzymes
4. **Gene Expression**
    - Protein synthesis, regulation of gene expression, effects of mutations
5. **Genetics and Inheritance**
    - Mendelian inheritance, non-Mendelian inheritance, genetic crosses, DNA technology
6. **Evolution**
    - Natural selection, reproductive success, microevolution (selection, mutation, recombination migration, genetic drift, gene flow), evidence of macroevolution (speciation, extinction), evidence for unity in diversity
7. **Origin and Diversity of Life on Earth**
    - Phylogeny, taxonomy, domains of life, animal and plant behavior, biological hierarchy
8. **Ecology and the Environment**
    - Population biology, community dynamics, organism relationships, biogeochemical cycles, ecosystem stability
9. **Human Anatomy & Physiology**
    - Tissue types and corresponding cell types, homeostasis (regulation, effects of imbalance), organ systems (any of them!)
10. **Diseases**
    - Eukaryotic diseases, viral diseases, bacterial diseases, pathogenesis, etiologic agents, disease signs or symptoms (differential diagnosis)

CHEMISTRY

All of the chemistry questions will be drawn from the following topics, with each test designed to gradually increase in difficulty and complexity to build a strong foundation and deeper understanding over time.

Topics from Dr. Brian Anderson:

1. **Fundamentals**
    - Covers the basics of chemistry: measurements, units, conversions, significant figures, types of matter, the mole, and basic properties of substances.
2. **Stoichiometry**
    - Focuses on the math of chemical reactions: mole ratios, chemical formulas, balancing equations, limiting reactants, percent yield, and conversions between mass, moles, and volume.
3. **Atomic Theory**
    - Explains what atoms are made of, how electrons behave, and how light interacts with matter. Includes electron configurations, quantum numbers, and periodic trends.
4. **Chemical Bonding and Structure**
    - Looks at how atoms bond (ionic, covalent, metallic), how to draw Lewis structures, molecular shapes (VSEPR), hybrid orbitals, and whether molecules are polar or nonpolar.
5. **Gases**
    - Studies the behavior of gases using laws like Boyle's, Charles's, and the Ideal Gas Law. Includes pressure, volume, temperature, gas mixtures, and deviations from ideal gas behavior.
6. **Liquids and Solids**
    - Covers intermolecular forces (like hydrogen bonding), how they affect boiling/melting points, viscosity, and surface tension. Also touches on crystal structures.
7. **Thermodynamics**
    - Explores energy in chemical reactions—heat, work, enthalpy, entropy, and free energy (ΔG)—to predict whether reactions are spontaneous.
8. **Physical Equilibria**
    - Deals with phase changes (like melting or boiling), phase diagrams, and how solutes affect properties like freezing and boiling points (colligative properties).
9. **Chemical Equilibria**
    - Covers reversible reactions, equilibrium constants (K), reaction quotients (Q), and how systems respond to stress (Le Chatelier's Principle).

10. **Acids and Bases**
    - Covers pH, strong and weak acids and bases, calculations with Ka and Kb, buffer systems, and titrations with indicators.

11. **Solubility Equilibria**
    - Focuses on solubility rules, Ksp (solubility product), common ion effect, and predicting precipitation or complex ion formation.

12. **Electrochemistry**
    - Studies redox reactions, voltaic and electrolytic cells, standard and non-standard cell potentials, the Nernst equation, and how batteries work.

13. **Chemical Kinetics**
    - Explains how fast reactions happen, what affects reaction rates (like temperature and concentration), rate laws, activation energy, and reaction mechanisms.

PHYSICS

All of the physics questions will be based on key topics from mechanics to modern physics, with each test increasing in difficulty to guide students through a logical and skill-building progression.

Topics and reading choice from Dr. David Bixler:

P01 - P03: Radioactivity by Marjorie C. Malley.

Test #	***Chapters Used***	***P01***	***P02***	***P03***
Practice Test I	Chapters 1, 2	Ch.1	Ch.1	Ch.2
Practice Test II	Chapters 2, 3	Ch.2	Ch.3	Ch.3
Practice Test III	Chapters 4, 5	Ch.4	Ch.4	Ch.5
Practice Test IV	Chapters 5, 6	Ch.5	Ch.6	Ch.6
Practice Test V	Chapters 7, 8	Ch.7	Ch.7	Ch.8
Practice Test VI	Chapters 8, 9	Ch.8	Ch.9	Ch.9
Practice Test VI	Chapters 10, 11	Ch.10	Ch.11	Ch.11

P04: Astronomy

- Physics Question P04 will focus on stars, excluding our Sun, and will cover their properties, formation, evolution, and classification, etc...

P05: Measurement/Dimensional Analysis/Significant Figures/Order of Magnitude

- This topic covers the foundational skills needed for all of physics. Students will work with physical quantities, perform unit conversions using dimensional analysis, apply the rules of significant figures in calculations, and estimate values using order-of-magnitude reasoning. Precision, clarity, and logical problem-solving are emphasized throughout.

P06: Uniformly Accelerated Motion

- This topic deals with objects that move in a straight line while experiencing constant acceleration. Students will use kinematic equations to relate displacement, velocity, acceleration, and time. Key concepts include interpreting motion graphs, solving one- and two-dimensional problems, and applying formulas to appropriate scenarios

P07: Forces

- This topic focuses on how objects interact through pushes and pulls, described by Newton's Laws of Motion. Students will analyze one- and two-dimensional force problems involving tension, friction, normal force, and gravity. Concepts include free-body diagrams, net force, and how unbalanced forces cause acceleration. Understanding forces is key to explaining why objects move—or stay still—the way they do.

P08: Work/Energy/Power/Momentum

- This topic explores how forces cause changes in motion and energy. Students will calculate work done by forces, changes in kinetic and potential energy, and apply the Work-Energy Theorem. Concepts include conservation of energy, power as the rate of energy transfer, and momentum in both elastic and inelastic collisions. The momentum-impulse theorem and conservation laws help analyze systems before and after interactions.

P09: Circular and Rotational Motion/Equilibrium

- This topic covers objects moving in circles and rotating around axes. Students will analyze uniform circular motion using centripetal force and acceleration, and explore rotational analogs of linear motion—such as torque, rotational inertia, and angular momentum. Equilibrium problems involve balancing forces and torques to determine stability. Key ideas include Newton's second law for rotation, the conditions for static equilibrium, and real-world applications like seesaws and rotating platforms.

P10: Waves/Sound/Harmonic Motion

- This topic explores how energy travels through space and matter. Students will study the properties of mechanical and sound waves, including speed, frequency, wavelength, and amplitude. Concepts like superposition, interference, standing waves, and the Doppler Effect are covered. Harmonic motion includes oscillating systems such as springs and pendulums, where restoring forces cause repetitive motion. Students will apply equations for simple harmonic motion and analyze resonance in physical systems.

P11: Fluids Dynamics/Statics

- This topic focuses on the behavior of fluids at rest and in motion. In fluid statics, students study pressure, density, and buoyancy, including applications of Pascal's Principle and Archimedes' Principle. In fluid dynamics, they analyze flow rate, continuity, and Bernoulli's Equation to understand how fluids move through pipes and around objects. Key ideas include gauge vs. absolute pressure, and the relationship between pressure, velocity, and elevation in moving fluids.

P12: DC Circuits/Resistors/Capacitors

- This topic covers the behavior of electric charge in direct current (DC) circuits. Students will analyze series and parallel resistor combinations using Ohm's Law and the rules for current, voltage, and resistance. Power consumption and energy use in circuits are also explored. Capacitors are introduced as charge-storing devices, with emphasis on how they charge and discharge over time.

P13: Electric Fields and Forces/Electric Potential/Gauss' Law

- This topic explores how electric charges interact and influence space around them. Students will calculate electric forces using Coulomb's Law and determine electric fields from point charges and charge distributions. Electric potential and potential energy are introduced to describe the work done by electric forces. Gauss' Law is used to find electric fields from symmetric charge distributions.

P14: Magnetic Fields and Forces/Magnetic Materials/Ampere's Law

- This topic examines how moving charges and currents produce magnetic fields and how those fields interact with materials and other charges. Students will calculate magnetic forces on charged particles and current-carrying wires using the right-hand rule. The magnetic fields around wires, loops, and solenoids are analyzed using Ampere's Law.

P15: Faraday's Law/Induction/EM Oscillation and Waves/AC Circuits

- This topic explores how changing magnetic fields produce electric fields, leading to electromagnetic induction. Students will apply Faraday's Law and Lenz's Law to analyze induced currents and emf in loops and coils. Concepts include generators, transformers, and inductors. AC circuits introduce alternating current behavior, RMS values, reactance, impedance, and resonance in RLC circuits.

P16: Geometric Optics/Wave Optics

- This topic focuses on how light behaves as both a ray and a wave. In geometric optics, students analyze reflection and refraction using mirrors, lenses, and the lens/mirror equations to determine image location, size, and orientation. Concepts include real vs. virtual images, focal length, and magnification. Wave optics explores the wave nature of light, including interference, diffraction, polarization, and thin-film effects. Together, these topics explain how light forms images and how its wave behavior produces patterns seen in everyday and experimental settings.

P17: Modern Physics/Quantum Physics

- This topic explores the breakthroughs that challenged classical physics. Students will study the photoelectric effect, atomic spectra, and the idea of wave-particle duality. Key concepts include Planck's constant, photon energy, and the de Broglie wavelength. Students also explore simple models of the atom and how quantum mechanics explains atomic behavior that classical physics could not.

P18: Nuclear Physics/Particle Physics

- This topic explores the structure and behavior of atomic nuclei and the fundamental particles that make up matter. In nuclear physics, students study radioactivity (alpha, beta, and gamma decay), half-life calculations, nuclear reactions (fission and fusion), and binding energy. Particle physics introduces the Standard Model, including quarks, leptons, and fundamental forces. Key ideas include conservation laws, particle interactions, and the role of particles like neutrinos, photons, and gluons in explaining how the universe operates at its most basic level.

P19: Wildcard Question

- From topics traditionally covered in a Physics 1 course

P20: Wildcard Question

- From topics traditionally covered in a Physics 2 course

Overall, this complete series of practice tests in biology, chemistry, and physics was designed to do more than just evaluate—it was built to teach. Each test follows a logical progression in both content and difficulty, beginning with foundational concepts and gradually introducing more advanced, integrative problem-solving. Every question is thoughtfully constructed to mirror the style, rigor, and structure of official UIL science tests. The result is a practice resource that not only strengthens understanding across all three disciplines but also provides a competitive edge by staying fully on par with UIL expectations and standards.

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