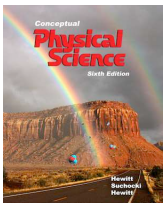
About This Course
Conceptual Physical Science — Physics, Astronomy, Chemistry
2020



Thank you for signing up for Conceptual Physical Science—PAC, with its focus on physics, astronomy, and chemistry. You are now looking over the users guide (aka, teacher's manual) to your Conceptual Academy course. There's a lot to digest, but please understand: This course is truly a guided course. We authors are your tour guides. We know the path rather well having traveled it many times before. You, the teacher, are your student's personal assistant. You are also their coach, cheering them onward and providing personalized help as needed. The purpose of this manual is to provide you, the teacher, a birds-eye view of an amazing adventure that's about to unfold for both yourself and your student. But throughout your journey, for any further support you might need, please write to us at Support@ConceptualAcademy.com.

1. About Conceptual Physical Science—Physics, Astronomy, Chemistry (PAC)
This course is divided into 6 *units*, which are divided into *lessons*. Each lesson is designed to take about one to two weeks to complete with the assumption that the student has other courses and extracurricular activities. For this course there are 26 lessons. This is ample for a full academic year of study. If few or no other courses are being taken, then this course could potentially be completed over a single semester or even over a summer term. This course makes for a focused introduction to physical science. Having completed this course, the student will be in a good position to enroll in one of our more in-depth courses, such Conceptual Physics or Conceptual Chemistry.

2. Laboratories
Science and experiments go together hand-in-glove. For this Conceptual Physical Science (PAC) course, ample laboratory activities are included right within the weekly lessons. You need not purchase any mail-order lab kit. Instead, the materials for these activities, such as white glue, coins, and popsicle sticks, are readily available within your household or a discount store. You'll find these lab activities to be substantial and meaningful allowing the student to apply the concepts of physical science, which is an essential part of the learning cycle. These lab activities are collated from a the following sources:

1) You'll find the "Think and Do" activities described within the textbook end-of-chapter material. These activities tend to be short and sweet, as well as numerous.

2) We offer "PhET Labs" that make use of interactive simulations created through the PhET program sponsored by the University of Colorado. The PhET simulations themselves are embedded within a lesson's From Your Instructor (FYI) page. For many of these simulations you'll also find within the Doc Share a write-up worksheet that guides the student through a simulation-based activity.

3) Select lab experiments are included from the Conceptual Physics *Beyond the Laboratory Manual* created by professor Stephanie Blake of Ozarks Technical College, MO. This creative manual features many engaging and mind-opening hands-on experiments utilizing only readily available materials. For each activity, after following through a prescribed set of instructions (guided learning), the student is then pushed to create their own experimental procedure on a related subject (inquiry learning). The full manual can be downloaded from LearnScience.Academy.

4) We also encourage you to download our Conceptual Chemistry *Beyond the Lab Manual* from LearnScience.Academy. This manual, created by Brandon Burnett of Weber State University together with John Suchocki, features chemistry experiments that use only materials available in the home or from a local discount store, such as Walmart.

5) Our official *Conceptual Physical Science Lab Manual* contains about 100 activities, which is way too much for any self-study course. So, in conjunction with the above mentioned activites, we have narrowed this down to 18 labs, which we have cut and pasted into documents made available to you through the FYI pages. You'll find most of these particular labs within the Earth science and astronomy chapters. Like the other activities, these too require materials that should be readily available. For example, to measure a star's ascension, you need only a straw, protractor, pencil, and a weighted string.

3. Learning Philosophy

We are strong proponents of "interleaving", which means a student undertakes a series of shorter study sessions on different subjects rather than one long study session on a single subject. For example, the student might spend an hour studying chemistry, followed by a history lesson. Interestingly, as the student is then studying history, the chemistry lesson remains brewing at a deeper level—and vice versa with history as the student turns back to the chemistry.

We are also advocates of "Step 1/Step 2" learning. Step 1 is where the student is being introduced to material, such as through the textbook and video tutorials. Step 1 is an input process. You'll note the mouth is closed. "Step 2" is an output process where the student tries to articulate (output) that which they think they learned from Step 1 through activities such as presentations and homework. Of these two steps, Step 2 is arguably the more difficult. Students tend to avoid Step 2 or neglect its importance. Learning, however, is only deep and durable when BOTH Step 1 and Step 2 have been employed. See our "How to Study Effectively" document to learn more.

4. A Typical Student Day

What should a student's typical day look like? We find it generally best for the student to begin with a Step 1 activity, such as reading the textbook or watching a video tutorial. After completing each textbook chapter section or video, the student is encouraged to ask themselves a most powerful learning question: "What did I just learn?" and then to answer this very question aloud or in writing. In doing so, the student is interleaving a Step 2 activity within a Step 1 activity, which is most productive.

After working with the textbook and videos, the student should put effort into the "Practice Page" worksheets available from the Doc share within each lesson.

There are the many end-of-chapter (EOC) questions within the textbook, all of them partitioned by chapter section. These are an important Step 2 activity for the student. Because of their great number, we recommend half of the odd-numbered questions as a goal post. Notably, the student will find the answers to the odd-numbered questions at the back of the book. This is important for the student to be able to confirm their understanding. It's also important that the student try their best to answer the question BEFORE looking at the answer. Any good answer will "make sense" after reading it. But it's not the answer that matters. What counts is being able to come up with the answer on one's own. A good student understands the world of difference between reading an answer and creating that answer him or herself.

Any opportunity the student has to summarize (aloud) what they believe they have learned to classmates, friends, or family members, is a serious bonus to the learning process—on many levels. You should consider the following capstone learning activity: Once a student "completes" a chapter, have the student provide a verbal summary of the main ideas of the chapter. You can call this: "The Summary Challenge". It's not as easy as it might sound, but it's a great way of identifying that which has been retained (or not). The process itself helps to make the learning durable. The student can then read the author's own chapter summary, which you'll find provided in the Doc Shares of the FYI pages. After reading the author's summary, ask the student to give their verbal summary another try. It's normal for students to stumble as they try their best to articulate what they think they learned.

Then there are Conceptual Academy's "Homework Practice Sessions", otherwise known as the HPS. The HPS serves a similar purpose to the end-of-chapter questions (Step 2 Learning). The goal is to provide the student ample opportunity to practice that which they think they have learned. As we'll describe shortly, the HPS questions are relatively difficult. Though there can be over 100 questions within a single HPS, the student is expected to study only as many as they can in a single session. Working on 10 to 20 questions in a single sitting is respectable.

In addition to the above activities, there are the labs and the unit exams. Which is to say, there is no shortage of resources available for your student. Success can be had by shifting from one resource to the next. As soon as the student becomes saturated with one

activity, then STOP. Move to another activity. Interleave these activities as per the wishes of the student. This is in contrast to a learning system of: "Hey kid. Here's the textbook. Now read until you learn something. Then we'll see if you can pass the test." Not good! We know from experience that the key to helping students learn is offering a variety learning resources. Variety is YUM! Let your student's typical day be filled with variety.

5. Grades—Summative and Formative

In traditional academics, most students are more focused on their letter grade than the actual learning that letter grade is suppose to represent. When scholarships and admissions to competitive colleges are at stake, this is understandable. Ideally, though, a higher letter grade reflects higher learning. But there are all sorts of exceptions. A student who has struggled for a "B" in a subject that is of sincere interest, is more likely to retain that knowledge over the long term, than a book savvy student who could care less but can still pull an "A".

We await the day when the standardized "Scholastic Aptitude Test" is replaced with a "Scholastic Attitude Test". In our experience as college professors, attitude is just as important as aptitude, if not more so.

It's not until grad school that many students begin to realize that the whole A|B|C|D|F grade system itself is to be taken with a huge grain of salt. What counts most is the learning, which is closely related to good attitude. But more than mere "knowledge" the ideal goal is nurturing our innate curiosity. Then beyond curiosity, and much more valuable than a perfect SAT score, is helping the student grow into a responsible, well-adjusted, happy, loving, and productive individual who can support him or herself and a family with a career they actually enjoy.

The true value of a grade is not as a final end-all to a particular course of study. Let's call that a "*summative grade*". Rather, grades are more important as feedback that helps us learn DURING that course of study. Let's call this a "*formative grade*". The value in a formative grade is in the guidance it provides while we still have time to make corrections—to let us know when we're on track and when we might still be holding onto misconceptions BEFORE the end of the semester.

We here at Conceptual Academy are not in a position to assign a final overall summative grade for each student taking one of our self-study courses. This is the responsibility of the teacher who has been working directly with the student throughout the course of study. We are, however, very much in a position to provide formative grades throughout. This comes in the form of the reading quizzes, the video quizzes, and the HPS as tracked by the Conceptual Academy grade book, as well as the answers to the chapter questions at the back of the textbook, and the answers to the Practice Pages available within the Doc Shares, as well as the answer keys we provide for all unit exams and lab activities. Let's talk about these components one by one.

Reading Quiz

A set of easy-to-answer questions collated from the chapter sections of each lesson. There is one "lesson reading quiz" for each lesson. These are designed to provide the student credit for having studied the paragraphs of the textbook. In many cases, the question is printed right within the margin of the textbook while the answer is highlighted within the paragraph. The "Reading Check" question at Conceptual Academy is the multiple choice version of that question.

Video Quiz

A set of easy-to-answer questions relating to a particular video. Each video has a video quiz, which consists of one to three questions. These questions focus on the content of the video, which will be similar to the content of the corresponding textbook chapter section. In most cases, a student who has studied the textbook chapter section, may be able to do well with the video quiz without watching the video. This is by design to minimize any "busy work". We don't want the student watching the video if they don't need to watch the video. Similarly, the student might be able to do well on a lesson reading quiz without reading the textbook but after watching all the videos. Ideally, a student works with both the textbook and the videos, which together provide the student a stereoscopic view of the material.

Homework Practice Session (HPS)

There is one Homework Practice Session (HPS) for each lesson. The HPS is an important Step 2 activity for the student after having studied the reading and video assignments for that lesson. The questions of the HPS are relatively difficult. Plus there are many of these questions—sometimes over 100 in a single session.

The goal of a homework practice session is PRACTICE. We liken it to practicing basketball. While practicing on the court, the basketball player should be taking chances, making mistakes, and learning from those mistakes. While practicing, the player should not be limited in the number of shots they're allowed to take. Also, the player should only practice for as long as is efficient. Push themselves, yes, but not to the point of exhaustion. When efficiency is lost, it's best to STOP. Take a break. Come back the next day to practice some more while fresh.

The same holds true for the Homework Practice sessions in which the student is encouraged to take chances, make mistakes, and learn from those mistakes. A session should go for as long as is reasonable for that student, which can vary from day to day. For each correct answer, the student earns 2 points. There's never a penalty for any wrong answer.

Each question is first presented in a short answer format. The student's free response is not graded, nor recorded in any database. Rather, it serves as a warm up to the multiple choice version of that question, which comes next.

If a student is averaging about 55% on a set of HPS questions, then this is admirable. It shows they're trying to answer the question without first looking up the answer, which is to be encouraged. Students should also be encouraged to work with others on these questions, which makes for a good group activity.

Points from the Reading and Video Quizzes and the HPS

For context, you should understand how the reading and video quizzes and the HPS are used at the college level. College students using Conceptual Academy are typically told they need to collect a certain number of CA points by the end of the semester. How many points depends upon the needs of the course, where 800 is a typical number. For such a course, all students who acquire at least 800 points will earn a 100% on this assignment, which counts for about 20% of their total summative letter grade. In this scenario, students aren't penalized for wrong answers. They just need to keep answering questions until they earn these 800 points. We call this an "encouragement-based approach" such that Conceptual Academy is there to reward students for good study habits. Yes, they can earn some points by random guessing. But random guessing won't help a student when it comes to their exams for which they are greatly penalized for their wrong answers.

So, in the college scenario, you've got one instructor with potentially 100+ students. For a self-study course where the student teacher ratio is closer to 1:1, then there's opportunity to take it to the next level, which means requiring your student to earn 1500 points by the end of the course. Consider the following:

At 2 pts for each correct answer there are about 3500 points possible within all the HPS's of this course. There are another 1500 points possible with the reading and video quizzes. Assume a student works on about 20 HPS questions per lesson getting about 55% of them correct. Also assume the student works on all the reading and video quizzes getting about 80% of them correct (they're easier). For such a diligent student, this calculates to about 1500 points over the entire course.

You'll want to get progress reports from your student as the course proceeds. Toward this, you can look at the student's Conceptual Academy grade book after each unit to see how they're doing. Within the gradebook, you'll find point totals, as well as breakdowns per unit. One thing you won't see is the percent score on the HPS. Why not? Because the goal of the HPS is not a high percentage. The goal of the HPS is a high volume of attempts. The gradebook does, however, provide percentages for the reading and video quizzes. Those percentages should be above 70%, hopefully closer to 90%.

Between the video quizzes, the reading quizzes, and the HPS, there is ample opportunity for your student to earn their 1500 points (or a similar point threshold you might set). Through this system, you will find much flexibility, which has many benefits. Most notably, the pressure to perform is minimized providing more space for the student to enjoy the material.

In assigning a final summative letter grade, we recommend the student's Conceptual Academy score from the video, reading, and HPS questions should be worth from 20% to 40% of the overall course grade. Once your student hits the 1500 point mark, they then have a 100% on their Conceptual Academy assignment. The remaining

portion of the overall course grade should be from the lab activities, unit exams, and any special projects.

End-of-Chapter Questions

Most of the questions at the back of each textbook chapter are presented in the short answer format. But which ones should your student answer? Here's a good rule of thumb: Every other odd-numbered question is relatively ambitious. You'll note that the questions start out easy, then build in difficulty level. We feel the "Think and Explain" questions are of most value.

Now, "how" should your student answer these questions? Think of these questions as conversation starters. Ideally, the student has some one they can explain their thoughts to verbally. There's a discussion that leads to an agreement. Only then is the answer looked up in the back of the book. The student might rate themselves as to the quality of their initial answer on a scale of 1 through 5. At that point most students would just move onto the next question. We have a better alternative: Now that the student has been exposed to the "real answer", have them explain it again (without looking at the answer). Then they rate again on a scale of 1 through 5. You'll see what's happening here is the student is articulating. As this is done, there are pathways within the brain that are literally being built. Durable learning is occurring. It requires effort. No one is exempt. It can be tiring. What to do when the student gets exhausted and feels like a sponge with all the water squeezed out of it? Why not some physical activity or even history? Or just take a break.

You should see that all the end-of-chapter questions are quite the resource for Step 2 learning. But how to grade their performance on these questions? The answer is: don't. Learning is still occurring. No grading please. For that, you can rely on the HPS. But you might consider setting a goal for the number of questions worked upon. For example, 10 questions. Dear student: Get through 10 questions and you'll have earned yourself a sticker, or better yet, a chocolate bar. Ultimately, the student should recognized that working on these EOC questions is great preparation for the unit exam. But beyond that, learning is its own reward. If all students could be brought to this understanding, we believe the bulk of problems in our nation's education system would melt away.

Practice Page Worksheets

These are pencil-pushing minds-on activities. In a way, they are similar to a lab experience, except it's all on paper. Our goal in creating these Practice Pages is to provide an enjoyable venue through which the student can *apply* what they think they understand. Please note: It's not like the student already understands something and then should be able to do the worksheet. It's the other way around. The understanding evolves only when the student is working on the worksheet.

This is similar to the end-of-chapter questions. The student may ask: How can I answer these questions if I don't first understand the material? They have it backward. The real question is: How can you understand the material if you don't

first work on these questions? The understanding itself arises from working on the questions. After Step 1? After reading the book and watching the videos? The student may feel they still don't really understand. That's correct. That's a wise student! An even wiser student knows that the understanding will grow like a seed from the soil only when watered by a stream of well-placed questions (Step 2). We call this "formative".

Unit Exams

Our unit exams can be considered a blend of both formative and summative grading, but with an emphasis on the formative. They are each presented in what at first seems like an unusual and complicated format, we call the "pyramid" format. But once you've been introduced to this format, you'll see it as a great learning opportunity. And fun too!

You'll find the pdf for each unit exam in the Doc Share on the last FYI page of each unit. Unlike the quizzes, and much like the Practice Pages, these are to be printed out. You'll find each exam begins with directions on how to run the exam in the pyramid format. Keep in mind that this format requires relatively tough level 3 questions. Your student is doing well upon earning around 60% on the first round. On subsequent rounds, this score will improve dramatically. It's important that students know of this design. Again, a 60% on round one is to be applauded.

In assigning a final summative grade, performance on these unit exams should be weighted heavily. For college students, their exams typically account from 50% to 80% of their course grade (lecture component). This would include their final exam. We have not included a final exam in this course as we expect different students will be covering different material. But for a final exam, if you wish for such, it would be fair for you to collate 40 relevant questions from all the previous unit exams taken over the course. Use the very same questions. That's legit and we would argue preferable.

Lab Activities

Many colleges still follow a 3:1 credit system, whereby the student earns 3 credit hours for "lecture" and 1 credit hour for "laboratory". On some campuses the student earns a single grade for both lab/lecture. At other campuses, the grade for lecture and lab are recorded separately. So, one way or the other, the lab component counts for about 25% of the overall assessment. It is typical that a student's lab scores tend to lift their lecture scores, which are based primarily on the mid-term exams as described above.

For your Conceptual Academy course, we recommend the same kind of balance. Ideally, the hands-on lab activities are there to complement the more minds-on process of learning concepts. The two work together. Relative to a grade, consider granting your student 75% just for completing a lab activity. You might then nit-pick the remaining 25% on the quality of a student's writing or their answers to questions.

On a final note, the course concludes with a downloadable, high-resolution Certificate of Completion, pre-signed by the author and awaiting the signature of the student's mentor.

6. Putting It All Together

In addition to the textbook, our library of video lessons (integrated with the textbook), the automated quizzes, the HPS, the Practice Pages, the unit exams, you will also find study advice from the author on each FYI page, interactive simulations, plus a number of Easter egg surprises spiced here and there. And for technical support, please write to Support@ConceptualAcademy.com.

We know you will find this self-study course to be rich not only in content but in flavor. Our goals go beyond imparting knowledge. We aim to nurture a life-long curiosity about this amazing natural world in which we are blessed to live. We know this to be an important path to becoming good stewards. Further, the rules of nature are what we all have in common and as this world gets smaller, a focus on what we have in common becomes all the more important. Further still, understanding science for what it is, for what it can do, for what it can't do, for how it, for better or worse, has impacted our daily lives, is critically important for any student in this modern age.

Thank you for your support of Conceptual Academy. We are so please and honored to be working with you.

Good science to you!

The Conceptual Academy Team

Prof. Hewitt
Geology

Prof. Suchocki
Chemistry & Astro

Prof. Hewitt
Physics

Prof. Lyons
Earth Science

Prof. Yeh
Biology

7. But wait, there's more! The Log Sheet

What follows is the table of contents of this course that you might use to demonstrate to any college admissions officer the college level of quality of this physical science course taken by your student. Keep in mind, our conceptual textbooks really are used at a great number of college campuses. The Beyond the Lab Manuals have a similar log sheet.

Syllabus: Physical Science, Phys/Astro/Chem

Unit : A: Mechanics

Lesson 1 (/ /)

- FYI page
- 1.1 Aristotle on Motion
- 1.2 Galileo's Concept of Inertia
- 1.3 Mass--A Measure of Inertia
- 1.4 Net Force
- 1.5 The Equilibrium Rule
- 1.6 Support Force
- 1.7 The Force of Friction
- 1.8 Speed and Velocity
- 1.9 Acceleration
- Lesson Reading Quiz
- Homework Practice Session

Lesson 2 (/ /)

- FYI page
- 2.1 Newton's First Law of Motion
- 2.2 Newton's Second Law of Motion
- 2.3 Forces and Interactions
- 2.4 Newton's Third Law of Motion
- 2.5 Summary of Newton's Three Laws
- Lesson Reading Quiz
- Homework Practice Session

Lesson 3 (/ /)

- FYI page
- 3.1 Momentum and Impulse
- 3.2 Impulse Changes Momentum
- 3.3 Conservation of Momentum
- 3.4 Energy and Work
- 3.5 Work-Energy Theorem
- 3.6 Conservation of Energy
- 3.7 Power
- 3.8 Machines
- 3.9 Efficiency
- 3.10 Sources of Energy
- Lesson Reading Quiz
- Homework Practice Session

Lesson 4 (/ /)

- FYI page
- 4.1 The Universal Law of Gravity
- 4.2 Gravity and Distance: The Inverse-Square Law
- 4.3 Weight and Weightlessness
- 4.4 Universal Gravitation
- 4.5 Projectile Motion
- 4.6 Fast-Moving Projectiles—Satellites
- 4.7 Circular Satellite Orbits
- 4.8 Elliptical Orbits
- 4.9 Escape Speed
- Lesson Reading Quiz
- Homework Practice Session

Unit : B: Fluids and Energy

Lesson 1 (/ /)

- FYI page
- 5.1 Density
- 5.2 Pressure
- 5.3 Buoyancy in a Liquid
- 5.4 Archimedes' Principle
- Lesson Reading Quiz
- Homework Practice Session

Lesson 2 (/ /)

- FYI page
- 5.5 Pressure in a Gas
- 5.6 Atmospheric Pressure
- 5.7 Pascal's Principle
- 5.8 Buoyancy in a Gas
- 5.9 Bernoulli's Principle
- Lesson Reading Quiz
- Homework Practice Session

Lesson 3 (/ /)

- FYI page
- 6.1 Temperature
- 6.2 Absolute Zero
- 6.3 Heat
- 6.7 Specific Heat Capacity
- 6.8 Thermal Expansion
- 6.9 Expansion of Water
- Lesson Reading Quiz
- Homework Practice Session

Lesson 4 (/ /)

- FYI page
- 7.5 Climate Change and the Greenhouse Effect
- 7.6 Heat Transfer and Change of Phase
- 7.7 Boiling
- 7.8 Melting and Freezing
- 7.9 Energy and Change of Phase
- Lesson Reading Quiz
- Homework Practice Session

Lesson 5 (/ /)

- FYI page
- 8.1 Electric Force and Charge
- 8.2 Coulomb's Law
- 8.3 Electric Field
- 9.4 Electric Currents and Magnetic Fields
- 9.5 Magnetic Forces on Moving Charges
- Lesson Reading Quiz
- Homework Practice Session

Unit : C: Waves and Atoms

Lesson 1 (/ /)

- FYI page
- 10.1 Vibrations and Waves
- 10.2 Wave Motion
- 10.3 Transverse and Longitudinal Waves
- 10.4 Sound Waves
- 10.5 Reflection and Refraction of Sound
- 10.6 Forced Vibrations and Resonance
- 10.7 Interference
- 10.8 Doppler Effect
- 10.9 Bow Waves and the Sonic Boom
- 10.10 Musical Sounds
- Lesson Reading Quiz
- Homework Practice Session

Lesson 2 (/ /)

- FYI page
- 11.1 Electromagnetic Spectrum
- 11.2 Transparent and Opaque Materials
- 11.3 Reflection
- 11.4 Refraction
- 11.5 Color

- 11.6 Dispersion
- 11.7 Polarization
- Lesson Reading Quiz
- Homework Practice Session

Lesson 3 (/ /)

- FYI page
- 12.1 Atoms Are Ancient and Empty
- 12.2 The Elements
- 12.3 Protons and Neutrons
- 12.4 The Periodic Table
- 12.5 Physical and Conceptual Models
- 12.6 Identifying Atoms Using the Spectroscope
- 12.7 The Quantum Hypothesis
- 12.8 Electron Waves
- 12.9 The Shell Model
- Lesson Reading Quiz
- Homework Practice Session

Lesson 4 (/ /)

- FYI page
- 13.1 Radioactivity
- 13.2 The Strong Nuclear Force
- 13.3 Half-Life and Transmutation
- 13.4 Radiometric Dating
- Lesson Reading Quiz
- Homework Practice Session

Lesson 5 (/ /)

- FYI page
- 13.5 Nuclear Fission
- 13.6 Mass-Energy Equivalence
- 13.7 Nuclear Fusion
- Lesson Reading Quiz
- Homework Practice Session

Unit : D: Astronomy

Lesson 1 (/ /)

- FYI page
- 26.1 The Solar System and its Formation
- 26.2 The Sun
- 26.3 The Inner Planets
- 26.4 The Outer Planets
- Lesson Reading Quiz
- Homework Practice Session

Lesson 2 (/ /)

- FYI page
- 26.5 Earth's Moon
- 26.6 Failed Planet Formation
- Lesson Reading Quiz
- Homework Practice Session

Lesson 3 (/ /)

- FYI page
- 27.1 Observing the Night Sky
- 27.2 The Brightness and Color of Stars
- 27.3 The Hertzsprung-Russell Diagram
- 27.4 The Life Cycles of Stars
- 27.5 Black Holes
- 27.6 Galaxies
- Lesson Reading Quiz
- Homework Practice Session

Lesson 4 (/ /)

- FYI page
- 28.1 Looking Back in Time
- 28.2 Cosmic Inflation
- 28.3 General Relativity
- 28.4 Dark Matter
- 28.5 Dark Energy
- 28.6 The Fate of the Universe
- Lesson Reading Quiz
- Homework Practice Session

Unit : E: Elements of Chemistry

Lesson 1 (/ /)

- FYI page
- 14.1 Chemistry: The Central Science
- 14.2 The Submicroscopic World
- 14.3 Physical and Chemical Properties
- 14.4 Determining Physical and Chemical Changes
- 14.5 Elements to Compounds
- 14.6 Naming Compounds
- 14.7 The Advent of Nanotechnology
- Lesson Reading Quiz
- Homework Practice Session

Lesson 2 (/ /)

- FYI page
- 15.1 Electron-Dot Structures
- 15.2 The Formation of Ions
- 15.3 Ionic Bonds
- 15.4 Metallic Bonds
- 15.5 Covalent Bonds
- Lesson Reading Quiz
- Homework Practice Session

Lesson 3 (/ /)

- FYI page
- 15.6 Polar Covalent Bonds
- 15.7 Molecular Polarity
- 15.8 Molecular Attractions
- Lesson Reading Quiz
- Homework Practice Session

Lesson 4 (/ /)

- FYI page
- 16.1 Most Materials Are Mixtures
- 16.2 The Chemist's Classification of Matter
- 16.3 Solutions
- 16.4 Solubility
- 16.5 Soaps, Detergents, and Hard Water
- 16.6 Purifying the Water We Drink
- 16.7 Wastewater Treatment
- Lesson Reading Quiz
- Homework Practice Session

Unit : F: Chemical Reactions

Lesson 1 (/ /)

- FYI page
- 17.1 Chemical Equations
- 17.2 Counting Atoms and Molecules by Mass
- 17.3 Reaction Rates
- 17.4 Catalysts
- 17.5 Energy and Chemical Reactions
- 17.6 Chemical Reactions Are Driven by Entropy
- Lesson Reading Quiz
- Homework Practice Session

Lesson 2 (/ /)

- FYI page
- 18.1 Acids Donate Protons; Bases Accept Them
- 18.2 Relative Strengths of Acids and Bases
- 18.3 Acidic, Basic, and Neutral Solutions
- 18.4 Acidic Rain and Basic Oceans
- Lesson Reading Quiz
- Homework Practice Session

Lesson 3 (/ /)

- FYI page
- 18.5 Losing and Gaining Electrons
- 18.6 Harnessing the Energy of Flowing Electrons
- 18.7 Electrolysis
- 18.8 Corrosion and Combustion
- Lesson Reading Quiz
- Homework Practice Session

Lesson 4 (/ /)

- FYI page
- 19.1 Hydrocarbons
- 19.2 Unsaturated Hydrocarbons
- 19.3 Functional Groups
- 19.4 Alcohols, Phenols, and Ethers
- 19.5 Amines and Alkaloids
- 19.6 Carbonyl Compounds
- 19.7 Polymers
- Lesson Reading Quiz
- Homework Practice Session