This course supports the assessments for Advanced Geosciences. The course covers 4 competencies.

Introduction

Overview

Advanced Geosciences explores the formation and evolution of the Solar System and the Universe. Focusing on the Earth's systems and subsystems, students analyze how the Earth's atmosphere has evolved as a result of biological and geological processes. This course also examines contributions made by astronomers that validate theories and facts about the Solar System and the Universe. Course: Earth & Space Science.

Getting Started

Welcome to Advanced Geosciences! You should begin this course by completing the Math Skills Review and the Basic Principles of Science Review before proceeding to the topics. This course consists of two broad topics which are organized into smaller manageable sections containing essential readings, interactive tutorials from Pearson Education, labs from Hands-On Labs, and built-in knowledge checks. Requesting the answer key from your course instructor upon completion of the labs, and recording answers to knowledge checks in your notebook, will increase your ability to demonstrate competency. Use the pacing guide to help you track your progress in the course.

You also have a unique opportunity to participate in seminars offered through the American Museum of Natural History (AMNH). Although these seminars are not mandatory, you are encouraged to register for them and take advantage of this opportunity to enhance your content understanding through multimedia presentations, discussions with other teachers, and observation of teaching techniques. Participation in these seminars will also provide you with an array of classroom resources to use in the future. Your competency will be demonstrated through the completion of a performance assessment, in which you will write five short essays regarding the evolution of the Earth systems and the solar system.

Pacing Guide

This outline suggests a weekly structure to pace your completion of learning activities. It is provided as a suggestion and does not represent a mandatory schedule. Follow these guidelines carefully to complete the course in the suggested timeframe.

Week One

- Necessary Reviews
- Earth's Exterior: Minerals
- Register for AMNH (optional)

Week Two

- Earth’s Exterior Rocks
- Weathering and Soils
- Water, Glaciers, and Wind

Week Three

- Earth’s Interior
- Earth Structure Performance Task

Week Four

- Earth’s Dynamic Equilibrium
- Bio-Geo Interactions Performance Task
- Earth’s Atmosphere

Week Five

- Modern Astronomy
- European Astronomers Performance Task
- Our Solar System

Week Six

- Beyond the Solar System
- Stellar Remnants Performance Task
- Cosmology Performance Task

Competencies
This course provides guidance to help you demonstrate the following 4 competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.
- **Competency 205.2.3: Solar System**
  The graduate understands the components and properties of the solar system, and understands that the major components are in a state of regular and predictable motion.
- **Competency 205.2.4: The Universe**
  The graduate understands the composition, history, and properties of the earth and the universe, and the scale of the universe in space and time.

Teaching Dispositions Statement

Please review the Statement of Teaching Dispositions.

Course Instructor Assistance
As you prepare to successfully demonstrate competency in this subject, remember that course instructors stand ready to help you reach your educational goals. As subject matter experts, mentors enjoy and take pride in helping students become reflective learners, problem solvers, and critical thinkers. Course instructors are excited to hear from you and eager to work with you.

Successful students report that working with a course instructor is the key to their success. Course instructors are able to share tips on approaches, tools, and skills that can help you apply the content you're studying. They also provide guidance in assessment preparation strategies and troubleshoot areas of deficiency. Even if things don't work out on your first try, course instructors act as a support system to guide you through the revision process. You should expect to work with course instructors for the duration of your coursework, so you are welcome to contact them as soon as you begin. Course instructors are fully committed to your success!

Preparing for Success

The information in this section is provided to detail the resources available for you to use as you complete this course.

Learning Resources

The learning resources listed in this section are required to complete the activities in this course. Read the full instructions provided to ensure that you have access to all of your resources in a timely manner.

Automatically Enrolled Resources

You can access the learning resources listed in this section by clicking on the links provided throughout the course. You may be prompted to log in to the WGU student portal to access the resources.

VitalSource E-Texts
The following textbook is available to you as an e-text within this course of study. You will be directly linked to the specific readings required within the activities that follow.

- [redacted]. *Earth science (14*[redacted]

Note: These e-texts are available to you as part of your program tuition and fees, but you may purchase a hard copy at your own expense through VitalSource or a retailer of your choice. If you choose to do so, please use the ISBN listed to ensure that you receive the correct edition. The following sites provide instruction on how to create a VitalSource account, use features such as downloading your e-texts for offline use, and purchase a print-on-demand option, if available.

VitalSource Navigational Video
Print-On-Demand Option

Resources You Must Order or Enroll For

LabPaq

The *Advanced Geoscience* LabPaq, sometimes referred to as a lab kit, from Hands-On Labs, is a physical shipment. This lab kit (LabPaq) is covered by your program's Science Lab Fee, and includes science equipment, specimens, supplies, and chemicals necessary to complete laboratory experiments at home. The experiments reinforce science content and teach laboratory techniques. If you have ordered this in a previous course, there is no need to order another.

1. Use these instructions to order your LabPaq: Advanced Geoscience LabPaq Ordering Instructions.
2. Click here for your Advanced Geoscience LabPaq Manual: To be used throughout your course and assessment where applicable.

AMNH Seminars (Optional)

To enroll for the AMNH Seminar, navigate to the "Learning Resources" tab, click the "Sections" button, then click the "Enroll Now" button. Once your mentor approves this resource enrollment, you will receive an e-mail with further access instructions.

This online seminar offered by the American Museum of Natural History (AMNH) uses multimedia and discussions to connect teachers and future teachers from around the world to cutting-edge research, classroom resources, and each other. Participating in this seminar develops your understanding of the content, models appropriate teaching pedagogy, and exposes you to an array of resources that can be used in your classroom or to help with lesson planning. While this is an optional learning resource, you are strongly encouraged to take advantage of this opportunity. This seminar is covered as part of your WGU tuition.

While this is an optional learning resource, you are strongly encouraged to take advantage of this opportunity. These seminars, which are typically around $450, are covered as part of your WGU tuition.

The following three seminars relate to WWT1 assessments:

- "Earth Inside and Out"
- "The Solar System"

Each six-week seminar requires about 8 hours per week of your time. The seminars have definite start and stop times, so, review the AMNH Calendar to determine when the course is offered, and consult your mentor to coordinate this seminar into your schedule.
Discuss the AMNH-WGU FAQ with your mentor to better understand how to successfully use the AMNH course as a WGU learning resource.

Once your mentor approves your enrollment on the "Learning Resources" tab, you will be sent a confirmation email. Please check your email regularly for a registration email directly from AMNH. This message will contain the information you will need to access this online seminar.

Necessary Reviews

The following activities will provide you with the necessary subject reviews that will best prepare you for success in this course. Please complete all the reviews before beginning work on the course.

Math Skills Review

Geosciences topics involve understanding basic math, even if you do not use these skills often. In this section, you will review rules of math such as powers of 10, scientific notation, and units. It is suggested that you review the math rules for each section and then use the practice exercises to check your understanding and skills.

Powers of 10, Scientific Notation, and Units

Review the following web pages:

For practice in these math skills, please take the practice tests listed above. If you are unable to answer at least 80% of the problems correctly without a calculator, or if you have any question about the content, please contact your course instructor.

- Powers of 10
  - Practice test
- Scientific Notation
  - Practice test
  - Practice problems
- Units
  - Practice test
  - Practice problems

For practice in these math skills, please take the practice tests listed above. If you are unable to answer at least 80% of the problems correctly without a calculator, or if you have any question about the content, please contact your course instructor.

Basic Principles of Science Review

The National Science Teachers Association (NSTA) has published principles and standards that address important Earth and space science topics that should be covered through the K-12 curriculum. Many states have followed the NSTA's lead and are increasingly requiring that these concepts be taught to the students throughout the course of their science education. A firm grasp of the concepts covered in this course will allow you to confidently teach this material when you enter the classroom.

Science is about gathering data and determining the most probable explanation based on the data. The explanations can change over time, as new data is collected. Scientists use tools to collect data and follow safety procedures while using those tools. Within all the disciplines, scientists make observations and ask questions, then test their ideas to learn more. It is a continual process.

As scientists work on experiments, their data is only as good as their measurement tools. As

technology improves, scientists can make more accurate measurements. Scientists create graphs and charts to share their findings with others.

Providing a safe learning environment is essential in the classroom. Teachers need to be aware of proper laboratory procedures to ensure a safe experience for the students. Performing experiments helps with the learning process and should be a part of the science curriculum. Read through the following flowchart which represents the process of scientific inquiry.

- How science works: The flowchart

Review the following concepts:

- processes involved in scientific inquiry
- problem-solving methods
- experimental design
- nature of scientific knowledge

Earth's Exterior: Minerals

This section will discuss the minerals which make up the planet and how to identify minerals.

Minerals

Atoms make minerals and minerals make rocks.

Identifying minerals is challenging, but with practice you will get better. With your new knowledge, you will be able to identify rocks picked up outside. Learning your local minerals will help the process.

This topic addresses the following competencies.

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Classifying Minerals

Review the following pages in chapter 2 ("Matter and Minerals") of the *Earth Science* e-text:

- Section 2.1 Minerals: Building Blocks of Rock
- Section 2.3 Why Atoms Bond
- Section 2.4 Properties of a Mineral
- Section 2.5 Mineral Groups

Complete the following activity

- GEODe Minerals — Introduction to Minerals

https://lrps.wgu.edu/provision/34044723

To practice mineral identification through their unique characteristics, please work through each sample at:

- Earth Science Lab

Identifying Mineral Groups

Access the following in chapter 2 ("Matter and Minerals") of the *Earth Science* e-text:

- Figure 2.24 Common Silicate Minerals
- Table 2.1 Common Nonsilicate Mineral Groups

In your study notebook, list the mineral groups as shown in the table. Different mineral combinations make different rocks.

Review the following figure:

https://lrps.wgu.edu/provision/33482753

Practice identifying examples of minerals for each major mineral group (e.g., graphite is a native element, quartz is a framework silicate, and calcite is a carbonate).

You need to know common silicate and non-silicate mineral groups. You also need to know the key atoms that define a silicate and the ion(s) that represent each of the non-silicate mineral groups.

Note that a “three-dimensional network” is more commonly called a “framework.” Please write the name and mineral formula of one framework silicate and one framework non-silicate. (Hint: In the Mohs Hardness Scale, this non-silicate is a “10”.)

Review the following figure:

https://lrps.wgu.edu/provision/33482842

An anion is an ion with a negative charge. Minerals are classified by their anionic group or by the anion associated with the mineral. Table 2.1 of *Earth Science* lists common non-silicate mineral groups. In your study notebook, explain the system of classifying minerals by anionic groups by noting the difference between groups ending in “-ate” and “-ide,” and what is a native element.

Look at Table 2.1. Is there a difference in chemical formula between graphite and diamond? Reason it out — what might explain why graphite (pencil lead) and diamond behave so differently?

Must a mineral be in an ore deposit to be a valuable resource?

Identification Lab

Complete the following in the Geology LabPaq:

- "Mineralogy and Identification" — *Note to student: Please do not use a hammer to break your samples to look for cleavage as instructed. It ruins the samples.*

After completing the lab please request an answer key from your course instructor so that you may self-grade. Your goal is to identify samples of common minerals that form rocks.

If you have already done this lab in a previous WGU course, then please move ahead to the next section.

Minerals Quiz

https://lrps.wgu.edu/provision/33619769

Earth's Exterior: Rocks

This section will discuss the minerals which make up the planet and how to identify minerals.

Rocks

This topic will explore rocks and the rock cycle.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

The Rock Cycle

Review the following chapter in the *Earth Science* e-text:

- chapter 3 ("Rocks: Materials of the Solid Earth")

Review the general details of the processes involved when one type of rock (igneous, metamorphic, or sedimentary) is transformed into any other.

Complete the following activity:

- GEODe Rock Cycle

https://lrps.wgu.edu/provision/33483328

Igneous Rock Lab

Complete the following in the Geology LabPaq:

- “Igneous Rock Identification”

After completing the lab, request an answer key from your course instructor so that you may self-grade. You should be able to name common igneous rocks.

If you have already done this lab in a previous WGU course, then please move ahead to the next section.

Igneous Rocks Review

Review the following section in chapter 3 ("Rocks: Materials of Solid Earth") of the *Earth Science* e-text:

- Section 3.2 Igneous Rocks: Formed by Fire

In your study notebook, explain the formation of different kinds of igneous rocks in terms of available parent material and fast or slow cooling through Bowen's reaction series.

Complete the following activities:

- GEODe Minerals — GEODe Igneous Rocks — Introduction to Igneous Rocks
- GEODe Minerals — GEODe Igneous Rocks — Igneous Textures
- GEODe Minerals — GEODe Igneous Rocks — Igneous Compositions
- GEODe Minerals — GEODe Igneous Rocks — Naming Igneous Rocks

https://lrps.wgu.edu/provision/34044742

Review the following figure:

https://lrps.wgu.edu/provision/33483018
Sedimentary Rock Lab

Complete the following in the Geology LabPaq:

- “Sedimentary Rock Identification”

After completing the lab, please request an answer key from your course instructor so that you may self-grade. You should be able to name common sedimentary rocks.

If you have already done this lab in a previous WGU course, then please move ahead to the next section.

Types of Sedimentary Rock

Create a table that compares and contrasts different kinds of sedimentary rocks (e.g., large and small-grained clastic rocks, chemical and biogenic rocks) in terms of their parent materials and environment of deposition.

Note: “Biogenic” means formed from living things – these rocks are also called “bioclastic” or “biochemical” in the textbook. The key term is “bio” since that relates to the carbon from living organisms rather than the carbon that came from non-living sources.

Complete the following activities in chapter 3 (“Rocks: Materials of the Solid Earth”):

- GEODe Sedimentary Rocks — Introduction to Sedimentary Rocks
- GEODe Sedimentary Rocks — Types of Sedimentary Rocks

https://lrps.wgu.edu/provision/34044754

Sedimentary Rock Formation Lab

Complete the following in the Geology LabPaq:

- “Sedimentary Rock Formation” for sedimentary environments

After completing the lab, please request an answer key from your course instructor so that you may self-grade.

If you have already done this lab in a previous WGU course, then please move ahead to the next section.

Formation of Sedimentary Rock

Review the following section in chapter 3 ("Rocks: Materials of the Solid Earth") of the *Earth Science* e-text:

- Section 3.3 Sedimentary Rocks: Compacted and Cemented Sediment

Then go back to Figure 3.2 and look at the Rock Cycle.

https://lrps.wgu.edu/provision/33482940

In your study notebook, explain the following steps in the formation of sedimentary rocks:

- weathering
- erosion
- transportation
- deposition
- burial (cementation and/or compaction)
- diagenesis (lithification)

Please note the difference between compaction and cementation during burial and how that leads to lithification.

What does your textbook consider the most important characteristic feature of sedimentary rocks? Why might this be relevant to economic use of resources trapped in sedimentary rocks?

Complete the following activity:

- GEODe Sedimentary Rocks — Sedimentary Environments

https://lrps.wgu.edu/provision/34044754

Metamorphic Rock Lab

Complete the following in the Geology LabPaq:

- "Metamorphic Rock Identification"

After completing the lab, please request an answer key from your course instructor so that you may self-grade. You should be able to name common metamorphic rocks.

If you have already done this lab in a previous WGU course, then please move ahead to the next section.

Metamorphic Rock Review

Review the following section in chapter 3 ("Rocks: Materials of the Solid Earth") of the *Earth Science* e-text:

- Section 3.4 Metamorphic Rocks: New Rock from Old

Review the following:

https://lrps.wgu.edu/provision/33483272

In your study notebook, explain the formation of different types of metamorphic rocks in terms of available parent material and increased temperature, directed pressure, and various amounts of time in different geological settings.

Do rocks melt during metamorphism? Explain thermal (contact) metamorphism and regional metamorphism. What is the role of chemically active fluids? Discuss the difference between foliated and nonfoliated metamorphic rocks.

Complete the following activities:

- GEODe Metamorphic Rocks — Introduction to Metamorphic Rocks
- GEODe Metamorphic Rocks — Agents of Metamorphism
- GEODe Metamorphic Rocks — Textural and Mineralogical Changes
- GEODe Metamorphic Rocks — Common Metamorphic Rocks

https://lrps.wgu.edu/provision/34044674

Rocks Quiz

https://lrps.wgu.edu/provision/33619209

Weathering and Soils

In this section, you will learn about the processes involved in breaking rocks into smaller

particles and how those particles combine with organic matter, water, and air to form soil.

Weathering

In this section, you will study two kinds of weathering: the physical breaking apart of rocks, and the chemical reactions that change their makeup.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Causes of Weathering

Read the following sections in chapter 4 ("Weathering, Soil, and Mass Wasting") of the *Earth Science* e-text:

- Section 4.2 Weathering
- Section 4.3 Rates of Weathering

Explain in your study notebook the mechanisms involved in the mechanical weathering of rocks (e.g., frost wedging, exfoliation, abrasion).

Chemical Weathering

Explain in your study notebook how granite weathers. Specifically, please explain what happens when carbonic acid and water come in contact with potassium feldspar.

How does the climate affect the rate of weathering?

- Read the caption to Figure 4.10 (limestone cherub) and explain what happens with acid precipitation.

Review the following figure:

https://lrps.wgu.edu/provision/33483549

Weathering Lab

Complete the following in the Geology LabPaq:

- “Weathering”

After completing the lab, please request an answer key from your course instructor so that you may self-grade.

If you have already done this lab in a previous WGU course, then please move ahead to the next section.

Weathering Review

Complete the following activities:

- GEODe Weathering and Soil — Earth’s External Processes
- GEODe Weathering and Soil — Types of Weathering
- GEODe Weathering and Soil — Mechanical Weathering
- GEODe Weathering and Soil — Chemical Weathering

https://lrps.wgu.edu/provision/34044678

Soils

Soil is produced by weathering. Soil is mostly a mixture of particles of broken rocks, but it also contains organic matter, water, and air. The type of soil that forms depends on the rocks, landforms, vegetation, animals, and climate of an area.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Soil Formation

Explain in your study notebook the process of soil formation, including the influence of differing climates. Why would the A Horizon likely be the thickest horizon to form in a humid climate?

Review the following in chapter 4 ("Weathering, Soil, and Mass Wasting") of the *Earth Science* e-text:

- Table 4.2 Basic Soil Orders, within Section 4.7 Classifying Soils

What is the difference between alfisols and aridosols? What can you say about soil fertility in a mollisol?

Now look at Figure 4.18 Global Soil Regions. What is the soil region where you live?

Soil and Mass Wasting Quiz

https://lrps.wgu.edu/provision/33619617

Water, Glaciers, and Wind

This section will look at how moving water, wind, and glaciers shape the landscape by moving weathered particles from one location to another.

Water, Glaciers, and Wind

In this topic, you will discuss the forces (i.e., water, glaciers, and wind) that cause the external processes previously discussed.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Review Ground and Surface Water

Read the following chapter in the *Earth Science* e-text to review the water cycle and the benefits of running water:

- chapter 5 ("Running Water and Groundwater")

Review the following figure in chapter 5 ("Running Water and Groundwater"):

https://lrps.wgu.edu/provision/33483655

In your study notebook, explain how transpiration and infiltration work with the three main stages of the hydrologic cycle.

Review the following:

https://lrps.wgu.edu/provision/33483845

Review the following figure:

https://lrps.wgu.edu/provision/33483729

What are the three ways load can be carried by a stream? How can you differentiate between a meandering stream and a braided stream?

Surface Water Review

Complete the following activities:

- GEODe Running Water — Hydrologic Cycle
- GEODe Running Water — Stream Characteristics
- GEODe Running Water — Reviewing Valleys and Stream-Related Features

https://lrps.wgu.edu/provision/34044804

Floods and Flood Control

Review the following section in chapter 5 ("Running Water and Groundwater") of the *Earth Science* e-text:

- Section 5.8 Floods and Flood Control

Use the following document to complete the next part of this activity:

- Flood Control Table

Groundwater

Review the following section in chapter 5 ("Running Water and Groundwater") of the *Earth Science* e-text:

- Section 5.9 Groundwater": Water Beneath the Surface

Review the following:

https://lrps.wgu.edu/provision/33483951

Review the following figure:

https://lrps.wgu.edu/provision/33483794

In your study notebook, explain the movement of groundwater into aquifers, considering the importance of rock porosity and permeability. What factors influence the storage and movement of ground water?

Please give an example of an environmental problem associated with groundwater. How do caverns and karst topography result from groundwater?

Groundwater Review

Complete the following activities:

- GEODe Groundwater — Importance and Distribution
- GEODe Groundwater — Springs and Wells

https://lrps.wgu.edu/provision/34044688

Running Water and Groundwater Quiz

https://lrps.wgu.edu/provision/33619724

Changes in the Landscape

Read the following chapter in the *Earth Science* e-text to understand glaciers, deserts, and

wind:

- chapter 6 ("Glaciers, Deserts, and Wind")

Describe some of the landforms indicative of glacial erosion and deposition. What landforms are created by wind, especially in deserts? In the United States, why are loess deposits (very dry wind-blown sediments) often associated with glaciers?

Glaciers Review

Complete the following activities:

- GEODe Glaciers and Glaciation — Introduction
- GEODe Glaciers and Glaciation — Budget of a Glacier
- GEODe Glaciers and Glaciation — Reviewing Glacial Features

https://lrps.wgu.edu/provision/34044832

Review the following:

https://lrps.wgu.edu/provision/33484254

Deserts and Winds Review

Complete the following activities:

- GEODe Deserts and Wind — Distribution and Causes of Dry Lands
- GEODe Deserts and Wind — Common Misconceptions About Deserts
- GEODe Deserts and Wind — Reviewing Landforms and Landscapes

https://lrps.wgu.edu/provision/34044861

Review the following:

https://lrps.wgu.edu/provision/33484303

https://lrps.wgu.edu/provision/33484324

Glaciers, Deserts and Wind Quiz

https://lrps.wgu.edu/provision/33619665

Earth's Interior

This topic includes plate tectonics and geologic hot spots, geologic landforms that result from plate tectonics activity, and Earth's magnetic field.

Plate Tectonics

This topic will explain how ideas such as continental drift and seafloor spreading evolved into modern understanding of plate tectonics and geologic hot spots. Plate tectonic processes help show how Earth’s magnetic field changes over geologic time.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Plate Boundaries

Tectonic plates are made of lithosphere, which is a combination of crust and upper mantle rock.

Review the following figure:

https://lrps.wgu.edu/provision/33484417

In your study notebook, please discuss the three types of plate boundaries: divergent, convergent, and transform.

Review the following figure:

https://lrps.wgu.edu/provision/33484421

Review the following:

https://lrps.wgu.edu/provision/33484594

https://lrps.wgu.edu/provision/33484540

Convergent boundaries involve either collision or subduction. While reading about these types,

please explain (write down or draw) what is occurring.

Review the following figure:

https://lrps.wgu.edu/provision/33484436

Transform boundaries allow plates to change from one tectonic environment to another.

Review the following figure:

https://lrps.wgu.edu/provision/33484485

Does it matter if the plates involved are made of oceanic rock or continental rock? Describe the geologic structures and landforms commonly found at each plate boundary.

Review the following:

https://lrps.wgu.edu/provision/33484646

Which boundaries result in

1. both mountains and volcanoes (especially underwater)?
2. curved chains of **mountains only** (no volcanoes)?
3. deep V-shaped trenches next to curved chains of volcanic islands?
4. neither mountains nor volcanoes but straight fault lines?

What can account for **straight chains of islands (like Hawaii)**?

Review the following:

https://lrps.wgu.edu/provision/33484567

https://lrps.wgu.edu/provision/33484692

For an interactive view of straight-line volcanic eruptions at Yellowstone National Park, please visit:

- Tracking the Hotspot

Plate Tectonics Labs

Complete the following in the Geology LabPaq:

- “Plate Tectonics I”
- “Plate Tectonics II”

After completing the lab, please request an answer key from your course instructor so that you

may self-grade.

Plate Tectonics Review

Complete the following activities:

- GEODe Plate Tectonics — Introduction to Plate Tectonics
- GEODe Plate Tectonics — Divergent Boundaries
- GEODe Plate Tectonics — Convergent Boundaries
- GEODe Plate Tectonics — Transform Boundaries

https://lrps.wgu.edu/provision/34044867

Review the following:

https://lrps.wgu.edu/provision/33484587
Earth?s Magnetic Field

Describe in your study notebook the modern evidence supporting the theory of plate tectonics with at least one sentence each on the following topics:

- ocean drilling
- paleomagnetism
- apparent polar wandering
- magnetic reversals
- seafloor spreading

In your study notebook, briefly describe the pattern of changes in Earth's magnetic field over time.

Note that the past and present magnetic field is generated by the movement of Earth’s outer core while reading the following section in chapter 7 ("Plate Tectonics: A Scientific Theory Unfolds") of the *Earth Science* e-text:

- Section 7.9 Testing the Plate Tectonics Model

Review the following figure:

https://lrps.wgu.edu/provision/33484501

In your study notebook, make a drawing of Earth with its magnetic field as if it were a bar magnet. (your drawing should look like a butterfly). Label the north and south poles.

Magnetic Field Lab

Complete the following in the Geology LabPaq:

- "Mapping a Magnetic Field"

After completing the lab, please request an answer key from your course instructor so that you may self-grade.

If you have already done this activity in a previous WGU course, then please move ahead to the next section.

Earth?s Magnetic Field Review

Complete the following activity:

- Paleomagnetics — Magnetic Polarity and Polarity Timescales

https://lrps.wgu.edu/provision/34077729

Geologic Hot Spots: Measuring Plate Tectonics

Describe in your study notebook how seafloor spreading and hot spot tracks are used to measure the rate of plate motion while reading the following section in chapter 7 ("Plate Tectonics: A Scientific Revolution Unfolds") of the *Earth Science* e-text:

- 7.10 How is Plate Motion Measured

What is a geologic hot spot? It is sometimes called an intraplate volcano — what does “intraplate” mean?

Visit the webpage below for more information on volcano hot spots:

- Volcano Hot Spot

Geologic hot spots also exist on Venus and Mars:

- Recent Hotspot Volcanism on Venus from VIRTIS Emissivity Data
- Olympus Mons

Plate Tectonics Quiz

https://lrps.wgu.edu/provision/33619603

Earthquakes

This topic will explore the complexities of earthquakes.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Earthquake Waves

Read the following chapter in the *Earth Science* e-text:

- chapter 8 ("Earthquakes and Earth's Interior")

Review the following figure:

https://lrps.wgu.edu/provision/33484738

Use the following document to complete the next part of this activity:

- Earthquake Seismic Wave Table

Earthquake Destruction

Read the following section in chapter 8 ("Earthquakes and Earth's Interior") of the *Earth Science* e-text:

- Section 8.4 Earthquake Destruction

In your notes, describe the characteristics of a tsunami, including the cause and what happens as one approaches the shore.

Review the following:

https://lrps.wgu.edu/provision/33484908

Earthquakes Review

Complete the following activities:

- GEODe Earthquakes — What is an Earthquake
- GEODe Earthquakes — Seismology
- GEODe Earthquakes — Locating the Source of an Earthquake
- GEODe Earthquakes — Earthquakes at Plate Boundaries

https://lrps.wgu.edu/provision/34044890

Review the following:

https://lrps.wgu.edu/provision/33484824

https://lrps.wgu.edu/provision/33484839

Earth?s Internal Structure

Complete the following activities:

- GEODe Earth's Interior — Earth's Layered Structure

https://lrps.wgu.edu/provision/34044901

Earthquakes and Earth Interior Quiz

https://lrps.wgu.edu/provision/33619293
Seismology for Mineral and Fossil Fuel Exploration

Seismology plays an important factor in fossil fuel exploration. Study the following web pages:

- Utah Geological Survey
- Encyclopedia Brittanica

Earth Structure Performance Task

You will now complete the Earth Structure Task in Taskstream.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Earth Structure Task

Complete the following task in Taskstream:

- Interdisciplinary Geosciences: Earth Structure

Refer to Section 8.2 Seismology: The Study of Earthquake Waves as you distinguish between a seismograph and a seismogram. Discuss how a seismograph works. Make sure to explain in detail what is represented on a seismogram.

For details about this performance assessment, see the "Assessment" tab in this course.

Earth's Dynamic Equilibrium

You will continue your study of the changing Earth by exploring volcanoes and mountains. Mountains typically form at the boundary between two plates. A mountain that has been built from molten rock and gases escaping the interior of Earth is called a volcano. Volcanoes are typically classified by their shape, which is determined by how they form.

Volcanoes and Mountains

Volcanoes and mountains are large landforms that result from geologic processes such as plate tectonics and geologic hot spots. Smaller features, such as hills and dunes, result from sedimentary processes that reshape the landscape.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**

The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.

- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Volcanoes Review

Read the following chapter in the *Earth Science* e-text:

- chapter 9 ("Volcanoes and Other Igneous Activity")

Review the following figure:

https://lrps.wgu.edu/provision/33485226

Review the following:

https://lrps.wgu.edu/provision/33485369

In your notes, list and describe the three (3) types of volcanoes based on their magma composition and shape. Viscosity plays a crucial role – what is viscosity?

How can you tell whether a volcano (or seamount or mountain) is caused by hot spot activity, plate divergence, or plate convergence?

Review the following:

https://lrps.wgu.edu/provision/33485326

Complete the following activities:

- GEODe Volcanoes — The Nature of Volcanic Eruptions
- GEODe Volcanoes — Materials Extruded During an Eruption
- GEODe Volcanoes — Volcanic Structures and Eruptive Styles
- GEODe Volcanoes — Intrusive Igneous Activity

https://lrps.wgu.edu/provision/34044944

Review the following:

https://lrps.wgu.edu/provision/33485407

Volcanoes and Other Igneous Activity Quiz

https://lrps.wgu.edu/provision/33619532
Rock Deformation

Read the following section in chapter 10 ("Crustal Deformation and Mountain Building") of the *Earth Science* e-text:

- Section 10.1 Crustal Deformation

In your study notebook, describe the properties of elastic, plastic, and brittle strain. Also, describe what happens when rocks fail in brittle strain.

What is an accreted terrane?

Review the following figure:

https://lrps.wgu.edu/provision/33485630

Review the following:

https://lrps.wgu.edu/provision/33485053
Stress and Deformation Lab

Complete the following in the Geology LabPaq:

- “Stress and Deformation”

After completing the lab, please request an answer key from your course instructor so that you may self-grade.

If you have already done this activity in a previous WGU course, then please move ahead to the next section.

Folding Rock

Read the following section of chapter 10 ("Mountain Building") in the *Earth Science* e-text:

- Section 10.2 Folds: Rock Structures Formed by Ductile Deformation

Review the following figure:

https://lrps.wgu.edu/provision/33485522

While reading, recognize the geologic structures formed by folding rock strata (e.g., anticline, syncline, dome, basin, overturned structures). In your study notebook, draw simple pictures so that you can recognize each feature.

Faults

Read the following section of chapter 10 ("Mountain Building") in the *Earth Science* e-text:

- Section 10.3 Faults and Joints: Rock Structures Formed by Brittle Deformation

Review the following figure:

https://lrps.wgu.edu/provision/33485015

Use the following document to complete the next part of this activity:

- Faults Table

Please explain how to determine the hanging wall from the footwall in a dip-slip fault. Also discuss how to tell whether a strike-slip fault is right-lateral or left-lateral.

Rock Deformation Review

Complete the following activities:

- GEODe Mountain Building — Deformation
- GEODe Mountain Building — Folds
- GEODe Mountain Building — Faults and Fractures

https://lrps.wgu.edu/provision/34044975

Isostasy: Vertical Movement

Review the vertical movements of the crust in the following chapter of the *Earth Science* e-text:

- chapter 10 ("Crustal Deformation and Mountain Building")

Write an explanation in your study notebook: What might happen to the land if all the ice currently on Greenland melts or slides off? Could there be any effect on local climate over time as a result of isostatic rebound?

Isostasy Review

Complete the following activity:

- Isostasy

https://lrps.wgu.edu/provision/34077615

Crustal Deformation and Mountain Building Quiz

https://lrps.wgu.edu/provision/33619525

Geologic Time

Planets evolve as well as lifeforms do. Geologic time periods indicate significant changes in the development of a planet’s crust, atmosphere, and surface liquids, as well as major events in biological evolution. On Earth, if you climb to the top of many mountains, you may find evidence of ocean animals. This topic will, in part, explore how animal remains can be found on top of mountains.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Earth?s Early Beginnings

To better understand life’s early beginnings, read the following chapters in the *Earth Science* e-text:

- chapter 11 (“Geologic Time”)
- chapter 12 ("Earth's Evolution through Geologic Time")

Geologic Time and Age-Dating Review

Complete the following activities:

- GEODe Geologic Time Scale

https://lrps.wgu.edu/provision/33486052

- GEODe Relative Dating—Key Principles

https://lrps.wgu.edu/provision/33486060

Review the following figure:

https://lrps.wgu.edu/provision/33485930

Review the following:

https://lrps.wgu.edu/provision/33485979

https://lrps.wgu.edu/provision/33486017

Review the following figure:

https://lrps.wgu.edu/provision/33485923

- GEODe Dating with Radioactivity

https://lrps.wgu.edu/provision/33486100

Review the following:

https://lrps.wgu.edu/provision/33486036

Review the following figure:

https://lrps.wgu.edu/provision/33485966

Geologic Time Quiz 1

https://lrps.wgu.edu/provision/33619429

Geologic Time Quiz 2

https://lrps.wgu.edu/provision/33619142

Evolution of Earth?s Atmosphere

In your notebook, write down the history of Earth's current atmosphere.

Please read the following article from the American Museum of Natural History:

- How Has the Earth Evolved?

In your study notebook, please explain:

- What are Banded Iron Formations?
- When did they form?
- How do Banded Iron Formations tell us about the evolution of Earth’s atmosphere over time?

Current research significantly modifies the old “primodial soup” theory:

- New Research Rejects 80-Year Theory of 'Primordial Soup' as the Origin of Life

Earth’s 2nd atmosphere probably formed in the same way and at the same time as the atmospheres of Venus and Mars. Take a look at the thickness and composition of the atmospheres of Venus and Mars today:

- Planetary Atmosphere Comparison Chart

In your study notebook, please answer the following questions based on the NASA link provided above**:**

- What is the most dominant gas in the atmospheres of Venus and Mars?
- What geological process that used to occur on all three planets but now only occurs on Earth might account for that gas? Are any other gases emitted by that same geological process?
- The atmosphere of Earth no longer matches that of Venus and Mars. What are the two most dominant gases on Earth?

Real change occurred during the “Great Oxidation Event”. When was that?

What NON-geological processes made Earth’s atmosphere change from the 2nd atmosphere to the 3rd one we have today?

Bio-Geo Interactions Performance Task

You will now complete the Bio-Geo Interactions Performance Task in Taskstream.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.

- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Bio-Geo Interactions Performance Task

Complete the following task in Taskstream:

- Interdisciplinary Geosciences: Bio-Geo Interactions Atmosphere

For details about this performance assessment, see the "Assessment" tab in this course.

Earth's Atmosphere

This section will describe the structure and composition of Earth’s atmosphere. How and why air moves globally and locally is related to climate and weather.

Atmosphere and Heat

In this section, you will explore the relationship of the atmosphere and heat transfer.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

The Atmosphere

Review the following section in chapter 16 ("The Atmosphere: Composition, Structure, and Temperature") of the *Earth Science* e-text:

- Section 16.3 Vertical Structure of the Atmosphere

In your study notebook, please draw and discuss the following concepts:

- troposphere
- stratosphere
- mesosphere
- thermosphere
- exosphere

For details, see:

- Layers of the Atmosphere

The thermosphere includes the ionosphere:

- The Ionosphere

In your study notebook, please answer in which layer of Earth's atmosphere you would find the following:

- weather
- ozone that protects surface life from ultraviolet radiation
- meteors burning up
- auroras and ions that can reflect radio signals
- so few atoms that it is barely an atmosphere at all

Layers of the Atmosphere review

Complete the following activities:

- GEODe Intro. Atmosphere — Composition of the Atmosphere
- GEODe Intro. Atmosphere — Temperature Structure of the Atmosphere
- GEODe Intro. Atmosphere — Extent of the Atmosphere

https://lrps.wgu.edu/provision/34045059

Heat transfer

Read the following section in chapter 16 ("The Atmosphere: Composition, Structure, and Temperature") of the *Earth Science* e-text:

- Section 16.5 Energy, Heat, and Temperature

In your study notebook, please discuss the three mechanisms of heat transfer. Note that these mechanisms are important for heat transfer in Earth's oceans and in Earth's mantle.

Review the following figure:

https://lrps.wgu.edu/provision/33486808

Review and summarize what heats air and how air moves.

https://lrps.wgu.edu/provision/33486816

What is albedo? How does albedo influence surface temperature?

Heat Transfer Review

Complete the following activities:

- GEODe Temperature Data — Controls of Temperature

https://lrps.wgu.edu/provision/33487035

- GEODe Heating Earth's Surface & Atm. — What Happens to Incoming Solar Radiation
- GEODe Heating Earth's Surface & Atmosphere — In the Lab: The Influence of Color on Albedo

https://lrps.wgu.edu/provision/34045069
Atmosphere Composition, Structure, & Temperature Quiz

https://lrps.wgu.edu/provision/33619156

Water and Clouds

This topic will explore the basic cycles of water.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Phases of Water

Read the following section in chapter 17 ("Moisture, Clouds, and Precipitation") of the *Earth Science* e-text:

- Section 17.1 Water’s Changes of State

Review the following figure:

https://lrps.wgu.edu/provision/33487070

In your study notebook, please identify or define the following concepts:

- the three phases of water that can co-exist at water’s triple point
- condensation
- deposition
- dew point
- evaporation
- freezing
- melting
- saturation point
- sublimation

Phases of Water Review

Complete the following activities:

- GEODe Moisture-Cloud Formation — Water's Changes of State
- GEODe Moisture-Cloud Formation — Humidity: Water Vapor in the Air

https://lrps.wgu.edu/provision/34045104
Clouds and Precipitation

Read the remainder of chapter 17 ("Moisture, Clouds, and Precipitation"). In your study notebook, discuss how clouds form and move. Review the following table:

- table 17.3 (“Forms of Precipitation”)

Complete the following activities:

- GEODe Moisture-Cloud Formation — Processes That Lift Air
- GEODe Moisture-Cloud Formation — Basics of Cloud Formation: Adiabatic Cooling
- GEODe Moisture-Cloud Formation — Critical Weathermaker: Atmospheric Stability

https://lrps.wgu.edu/provision/34045104

Review the following figures:

https://lrps.wgu.edu/provision/33487190

https://lrps.wgu.edu/provision/33487198

Clouds and Precipitation Quiz

https://lrps.wgu.edu/provision/33619241

Air Pressure and Weather

This topic will explore the relationship of air pressure to weather events.

This topic addresses the following competencies:

- **Competency 205.2.1: Earth Systems Structure and Function**
  The graduate understands the structure and function of Earth systems, including the closely coupled subsystems: geosphere, hydrosphere, atmosphere, and biosphere.
- **Competency 205.2.2: Earth Systems Equilibrium**
  The graduate understands the Earth's history and that the Earth exists in a state of dynamic equilibrium that evolves over geologic time.

Air Pressure and Wind

Read the following section in chapter 18 ("Air Pressure and Wind") of the *Earth Science* e-text:

- Section 18.2 Factors Affecting Wind

Review the following figures:

https://lrps.wgu.edu/provision/33487893

https://lrps.wgu.edu/provision/33487940

In your study notebook, please explain how pressure gradient force, the Coriolis Effect, and friction with earth's surface affect the way winds blow (air moves).

Complete the following activities:

- GEODe Air Pressure and Wind — Measuring Air Pressure
- GEODe Air Pressure and Wind — Factors Affecting Wind
- GEODe Air Pressure and Wind — Highs and Lows

https://lrps.wgu.edu/provision/34045167
Weather Fronts

Read the following section in chapter 19 ("Weather Patterns and Severe Storms") of the *Earth Science* e-text:

- Section 19.2 Fronts

Review the following figure:

https://lrps.wgu.edu/provision/33488053

In your study notebook, please draw and label warm, cold, stationary, and occluded fronts. As your guides, use SmartFigures 19.11. Line drawings like these are often used in content knowledge exams like the Earth and Space Sciences Praxis II exam.

Complete the following activities:

- GEODe Basic Weather Patterns — Air Masses
- GEODe Basic Weather Patterns — Fronts
- GEODe Basic Weather Patterns — In the Lab: Examining a Middle-Latitude Cyclone

https://lrps.wgu.edu/provision/34045185
Air Pressure and Weather Quiz

https://lrps.wgu.edu/provision/33619805

Modern Astronomy

This section will discuss the scale and structure of our solar system and of the known universe.

Origin of Modern Astronomy

Our ancestors' understanding of the solar system began when they tried to explain what they could observe in the sky. Using scientific thinking and logic, they began to create models that explained what they saw.

This topic addresses the following competencies:

- **Competency 205.2.3: Solar System**
  The graduate understands the components and properties of the solar system, and understands that the major components are in a state of regular and predictable motion.

Origins of Modern Astronomy

Read the following section of chapter 21 ("Origins of Modern Astronomy") in the *Earth Science* e-text:

- Section 21.1 Ancient Astronomy

In your study notebook, please answer:

- What were the seven heavenly bodies known to the Greeks?
- Is there a difference between geocentric and heliocentric?
- How was the circumference of Earth measured?
- Who were some of the ancient Greeks known for their astronomy and what did they contribute?

Retrograde Motion

Review the following figure in chapter 21 ("Origins of Modern Astronomy") of the *Earth Science* e-text:

https://lrps.wgu.edu/provision/33488378

Figure 21.6 shows why Mars might appear to be traveling backwards at times. Earth passes Mars on the inside, creating this illusion. In your study notebook, define retrograde motion. How did Ptolemy explain it? As Copernicus realized, what is actually occurring?

Early Astronomers

Read the following section in chapter 21 ("Origins of Modern Astronomy") of the *Earth*

Science e-text:

- 21.2 Birth of Modern Astronomy

Review the following figures:

https://lrps.wgu.edu/provision/33488378

https://lrps.wgu.edu/provision/33488413

In your study notebook, describe the contributions of ancient astronomers, Nicolaus Copernicus, Tycho Brahe, Johannes Kepler, Galileo Galilei, and Isaac Newton.

Answer the following questions in your study notebook:

- Listing at least three Ancient Greeks, what was known about celestial bodies during the “Golden age” of early astronomy?
- How did Copernicus challenge Ptolemy?
- How did Brahe revolutionize observational astronomy?
- What are Kepler's laws of planetary motion?
- What did Galilei discover with the telescope?
- What is Newton's law of universal gravitation?

European Astronomers Performance Task

You will now complete the European Astronomers Performance Task in Taskstream.

This topic addresses the following competency:

- **Competency 205.2.3: Solar System**
  The graduate understands the components and properties of the solar system, and understands that the major components are in a state of regular and predictable motion.

European Astronomers Performance Task

Complete the following task in Taskstream:

- Interdisciplinary Geosciences: European Astronomers

For details about this performance assessment, see the "Assessment" tab in this course.

Note: In the evaluation rubric, the word “key” does not refer to “answer key” but to “important basic ideas from each man.”

Astronomical Observations

Telescopes are the most notable tool for observing the sky. They are a perfect example of how advances in technology provide a means for increasing understanding of science. In turn, advances in science have allowed technologies to be improved.

This topic addresses the following competencies:

- **Competency 205.2.3: Solar System**
  The graduate understands the components and properties of the solar system, and understands that the major components are in a state of regular and predictable motion.

Telescopes

Read the following sections in chapter 23 ("Light, Astronomical Observations, and the Sun") in *Earth Science:*

- Section 23.2 Spectroscopy
- Section 23.3 Collecting Light Using Optical Telescopes
- Section 23.4 Radio- and Space-Based Astronomy

In your study notebook, please define what is a: spectroscope, optical telescope (discuss refracting versus reflecting), and radio telescope. Please list and provide one fact for each of the four orbiting observatories discussed in the textbook.

Positions in the Sky

For a description of the celestial sphere, read the following section in chapter 21 ("Origins of Modern Astronomy") of the *Earth Science* e-text:

- Section 21.3 Positions in the Sky

Review the following figure:

https://lrps.wgu.edu/provision/33486760

Describe the celestial sphere and the coordinate systems astronomers use to locate objects in the sky. Describe the effect of the observer's latitude on the position of an object in the sky.

Constellations

In your study notebook, please explain why an amateur astronomer should know the constellations. Pretend that this person has just discovered a new comet (which, actually, amateurs do far more often than professional astronomers) and wants to share information about location and brightness with NASA and the public.

Earth Motions

In your study notebook, please summarize:

- Precession
- Moon phases
    - During which phases of the Moon are we likely to see the Sun and the Moon in the sky at the same time (during the day)?
- Lunar and Solar Eclipses

Review the following figures:

https://lrps.wgu.edu/provision/33488489

https://lrps.wgu.edu/provision/33488525

https://lrps.wgu.edu/provision/33488489

Our Solar System

The solar system consists of the sun, eight planets, and countless other astronomical objects, including asteroids, meteorites, comments, dwarf planets, and moons. The density of the solar system is concentrated at the center; the sun contains more than 99.8% of the mass in the solar system. The planets contain most of the remaining mass. While all the planets share certain characteristics, they also have a wide variety of properties.

The Solar System

There are many characteristics that the four inner planets (i.e., terrestrial planets) share with each other, which are in contrast to some of the characteristics of the four outer planets (i.e., Jovian planets).

This topic addresses the following competencies:

- **Competency 205.2.3: Solar System**
  The graduate understands the components and properties of the solar system, and understands that the major components are in a state of regular and predictable motion.

The Planets: An Overview

In 2006, the International Astronomical Union formally defined the word “planet” for the first time and created a new category: “dwarf planet.”

For more details, please see:

- Pluto and the Developing Landscape of Our Solar System

Analysis of other solar systems helps confirm that they follow the same rules of formation, dynamics, and evolution as our own. A mature solar system (like ours) contains about one million objects, of which the largest are one or more suns, 5-10 planets, dozens of dwarf planets, and several hundred moons. The remaining objects are tiny rocky bodies formerly known as asteroids and small icy bodies that used to be called comets—since it is difficult to tell them apart when they are far from the Sun, these are now all “small solar system bodies.”

Read the following sections in chapter 22 ("Touring Our Solar System") of the *Earth Science* e-text:

- Section 22.1 Our Solar System: An Overview

In your study notebook, please briefly answer:

- How did the planets form? (Note: What is the nebular hypothesis?)

In terms of composition, sizes, and atmosphere, how are Terrestrial (Earth-like) planets similar to or different from Jovian (Jupiter-like) planets?

Look at Figure 22.2 (Comparing Internal Structures of the Planets). Please note that inside each Jovian planet is an Earth-sized Terrestrial planet.

Sketch a diagram of our solar system showing the main bodies inside each of the 5 main zones:

- Terrestrial planets
- Asteroid belt (include our smallest dwarf planet)
- Jovian planets
- Kuiper belt (include our two largest dwarf planets)
- Oort cloud

What sorts of objects dominate in the Kuiper Belt and Oort Cloud?

Name the biggest moons of each Jovian planet; add two more moons each for Jupiter and Saturn—how many moons do those planets have now? What is a habitable zone? Why are some of the big moons of Jupiter and Saturn likely to have habitable zones?

Earth's Moon

Read the following section in chapter 22 ("Touring Our Solar System") of the *Earth Science* e-text:

- Section 22.2 Earth's Moon: A Chip off the Old Block
- SmartFigure 21.27 “Lunar Eclipse”

https://lrps.wgu.edu/provision/33488647

Look at the Figure 22.4 (Formation of an Impact Crater) and Figure 22.7 (Formation and Filling of Large Impact Basins). How would you explain to a friend how impact craters form?

Please answer the following questions:

- How does the size, mass, and gravitational pull of the moon compare to that of Earth?
- Which geologic processes led to surface features we see today in the lunar highlands and maria? What geologic processes act on the moon today?
- What is the collision theory of the formation of the moon, and what evidence is there to support it?

Galileo mistakenly believed there were large seas on the moon but he was correct that there is water in and on the lunar crust, some of it brought by icy bodies that hit the surface of the moon. For more info, please see:

- Ice may lurk in shadows beyond Moon's poles

Another misconception is that the moon has no core and had no magnetic field. The moon’s iron core is small but was sufficient to induce a magnetic field for at least a billion years. For more info, please see:

- Mystery of the Moon’s Lost Magnetism Explained

The moon is often called airless but that is yet another misconception. Reason it out—which geologic processes might produce the moon’s tenuous exosphere?

- Is the Moon Still Alive?

The Planets: Details

Read the following in Chapter 22 (“Touring Our Solar System”) of the *Earth Science* e-text:

- Section 22.3 Terrestrial Planets
- Section 22.4 Jovian Planets

Look at Table 22.1 (“Planetary Data”) and at Figure 22.2(Comparing Internal Structures of the Planets) to compare the internal structures of the planets. Note that every planet has a solid core! Terrestrial planet cores are metal while Jovian planets have Earth-sized rocky cores.

Please make a grid with the names of the 8 planets on the left and features you want to compare at the top. (This may take a 2-page spread in your study notebook.) For each planet, describe its:

- type (rocky or gaseous surface);
- size compared to Earth (smaller or larger);
- relative distance from the sun (Earth's distance is 1 AU);
- most striking surface features;;
- number of moons (zero? few? many?);
- whether it has a ring system;
- and any other special features (such as unusual rotation rate, tilt, or density).

Now talk about each planet's atmosphere:

- composition;
- density (compared to Earth's);
- features (like winds blowing in particular directions or long-lasting storms).

Magnetic fields protect atmospheres from being blown away by the solar wind (which extends well past Pluto). What other factors may account for whether a planet has a thin or thick atmosphere?

Earth's magnetic field is induced by the rotation of the liquid outer core around the solid inner core; both spin in the same direction but at different speeds. Do other planets have a magnetic field? If yes, what internal process generates it? If not, why not?

Now make another grid to compare some key moons of Jovian planets: Io, Europa, Ganymede, Callisto, Titan, Enceladus, Miranda, Triton. Compare their size, atmospheres, and surface features.

What is cryovolcanism? What causes it?
Planets and Earth?s Moon Review

Complete the following activities:

- GEODe The Planets: An Overview

https://lrps.wgu.edu/provision/33488742

- GEODe A Brief Tour of the Planets

https://lrps.wgu.edu/provision/33488755

- GEODe Earth's Moon

https://lrps.wgu.edu/provision/33488748

- Chapter 21: Smart Figure: Orbital Motion of Earth and Other Planets

https://lrps.wgu.edu/provision/34451484

Small Solar System Bodies

Read the following section in Chapter 22 ("Touring Our Solar System") of the *Earth Science* e-text:

- Section 22.5 Small Solar System Bodies

Dwarf planets are considerably larger and have very different internal structures than smaller bodies, more commonly known as asteroids and comets. Dwarf planets are simply smaller versions of traditional planets—they are round; differentiated into layers; have active geological processes on their surfaces; and many have atmospheres and moons.

Smaller bodies are not round; are not differentiated so have no layers (although some bodies may have large patches of surface ice covered in rocky dust); are less likely to be geologically active; and generally do not have atmospheres (although some have moons).

In your study notebook, answer the following questions:

- What is the asteroid belt?
- What is the Kuiper belt?
- What is the Oort cloud, and what evidence is there to support its existence?
- What is the composition of a comet?
- How is the coma of a comet produced?
- What is a meteor shower? Does a meteor shower produce meteorites?
- Compare the terms meteor, meteoroid, and meteorite. Where do meteorites come from?
- Describe iron, stony-iron, and stony meteorites. How do meteorites help us determine the internal structure of Earth?
- Why are carbonaceous chondrites of particular interest?

Touring the Solar System Quiz

https://lrps.wgu.edu/provision/33619576

The Sun

In this section, you not only discuss some of the sun's properties, you also consider how scientists are able to determine said properties.

This topic addresses the following competencies:

- **Competency 205.2.3: Solar System**
  The graduate understands the components and properties of the solar system, and understands that the major components are in a state of regular and predictable motion.

The Sun

Read the following section in chapter 23 ("Light, Astronomical Observations, and the Sun") of the *Earth Science* e-text:

- Section 23.5 The Sun
- SmartFigure 23.20 “Diagram of the Sun’s Structure”

https://lrps.wgu.edu/provision/33488879

Please look at SmartFigure 23.20 (Diagram of the Sun's Structure) showing a diagram of solar structure in cutaway view.

Make a labeled drawing describing the sun's structure and its surface, including sunspots. Include the six layers of the sun in your drawing:

- inner core
- radiative zone
- convection zone
- photosphere
- chromosphere
- corona

Discuss the role of granules and spicules in moving energy. Explain the cycle of sunspots in terms of changes in the sun's magnetic field geometry.

In your study notebook, please explain how a photon created in the Sun’s core would migrate through each layer to become part of a coronal mass ejection or solar flare flung toward Earth.

How long would it take a photon in a solar flare to reach Earth?

How would the photon interact with Earth’s atmosphere to produce an aurora?

The Sun: Review

Complete the following activity:

- Vocabulary in Context: Structure of the Sun

https://lrps.wgu.edu/provision/34451495

Light and The Sun Quiz

https://lrps.wgu.edu/provision/33619632

Beyond the Solar System

This subject will discuss stars and other components of galaxies and the known universe.

Stars

This topic will discuss the Hertzsprung-Russell (H-R) diagram and how it is used to effectively

communicate basic information about stars. It also concerns the evolution of stars and stellar remnants (i.e., white dwarf, neutron star, black hole).

This topic addresses the following competencies:

- **Competency 205.2.4: The Universe**
  The graduate understands the composition, history, and properties of the earth and the universe, and the scale of the universe in space and time

Stellar Properties

Read the following section in chapter 24 ("Beyond Our Solar System") of the *Earth Science* e-text:

- Section 24.3 Classifying Stars: Hertzsprung-Russell Diagrams (H-R Diagrams)"

https://lrps.wgu.edu/provision/33489005

Please look at the idealized Hertzsprung-Russell diagram and notice that every axis of the diagram is labeled, including the right side and the top.

Define the following:

- luminosity
- surface temperature
- absolute magnitude
- spectral class

In your study notebook, please explain:

- What does the main sequence represent? Which stars on the main sequence are the youngest and which are the oldest?
- What is a white dwarf?

Stars Review

Complete the following activity:

- Visual Activity: Using an H-R Diagram to Eplore the Properties of Main-Sequence Stars

https://lrps.wgu.edu/provision/34579789

Stellar Evolution

Read the following section in chapter 24 ("Beyond Our Solar System") of the Earth Science e-text:

- Section 24.4 Stellar Evolution

Stars have lifespans — they are born in stellar nurseries, live and mature in solar systems, and die. How stars live and die is totally dependent upon mass, which determines how quickly the star will consume its fuel and how strong outward pressures will be to counteract the force of gravity.

Describe the characteristics of each stage in the evolution of a star. Pay particular attention to the balance between gravity (which pulls inward) and thermal expansion (which pushes outward). Watch the following videos regarding stellar evolution:

- “Life of a Star” (Cherenkov Telescope Array)
- Hydrostatic equilibrium and degenerate pressures (Afterschool Universe)

Visit these links for further information:

- NASA: What is a Star?
- hydrostatic equilibrium
- Electron Degeneracy Pressure

Read the information on Neturon Degeneracy on the following webpage:

- Neutron Stars and Pulsars

In your study notebook, please outline stellar evolution in terms of star birth, the proto-star stage, being on the main sequence, becoming a red giant, burnout and death.

Please discuss:

- Hydrostatic equilibrium
- Electron Degeneracy Pressure
- Neutron Stars and Pulsars

Stellar Remnants

Read the following section in chapter 24 ("Beyond Our Solar System") of the *Earth Science* e-text:

- Section 24.5 Stellar Remnants

Stars die and follow one of three paths: low-mass, medium-mass, or high-mass. In your study notebook, please define these terms compared to the mass of the sun (1 solar mass).

Why are more massive neutron stars smaller in diameter than less massive white dwarfs? What is a black hole, and how do astronomers hope to detect one?

Look at Table 24.1(“Summary of Evolution for Stars of Various Masses”) and read the accompanying text about white dwarfs, neutron stars, and black holes. What are the ranges of final masses for each object (compared to 1 solar mass)?

In your study notebook, describe how a star becomes a white dwarf, neutron star, or a black hole.

Stellar Remnants Review

Complete the following activity:

- Ranking Task: The Size of Planets, Stars, and Stellar Remnants

https://lrps.wgu.edu/provision/34579797

In the text, are there any comparisons between objects on Earth (like a spoonful or a pea) with the extreme densities of these objects?

Please visit these links to learn about the following terms:

- Chandrasekhar limit
- Event horizon
- Schwarzschild radius

In your study notebook, please answer:

- How will our sun die?
- What is the Chandrasekhar limit and why is it relevant to our Sun?
- Why are neutron stars so dense?
- How massive must a star be to become a black hole?
- For any black hole, what are the Schwartzschild radius and event horizon?
- When they die, why do some stars leave behind huge, colorful structures called nebulae?

Read the box titled “From Stardust to You.” Where does every atom in your body ultimately

come from?

Beyond Our Solar System Quiz

https://lrps.wgu.edu/provision/33619440

Stellar Remnants Performance Task

You will now complete the Stellar Remnants Performance Task in Taskstream.

This topic addresses the following competency:

- **Competency 205.2.4: The Universe**
  The graduate understands the composition, history, and properties of the earth and the universe, and the scale of the universe in space and time

Stellar Remnants Performance Task

Complete the following task in Taskstream:

- Advanced Geosciences: Stellar Remnants

For details about this performance assessment, see the "Assessment" tab in this course.

Galaxies

In this section, you will begin by studying the different types of galaxies within the universe.

This topic addresses the following competency:

- **Competency 205.2.4: The Universe**
  The graduate understands the composition, history, and properties of the earth and the universe, and the scale of the universe in space and time

Galaxies

Read the following section in chapter 24 ("Beyond Our Solar System") of the *Earth Science* e-text:

- Section 24.6 Galaxies and Galactic Clusters

Create a table in your notebook to compare and contrast spiral, elliptical, and irregular galaxies. Our galaxy, the Milky Way Galaxy, is a barred spiral. What does that mean?

In your study notebook, please define the following concepts:

- a galactic cluster

- the Local Group
- a supercluster

Dark Matter

Each galaxy seems to contain or be surrounded by a cloud of dark matter.

Watch Vera Rubin explain her discovery of dark matter in her own words in this video clip from the BBC:

- The Mystery of Dark Matter

Based on what you learned in the video, what is dark matter?

Cosmology

Cosmology is a branch of astronomy that studies the characteristics of your universe. This includes if, when, and how the universe began; the shape of the universe; how galaxies are spread across the universe; how galaxies are moving; and if, when, and how the universe will end.

This topic addresses the following competencies:

- **Competency 205.2.4: The Universe**
  The graduate understands the composition, history, and properties of the earth and the universe, and the scale of the universe in space and time

Big Bang Theory

Read the following sections in chapter 24 ("Beyond Our Solar System") of *Earth Science:*

- Section 24.1 The Universe
- Section 24.7 The Big Bang Theory

Review the following figures:

https://lrps.wgu.edu/provision/33488806

https://lrps.wgu.edu/provision/33488816

In your study notebook, please explain:

- How does the Doppler Shift apply to light?
- How did Edwin Hubble use redshift to determine the motion of galaxies?

Review the following figure in your textbook that illustrates the raisin bread analogy for an expanding universe.

https://lrps.wgu.edu/provision/33489110

In cosmology, isotropy refers to the uniform expansion of the universe. How does the raisin bread analogy describe how objects farther from Earth appear to be moving faster?

In your study notebook, please answer:

- What is the Big Bang theory?
- How does the Cosmic Microwave Background radiation help prove the Big Bang theory?
- What is critical density?
- What might the fate of the universe be if the density of the universe is more than the critical density? Or less than the critical density?

Cosmology Review

Complete the following activities in chapter 24 ("Beyond the Solar System"):

- Ranking Task: Size and Distance Scales of Levels of Structure in the Universe

https://lrps.wgu.edu/provision/34451571

- Vocabulary in Context: Describing Motions in the Universe

https://lrps.wgu.edu/provision/34579839

- Visual Activity: Exploring the Expanding Raisin Cake Universe

https://lrps.wgu.edu/provision/34579872

To gain more data about the expanding universe, researchers realized that Type Ia supernovae behaved like “standard candles” so they could be used to accurately determine distances and rates of motion in galaxies that contained them.

Because galaxies act as though something “anti-gravity” is pushing them apart, astronomers use the term “dark energy” to explain that motion. Dark energy may be a force that Albert Einstein predicted when he developed the cosmological constant. Ironically, when Edwin Hubble shared his data showing how galaxies move, Einstein threw out the cosmological constant and called it the “biggest blunder” of his life. Astronomers are now taking a much closer look at it with regard to dark energy.

Please visit these links to learn about the following terms:

- Type Ia supernova
- Cosmic Microwave Background
- Critical density

For estimated percentages of normal (ordinary or baryonic) matter, dark matter, and dark energy, please view the following:

- TED talk by Risa Wechsler
- Dark Energy

To gain deeper understanding of these topics, please watch the following videos regarding cosmology:

- BBC primer on Cosmic Microwave Background
- ESA intro to cosmology
- KQED interview (2008) with 2011 Nobel Prize winner Saul Perlmutter
- University of Nottingham - Cosmological Constant

To see the furthest galaxies ever observed, please go to:

- Hubble XDF

Cosmology Performance Task

You will now complete Cosmology Preformance Task in Taskstream.

This topic addresses the following competency:

- **Competency 205.2.4: The Universe**
  The graduate understands the composition, history, and properties of the earth and the universe, and the scale of the universe in space and time

Cosmology Performance Task

Complete the following task in Taskstream:

- Advanced Geosciences: Cosmology

For details about this performance assessment, see the "Assessment" tab in this course.

Final Steps

Congratulations on completing the activities in this course! This course has prepared you to complete the assessments associated with this course. If you have not already been directed to complete the assessments, schedule and complete your assessments now.

Assessment Information

The activities in this course of study have prepared you to complete the WWT2 performance assessment. If you have not already completed the assessment, you will do so now.

Accessing Performance Assessments

You should have completed the following tasks as you worked through this course of study. If you have not completed the tasks in Taskstream, do so now.

- WWT2: Early astronomers
- WWT2: Early atmosphere
- WWT2: Earth components
- WWT2: Star properties
- WWT2: The future

For details about this performance assessment, see the "Assessment" tab in this course.