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Printed on: 08-09-2018 07:47 AM

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Geology

Santa Maria Joint Union High School District

Basic Course Information

School(s) Offering This Course:

School Name	Course Learning Environment	Transcript Code(s)
Ernest Righetti High School (053303)	Classroom Based	Abbreviation / Course Code Geology A / SC6638 Geology B / SC6639

Title:	Geology
Length of course:	Full Year
Subject area:	Laboratory Science ("d") / Earth and Space Sciences
UC honors designation?	No
Prerequisites:	Algebra 1 (Required) Biology or Biology (H) with a C or better (Required)
Co-requisites:	None
Integrated (Academics / CTE)?	Yes
Grade levels:	10th, 11th, 12th

Course Description

Course overview:

Geology is a 10th through 12th grade physical lab science course during which students will study the dynamic process that shape and change the surface of the Earth. Students will learn rock and mineral identification, study and interpret topographic and geological maps and study land forms and structures. Students will also apply real world applications of geology and how it can affect their everyday lives, the community in which they live and areas around the world. Throughout the year, students will study the different geological sciences to learn how they interact with one another while incorporating other disciplines such as Chemistry, Physics, Language Arts and Mathematics. This class emphasizes the hands-on approach along with inquiry-based labs that align to both the Next Generation Science Standards and the common core standards. Geology is a concentrator course for the CTE Environmental Resources Pathway.

Course content:

Course Content

Course Content

Students will be assessed using the standard multiple choice (30%) and written examinations (70%), Lab skills and practical examinations, homework, worksheets, lab reports, projects and teacher observations. A standard rubric for science writing (taken from:http://edweb.sdsu.edu/triton/tidepoolunit/Rubrics/reportrubric.html) will be used to grade reports and projects.

The criteria used for tracking and measuring student progress and program success are as follows:

Assessments per 18 week grading period:

1. Homework and Class Work 5%
2. Laboratory Work 20%
3. Laboratory Practical tests 10%
4. Exams 20%
5. Research Reports and Projects 15%
6. Midterm/Final Exams 20%
7. Quizzes 10%

Scoring is as follows:

90% - 100% A

80% – 89% B

70% - 79% C

60% - 69% D

0% - 59% F

Unit 1 Introduction

Maps are an important tool to know how to use when attempting to explain geologic phenomena. Topographic map are primary type of map used in the field of geology. Geologic Maps are used to interpret geologic reconstructions, rock types, faults of the area and are underlined by a topographic map. To review the scientific method, lab procedures, how to write a lab report, and learning about the maps in are used in geology will help students better under concepts that are taught in geology. In learning about the following tools students will:

1. **Introduction to Geology, Topographic Maps and Geologic Maps (weeks 1-2)**
2. **Discuss and explain the scientific method, review the metric system and go over how to write a lab report. Explain procedure for keeping and maintaining a vocabulary folder that consists of key vocabulary and terms. Each term should a paragraph definition put into the student's own words, a picture or illustration, a sentence that contain the term, and an example of the term.**
3. **Overview of Physical Geology and how it affects people and the surface of the earth. Why geology is an important field of study and which scientists made major discoveries in this field of science. Students will research a geologist of their choice. Students gather information and present it in "Geologist Wanted" poster. Describe the different branches involved in geology.**
4. **Map projections and purposes. Explain different types of maps and their purposes. Activities will explain map projections and scale. Students will review the concept of map scale and practice using distances on a map using fractional and graphic scales. Students will then examine the characteristics of different map projections.**
5. **Describe the difference between longitude and latitude. Demonstrate how to use longitude and latitude by using a map or globe to find various places on Earth by completing the location activity.**
6. **Topographic Maps and features will be discussed. Students will know the rules governing contour maps. How to interpret map symbols and find features on a topographic map. This will be accomplished by a contour activity and the interpreting topographic maps lab. Drawing contour intervals-worksheet with numbers in increments of 10's separate with lines using rules for contour intervals The contour activity involves learning to interpret elevation contour lines and discusses the rules governing contour lines.**
7. **Explain the different features and uses of geologic maps. Compare and contrast geologic and topographic maps.**

Lab: Interpreting topographic maps

Project: Geologist Wanted Poster

Activity: Location activity to review the system of longitude and latitude and experience how to

use a

globe and world maps.

Activity: Interpreting contour elevation lines.

Activity: Map scales and projection

Unit 2 Plate Tectonics

Next Generation Science standards:

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Plate tectonics will introduce by a short historical look and the development of the theory of plate tectonics itself. The different boundary features, mechanism and types will be described. Using the text and lecture/discussion as the primary mode of instruction and video support students will investigate the following:

Planet Earth Structure and Formation (weeks 2-3)

2. Discuss and know the internal structure, composition and characteristic behavior of materials found within the earth. Student will complete the Earth's interior lab to tie in the physical properties that associated with the different layers of the Earth. Students will construct a diagram of Earth's interior by coloring and labeling all appropriate structures.
3. The nature of continental and oceanic crust will be explored to determine the importance and involvement in plate tectonics. .Students will determine the differences in oceanic and continental crusts by completing the density of Earth's crust lab.
4. Discuss the physical evolution of Earth through time from formation to present day.

Lab; Earth's Interior

Lab: Density of Earth's crust

Worksheet: Blank diagram of Earth's interior

Worksheets: On atomic structure and periodic table

3. Study of plate tectonics (weeks 4-5)
4. Explain evidence for and against Alfred Wagner Continental Drift

5. Describe the Theory of Plate Tectonics and how sea floor spreading is involved. Describe the age and position of rock formations associated with the Mid-Atlantic Ridge to support the hypothesis of sea floor spreading. And explain how it relates to the theory of plate tectonics.
6. Describe in detail what happens at the following plate boundaries give examples and features associated with each one.

- Oceanic-oceanic convergence
- Oceanic-continental convergence
- Divergent boundary

Oceanic spreading centers

Continental rift valleys

- Transform fault boundary

1. Describe mechanisms that drive plate motion such as ridge push and slab pull. Explain how these mechanisms work at plate boundaries and how these mechanisms support the theory of plate tectonics.

Lab: Sea-floor spreading

Lab: Plates and plate boundaries

Worksheet; Comparing and contrasting different plate boundaries.

Unit 3 Minerals, the Rock Cycle and California's Mineral Resources

Next Generation Science standards:

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*

The chemistry of the earth and its' materials will be introduced in this unit, but not before students know the difference between a rock and a mineral. Students will:

4. **Mineralogy (weeks 6-7)**
5. **Know the definition of a mineral and it's properties and how mineral's form.**
6. **Identify the six different crystalline structures of a mineral. Students will construct block models of the six crystal systems to help them better understand crystal formation and structure of Earth's minerals.**
7. **Review basic atomic structure and the Periodic Table Elements. Discuss the types of bonding and how compounds and mixtures form. Students need to identify what an atom is and it's subatomic particles. As well as characteristics of the periodic table and how it relates to bonding.**
8. **Differentiate between ionic, covalent, metallic and Van der Waals bonds**
9. **Identify the different physical and diagnostic properties of minerals**
10. **Exploration of the different mineral families such as silicates and the different silicon oxygen tetrahedron chains, carbonates, oxides, sulfates and sulfides, halides, and native elements, Students will know the different chemical properties behind each family of minerals.**
11. **Know the definition of a rock and the difference between a rock and a mineral**
12. **Describe and explain the rock cycle.**

Lab: Mineral crystal systems

Lab: Mineral identification

5. **California's Mineral Resources (weeks 8-9)**
6. **Identify mineral distribution in California**
7. **Describe the location, type and distribution of mining in California**
8. **Learn the different methods use for mining in both the past and present in California. Types of mining to be discussed are hard rock, strip mining and panning.**
9. **Know the economic importance of California's mineral resources**

Lab: Mapping mineral distribution in California

Unit 4 Rocks

Next Generation Science standards:

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the

hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

In this unit students will learn the processes and variable environments that create igneous, sedimentary and metamorphic rocks. Igneous rocks are the "New" earth materials that are produced in a very dynamic and sometimes violent way. Sedimentary In reality most of the earth's surface is covered in sediments and sedimentary rocks is one of the keys to dynamic planets structure. Because of the dynamic nature of earth , rocks and minerals are subject to variable heat and pressure that can, and does, change these materials, parent, into a completely new material, daughter. The students will be able to:

6. **Igneous Petrology and Volcanism (weeks 10-13)**
7. **Know how igneous activity is related to plate tectonics.**
8. **Learn the difference between the different types of volcanoes such as strato, shield, cinder cones, and calderas. Student will design a power point presentation on a volcano of their choice. Projects can be on an individual basis or in as a team. Comparing and contrasting the different types of volcanoes.**
9. **Identify the different types of eruptions and what volcanoes they associated with.**
10. **Know the causes and effects of volcanic hazards.**
11. **Differentiate between the different types of lava, such as tholeitic and calc-alkaline.**
12. **Describe hot spots and how they are related to intra-plate volcanism**
13. **Describe the formation and evolution of magma**
14. **Know how Bowen's Reaction series works and know when mineral's precipitate from a magma**
15. **Identify intrusive rocks using phanaretic (intrusive), aphanitic (extrusive) and porphyritic, textures and classification as well as use mineral content and identify how the formed.**
16. **Describe the different intrusive magmatic bodies such as batholiths, laccolith, sills, dikes, stocks, volcanic pipes and necks.**
17. **Distinguish between the different extrusive rocks such as scoria, pumice, and obsidian and know how they were formed.**

Lab: Identification of igneous rocks

Project: Volcano Power Point Presentations

Worksheet: Locating the world's volcanoes- Use a coordinated system (longitude and latitude) to locate volcanoes on a world map.

7. Sedimentary Petrology (weeks 14-15)
8. Will be able to determine how weathering (chemical and physical) process are relate to erosion.
9. Know the processes behind for sediment formation, deposition, transport, lithification
10. Identify the different types of texture and classification of sedimentary rocks
11. Describe and Identify the physical properties Clastic sedimentary rocks
12. Identify and describe the properties of chemical sedimentary rocks
13. Interpretation of depositional environment of sedimentary rocks

Lab: Identification of sedimentary rocks

8. Metamorphism and Metamorphic Petrology (weeks 16-17)
9. Know the difference types of metamorphism regional and contact and the processes that create them.
10. Distinguish and identify the metamorphic rock characteristics, texture as more heat and pressure are applied, formation and parent daughter material.
11. Determine and identify how metamorphic rocks are classified into foliated and non-foliated.
12. Identify the different minerals as well as heat and pressure that forms these minerals in the metamorphic gradient
13. Identify the different kinds of folds and be able to interpret surface outcropping of the following: anticline, synclines, plunging and non-plunging, basins and domes.
14. Know the tectonic forces that result in the following faults and their varieties.; reverse, normal, thrust, and strike-slip

Lab: Identification of metamorphic rocks

Lab: Syncline, anticline and monocline block models

Lab: Fault block models

Unit 5 Earthquakes

Next Generation Science standards:

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

Earthquakes are a way of life in some parts of the world, specifically around the Pacific Ring of Fire. They are a reminder of the ever continuing dynamics of the planet in which we live. In this unit students will learn about the causes of earthquakes and why we study them. In the process students will:

9. **Earthquakes (weeks 18-20)**
10. **Describe the elastic rebound theory**
11. **Distinguish the different movement and speed of p-waves, s-waves and surface waves and how they behave within the Earth.**
12. **Interpret seismograms in order to determine the location of an epicenter, Richter magnitude and first motion and amplitude of the seismic waves.**
13. **Compare how earthquakes are measured using the Richter Scale and Mercalli Intensity Scale**
14. **Understand how seismic waves give us information about the interior of the Earth.**
15. **Describe earthquake hazards and safety by developing their emergency safety plan for their family.**

Lab: Locating an earthquake's epicenter

Project: Research an Earthquake

Project; Earthquake safety and Your Family

Worksheet: Locating the world's earthquakes- Use a coordinated system (longitude and latitude) to locate earthquakes on a world map.

Unit 6 Mass Wasting

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Living in Santa Brbara County Area, California unstable slopes are common due to the nature of the ground beneath our feet. Where does this loose material come from, and determines if a slope is stable or not? In this process, soils are produced, which is one of most valuable resources. In this unit students will:

10. **Mass wasting (weeks 21 - 22)**
11. **Identify the different types factors that contribute to mass wasting such as water content, nature of rock or sediment, steepness of the slope, angle of bedding planes or other areas of weakness.**

12. Describe different kinds of mass wasting by the speed and kind of movement, amount of water present and kind of material (rock, debris, mud): avalanche, slide, fall, flow, creep and solufluction
13. Describe hazards of mass wasting and ways to preventing and control mass wasting
14. Identify areas that are more prone to mass wasting.
15. Describe the process and conditions for the creation of soils and why this resource is important in today's society.

Lab: Slope stability

Unit 7 Water on Earth

Next Generation Science standards:

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

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Water is the most important resource for those that live on this planet. Water is necessary for the survival of many organisms that inhabit the Earth. California is no stranger when it comes to controversy of fresh water rights. In order for students to better understand water and its' issues, students will explore:

11. Water on Earth's surface (weeks 23 – 24)
12. Processes of the water cycle such as evaporations, transpiration, runoff, and condensation
13. Describe the development of rivers and streams, processes that formed them and features associated with rivers and streams. Features to be discussed include: headwaters, drainage basins, tributaries, sediment deposition at the base of mountains and alluvial fans, erosion and deposition in bedrock channels, and low-gradient river systems.
14. How a river or steam transports solid and dissolved material,
15. How velocity relates to sediment size and capacity
16. Describe flooding and its' hazards

Lab: Stream Table

Lab: Discharge Rate Investigation

12. **Groundwater (weeks 25- 26)**
13. **Porosity and permeability and how water moves through sediment and rock to accumulate and form ground water.**
14. **What features are associated with groundwater**
15. **How the movement of groundwater influences aquifers and springs**
16. **Describe unconfined, confined and artesian aquifers. What are some the difference between them and how are they similar.**
17. **What is required to form a spring and where and why do springs occur.**

Lab: Permeability and porosity

Lab: Ground water table

Unit 8 Glaciers

Next Generation Science standards:

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

In order to understand the effect of global climate change, it is import to recognize how the Earth has done this is the past. One way is to study periods of glaciation and glaciers of the past and evidence of their existence they have left behind. In doing this, students will:

13. **Glaciation (weeks 27 = 28)**
14. **Describe the Milankovitch Cycles with periods of glaciations.**
15. **Know the causes of the Pleistocene Ice age.**
16. **Understand how isostasy works and how it influences the crust**
17. **Describe the formation and movement of glaciers and long term effects of glaciations.**
18. **Identify glacier deposition and erosion and glacial features such as fiord, horn, arête, cirque, hanging valley, striations, kettle, erratic, eskers, outwash plain and glacial till.**

19. Identify and describe glacial features such as moraines, braided streams, crevasses, calving, firn and firn-line, ice burgs, and moulins.

Lab: Glacial valley reconstruction

Lab: Identify glacial features on a topographic map

Unit 9 Coastal Environment

Next Generation Science standards:

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

In order to understand the effect of global climate change, it is import to recognize how the Earth has done this is the past. One way is to study the ever changing costal environment and the shoreline. In doing this, students will:

14. Coasts and Wave Action (weeks 29 – 30)
15. Describe the properties of waves such as height, period and crest.
16. Identify the different types of waves associated with deep ocean and the shoreline

17. How coastlines development and features associated with them. Features that will be identified are beaches, cliffs, headlands, caves, stack, natural arches, spit, tombolo, sand dunes, lagoon and back bays and bays.
18. Different types and characteristics of beaches such as dissipative, reflective and bar-rip.
19. How wave energy determines the erosion and deposition of beaches. Students will describe how waves approach and break on the beach. They will also differentiate between the different types of waves and how ocean topography effects the formation of waves. Types of waves students will explore are plunging, spilling, collapsing and surging waves.
20. Describe the different features of a beach such as low tide flats, salt marshes, maritime forests, barrier flats, dunes, drift lines, backshore, foreshore and nearshore.
21. Identify manmade features that are used to manipulate the erosion of beaches by man. These features are jetties, groins and seawalls.

Lab: Compare and Contrast plunging, spilling, surging, breaking and ocean waves using block models

Unit 10 Eolian Environment

Next Generation Science standards:

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

In order to understand the effect of global climate change, it is import to recognize how the Earth has done this is the past. Another excellent link between climate and geology is seen when we examine arid landscapes. Arid regions are not dominated by a single geologic process, but by tectonic forces, running water and wind. When learning about arid landscapes students will:

15. Desert and Wind (weeks 31 - 32)
16. Know the distribution and causes of arid lands such as low-latitude deserts, middle-latitude deserts and rain shadow deserts
17. Describe the rain shadow effect
18. Identify and describe the geologic processes that help shape arid regions such as weathering, erosion and the effects of water,

19. Describe the evolution and of desert features such as ephemeral streams, bajadas, arroyos, and alluvial fans,
20. Know how sediments are transported by winds. Describe the process of saltation, bed load and suspended load.
21. Identify features that are formed from wind erosion such as deflation, blowouts and desert pavement.
22. Describe the different two types of wind deposits. Identify the different types of sand dunes Barchan, Transverse, barchanoid, Longitudinal, Parabolic, Star associated with wind deposits. Know what loess deposits are and how they form.

Lab: Topographic map interpretations of desert features

Unit 11 History of Earth

Next Generation Science standards:

HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

The rocks of the earth contain evidence of how it was changed over time. The "story" of geologic history and how we use geologic principles to reconstruct Earth History will be presented to the students in this unit. To understand this reconstruction students will:

16. **Geologic Time**

1) Know the Geologic Time Scale though time. Identify the eras Hadean, Archean, Proterozoic, Paleozoic, Mesozoic and Cenozoic. Students should also Identify the major time periods Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Eocene, Oligocene, Pliocene, Miocene, Pleistocene, and Holocene and describe the major events that occurred in each.

2) Be able to interpret and sequence rock layers based upon key principles of relative dating such as::

- **Law of Superposition**
- **Principle of Original Horizontality**
- **Principle of Cross-Cutting Relationships**
- **Law of Inclusions**
- **Faunal Successions**

3) Know what a fossil is and how it forms. Identify index fossils for the major time periods of the Geologic Time Scale.

4) Recognize and explain the following formations:

- **Unconformity**
- **Disconformities**
- **Nonconformity**
- **Angular Unconformity**

5) Understand the principle of radiometric dating.

Lab: Relative dating

Project: Reconstruction of the geologic time scale

Final Project: National Park Presentations

Labs/Activities

- **Topographic Maps**
- **Location using longitude and latitude**
- **Interpreting contour elevation lines.**
- **Map scales and projection**
- **Earth's Interior**
- **Density of Oceanic and Continental crust.**
- **Plates and Plate Boundaries**
- **Mineral Identification**
- **Identification of Igneous Rocks**
- **Identification of Sedimentary Rocks**
- **Identification of Metamorphic Rocks**
- **Location of Earthquakes**
- **Fault and Folding Block Models**

- Slope stability
- Stream Table
- Discharge Rate Investigation
- Permeability and Porosity
- Ground Water Table
- Glacier Valley Reconstruction
- Glacial Features on Topographic Map
- Wave Model Blocks- Compare and Contrast
- Eolian Features on a Topographic Map.
- Relative Dating- Sequencing Geologic Events

💻 Unit Assignment(s):

Assignments:

Vocabulary Folder: A folder that consists of key vocabulary and terms. Each term should a paragraph definition put into the student's own words, a picture or illustration, a sentence that contain the term, and an example of the term.

Assessment questions for each unit.

Assessments for each unit of study will include multiple choice, completion and short essay.

Supplemental worksheets

- Drawing contour intervals-worksheet with numbers in increments of 10's separate with lines using rules for contour intervals
- Earth's Layer's-coloring and labeling earth's layered interior
- On atomic structure and periodic table
- Plate Boundaries- compare and contrast the different plate boundaries.
- Different Volcanoes compare and contrast the different volcanoes
- Locating the world's volcanoes- Use a coordinated system (longitude and latitude) to locate volcanoes on a world map.
- Locating the world's earthquakes- Use a coordinated system (longitude and latitude) to locate earthquakes on a world map.

Projects:

Project: Geologist Wanted Poster:

Students research a geologist of their choice. Students gather information and present it in "Geologist Wanted" poster. Information that should be on the wanted poster is first, middle and last name of geologist, picture of geologist, date of birth and year of death or if still alive, what country they were born in and where do they do they work?, What is their field of study? What are their major contributions to geology? List at least three sources on the back of the poster.

Project: Volcano Power Point Presentations

Students are to work n groups of two. Create power point presentation of a volcano that is 10-15 minutes in length. Presentations will be presented to the class. Information should include location, name, elevation, near-by towns/cities, type of volcano, type of plate boundary or intra plate volcanism associate with the volcano, formation and eruptive history, types of igneous rock associated with volcano, alert level, should also include pictures, charts and illustration supporting information on volcano. At least three sources should be used.

Project: Research an Earthquake

A research paper on an earthquake of student's choice. The paper should be 3-5 pages in length and include the following, location, name of fault, type of faulting associated with the fault, type of tectonics associated with the faulting, history and development of fault, summary of damage done by the quake, and magnitude. The report should include at least sources.

Project: Earthquake safety and Your Family

Students are to research earthquake safety using the FEMA web sites dealing with earthquake safety such as:

http://www.fema.gov/earthquake/earthquake-safety-home

http://www.fema.gov/earthquake

http://www.ready.gov/earthquakes

They are gather information regarding earthquake safety and make a family presentation, safety plan, and summarize the presentation and safety plan in 2-3 page report. Reports must have signatures of those present in the family presentation

Project: Reconstruction of the geologic time scale

Create a booklet of geologic time using the following guide lines. The front cover should have an illustration of geologic time with definition for geologic time. On the inside cove is the table of contents. The following pages should include the following: name of the geologic time should include Eon, Era, period, ad epoch. An illustration of the time period including life present if any. A minimum of 6-8 sentences paragraph summing up geologic time. Paragraphs should include life, paleoclimate, major geologic events or any other interesting facts. The following geologic time should make up the book: Archeon and Hadean Eon, Proterozoic Eon, Cambrian Period, Ordovician Period, Silurian Period, Devonian Period, Carboniferous Period, Permian Period, Triassic Period, Jurassic Period, Cretaceous Period, Eocene Epoch, Oligocene Epoch, Miocene Epoch, Pliocene Epoch, Pleistocene Epoch, Holocene Epoch. A minimum of 3 sources should be used on this project.

Final Project: National Park Presentations

National Park presentations should be 10=15 minutes in length. Student's chose a national park and present the following information to the class as a whole as a power point presentation. Information should include the following: name of park, where it is located, when it was made a national park, why it was made a national park, what geologic province is the national park located, what type of rocks are present and how were they deposited, geologic event that formed the park, and what geologic events are still taking place today. Illustrations, maps pictures and charts should be used to support information. At least three sources should be used.

Unit Lab Activities:

The labs in this class are used as a summative and inquiry based activities that are important to teaching Geology. When appropriate students will be expected to write a formal laboratory report, but there will be exceptions when the activity is not conducive for writing a formal report.

In a formal lab report students will be required to write the following:

1. **A problem Statement**
2. **Hypothesis**
3. **The experimental design, including procedures and materials used in tests performed.**
4. **Analysis and conclusion to the initial problem stated.**
5. **Conclusion to the initial problem statement**
6. **Statements of further inquiry related to the original question and that can lead to new investigations.**

Laboratory Activities:

Lab: Interpreting topographic maps

Part 1 Lab Activity: Contour line

Purpose: To interpret elevation contour lines and determine the high spot and low spot on the map.

Materials: Lab hand-out with contour line definition, sample topographic map, contour line rules with exercises using a simple contour line map and problems.

Procedure; Read and familiarize the contour line rules. Look at simple topographic map and answer problems associated with the map. Problems involve answering question regarding what is the elevation on the map at certain given points. Identifying land features on a topographic map and observing cross-sectional data that is gained from the topographic map.

Part 2 Lab Activity Interpretation of a topographic map

Purpose: Read, interpret topographic maps and draw cross-sections

Materials: Topographic maps, handout with tasks regarding the use of the map.

Procedure: The hand-out has tasks that include naming the quadrangle of map and what series it is in. Determine the scale of map. Determine what quadrangles are located adjacent to the map. Determine the longitude and latitude of the map and the colors that are used on the topographic maps given for the lab. Find elevations of certain features as well as township and range that can be found on the map. Draw a cross-section of a determined area on the topographic map.

Lab Report: For this lab activity students will write reflection or opinion paper concerning the importance of accurate topographic maps to city planners, hikers, military personnel, environmentalists, and geologists.

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Laboratory Experiences:

Lab: Earth's Interior

Purpose: Identify the physical properties that are associated with the different portions of Earth's interior.

Materials: Graph paper, colored pencils, lab hand-out with Earth's interior temperature and depth chart with conclusion questions.

Procedure: Use the data in the given table to construct three separate line graphs showing temperature of Earth's interior, mantle melting point and core melting point. Shade in and label different portions of Earth's interior using five different colors. Answer conclusion questions using the information on the graph.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Density of Earth's crust

Purpose: To determine the differences in densities of the Earth's continental crust and oceanic crusts. Density plays a difference which is an important role in the interactions of the Earth's tectonic plates.

Materials: 10 samples of oceanic crust (basalt), 10 samples of continental crust (granite), balances or scales, 250 ml plastic graduated cylinders, and lab hand-outs

Procedure: Measure and record mass of 10 samples of oceanic crust. Then determine volume of all 10 oceanic crust by using the displacement method. Record volume in chart provided. Using the mass and volume calculate the density for each oceanic crust sample and record results. Average the mass, volume and density record. Repeat using 10 samples of continental crust. Find the mass, volume and density for each sample. Answer conclusion question regarding Which type of rock is more dense? Which type of rock makes up continental and oceanic crusts? Describe what would happen if an oceanic plate collided with a continental plate. Would the densities of the different rock influence what happens?

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Paleomagnetics & sea-floor spreading

Purpose: To use the positions and ages of oceanic rock formations associate with the Mid-Atlantic Ridge to support the idea of sea-floor spreading. Sea-floor spreading also present the idea that new crust is formed at mid-ocean ridges. This is thought to be the man mechanism for plate movement.

Materials: Metric ruler, colored pencils and lab hand-out.

Procedure: Use the cross-section in the hand-out to log data into the data table based on paleomagnetic data associated with the Mid-Atlantic ridge system. Calculate the spreading rate for each side of the ridge. Answer conclusion questions regarding lab. How does the mapping of the

sea-floor help support the theory of plate tectonics? How can the rate of sea-floor spreading be determined in both the Atlantic and Pacific Oceans? Are the rates the same for both ridge systems? Explain how sea-floor spreading helps the theory of continental drift.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Plates, plate boundaries & physical geography of the world

Purpose: To locate and identify the different plates and types of boundaries associated with each plate and determine the geologic hazards associated with each around the world

Materials: Plate tectonic map, blank tectonic map, colored pencils

Procedure: Use colored tectonic map to label and draw plate boundaries onto blank map. Name each plate and color each plate a different color, determining whether the plate consists of oceanic or continental crust. Mark convergent boundaries with a line that has a saw-tooth edge, use red to draw this boundary, Divergent plate boundaries draw line with alternating hatch marks, use blue for this boundary. Transform plate boundary draw arrows on both side of boundary indicating plate motion on either side of boundary. Take a black marker and mark arrows on the plate to indicate general plate motion. Complete the given table and determine the types of geologic hazards associated with each area, viscosity of magma, and whether it would have explosive or nonexplosive volcanoes.

Lab Practical: Students will draw geologic cross-sections for 8 different areas as noted on the tectonic map, noting the specific type of boundary associated with the area, type of rocks and minerals that are associated and whether this boundary would have explosive or non-explosive volcanoes.

Laboratory Experiences:

Lab: Mineral crystal systems

Purpose: To identify the six different crystal formations associated with minerals

Materials: Unassembled block models, scissors, glue, colored pencils.

Procedure: Cut out and assemble block models. Color each crystal. Identify the different facies, angles and cleavage planes.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Mineral identification

Purpose: To identify the different rock-forming minerals by their physical and chemical properties. Minerals are important resources as well as forming many common rocks that are found within the Earth's crust.

Materials: mineral samples, Mohs Hardness Scale specimens, glass plates, magnets, streak plates, dilute hydrochloric acid, safety goggles, hand-lens, lab hand out with diagnostic charts.

Procedure: Identify minerals using the minerals physical and chemical characteristics. Identify the density, luster, hardness, cleavage, color, streak, other special properties and name. Explain why color is not a diagnostic property, determine the type of luster each mineral has along with which mineral properties are most helpful when used to identify minerals. Use Mohs hardness scale in identifying minerals. Determine the difference between ore minerals and gangue minerals.

Post lab evaluation: **Lab practical identifying 18 different previously study minerals. Students will identify minerals using: streak, luster, hardness, effervescence, and cleavage. Minerals will be placed at various stations throughout the lab. Students will be able to determine whether each mineral could be classified as igneous rock forming, sedimentary rock forming or ore and gangue minerals.**

Lab: Identification of intrusive igneous rocks

Purpose: To identify common igneous rocks by the composition, texture, color and density. Be able to distinguish the difference between intrusive and extrusive igneous rocks. Use the Bowen's Reaction Series to determine which minerals are found together and determine the temperature of the magma.

Materials: Igneous rock samples, hand-lens and handouts with blank scheme igneous rock chart, blank igneous rock identification chart, Bowen's Reaction Series hand-out

Procedure: Fill in the blanks on the scheme for igneous rocks chart. The information should include name, environment of formation, texture, and mineral composition. Have chart checked for accuracy. Use your chart to identify the igneous rock samples provided. Explain what is meant by a rock sample's texture. What is the difference between phaneritic, aphanitic and porphyritic textures and what causes the differences. Explain the difference between lava and magma. Describe the specific mineral composition, density and color between mafic and felsic rocks. Describe the main physical properties that are used to identify igneous rocks. Define magmatic differentiation and fractionation process and use in evolution of magma along different types of tectonic boundaries.

Post lab evaluation: Lab practical identifying 10 samples of igneous rocks. Students will need to also state texture, classification and probable temperature rock formed at. Igneous rocks will be placed at various stations throughout the lab.

Lab: Identification of sedimentary rocks

Purpose: To identify common sedimentary rocks on the basis of grain size, composition and texture. Be able to identify the processes of the formation of sedimentary rocks and draw environments rocks were deposited in.

Materials: sedimentary rock samples, hand-lens, dilute hydrochloric acid, hand-outs for lab, including blank scheme sedimentary rock chart and blank sedimentary rock identification chart.

Procedure: Fill in the blanks on the scheme for sedimentary rocks chart. The information should include name, texture, grain size, and composition, method of lithification and processes of formation. Have chart checked for accuracy. Use your chart to identify the sedimentary rock

samples provided. What are the three types of textures used to classify sedimentary rock. Describe processes used to identify sedimentary rocks. What is the difference between silt, clay and sand sediments? How do sedimentary rocks become soil, an important resource in our agricultural area?

Post lab evaluation: **Lab practical identifying 10 samples of sedimentary rocks. Students will need to also state texture and classification of rock. Sedimentary rocks will be placed at various stations throughout the lab.**

Lab: Identification of metamorphic rocks

Purpose: To identify common metamorphic rocks on the basis of grain size, texture and degree of metamorphism and be able to identify the parent rock from which each metamorphic rock formed. Be able to determine whether metamorphic rocks are foliated or non-foliated and whether they were formed by contact or regional metamorphism.

Materials: Metamorphic rock samples, hand-lens, dilute hydrochloric acid, hand outs for lab That include blank scheme metamorphic rock chart and blank metamorphic rock identification chart.

Procedure: Fill in the blanks on the scheme for metamorphic rocks chart. The information should include name, texture, grain size, type of metamorphism and parent rock, Describe the three different textures used to classify metamorphic rocks. Know the difference between foliated and non-foliated metamorphic rocks. Why are metamorphic rocks usually found in mountainous regions? Describe characteristic used to identify metamorphic rocks.

***Post lab evaluation*: Lab practical identifying 10 samples of metamorphic rocks. Students will need to also state texture, parent material, whether its foliated or nonfoliated and whether it would be formed by contact or regional metamorphism along with the classification of rock. Metamorphic rocks will be placed at various stations throughout the lab**

Lab: Locating an earthquake's epicenter

Purpose: To use triangulation and lag-time to locate the epicenter of an earthquake. To find the seismic wave amplitude so that the magnitude of an earthquake may be determined. Determine the difference between the Richter Scale and Mercalli Scale.

Materials: Sothern Californian triangulation packets, markers, compasses, rulers. Lab hand-outs

Procedure: Find the lag-time, set compass at recording station using distance on the map to find the radius to make a complete circle. Calculate distance by finding the time in seconds from the first P wave to the first S wave on the bottom of the seismograph. Then use the chart to find the distance. Find this for all three stations. Find the Magnitude by using the chart that has distance magnitude, magnitude and amplitude on it. Find the amplitude by using ruler and seismograph. Repeat for two other earthquakes. Complete virtual earthquake lab at "Virtual Earthquakes." Science Course Ware. Online:
Http://www.sciencecourseware.org/VirtualEarthquake/VQuakeExecute.html
(Http://www.sciencecourseware.org/VirtualEarthquake/VQuakeExecute.html)

Answer: How is a seismograph is used. What is the triangulation method and why is it used? Why do you need three seismic stations? How do you find the magnitude of an earthquake? What is amplitude? What is the difference between the Richter Scale and the Mercalli Scale.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Fault block models

Purpose: To identify the different types of faults found within the Earth's crust

Materials: Unassembled block models, scissors, glue, colored pencils.

Procedure: Cut out and assemble block models. Color each block model according to color key. Describe each fault block model. Describe movement along each type of fault a strike-slip right lateral, thrust faults, reverse and normal faulting. Identify hanging wall and footwall and relative motion associated with each. Compare and contrast fault block models with each and whether each would be associated with extentional, compressional or shearing stress/strain.

Lab Report: **Each student will write a lab report describing the lab process and his/hers results and analysis.**

Lab: Syncline, anticline and monocline block models

Purpose: To identify the processes formed as a result of faulting.

Materials: Unassembled block models, scissors, glue, colored pencils.

Procedure: Cut out and assemble block models. Color each model according to color key. Describe each block. Identify what stress causes synclines, anticlines and monoclines. Compare and contrast the different blocks. What types of faulting causes these formations.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Slope stability

Purpose: To study the angle of repose, learn the effects of water on sediments and how the angle of repose is associated with landslides such as the one in La Conchita.

Materials: Buckets, sand, stream tables, water, coffee cans with holes in the bottom, protractors.

Procedure; Using a small stream table or square container, pour some dry sand out to form a cone. Stop periodically to observe and measure the shape and angle of the cone. Record your measurements and observations. Using the "rainmaker" carefully sprinkle water onto the cone until it becomes saturated. Determine the slope and angle of the sides of the dry cone. Determine what happens to the sand when it becomes saturated? Determine the slope and angle of the

saturated cone? How is the angle of reposed repose affected in the experiment? Equate the angle of repose in the lab to the angle of repose of areas such as areas associated with landslides in our local area, La Conchita, Malibu and other parts of California.

Lab Report: Each student will write a lab report following the prescribed format. Each student will describe the purpose of the lab, the experimentation process, and his/hers results and analysis.

Lab: Stream Table

Purpose: To study the formation of alluvial fans and deltas as well as the erosional power of water.

Materials: EmRiver stream table, sand, water

Procedure: Using sand, build a flat area with a very steep slope in the stream table. Turn on the water very slowly and allow it to run down the steep slope. Turn the water off after 30 seconds.

Describe the feature that has formed at the bottom of the slope. What is this feature called? Draw a picture. Are there any features that have formed along the steep slope away from the water channel? What are these called? Draw a picture. Turn the water back on and watch the feature build for about two minutes. What has happened to the feature at the bottom of the slope? Draw a picture. Turn the water on medium to high (for about three minutes) and observe sedimentation where the flowing water encounters still water. What feature are you watching form? How does this feature differ from the previous one? Draw a picture.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Discharge Rate Investigation

Purpose: to observe stream velocity vs. gradient and discharge.

Material: plastic flume, calculator, stands, paper, stop watch, large graduate cylinder and handouts.

Procedure: Set up the plastic flume with the stand such that the lower end of the flume is in/over the sink. The stand heights are set to produce 5º, 10º, and 15º. Adjust the output of the water to about 5cc/second (slow). Measure the discharge by running the water into the graduated cylinder for 5 seconds and measuring the amount accumulated volume of water (you may need to adjust the flow and measure again) and allow the water to run down the 5º slope. Measure the velocity by dropping a small piece of paper in and timing its trip down the marked section of the flume. Record velocity on the table in the hand out. Repeat for slopes 10º and 15º. Repeat the experiment having a 10 cc/second water flow. Plot the results on the graph in the hand out.

Lab Report: Each student will write a lab report following the prescribed format. Each student will describe the purpose of the lab, the experimentation process, and his/hers results and analysis.

Lab: Permeability and porosity

Purpose: To explore, determine, test and measure the amount of moisture, permeability, and

porosity of local soil samples.

Materials: Balance, cheese cloth, clear tube, one end open, clear tube open ends, plastic cup, small aluminum container, drying oven, 100 mL graduated cylinder, magnifying glass, rubber bands, 100 mL sand. 100 mL Soil (sediment), stop watch, teaspoon, tray or large piece of white paper, 400 mL of water, calculator and hand out for lab with questions.

Procedure:

Part 1: Get a soil sample of local origins. Place soil sample on tray or piece of white paper. Use the magnifying glass to observe the soil sample record your observations on the worksheet provided. Information should include color, particle size, organic material, insects, plant material ect.. Draw a picture of your soil sample.

Part 2: Use the balance and measure the mass of the aluminum container and record value. Using the spoon, place several spoonfuls of soil in the aluminum container. Measure the combined mass of soil and container record measure on the worksheet. Place container with into a drying oven at 90-95 ºC for 24 hours. Measure the combined mass of the soil and container after cooling the sample. Determine the loss in mass due to heating.

Part 3: Permeability

1. **Permeability of dry soil: Obtain a clear tube with open ends. Rubber-band two puces of cheese cloth to one end of the tube. Place tube upright with cheese cloth end down in a plastic cup. Using a graduated cylinder measure 40 mL of dry soil in tube. Hold the tube above the plastic cup and pour 20 mL of water into the tube. Use a stop watch and start timing as soon as all the water has been poured into the tube. Stop timing when the water stops dripping from the bottom of the tube Record time on worksheet. Calculate the time required for drainage then determine the drainage rate of the soil in mL per second. Record you value.**
2. **Permeability of wet soil. Pull tube with wet soil out of cup. Pour water out of the cup. Repeat above set with wet soil sample. What is the difference of the permeability of wet soil versus the dry soil? What would determine the permeability of a soil?**

Part 4: Porosity, Obtain a tube with a closed end..Using a graduated cylinder measure 100 mL of dry soil and place it into the tube. Measure 100 mL of water into graduated cylinder. This will be the initial amount of water. Use a stop watch and slowly pour the water from the graduated cylinder into the tube until the soil is saturated. Record the amount of time it takes for the water to reach the bottom of the tube. Write this on your worksheet. Empty the graduated cylinder. Pinch the tube and pour the water retained in the soil into the graduated cylinder. Be sure not to pour any of the soil into the graduated cylinder. Record this amount on your worksheet. Repeat the above steps using sand instead of dry soil. What is the benefit of having a moisture content in soils? What about possible drawbacks? What factors may affect the drainage rate of soils? What is the relationship between permeability and particle size? What is the relationship between particle size and porosity? Compare and contrast permeability and porosity.

Lab Report: Each student will write a lab report following the prescribed format. Each student will describe the purpose of the lab, the experimentation process, and his/hers results and analysis.

Lab: Ground Water—Can Water Get Through This & Arsenic Groundwater Pollution

Purpose: To identify pollution sources within the groundwater system

Materials: Groundwater Models, Can Water Get Through It lab hand-out, colored pencils

Procedure: Use groundwater models to observe permeability and porosity of sediments in the model, find the groundwater zones and water table. What is the zone of saturation? Explain in detail what happens to precipitation when it hits the Earth's surface? Explain where the pollutants are coming from and where the best place would be for a freshwater well. Students create a cross-section for their well log data, put it together for a class cross-section. Use well data on a given map to determine where the arsenic is coming from in.

Lab Report: **Each student will write a lab report describing the lab process and his/hers results and analysis.**

Lab: Glacial valley reconstruction

Purpose: To identify the different type of features formed from glacial erosion

Materials: Unassembled block models, scissors, glue, colored pencils.

Procedure: Cut out and assemble block models. Color. Identify glacial features and draw illustrations of features seen on model.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Identify glacial features on a topographic map

Purpose: To understand the processes of mountain and continental glacial and the land forms and water bodies that produced glacial action.

Materials: ruler, calculator, stereoscope (optional), lab hand out with review questions and topographic maps.

Procedure: Answer the following questions regarding the Siffleur River, Alberta, quadrangle. Name the glaciation features that formed Marmot Mountain and Conical Peak? How do these feature form? The boundary between Improvement District 9 and 10 follows a ridge from the Siffleur River Valley to Mount Kentigern. What type of ridge (glacial Feature) is this and how did it form? Near the northern edge of the map, what type of valley is located above the falls west of the Siffleur River and how did it form? What type of lake is at the headwaters of the stream that forms these falls? What other features produced by mountain glaciations can you see on the map. Explain and give locations of these features. Refer to the part of the Peterborough, Ontario, quadrangle to answer the following questions. Study the shape and size of the oblong hills. What type of feature are they and how did they form? In what direction did the ice move over this area? Explain how you determined the direction. What type of sediment would you find in a drumlin? Would it be stratified (layered) and well sorted? How could you tell? Explain your answer. Find the red highway

route 7, that crosses the upper part of the map. About 1¼ inches below the number 7, what is the long, narrow feature that runs northeast-southwest? How did it form? Explain the formation of this feature.

Lab Report: For this lab activity students will write reflection or opinion paper concerning the importance of recognizing geologic features on a topographic map.

Lab: Compare and Contrast plunging, spilling, surging, breaking and ocean waves using block models

Purpose: To identify the different type of waves

Materials: Unassembled block models, scissors, glue, colored pencils.

Procedure: Cut out and assemble block models. Color each model according to color key. Describe each block. Identify what types of waves they are and how the break. What type of beach shore causes which types of wave to break/form? How does sea-floor topography play a role in how a wave breaks/forms? Compare and contrast the different types of waves.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Lab: Topographic map interpretations of desert features

Purpose: To identify desert associate with an arid landscape.

Materials: Part of the Furnace Creek California, quadrangle, colored pencils, ruler, calculator, lab hand out with questions

Procedure: Complete the following tasks using the Furnace Creek, California, quadrangle. Color the alluvial fans yellow. What feature formed from the joining of alluvial fans? Color the inselbergs red. Color the arroyos brown. Color the zero-level contour line. This is sea level. Mark a green line to indicate the edge of the mountain front. Find the playa and place a capital P on it. Color the playa light blue. How would the grain size of the sediment along the streams on the map change as you walk down slope from the high arroyos? Draw dark dashed lines to indicate where you think there might be faults. Notice that people built a ranch on one of the alluvial fans, even though this region arid. Why do you think they chose this alluvial fan and not one of the other ones?

Lab Report: For this lab activity students will write reflection or opinion paper concerning the importance of recognizing geologic features on a topographic map.

Lab: Relative dating vs Absolute dating

Purpose: To learn and be able to apply techniques for relative and absolute age dating of Earth's materials and events. To apply stratigraphic principles regarding sequencing geologic events.

Materials: Hand-outs, colored pencils, West of the West DVD, Radioactive Wolves DVD, case studies—radiation poisoning

Procedure: Number each event, using the stratigraphic principles you learned and outlined in the hand out. Each of the following cross sections show geologic development of a sequence of rocks. The rock patterns are the same as given in the hand out. Review the sample sections shown in the hand out to see how the stratigraphic principles are applied. Number the formations of rock units and geologic events in each cross section, in the order in which they occurred. Write each number in the appropriate circle. If two or more circles are found within the same formation give them the same number. A few fossils and isotopic dates occur in these sections, so there are some time constraints in the possible ages for many of the rock units given. Write in the appropriate space on the hand out the possible age ranges for each unit.

Lab Report: Each student will write a lab report describing the lab process and his/hers results and analysis.

Course Materials

Textbooks

Title	Author	Publisher	Edition	Website	Primary
Physical Geology	Charles (Carlos) Plummer, Diane Carlson, Lisa Hammersley	McGraw-Hill Education	14th edition	[empty]	Yes

Supplemental Materials

Title	Content

Title	Content
Supplemental Materials	Periodicals: Geology GSA California Geology Various World Wide Web Resources Movies/Videos/Pod Casts