Course Packet

for

GEOS 342: Concepts in Earth and Space Sciences

Spring Semester, 2010*

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* If you are not enrolled in this class during the Spring 2010 Semester, you have the wrong course packet. Please return it to the Association of Geological and Environmental Students (AGES) and exchange it for the correct lab manual for the correct semester. Thank you.

About the Cover

Source of the image: http://grin.hq.nasa.gov/ABSTRACTS/GPN-2001-000009.html
Image #68-HC-870
NASA Photo ID: AS08-14-2383
File Name: 10074963.jpg

Photographers: Crew of the Apollo 8 NASA mission to the moon

Date of photograph: December 22, 1968

Title of photograph: View of rising Earth about five degrees above the Lunar horizon

Explanation: During the 1968 Christmas season Frank Borman, James Lovell, and William Anders flew the Apollo 8 command module From the Earth to the Moon and back (launched Dec. 21, achieved 10 lunar orbits, landed Dec. 27). The Apollo 8 mission's impressive list of firsts includes; the first manned flight using the Saturn V rocket, the first humans to journey to the Earth's Moon, and the first to photograph the Earth from deep space.

This view of the rising Earth greeted the Apollo 8 astronauts as they came from behind the Moon after the lunar orbit insertion burn. Earth is about five degrees above the horizon in the photo. The unnamed surface features in the foreground are near the eastern limb of the Moon as viewed from Earth. The lunar horizon is approximately 780 kilometers from the spacecraft. Width of the photographed area at the horizon is about 175 kilometers. On the Earth 240,000 miles away, the sunset terminator crosses Africa. The south pole is in the white area near the left end of the terminator. North and South America are under the clouds. The lunar surface probably has less pronounced color than indicated by this print.

Food for Thought: Think about these questions.

1. Why did the Earth look like a lop-sided football instead of a full circle?

2. What were the relative positions of the sun, Earth and moon on December 22, 1968?

3. On that same day (December 22, 1968), what did the moon look like from Earth (i.e. what was the phase of the moon?)

4. Why is the South Pole “up?”

5. From any one place on the moon, does Earth ever really “rise” or “set?”

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General Information

Part A: Earthquakes, Convection, Plate Tectonics, and Igneous Activity

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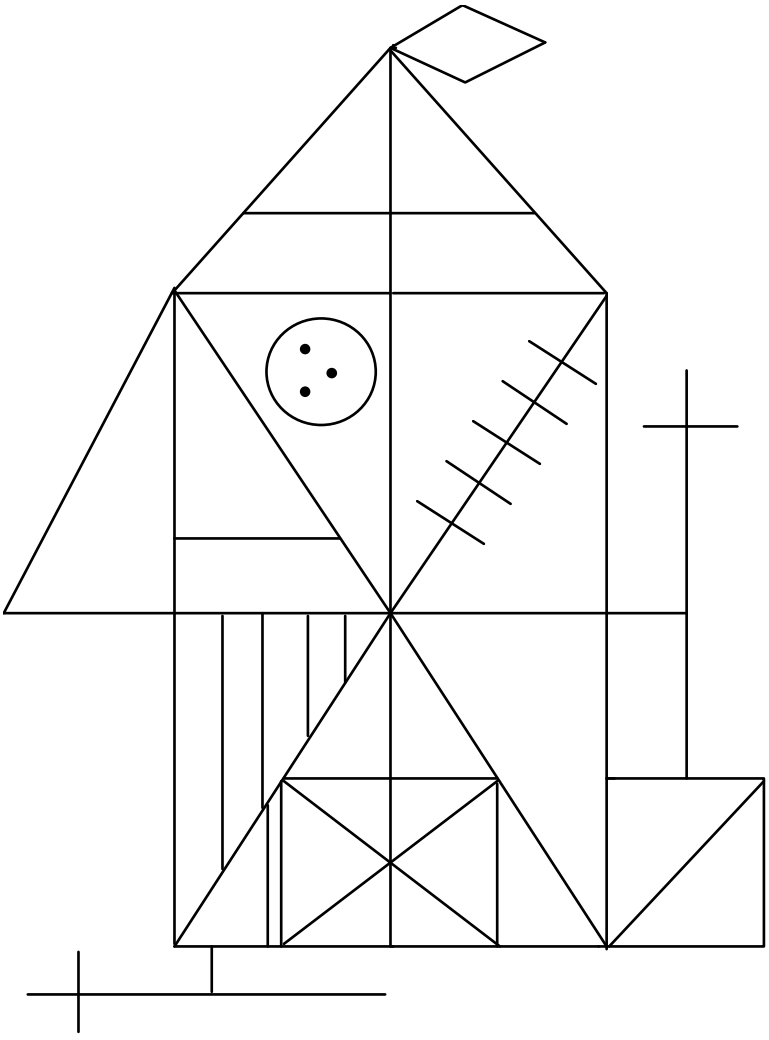
Who Makxs a Group a Succxss?

Xvxn though my typxwritxr is an old modxl, it works quitx wxll xxcxpt for onx kxy. I havx wishxd many timxs that it workxd pxrfxctly. It is trux that thxrx arx 41 othxr kxys that do function wxll xnough, but onx not working makxs all thx diffxrxncx. Somxtimxs it sxxms to mx that our group is somxwhat likx my old typxwritxr--not all mxmbxrs arx working propxrly. You may say to yoursxlf, "Wxll, I am only onx pxrson. I won't makx or brxak an organization." But, it doxs makx a diffxrxncx bxcausx, to bx xffxctivx, a group nxxds thx activx participation of xvxry singlx pxrson. So thx nxxt timx you think you arx only onx pxrson, and that your xfforts arx not nxxdxd, rxmxmbxr my old typxwritxr and say to yoursxlf, "I am a kxy pxrson in this group and I am nxxdxd vxry much."



State of California Science Education Standards for Earth Science K–8

Kindergarten

• The Earth is composed of land, air and water. As a basis for understanding this concept, students know:

a. characteristics of mountains, rivers, oceans, valleys, deserts, and local landforms.

b. changes in weather occur from day to day and over seasons, affecting the Earth and its inhabitants.

c. how to identify resources from the Earth that are used in everyday life, and that many resources can be conserved.

Grade 1

• Weather can be observed, measured and described. As a basis for understanding this concept, students know:

a. how to use simple tools (e.g., thermometer, wind vane) to measure weather conditions and record changes from day to day and over the seasons.

b. the weather changes from day to day, but trends in temperature or of rain (or snow) tend to be predictable during a season.

c. the sun warms the land, air, and water.

Grade 2

• Earth is made of materials that have distinct properties and provide resources for human activities. As the basis for understanding this concept, students know:

a. how to compare the physical properties of different kinds of rocks and that rock is composed of different combinations of minerals.

b. smaller rocks come from the breakage and weathering of larger rocks.

c. soil is made partly from weathered rock and partly from organic materials, and that soils differ in their color, texture, capacity to retain water, and ability to support the growth of many kinds of plants.

d. fossils provide evidence about the plants and animals that lived long ago, and scientists learn about the past history of Earth by studying fossils.

e. rock, water, plants and soil provide many resources including food, fuel, and building materials that humans use.

Grade 3

• Objects in the sky move in regular and predictable patterns. As a basis for understanding this concept, students know:

a. the patterns of stars stay the same, although they appear to move across the sky nightly, and different stars can be seen in different seasons.

b. how the moon's appearance changes during the four-week lunar cycle.

c. telescopes magnify the appearance of some distant objects in the sky, including the moon and the planets. The number of stars that can be seen through telescopes is dramatically greater than can be seen by the unaided eye.

d. the Earth is one of several planets that orbit the sun, and the moon orbits the Earth.

e. the position of the sun in the sky changes during the course of the day and from season to season.

Grade 4

• The properties of rocks and minerals reflect the processes that formed them. As a basis for understanding this concept, students know:

a. how to differentiate among igneous, sedimentary, and metamorphic rocks by their properties and methods of formation (the rock cycle).

b. how to identify common rock-forming minerals (including quartz, calcite, feldspar, mica, and hornblende) and ore minerals using a table of diagnostic properties.

• Waves, wind, water, and ice shape and reshape the Earth's land surface. As a basis for understanding this concept, students know:

a. some changes in the Earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

b. natural processes, including freezing/thawing and growth of roots, cause rocks to break down into smaller pieces.

c. moving water erodes landforms, reshaping the land by taking it away from some places and depositing it as pebbles, sand, silt, and mud in other places (weathering, transport, and deposition).

Grade 5

• Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept, students know:

a. most of the Earth's water is present as salt water in the oceans, which cover most of the Earth's surface.

b. when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water.

c. water moves in the air from one place to another in the form of clouds or fog, which are tiny droplets of water or ice, and falls to the Earth as rain, hail, sleet, or snow.

d. the amount of fresh water, located in rivers, lakes, underground sources, and glaciers, is limited, and its availability can be extended through recycling and decreased use.

e. the origin of water used by their local communities.

• Energy from the sun heats the Earth unevenly, causing air movements resulting in changing weather patterns. As a basis for understanding this concept, students know:

a. uneven heating of the Earth causes air movements (convection currents).

b. the influence of the ocean on weather, and the role of the water cycle in weather.

c. causes and effects of different types of severe weather.

d. how to use weather maps and weather forecasts to predict local weather, and that prediction depends on many changing variables.

e. the Earth's atmosphere exerts a pressure that decreases with distance above the Earth's surface, and is the same in all directions.

• The solar system consists of planets and other bodies that orbit the sun in predictable paths. As a basis for understanding this concept, students know:

a. the sun, an average star, is the central and largest body in the solar system and is composed primarily of hydrogen and helium.

b. the solar system includes the Earth, moon, sun, eight other planets and their satellites, and smaller objects such as asteroids and comets.

c. the path of a planet around the sun is due to the gravitational attraction between the sun and the planet.

Grade 6

• Plate tectonics explains important features of the Earth's surface and major geologic events. As the basis for understanding this concept, students know:

a. the fit of the continents, location of earthquakes, volcanoes, and mid-ocean ridges, and the distribution of fossils, rock types, and ancient climatic zones provide evidence for plate tectonics.

b. the solid Earth is layered with cold, brittle lithosphere; hot, convecting mantle; and dense, metallic core.

c. lithospheric plates that are the size of continents and oceans move at rates of centimeters per year in response to movements in the mantle.

d. earthquakes are sudden motions along breaks in the crust called faults, and volcanoes/fissures are locations where magma reaches the surface.

e. major geologic events, such as earthquakes, volcanic eruptions, and mountain building result from plate motions.

f. how to explain major features of California geology in terms of plate tectonics (including mountains, faults, volcanoes).

g. how to determine the epicenter of an earthquake and that the effects of an earthquake vary with its size, distance from the epicenter, local geology, and the type of construction involved.

• Topography is reshaped by weathering of rock and soil and by the transportation and deposition of sediment. As the basis for understanding this concept, students know:

a. water running downhill is the dominant process in shaping the landscape, including California’s landscape.

b. rivers and streams are dynamic systems that erode and transport sediment, change course, and flood their banks in natural and recurring patterns.

c. beaches are dynamic systems in which sand is supplied by rivers and moved along the coast by wave action.

d. earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

• Heat moves in a predictable flow from warmer objects to cooler objects until all objects are at the same temperature. As a basis for understanding this concept, students know:

a. energy can be carried from one place to another by heat flow, or by waves including water waves, light and sound, or by moving objects.

b. when fuel is consumed, most of the energy released becomes heat energy.

c. heat flows in solids by conduction (which involves no flow of matter) and in fluids by conduction and also by convection (which involves flow of matter).

d. heat energy is also transferred between objects by radiation; radiation can travel through space.

• Many phenomena on the Earth's surface are affected by the transfer of energy through radiation and convection currents. As a basis for understanding this concept, students know:

a. the sun is the major source of energy for phenomena on the Earth's surface, powering winds, ocean currents, and the water cycle.

b. solar energy reaches Earth through radiation, mostly in the form of visible light.

c. heat from Earth's interior reaches the surface primarily through convection.

d. convection currents distribute heat in the atmosphere and oceans.

e. differences in pressure, heat, air movement, and humidity result in changes of weather.

• Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. As a basis for understanding this concept, students know:

a. the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.

b. different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and classify them as renewable or nonrenewable.

c. natural origin of the materials used to make common objects.

Grade 7

• Evidence from rocks allows us to understand the evolution of life on Earth. As the basis for understanding this concept, students know:

a. Earth processes today are similar to those that occurred in the past and slow geologic processes have large cumulative effects over long periods of time.

b. the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impact of an asteroid.

c. the rock cycle includes the formation of new sediment and rocks. Rocks are often found in layers with the oldest generally on the bottom.

d. evidence from geologic layers and radioactive dating indicate the Earth is approximately 4.6 billion years old, and that life has existed for more than 3 billion years.

e. fossils provide evidence of how life and environmental conditions have changed.

f. how movements of the Earth's continental and oceanic plates through time, with associated changes in climate and geographical connections, have affected the past and present distribution of organisms.

g. how to explain significant developments and extinctions of plant and animal life on the geologic time scale.

Grade 8

• The structure and composition of the universe can be learned from the study of stars and galaxies, and their evolution. As a basis for understanding this concept, students know:

a. galaxies are clusters of billions of stars, and may have different shapes.

b. the sun is one of many stars in our own Milky Way galaxy. Stars may differ in size, temperature, and color.

c. how to use astronomical units and light years as measures of distance between the sun, stars, and Earth.

d. stars are the source of light for all bright objects in outer space. The moon and planets shine by reflected sunlight, not by their own light.

e. the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

• All objects experience a buoyant force when immersed in a fluid. As a basis for understanding this concept, students know:

a. density is mass per unit volume.

b. how to calculate the density of substances (regular and irregular solids, and liquids) from measurements of mass and volume.

c. the buoyant force on an object in a fluid is an upward force equal to the weight of the fluid it has displaced.

d. how to predict whether an object will float or sink.

State of California Science Education Standards for Investigation and Experimentation K–8

• Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in the other three strands, students should develop their own questions and perform investigations. Students will:

Kindergarten

a. observe common objects using the five senses.

b. describe the properties of common objects.

c. describe the relative position of objects using one reference (e.g., above or below).

d. compare and sort common objects based on one physical attribute (including color, shape, texture, size, weight).

e. communicate observations orally and in drawings.

Grade 1

a. draw pictures that portray some features of the thing being described.

b. record observations and data with pictures, numbers, and/or written statements.

c. record observations on a bar graph.

d. describe the relative position of objects using two references (e.g., above and next to, below and left of).

e. make new observations when discrepancies exist between two descriptions of the same object or phenomena.

Grade 2

a. make predictions based on patterns of observation rather than random guessing.

b. measure length, weight, temperature, and liquid volume with appropriate tools and express measurements in standard and non-standard units.

c. compare and sort common objects based on two or more physical attributes (including color, shape, texture, size, weight).

d. write or draw descriptions of a sequence of steps, events, and observations.

e. construct bar graphs to record data using appropriately labeled axes.

f. write or draw descriptions of a sequence of steps, events and observations, and include the use of magnifiers or microscopes to extend senses.

g. follow verbal instructions for a scientific investigation.

Grade 3

a. repeat observations to improve accuracy, and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

b. differentiate evidence from opinion, and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.

c. use numerical data in describing and comparing objects, events and measurements.

d. predict the outcome of a simple investigation, and compare the result to the prediction. conclusion.

Grade 4

a. differentiate observation from inference (interpretation), and know that scientists' explanations come partly from what they observe and partly from how they interpret their observations.

b. measure and estimate weight, length, or volume of objects.

c. formulate predictions and justify predictions based on cause and effect relationships.

d. conduct multiple trials to test a prediction and draw conclusions about the relationships between results and predictions.

e. construct and interpret graphs from measurements.

f. follow a set of written instructions for a scientific investigation.

Grade 5

a. classify objects (e.g., rocks, plant, leaves) based on appropriate criteria.

b. develop a testable question.

c. plan and conduct a simple investigation based on a student-developed question, and write instructions others can follow to carry out the procedure.

d. identify the dependent and controlled variables in an investigation.

e. identify a single independent variable in a scientific investigation and explain what will be learned by collecting data on this variable.

f. select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.

g. record data using appropriate graphic representation (including charts, graphs, and labeled diagrams), and make inferences based on those data.

h. draw conclusions based on scientific evidence and indicate whether further information is needed to support a specific conclusion.

i. write a report of an investigation that includes tests conducted, data collected or evidence examined, and conclusions drawn.

Grade 6

a. develop a hypothesis.

b. select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

c. construct appropriate graphs from data and develop qualitative statements about the relationships between variables.

d. communicate the steps and results from an investigation in written reports and verbal presentations.

e. recognize whether evidence is consistent with a proposed explanation.

f. read a topographic map and a geologic map for evidence provided on the maps, and construct and interpret a simple scale map.

g. interpret events by sequence and time from natural phenomena (e.g., relative ages of rocks and intrusions).

h. identify changes in natural phenomena over time without manipulating the phenomena (e.g., a tree limb, a grove of trees, a stream, a hillslope).

Grade 7

a. select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

b. utilize a variety of print and electronic resources (including the World Wide Web) to collect information as evidence as part of a research project.

c. communicate the logical connection among hypothesis, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

d. construct scale models, maps and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).

e. communicate the steps and results from an investigation in written reports and verbal presentations.

Grade 8

a. plan and conduct a scientific investigation to test a hypothesis.

b. evaluate the accuracy and reproducibility of data.

c. distinguish between variable and controlled parameters in a test.

d. recognize the slope of the linear graph as the constant in the relationship $y=kx$ and apply this to interpret graphs constructed from data.

e. construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

f. apply simple mathematical relationships to determine one quantity given the other two (including speed = distance/time, density = mass/volume, force = pressure x area, volume=area x height).

g. distinguish between linear and non-linear relationships on a graph of data.

List of Materials on Two-Hour Reserve in the Library

General References

Earth Science, by Tarbuck and Lutgens (THE textbook)	BYKERK-KAUFFMAN A 3-B
Introduction to the Geology of Bidwell Park, by Guyton and DeCourten	BYKERK-KAUFFMAN A 17-PAM

K-8 Curriculum Materials – Astronomy

Universe at Your Fingertips (Project Astro)	BYKERK-KAUFFMAN A 36-BINDER
Earth, Moon and Stars (GEMS—Great Explorations in Math and Science)	BYKERK-KAUFFMAN A 21-PB
Moons of Jupiter (GEMS—Great Explorations in Math and Science)	BYKERK-KAUFFMAN A 101-PB
Astro Adventures (Pacific Science Center)	BYKERK-KAUFFMAN A 103-PB
Project Earth Science: Astronomy (National Science Teacher's Association	BYKERK-KAUFFMAN A 102-PB

Descriptions of Moon Project Topics

This semester, you will complete a project on the moon. There are four different topics for you to choose from; each person in your lab group must choose a different topic. All of the topics require you to gather and graph data that can be used as evidence for which way the moon revolves around Earth. Each topic requires a different type of data collection. All topics require you to make at least 20 observations of the moon. This isn't as hard as it sounds; each observation only takes about 5 minutes and can be squeezed into odd times of the day. Get creative! Students have even been known to do their moon observations while standing in line outside of a downtown bar—entertain your friends while they're stuck waiting around.

Topic #1: Compass Direction to the Moon
This topic is for you if you own a good magnetic compass or are outdoors oriented and don't mind buying one because you'll use it a lot anyway. I recommend a compass that has a setting to automatically correct for magnetic declination (The magnetic declination in Chico is 18° east.). Mountain Sports (on 3rd Street, between Main and Wall) carries a nice Brunton "Classic" model that does this for around $35.

You will make several sets of observations. Within each set, you will observe the moon at the same time of day (give or take half an hour) for several days in a row. Each time, you will record the compass direction to the moon and draw the moon's appearance. Note that you cannot choose the exact same time of day for all observations; there are days when the moon just isn't out in the evening, but it is out in the morning; and visa versa. You will receive a detailed description of your moon project topic that includes a table with moonrise and moonset times.

Topic #2: Moon/Planet Relationships
This topic is for you if you have ample opportunity to get outside when it's dark out and observe both the moon and a prominent planet. Since the moon is out at different times on different days, you will sometimes have to do this in the evening and sometimes have to do this in the early morning.

Topic #3: Daytime Moon Watching
This topic is for you if your best moon-viewing times are during the day, especially around sunrise and sunset. Each time you make an observation, you will measure the angular distance between the moon and the sun.

Topic #4: Time of Moonrise and Astronomical Place of the Moon
This topic is for you if you have a variable schedule and can't observe the moon at fixed times. You will be able to view the moon any time you like as long as it's actually out. Your moon observations will be fairly simple and straightforward, but you will be graphing two kinds of given data (i.e. your graphs will not have to be based on data you collect) on two different graphs and using both kinds of data to support your conclusion about the direction of the Moon's rotation around Earth. In comparison with the other three topics, your analysis will be a bit more complex and your paper will be a bit longer.