



# EARTH SCIENCE Learning Objectives



## **EARTH'S PLACE IN THE UNIVERSE**

### **The learner will**

- ☑ know astronomy and planetary exploration reveal the solar system's structure, scale and change over time.
- ☑ know how the differences and similarities among the sun, the terrestrial planets and the gas planets may have been established during the formation of the solar system.
- ☑ know evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.
- ☑ know the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today.
- ☑ know the evidence indicating that the planets are much closer to Earth than the stars are.
- ☑ know the sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.
- ☑ know the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.
- ☑ know the evidence for the existence of planets orbiting other stars.
- ☑ know the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.
- ☑ know galaxies are made of billions of stars and comprise most of the visible mass of the universe.
- ☑ know the evidence indicating that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars.
- ☑ know that stars differ in their life cycles and that visual, radio and X-ray telescopes may be used to collect data that reveal those differences.
- ☑ know earth-based and space-based astronomy reveal the structure, scale and changes in stars, galaxies and the universe over time.
- ☑ know accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed.
- ☑ know the evidence indicating that the color, brightness and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.
- ☑ know the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years.

## **DYNAMIC EARTH PROCESSES**

### **The learner will**

- ☑ know plate tectonics operating over geologic time has changed the patterns of land, sea and mountains on Earth's surface.
- ☑ know features of the ocean floor (magnetic patterns, age and sea-floor topography) provide evidence of plate tectonics.
- ☑ know the principal structures that form at the three different kinds of plate boundaries.
- ☑ know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
- ☑ know why and how earthquakes occur and the scales used to measure their intensity and magnitude.
- ☑ know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
- ☑ know the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.
- ☑ know energy enters the Earth system primarily as solar radiation and eventually escapes as heat.
- ☑ know the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
- ☑ know the fate of incoming solar radiation in terms of reflection, absorption and photosynthesis.
- ☑ know the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.
- ☑ know the differing greenhouse conditions on Earth, Mars and Venus; the origins of those conditions; and the climatic consequences of each.
- ☑ know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
- ☑ know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.
- ☑ know the origin and effects of temperature inversions.



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## **DYNAMIC EARTH PROCESSES**

### **The learner will**

- ☑ know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents and the geographic distribution of marine organisms.

## **ENERGY IN THE EARTH SYSTEM**

### **The learner will**

- ☑ know heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
- ☑ know rain forests and deserts on Earth are distributed in bands at specific latitudes.
- ☑ know the interaction of wind patterns, ocean currents and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts.
- ☑ know features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.
- ☑ know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.
- ☑ know the effects on climate of latitude, elevation, topography and proximity to large bodies of water and cold or warm ocean currents.
- ☑ know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition and other factors, such as solar radiation and plate movement.
- ☑ know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.
- ☑ know climate is the long-term average of a region's weather and depends on many factors.
- ☑ know the carbon cycle of photosynthesis and respiration and the nitrogen cycle.
- ☑ know the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere
- ☑ oceans, biomass, fossil fuels and the movement of carbon among these reservoirs.
- ☑ know the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.
- ☑ know the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

## **BIOGEOCHEMICAL CYCLES**

### **The learner will**

- ☑ know each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere and within and among organisms as part of biogeochemical cycles.
- ☑ know the thermal structure and chemical composition of the atmosphere.
- ☑ know how the composition of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration and the origin of atmospheric oxygen.
- ☑ know the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation and the way in which this layer varies both naturally and in response to human activities.

## **STRUCTURE AND COMPOSITION OF THE ATMOSPHERE**

### **The learner will**

- ☑ know life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life.



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## **GEOLOGY OF SOUTH AFRICA**

### **The learner will**

- ☑ know the geology of South Africa underlies the country's wealth of natural resources as well as its natural hazards.
- ☑ know the resources of major economic importance in South Africa and their relation to South African geology.
- ☑ know the principal natural landforms in different South African regions and the geologic basis of those landforms.
- ☑ know the importance of water to society, the origins of South Africa's fresh water and the relationship between supply and need.
- ☑ know how to analyze published geologic maps of South Africa and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

## **RESOURCES**

Prentice-Hall Earth Science (2005 Ed.)

Internet research, applications, modeling; PASCO measurement devices, laboratory investigations and supplemental materials.