

**ES Ch. 1:**

1. a. **Oceanography** is the science that deals with the dynamics of the oceans.  
b. **Geology** is the word that literally means “the study of the Earth.”  
c. **Meteorology** is the study where the primary focus is on gaining an understanding of the atmosphere  
d. **Astronomy** is the science that helps us understand Earth’s place in the universe. (Page 2)
2. Renewable resources can be replenished over relatively short time spans. Some examples are plants and animals for food, natural fibers for clothing, and forest products for lumber and paper. Nonrenewable resources do continue to form but the processes that create them are so slow that significant deposits take millions of years to accumulate. Some examples of these include important metals such as iron, aluminum, and copper, as well as fuel like oil, natural gas, and coal. (Page 3 and 4)
7. The four “spheres” that constitute our environment include: the hydrosphere, which is the global ocean, streams, lakes, glaciers, and what water can be found underground; the atmosphere, which surrounds Earth as a life-giving gaseous envelop; the biosphere, which includes all life on Earth; and the geosphere, the solid Earth beneath the atmosphere and the ocean. (Page 12-14)
10. The lithosphere is Earth’s outermost layer and consists of the crust and the uppermost mantle. It forms a relatively cool, rigid shell, whereas the asthenosphere is beneath the lithosphere and is a soft and comparatively weak layer with mostly solid rocks and melting temperatures. (Page 16)
13. The three major regions of the ocean floor include the continental margins, deep-ocean basins, and oceanic (mid-ocean) ridges. (Page 19)

**ES Ch. 2:**

3. The three main particles of an atom are the protons, which are very dense particles with positive electrical charges; the neutrons, which have the same mass as a proton but lack an electrical charge; and the electrons, which have negative electrical charges. (Page 32-33)
4. If the number of electrons in an atom is 35 and its mass number is 80: (Page 33-34)  
There are:
  - a. 35 protons.
  - b. The atomic number is 35.
  - c. The number of neutrons is 45.
6. An ion is produced when atoms have an electrical charge because of the unequal numbers of electrons and protons. (Page 35)

**CPS Ch. 12:**

7. In the periodic table, the atomic number tells the number of protons each atom of a given

element contains. (Page 288)

8. The atomic number tells the number of protons each atom of a given element contains, while a mass number tells the total number of nucleons in an atomic nucleus. (Page 288 and 291)

9. Mass number tells the total number of nucleons in an atomic nucleus, while the atomic mass shows the mass of an element's atoms listed in the periodic table as an average value based on the relative abundance of the element's isotopes. (Page 291)

12. Properties of elements across any period or the periodic table gradually change in a periodic trend. (Page 293)

26. Valence electrons are most responsible for the properties of an atom. (Page 305)

### **CPS Ch. 15:**

16. Elements that tend to form covalent bonds are those that have a mutual attraction for shared electrons, such as two fluorine atoms. (Page 363)

18. An oxygen atom can form up to two covalent bonds. (Page 364)

19. A dipole is the separation of a charge. (Page 366)

25. Oil and water do not mix because water molecules are so attracted to themselves because of their polarity that they pull themselves together and the non-polar oil molecules are thus excluded and left to themselves. (Page 371)

27. The primary difference between a chemical bond and an attraction between two molecules is that attraction between two molecules is relatively weak in comparison to a chemical bond, but their effects on the physical properties of substances are more significant. (Page 372)

29. Induced dipoles are not permanent. (Page 374)

### **CPS Ch. 6:**

1. The temperatures for freezing water are Celsius 0 and Fahrenheit 32, while the temperatures for boiling water Celsius 100 and Fahrenheit 212. (Page 142)

8. When you touch a cold surface, the thermal energy travels from your finger to the cold surface because thermal energy always flows from the higher-temperature substance into the lower-temperature substance until thermal equilibrium is reached, unless it is assisted otherwise. (Page 144)

9. Temperature measure the hotness or coldness of substances, whereas heat is the thermal energy that is transferred from one thing to another due to a temperature difference. (Page 144)

10. Thermal energy is the total energy of the submicroscopic particles that make up a substance and heat is the thermal energy that is transferred from one thing to another due to a temperature difference. (Page 144)

11. The direction of heat flow is determined by higher and lower-temperature substances and the need for equilibrium between the two. (Page 144)

22. When heat is applied, silver warms up faster than iron. (Page 147)

24. The specific heat capacity of water compares with the specific heat capacities of other common materials because it has a much higher capacity for storing thermal energy than almost any other substance. (Page 148)

26. Liquids expand more than solids for an equal increase in temperature. (Page 151)

27. When the temperature of ice-cold water is increased slightly, it undergoes both net contraction and expansion as the volume decreases as ice crystals collapse, while volume increases due to greater molecular motion. Once most of the ice crystals have melted expansion overrides the contraction. (Page 152)

28. The reason for ice being less dense than water is that its volume increases tremendously and it contracts which make it less dense and gives it the ability to float on water. (Page 152)

#### **ES Ch. 5:**

1. Water in the hydrologic cycle evaporates into the atmosphere from the oceans and continents, wind transports this moisture-laden air until conditions cause the moisture to condense into clouds and precipitate and fall. Eventually all of the water is returned to the ocean and the cycle begins again. Once the precipitation falls onto the land a portion of the water soaks into the ground, then into lakes, streams, or directly into the ocean. Some of it is also absorbed by plants which release it into the atmosphere. (Page 116)

17. The percentage of freshwater that is groundwater is 14.158%. If glacial ice is excluded and only liquid freshwater is considered, the percentage that is groundwater is 14.158%. (Page 134)

18. A significant geological role of groundwater, apart from its being an erosional agent, is as an equalizer of streamflow. (Page 135)

19. Groundwater is water in the zone of saturation and only about six-tenths of 1% of water occurs underground rather than on Earth's surface and yet it is still considered to be a vast quantity. (Page 134)

20. Porosity is the volume of open spaces in rock or soil, whereas permeability is a measure of a material's ability to transmit water. (Page 137)

21. Aquitards are impermeable beds that hinder or prevent groundwater movement and aquifers are rocks or soils through which groundwater moves easily. (Page 137)

22. The source of heat for most hot springs and geysers is cooling igneous rock, and this is reflected in the distribution of these features because most recent igneous activity has been in the

West. (Page 139)

23. Artesian means a well in which the water rises above the level where it was initially encountered and the two conditions that must be present in order for these wells to exist are that water must be confined to an aquifer that is inclined so that one end is exposed at the surface, where it can receive water and aquitards both above and below the aquifer must be present to prevent the water from escaping. (Page 141)

24. The problem that is associated with the pumping of groundwater for irrigation in the southern part of the High Plains is that the natural recharge of the aquifer is very slow and the problem of declining groundwater levels is acute. (Page 142)

25. As a result of excessive groundwater withdrawal in the San Joaquin Valley of California land subsidence began in the valley. (Page 143)

26. The most effective in purifying polluted groundwater is an aquifer composed mainly of sand. (Page 143)

### **ES 13:**

1. The average elevation of the continents above sea level is about 840 meters, whereas the average depth of the oceans is about four times that amount (3729 meters). Also, the volume of ocean water is so large that if Earth's solid mass were level and spherical, the oceans would cover Earth's entire surface to a uniform depth of more than 2000 meters. (Page 361)

2. The four main ocean basins are: the Pacific Ocean, the largest and the deepest; the Atlantic Ocean; the Indian Ocean, which is the smallest and is in the Southern Hemisphere; and the Arctic Ocean which is the shallowest. None of these are exclusively in the Northern Hemisphere since that is mainly a land hemisphere. (Page 361)

4. If the average speed of sound waves in water is 1500 meters per second, then the water depth where a signal required 6 seconds to strike the bottom and return is 4500 meters because  $\text{depth} = \frac{1}{2} (1500 \text{ m/sec} \times 6 \text{ sec})$ . (Page 363)

6. The three major subdivisions of a passive continental margin are the continental shelf, which is considered to be a flooded extension of the continents; the continental slope, which is a relatively steep slope; and the continental rise. (Page 364-366)

7. The passive continental margins consist of a continental shelf, slope, and rise and are not associated with plate boundaries and therefore experience little volcanism and few earthquakes. Sediment deposits can accumulate thickly along gradually subsiding continental margin. An example of this is along the East coast of the US where the shallow-water deposits can reach several kilometers in thickness. The active continental margins are usually narrow and consist of highly deformed sediments, and they occur where oceanic lithosphere is being subducted beneath the margin of a continent. An example of this is in the Pacific Ocean where areas of oceanic lithosphere is being subducted beneath the leading edge of a continent. (Page 365-367)

9. Turbidity currents are periodic downslope movements of dense, sediment-laden water, whereas turbidites are finer deposits of silt and then clay. Graded bedding are sediment layers that are characterized by a decrease in sediment size from bottom to top. (Page 366-367)

10. Submarine canyons are deep, steep-sided valleys and deep-ocean trenches are long, relatively narrow creases in the sea floor that form the deepest parts of the ocean. (Page 366 and 369)

17. The three basic types of sea floor sediment are terrigenous sediment, consisting primarily of mineral grains that were weathered from continental rocks and transported to the ocean (gravel and sand); biogenous sediment, consisting of shells and skeletons of marine animals and algae (*foraminifers*, small organisms); and hydrogenous sediment, consisting of minerals that crystallize directly from seawater through various chemical reactions (metal sulfides). (Page 374-375)

18. Sea floor sediments are useful in studying past climates because the numbers and types of organisms living near the sea surface change with the climate. Sediments can reveal periods of Ice Ages, global warming, ocean circulation changes, the timing of major extinction events, and the movement of Earth's plates. (Page 376)

#### **ES Ch. 14:**

1. Salinity is the total amount of solid material dissolved in water. The average salinity of the ocean is 3.5%. Oceanographers typically express salinity in parts per thousand because the proportion of dissolved substances in seawater is such a small number. (Page 384)

2. The six most abundant components (elements) dissolved in seawater are sodium chloride, magnesium chloride, sodium sulfate, calcium chloride, potassium chloride, and sodium bicarbonate. When the two most abundant elements are combined they produce over 99 percent of all dissolved substances in the sea. (Page 384)

3. The two primary sources for the materials that comprise the dissolved components in seawater are chemical weathering of rocks on the continents and water vapor and other gases released from Earth's interior. (Page 384)

4. The process that affect seawater salinity are precipitation, runoff from land, icebergs melting, and sea ice melting all of these add large amounts of fresh water and thereby decrease salinity. Evaporation and the formation of sea ice remove large amounts of fresh water and thereby increase salinity. High salinity in the Red Sea comes from high evaporation levels that exceed precipitation in the restricted waters. In the Baltic Sea, there are very low salinities due to large quantities of fresh water supplied by rivers and precipitation. (Page 358)

9. Two factors that influence water density are salinity and temperature. Temperature has the greatest influence on surface seawater density. (Page 389)

10. Density variation with depth in low-latitudes increases rapidly with depth because the water temperature is getting colder and in high-latitudes it is high-density (cold) water at the surface and high-density (cold) water below. High-latitude waters generally lack a pycnocline because

the water column is isopycnal instead. (Page 388-389)

11. The ocean's layered structure is layered according to density with low-density water near the surface and higher-density water below. It is separated into three parts: a shallow surface mixed zone, a transition zone, and a deep zone. The three-layer structure does not exist in high latitudes because the water column is isothermal which indicates there is no rapid change in temperature with depth. (Page 389)

12. Plankton are organisms - algae, animals, and bacteria- that drift with currents, even though they can actually swim if they feel like it, and they are extremely abundant and very important within the marine environment as they are the vast majority of the ocean's biomass. Nekton include animals that are capable of moving independently of the ocean currents by swimming or propulsion - marine reptiles, squid, adult fish - but they are unable to move throughout the breadth of the ocean since they can die from changes in pressure, temperature, density, and salinity. They are most abundant near continents, islands, and colder waters. Benthos are organisms that live on or in the ocean bottom and are either attached to rocks, move along the bottom (*Epifauna*), live buried in the sand or mud (*Infauna*). Shallow coastal areas are the only locations where they are found and they often live in deep places where photosynthesis cannot occur so they must feed on each other or on nutrients that fall down to them. (Page 390-391)

13. Of plankton, nekton, and benthos plankton comprises the largest amount of biomass because they live in places where growth is easier than in places where benthos reside, and they also do not have to worry about water changes as nekton do. (Page 390)

### **ES Ch.15:**

1. The primary driving force of surface ocean currents is local or seasonal influences. The distribution of continents on Earth and the Coriolis effect influence these currents because the continents create five major current gyres, large whirls of water within an ocean basin, and the Coriolis effect deflects the current to the right in the Northern Hemisphere and the left in the Southern Hemisphere. (Page 404-405)

2. A gyre is a large whirl of water within an ocean basin and have four main currents each. The five subtropical gyres are the North Pacific Gyre (the North Equatorial Current, the Kuroshio Current, the North Pacific Current, and the California Current), the South Pacific Gyre (S. Equatorial Current, and the Peru Current), the North Atlantic Gyre (the Gulf Stream, the Canary Current, and the North Equatorial Current), the South Atlantic Gyre (the Brazil Current, S. Equatorial Current, and the Benguela Current), and the Indian Ocean Gyre (the West Australian Current, N. Equatorial Current, and the Agulhas Current). (Page 404-405)

4. Ocean currents influence climate by transferring heat from warmer to cooler areas on Earth, such as how the North Atlantic Current keeps Great Britain and much of the northwestern Europe warmer during the winter. Some cold currents also moderate the warm temperatures in some areas as they travel equatorward. Ocean currents play a major role in maintaining Earth's heat balance. (Page 408)

6. The driving force of deep-ocean circulation is density differences among water masses that cause denser water to sink and slowly spread beneath the surface. The movement of deep

currents is often termed “thermohaline circulation” because of the density variations that cause deep-ocean circulation that are caused by differences in temperature and salinity. (Page 409)

7. Shore is the area that extends between the lowest tide level and the highest elevation on land that is affected by storm waves, shoreline is the line that marks the contact between the shore and the land, coast is a strip of land that extends inland from the coastline as far as the ocean-related features can be found, and coastline marks the coast’s seaward edge. (Page 410)

10. The motion of a floating object as a wave passes can be described as rotating in a sort of imaginary circle as the wave passes beneath it and it goes up and then loops back to a place that is almost exactly where it began. (Page 414)

11. The physical changes that occur to a wave’s speed, wavelength, and height as a wave moves into shallow water and breaks on the shore are that the water becomes shallower, the wavelength decreases, the speed diminishes, and the height actually collapses when the wave becomes too steep to support itself. (Page 414)

13. Wave refraction is the bending of waves. The effect of this process along irregular coastlines is that because waves reach the shallow water in front of the headland sooner than they do in adjacent bays, they are bent more nearly parallel to the protruding land and strike it from all three sides. (Page 416-417)

15. The formation of shoreline features are that wave-cut cliffs form by the cutting action of the surf against the base of coastal land, wave-cut platform is left behind by the receding cliff, marine terraces are formed when a wave-cut platform is up-lifted above sea level by tectonic forces, sea stacks is an isolated remnant of a sea arch on a wave-cut platform, a spit is an elongated ridge of sand that projects from the land into the mouth of an adjacent bay, a baymouth bar is a sandbar that completely crosses a bay and seals it off from the open ocean and forms across bays where currents are weak, and a tombolo is a ridge of sand that connects an island to the mainland or to another island and is formed similar to a spit. (Page 417-419)

22. The origin of ocean tides comes from a large tidal bulge that appears on the sides of the Earth that are both nearest and farthest from the Moon and its gravitational pull. The bulges migrate as the Moon moves around. Even though it is so much more massive than the Moon, the Sun has only about half the influence on Earth’s tides because it is farther away. (Page 426-428)

### **ES Ch. 21:**

14. The approximate length of the cycle of the phases of the Moon is one month. (Page 603)

15. The crescent phase that precedes the new-Moon phase is waning (declining), while the crescent phase following the new-Moon phase is waxing (increasing). (Page 603)

17. When you observe the crescent phase early in the evening, the visible Moon is in the waxing (growing) stage. (Page 604)