Matter and Energy Transfers in Earth's Spheres

1 The Earth system is made up of spheres through which the energy and matter on our Earth move. The biosphere, hydrosphere, atmosphere, geosphere, and cryosphere all interact to support the transfer of matter and energy.

Earths Spheres

The Geosphere *(prefix geo-means earth)*

2 The geosphere is made up of all of Earth's rocks, stones, and minerals. Landforms, molten rocks created by lava, sediments, soils, and Earth's inner layers are also part of the geosphere.

The geosphere contains the rocks of the earth's surface.

The Hydrosphere *(prefix hydro-means water)*

3 The hydrosphere includes all the water found on earth. It includes the ocean, lakes, rivers, streams and even ground water. Dew, water vapor, rain, and even clouds are also part of the hydrosphere.

Water vapor from clouds condenses to form rain that will fill our bodies of water in the hydrosphere.

The Cryosphere *(prefix cryo-means cold)*

4 The cryosphere includes all the ice on earth. Glaciers, sea ice, snow, frozen lakes and even icicles are part of the cryosphere. The cryosphere isn't just at the poles. Ice forms in the winter nearly all over the globe!

The ice near the poles makes up portions of the cryosphere.

The Atmosphere *(prefix atmo-means air)*

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The Earth is wrapped in a blanket of air called the 'atmosphere', which is made up of several layers of gases. The atmosphere starts from the ground and stretches to 6,200 miles above the earth. It is like a protective layer around the earth that ends right before space begins and keeps our oxygen, nitrogen, and other gases in. The atmosphere is also where all the weather such as storms, hurricanes, tornadoes, and all happen. Our atmosphere is made mostly of the following elements: 78% nitrogen, 21% oxygen, 0.9% argon, and about 0.04% carbon dioxide.

The atmosphere is where our weather patterns form.

The Biosphere *(prefix bio-means life)*

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The biosphere is all living things. Humans, plants, animals, and even single cell organisms make up the biosphere. Plants in the biosphere interact with the atmosphere. Plants absorb carbon dioxide and transpire out oxygen.

Plants and animals are key elements of the biosphere.

Matter and Energy Transfer in Earth's Spheres

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Thermal energy (heat energy) can transfer through Earth's spheres in several different ways. It can occur without direct contact (radiation) and through direct contact between two substances (conduction). Thermal energy can also transfer within liquids and gases through a process called convection.

Radiation

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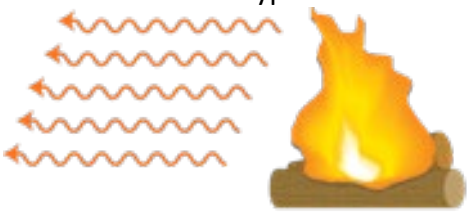
One type of energy transfer is called **radiation**. This type of energy transfer happens through electromagnetic waves from the sun or from other sources, such as a light bulb or a fire. The sun's energy radiates through space to reach Earth. We can feel the sun's energy on our skin when we stand outside on a sunny day. This happens without direct contact between our skin and the sun. The sun is millions of miles away!

The sun transfers energy to Earth by radiation

9 We can also feel radiation if we put our hand near a fire or a lamp. Light is just one tiny part of all the kinds of electromagnetic radiation. We are not able to see most types of electromagnetic radiation.



A fire can transfer energy by radiation

10 All objects actually **emit** (send out) and absorb radiation—even people! If you hold your hand close to your face, you may even be able to feel the electromagnetic waves radiating from it. High-temperature objects like a fire or the sun send out radiation that we can see in the form of light, in addition to other types that we are not able to see. Lower-temperature objects send out radiation that we cannot see, but we can sometimes feel it as warmth if our bodies absorb it. When an object absorbs more radiation than it emits, its temperature increases. When it sends out more radiation than it absorbs, its temperature decreases. For example, during the day, the part of Earth where San Francisco is located absorbs more radiation from the sun than it emits, thus that part of Earth gets warmer. At night, the part of the Earth where San Francisco is located sends out more radiation than it absorbs, thus it gets colder.

Conduction

11 **Conduction** happens when energy is transferred from particle to particle when two objects, or samples of matter, are touching each other. For example, sand from the geosphere can conduct heat. Therefore, walking on the beach on a hot summer day will warm your feet when you stand on it. When your cool feet walk on the warm sand, soon your feet become hot. When you touch an object and it feels warm to you, a **thermal energy transfer** is happening. Energy is being transferred from the object to your body.

Energy from the geosphere is transferred to the biosphere.

12 When two samples of matter are in contact, energy always conducts from the hotter sample of matter to the colder sample of matter. Energy never transfers from the colder sample to the hotter sample. The particles in the hotter substance have more kinetic energy on average than the particles in the substance that has a lower temperature. When the substances are in contact, the particles in the hotter substance hit the particles in the colder substance. This causes the particles in the hotter substance to slow down and the particles in the colder substance to speed up. Thus, the hotter substance cools down and the colder substance warms up. This happens until both objects have the same temperature—when both objects have the same average kinetic energy.

Convection

13 The convection currents tend to move a fluid or gas particles from one place to another. These are created because of the differences occurring within the densities and temperature of a specific gas or a fluid. Convection process only happens in the fluids i.e. in liquids and gases. This happens due to the reason that molecules within liquids or gases are free to move.

14 The heat energy can be transferred by the process of convection by the difference occurring in temperature between the two parts of the fluid. Due to this temperature difference, the hot fluids tend to rise, whereas cold fluids tend to sink. This creates a current within the fluid called Convection current.

15 The mantle within the earth's surface flows due to convection currents. These currents are mainly caused by a very hot material present in the deepest part of the mantle which rises upwards, then cools, sinks, again and again, repeating the same process of heating and rising.

Convection currents in the mantle help to create volcanoes.

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- **Changes in the weather-** The cool air and breeze occurring near to a beach are all the effects of convection currents. Daily weather changes are also affected by these currents.
- **Convection currents occurring in the ocean**– The Oceanic currents are also the convection currents. These are caused due to the difference in the water density and the temperature occurring in different parts of the ocean.
- **Convection currents are present in the air**– A good example of convection current is the warm air that rises towards the ceiling in your house. The process happens as the warm air is said to be less dense than that of the colder air. Another good example of convection current is wind. The wind is mainly caused when the reflected radiation of the light from the sun heats up the air, thus displacing the cooler air.