ESS 200 (Stapleton) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Climate Pattern Questions and Answers

1. **Compare and contrast the words weather and climate?**

Weather describes the day-to-day conditions of the atmosphere in a particular location on the Earth’s surface. That location’s climate describes its long term weather patterns from year to year.

1. **What is *precipitation*?**

Precipitation is water that falls from the sky. Precipitation can be solid, liquid, or a mixture of solid and liquid.

1. **Why does the Earth’s atmosphere circulate?**

Temperature differences cause the atmosphere to circulate. Air sinks at the cold poles and rises at the hot equator. These rising and sinking currents provide the pushes that cause the rest of the atmosphere to move.

1. **Describe the Coriolis Effect’s effect on winds and other flying objects in the Northern and Southern Hemispheres.**

The Coriolis Effect causes flying objects to curve clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

1. **How would the circulation of the Earth’s atmosphere be different if the Earth did not rotate?**

If the Earth did not rotate, winds would blow all of the way from the poles to the equator, in a straight path. This is because, if the Earth did not rotate, there would be no Coriolis effect, so the winds would not curve.

1. **What causes the Coriolis Effect?**

Due to the Earth’s rotation, different parts of the Earth move at different speeds. Locations on the equator move fastest because they travel in the biggest circles with each rotation of the Earth. All locations on the Earth rotate Eastward. When an object flies toward the equator (from a slower place to a faster place), the object falls behind the land beneath it (so it appears to curve westward), because the land beneath the object is now traveling eastward faster than the object itself. When an object moves toward a pole (from a faster place to a slower place), the object pulls ahead (to the east) of the slower land beneath it.

1. **Where is the Intertropical Convergence Zone? (ITCZ) How does it get its name?**

ITCZ stands for Intertropical convergence zone. The ITCZ exists at or near the equator. It gets its name from the northerly and southerly winds that converge at the ITCZ.

1. **Describe the general weather pattern in the ITCZ.**

Hot and rainy, with rising air. Very little prevailing wind.

1. **What is the other common name for the ITCZ? How did it get that name?**

Its other name is “The Doldrums.” Being “down in the doldrums” is an old phrase that describes a depressed state of mind. The ITCZ was depressing because it did not have enough wind to satisfy sailors, so they named it The Doldrums.

1. **Where are the *horse latitudes*? Describe the general weather pattern in the horse latitudes.**

 The horse latitudes are the regions of dry, sinking air around 25° North and South. Sailors stuck in these latitudes often ran out of water. They sometimes threw horses overboard to conserve water.

1. **List the approximate range of latitudes of all of the Earth’s high and low pressure belts. Identify the pressure at each of those latitudes, and describe what the air is doing at each of those latitudes.**

High pressure (air is sinking): Occurs at 90° and from 20°-30°. Low pressure (air is rising): Occurs at 0° and from 55°-65°.

1. **Draw a cross-section diagram showing all of the cells of circulation in the Earth’s atmosphere. Show the approximate latitudes of the areas of rising and sinking air.** We have covered this in other notes.
2. **Draw a map of the Earth’s prevailing wind patterns.** We have covered this in other notes.
3. **Explain what causes the pattern of prevailing winds. You should explain two things: Why the air moves in the first place, and why the air curves in a particular direction.**

Winds begin moving because of pressure differences. They begin moving directly from high pressure to low pressure. Once the winds begin moving, the Coriolis Effect causes them to curve until they are traveling either eastward or westward.

1. **Describe two differences between a prevailing wind and a local wind.**

Prevailing winds blow consistently (most of the year) over large areas of the Earth. Local winds change from day to day and generally travel shorter distances.

1. **How are ocean surface currents created?**

Ocean surface currents are created by winds. They move with the winds.

1. **Where, on the Earth, do ocean currents generally flow toward the poles? Where do they flow toward the equator? Give specific latitudes.**

Ocean currents flow poleward along the east coasts of continents between 20° and 30° latitude in both the Northern and Southern Hemispheres. Ocean currents flow toward the equator along the west coasts of continents at those same latitudes (between 20° and 30°).

1. **Prevailing winds generally blow westward or eastward. Why, then, do ocean currents sometimes flow northward or southward?**

The following represents one valid explanation. There are other valid ways to explain this…

When an ocean current that is being pushed westward or eastward by wind hits the coast of a continent, the current splits and follows the continent’s coastline north or south. The water’s momentum keeps it moving northward or southward even when there is no wind pushing it in that direction.

1. **If it is big enough, an ocean will have a gyre in each hemisphere. What is a gyre?**

A gyre is a swirling current pattern in an ocean.

1. **Describe the direction of the North Atlantic Gyre, and explain why it turns in that direction.**

The North Atlantic Gyre rotates clockwise. It spins in this direction because it is situated between two wind belts that cause it to spin. To the north of the gyre, the prevailing winds blow eastward. To the south of the gyre, the winds blow westward. Viewed as if it were on a map, this causes the top of the ocean to move rightward while the bottom moves westward, so the ocean spins clockwise.

1. **Which coasts of continents generally have colder ocean currents, east coasts or west coasts? What makes those currents cold? Which coasts have warmer currents? Why?**

West coasts generally have colder ocean currents, because the currents come from the poles. East coast currents usually come from the equator, so they are warm.

1. **Which coasts of continents are generally more humid? Why?**

East coasts are more humid because the warmer ocean currents increase humidity in the same way that a hot shower increases the humidity in a bathroom.

1. **At what latitudes is there the most precipitation? Why?**

Precipitation is highest where air rises. Air rises at the equator (0°) and between 55° and 65° latitude.

1. **At what latitudes is there the least precipitation? Why?**

Precipitation is lowest where air sinks. Air sinks at the poles (90°) and between 20° and 30° latitude.

1. **How and why do warm and/or cold ocean currents affect the shapes of deserts and rainforests?**

Deserts shrink near warm ocean currents and expand near cold currents. Rainforests shrink by cold currents and expand near warm currents.

1. **Prevailing winds can cause some coastlines to receive more precipitation than others. Explain how and why wind direction can affect the precipitation on a particular coastline.**

Coastlines are wetter where the wind blows from ocean to land. This wind contains more water than wind that comes from the middle of a continent. Furthermore, when wind blows from ocean to land, the wind must rise up when it hits the land. Rising air produces precipitation.

1. **What is the rain shadow effect? Describe what causes it and how it works.**

The rain shadow effect describes wetter and drier conditions on different sides of a mountain range or valley. As winds travel over a mountain or a valley, they must rise on one side and sink on the other. Rising air produces precipitation on the windward side of the mountains. The leeward side (where the air is sinking) is dry.

1. **What is latent heat of vaporization? Why is it called “latent?”**

Latent heat of vaporization is energy that is added specifically to change the phase of a substance from a liquid to a gas. When a substance condenses, this latent heat is released. This is called “latent” heat because the addition of this energy does not change the temperature of the substance. Latent means hidden. The heat is hidden in the sense that no temperature change is observed when the heat is added – only phase change. For example, the addition of latent heat causes liquid water molecules at 100°C to gas water molecules at 100°C.

1. **The wet and dry adiabatic lapse rates are approximately 5°C/1,000m 10°C/1,000m. What are adiabatic lapse rates? Why is the wet adiabatic lapse rate lower than the dry rate?**

Adiabatic lapse rates describe how fast air temperature changes when it rises and sinks. Air cools when it rises because the lower pressure at higher elevations allows it to expand (which causes cooling). Air heats when it sinks because higher pressure compresses it. When air rises, it often cools enough to cause water in the air to begin to condense. Condensation (gas-to-liquid phase change) requires the water to lose latent heat, so it releases this heat to the surrounding air, heating up that surrounding air. In other words, when air is rising and water is condensing (clouds are forming), the rising air doesn’t cool as fast as it would if there were no condensation. The release of latent heat by condensing water slows the rate at which rising air cools. When air is “dry” (no condensation is occurring), latent heat is not released, so the air can cool off more rapidly.

1. **Explain why the leeward side of a mountain range is often warmer than the windward side.**

This happens when the rain shadow effect occurs. Air rises up one side of the mountain range, forming clouds and cooling slowly at the wet adiabatic rate. When the air sinks down the other side of the mountain, clouds are no longer forming, so the air heats up at the dry adiabatic rate. The leeward side of the mountain is warmer because the air heated up faster on its trip down the mountains compared to its slower cooling on the trip up the mountains.

1. **Provide multiple reasons explaining why, in the Northern Hemisphere, June-September is hotter than December-March.**

Two things cause us to have seasons: 1) the Earth’s axis is tilted 23.5°, and 2) the Earth orbits the Sun annually. Due to these phenomena, in June, the Northern Hemisphere is tilted toward the sun. This increases our hours of daylight. It also causes sunlight to hit us more directly, so that the sunlight is more concentrated on the Northern Hemisphere’s surface. Furthermore, the increased directness of the sun’s rays means that those rays remain stonger because they travel through a thinner cross-section of atmosphere before reaching Earth’s surface.

1. **Where are summer wet/winter dry climates located? What causes them?**

Summer wet/winter dry climates are located between 5° and 20° in both hemispheres. These climates are caused by the seasonal shifting of the ITCZ (doldrums). The ITCZ is hot rainy because it is generally the place on Earth that is heated the most by the sun. However, during June the sun is actually most direct in north of the equator. This causes the ITCZ to shift northward, bringing rain to the region between 5°N and 20°N (which is experiencing summer at this time -- June). At the same time, ITCZ has shifted away from region just south of the equator (which is experiencing winter), causing that area to become drier. During December, this arrangement shifts, causing a rainy summer south of the equator and dry winter north of the equator.

1. **What is the monsoon effect? What causes it?**

The monsoon effect is caused by the difference in the rate at which continents and oceans warm and cool. For a variety of reasons, oceans change temperature more slowly. Therefore, during the summer, continents heat up faster and become relatively hot compared to ocean temperatures. This means that, during summers, the air over the continents is less dense than air over oceans. This creates causes low pressure over continents and higher pressure over oceans. The pressure difference causes winds to blow from ocean to land. In some cases (e.g. India), these rain-bearing winds can cause extreme precipitation. In general, larger landmasses (e.g. Asia and North America) cause stronger monsoon effects. During winter this dynamic reverses, with cold, dry, heavy air sinking over the continents and blowing out to sea.