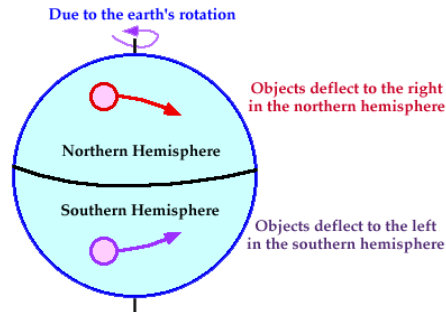


## Ocean Current Worksheet

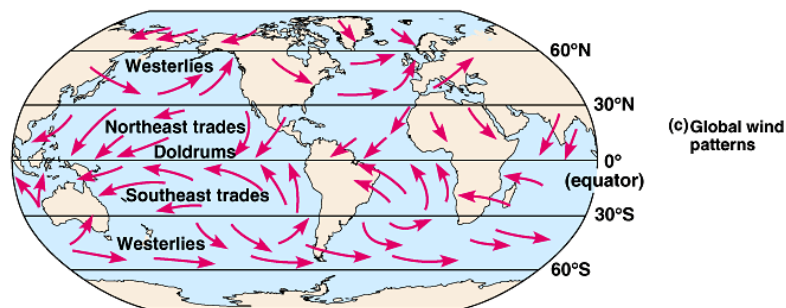
**Temperature Affects and Surface Currents:** Surface waters of the Earth's oceans are forced to move, primarily by winds. Where winds blow in the same direction for a long period of time, currents will develop that transport large masses of water over considerable distances across ocean surfaces. Why do ocean currents and global winds move in a circular pattern? The circular pattern is caused by the **Coriolis Effect**. The Earth's rotation on its axis causes ocean currents and winds to curve to the right (clockwise direction) in the Northern Hemisphere and to the left (counterclockwise direction) in the Southern Hemisphere. As the winds and currents move, the Earth rotates underneath them. The currents appear to curve in relation to the Earth's surface. If the Earth did not spin on its axis then the currents and winds would appear to move in a straight direction.



### Part I:

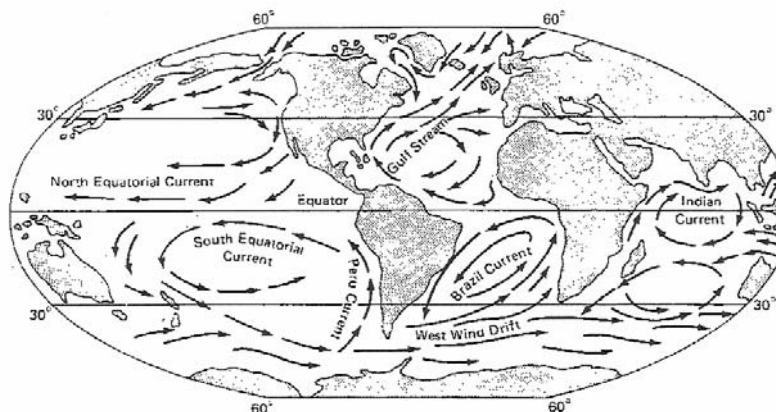
Compare the two pictures below (surface ocean currents and global wind patterns).

#### Global Wind Patterns



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#### Ocean Surface Current Patterns



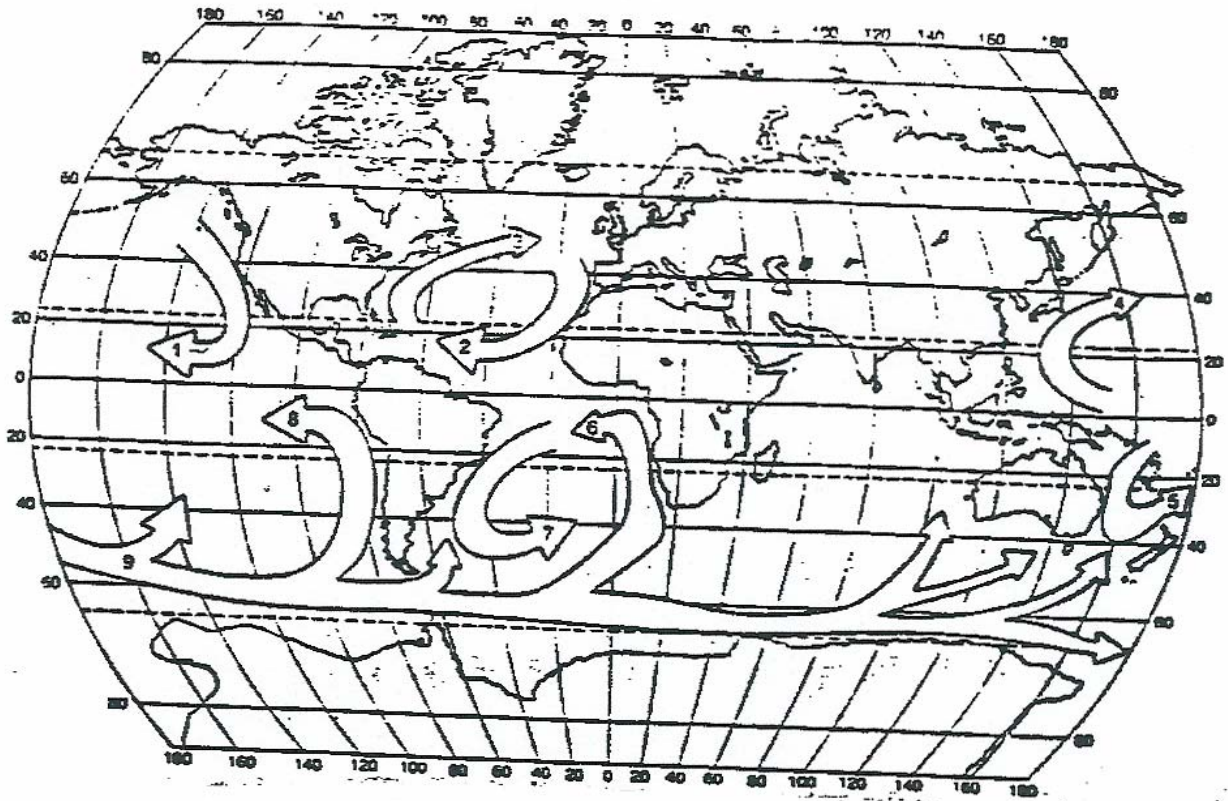
### Questions:

- Take a look at the two pictures above. What do you notice about the global wind and surface current patterns? In general, the direction of the wind flows in the \_\_\_\_\_ direction as the ocean surface currents.
- The global winds in the first map generally travel in either a **clockwise or counterclockwise** direction. Look at the global winds and compare the general direction of flow in the Northern Hemisphere with the general direction in the Southern Hemisphere.
  - In the Northern Hemisphere the general direction is \_\_\_\_\_.
  - In the Southern Hemisphere the general direction is \_\_\_\_\_.
- The difference in direction is caused by the \_\_\_\_\_.

## Part II:

Using the table below label and color the currents in the picture (red = warm, blue = cold).

Number	Name of Surface Current	Characteristic Temperature of Water Transported by Current
1	California Current	Cold
2	Canary Current	Cold
3	Gulf Stream	Warm
4	Kuroshio Current	Warm
5	East Australian Current	Warm
6	Benguela Current	Cold
7	Brazil Current	Warm
8	Peru Current	Cold
9	Antarctic Circumpolar Current	Cold



### Questions:

- The ocean currents on your map generally travel in either a **clockwise or counterclockwise** direction. Look at the ocean currents and compare the general direction followed by currents in the Northern Hemisphere with the direction of those in the Southern Hemisphere.
  - In the Northern Hemisphere the general direction is \_\_\_\_\_.
  - In the Southern Hemisphere the general direction is \_\_\_\_\_.
- What happens to the direction of an ocean current when it approaches the coast of a large landmass?
- Cold water currents tend to have a cooling affect on the continental coastlines that they border, while warm water currents tend to have a warming effect. Look at the pattern of currents in the Northern and Southern hemispheres and describe the effect the currents have on the temperature of the coastal areas they border.
  - The East coasts generally have \_\_\_\_\_ (warm or cold) water currents.
  - The West coasts generally have \_\_\_\_\_ (warm or cold) water currents.
  - The East coast climates will generally be \_\_\_\_\_ (warmer or cooler) than it's supposed to be.
  - The West coast climates will generally be \_\_\_\_\_ (warmer or cooler) than it's supposed to be.
- Look at the pattern of cold and warm water currents. What seems to determine whether a current carries warm or cold water? Explain why this is so.

## Answer Key:

### Part I:

1. Take a look at the two pictures above. What do you notice about the global wind and surface current patterns? In general, the direction of the wind flows in the **same** direction as the ocean surface currents.
2. The global winds in the first map generally travel in either a **clockwise or counterclockwise** direction. Look at the global winds and compare the general direction of flow in the Northern Hemisphere with the general direction in the Southern Hemisphere.
  - c. In the Northern Hemisphere the general direction is **clockwise**.
  - d. In the Southern Hemisphere the general direction is **counterclockwise**.
3. The difference in direction is caused by the **coriolis effect**.

### Part II:

1. The ocean currents on your map generally travel in either a **clockwise or counterclockwise** direction. Look at the ocean currents and compare the general direction followed by currents in the Northern Hemisphere with the direction of those in the Southern Hemisphere.
  - a. In the Northern Hemisphere the general direction is **clockwise**.
  - b. In the Southern Hemisphere the general direction is **counterclockwise**.
2. What happens to the direction of an ocean current when it approaches the coast of a large landmass?
3. Cold water currents tend to have a cooling affect on the continental coastlines that they border, while warm water currents tend to have a warming effect. Look at the pattern of currents in the Northern and Southern hemispheres and describe the effect the currents have on the temperature of the coastal areas they border.
  - e. The East coasts generally have **warm** (warm or cold) water currents.
  - f. The West coasts generally have **cold** (warm or cold) water currents.
  - g. The East coast climates will generally be **warmer** (warmer or cooler) than it's supposed to be.
  - h. The West coast climates will generally be **cooler** (warmer or cooler) than it's supposed to be.
4. Look at the pattern of cold and warm water currents. What seems to determine whether a current carries warm or cold water? Explain why this is so.

**Warm water currents are carried from the equator to the poles. The sun's rays strike the Earth directly at the equator (they are more concentrated) and so, it warms up the water in this area. Cold water currents are carried from the poles to the equator. The sun's rays strike the Earth at a low angle at the poles (they are spread out) and so, the water is cold in this area.**

# Moving Right Along Lab

## (Teacher Directed)

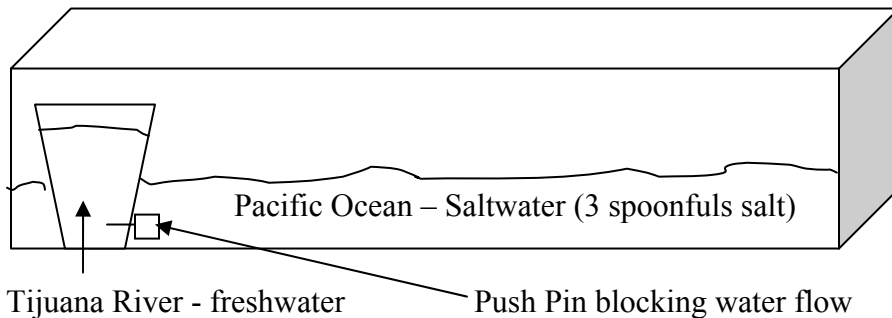
**Purpose:** What causes the currents that sometimes help, sometimes hinder the California gray whale? What forces can move enough water to slow the progress of a twenty ton swimmer? In the following activities you will observe some of the environmental factors which may cause movement of ocean waters. You will also have a chance to observe what happens when different ocean currents meet.

### **PART I: Teacher Directed Lab**

#### **Background:** The Tijuana River and the Tijuana Estuary

The Tijuana Estuary is a distinctive area where a river meets the sea. Fresh water, from rainfall and runoff flows down the Tijuana River into this inland arm of the sea, mixing with the saltwater of the Pacific Ocean tides. The surrounding areas, known as salt marshes or coastal wetlands, are home to plants and animals which are especially adapted for survival in an area constantly changing between fresh and salt water.

#### **Setup (draw on your paper):**



#### **Data (record on your paper):**

Temperature of Pacific Ocean (water in container): \_\_\_\_\_ °C

Temperature of Tijuana River (water in cup): \_\_\_\_\_ °C

#### **Prediction (write on your paper):**

What do you think is going to happen when you carefully pull the pin releasing the water in the cup?

#### **Observations (write on your paper):**

After you pulled the pin and observed what happened for 2-3 minutes write down/draw what you saw.

#### **Questions (write and answer questions on your paper):**

1. Is fresh water more or less dense than salt water?

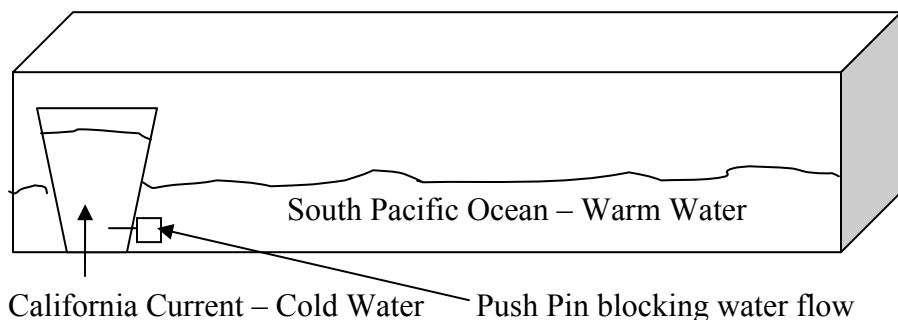
2. Fresh waters tend to sink or float when they meet salt waters? (choose one)
3. During the winter (rainy season), surface water taken from docks at the mouth of the river (place where river meets the ocean) is almost entirely fresh water. How do your experimental results help explain this observation?

## **PART II: Teacher Directed Lab**

**Background:** The cold California Current and warmer Southern waters.

The cold California Currents flows south along the Canadian and U.S. west coast. It mixes with warmer waters off of Mexico. The California gray whale swims southward in this current. The southward movement of the California Current can cause upwelling. Upwelling brings nutrient-rich water from the ocean bottom to the surface. This nutrient rich water and sunlight helps plankton grow. Certain species of fishes feed on this plankton. Gray whales are baleen whales, which mean they are filter feeders. They suck in water and sediment from the ocean floor. They filter out small crustaceans (1/2 inch (1.2 cm) long shrimp-like crustaceans called amphipods, krill, copepods, etc.), plankton, and mollusks (including squid and fish) from the ocean sediment.

**Setup (draw on your paper):**



**Data (record on your paper):**

Temperature of South Pacific Ocean (water in container): \_\_\_\_\_ °C

Temperature of California Current (water in cup): \_\_\_\_\_ °C

**Prediction (write on your paper):**

What do you think is going to happen when you carefully pull the pin releasing the water in the cup?

**Observations (write on your paper):**

After you pulled the pin and observed what happened for 2-3 minutes write down/draw what you saw.

**Questions (write and answer questions on your paper):**

1. Where did the cold California Current flow?

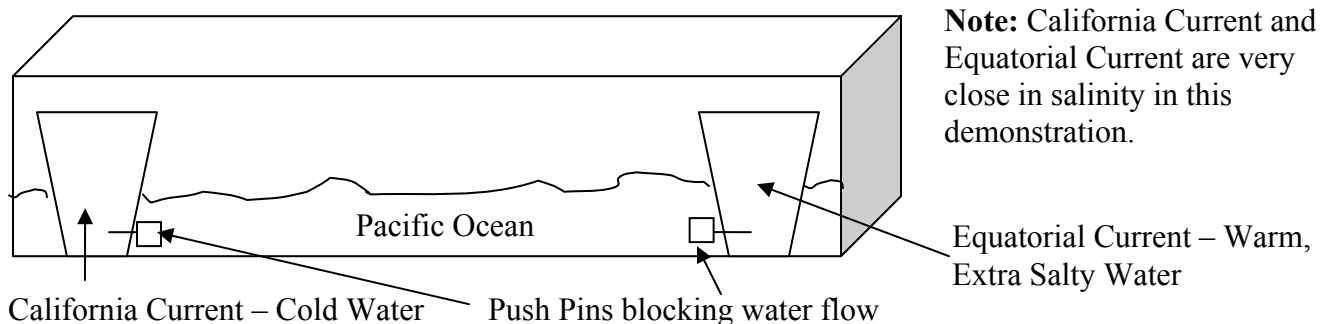
2. What happened to the California Current when it hit land (the side of the container in your lab setup)?
3. Cold waters tend to sink or float when they meet warm waters? (choose one)
4. The southward movement of the California Current may cause upwelling (see background information).
  - a. What is the effect of upwelling on plankton growth?
  - b. What is the effect of upwelling on fish populations?
  - c. Would areas of upwelling be good places for young gray whales to feed? Explain why.

### **PART III: Demonstration**

**Background:** The cold California Current and the warm salty Equatorial Counter Current

The cold California Current flows south along the west coast of Canada and the U.S. It runs into the warm, salty Equatorial Counter Current near the equator. In this part of the activity you will observe a demonstration showing some of the conditions where these currents mix.

**Setup (draw on your paper):**



**Prediction (write on your paper):**

What do you think is going to happen when the pins are pulled releasing the water in the bottles?

**Observations (write on your paper):**

After the pins were pulled and you observed what happened for 2-3 minutes write down/draw what you saw.

**Questions (write and answer questions on your paper):**

1. What happens when the two currents meet?
2. Where did the cold California Current flow?
3. Where did the warm, salty Equatorial Counter Current flow?
4. Cold water is denser than warm water. Salty water is denser than fresh water. Cold water and salty water tend to sink. Was the cold California Current more or less dense than the warm, salty Equatorial Counter Current? Explain your answer.

## Answers:

### Part I

Observations – When you pulled the push pin you should have seen the blue water flow towards the surface. A dark blue layer was created at the top.

#### Questions:

1. Is fresh water more or less dense than salt water?  
Less dense.
2. Fresh waters tend to sink or float when they meet salt waters? (choose one)  
Float
3. During the winter (rainy season), surface water taken from docks at the mouth of the river (place where river meets the ocean) is almost entirely fresh water. How do your experimental results help explain this observation?

The blue water in the cup represented the fresh river water while the water in the container represented the Pacific Ocean (salty). We saw that the river water (blue colored) in the lab flowed to the top representing the surface water of the river mouth, which would be fresh water if we took a sample.

### Part II:

Observations – When you pulled the push pin you should have seen the cold blue water flow to the bottom. A dark blue layer was created at the bottom.

#### Questions:

1. Where did the cold California Current flow?  
To the bottom.
2. What happened to the California Current when it hit land (the side of the container in your lab setup)?  
It bounced off and went the opposite direction.
3. Cold waters tend to sink or float when they meet warm waters? (choose one)  
sink
4. The southward movement of the California Current may cause upwelling (see background information).
  - a. What is the effect of upwelling on plankton growth?  
Causes a plankton bloom (lots of plankton will grow).
  - b. What is the effect of upwelling on fish populations?  
The fish population will grow because they feed on plankton.
  - c. Would areas of upwelling be good places for young gray whales to feed? Explain why.  
Young gray whales are not good divers yet. This means that they filter feed at the surface unlike the adults do (filter feed at bottom). If there is a plankton bloom there is plenty of food for the calf to feed on.

### Part III



Observations – The warm and cold currents met in the middle. The cold current shifted to the bottom while the warm current went above it. When the cold current reached the warm side, it warmed up and rose to the surface. When the warm current reached the cold side it cooled down and sunk to the bottom. This movement created convection current.

1. What happens when the two currents meet?

The cold moves below the warm water current. Creates some turbulence.

2. Where did the cold California Current flow?

Towards the bottom underneath the Equatorial Counter Current.

3. Where did the warm, salty Equatorial Counter Current flow?

Above the cold CA current.

4. Cold water is denser than warm water. Salty water is denser than fresh water. Cold water and salty water tend to sink. Was the cold California Current more or less dense than the warm, salty Equatorial Counter Current? Explain your answer.

There densities were relatively the same (slight difference). The colder water was a little more dense than the salty equatorial current so when they ran into each the cold water went underneath the warm current went above.

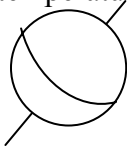


## What Causes Climate Worksheet p. 538-541

**\*\* You must READ the pages in order to answer the questions. Please write the questions OR answer in complete sentences.**

1. What is the difference between weather and climate? Weather is \_\_\_\_\_? Climate is \_\_\_\_\_?
2. What are the 2 main factors that help determine what the climate is like for a region on earth?
3. What is a climate region?

### Factors Affecting Temperature

1. Name the 4 main factors that affect temperatures in a region.
2. Why are climates located farther from the equator cooler than those closer to the equator?
3. Name the three main temperature zones on Earth and label them on an Earth drawing (like the one here)  

4. Mt. Kilimanjaro is a mountain located close to the equator (which would seem to make it warm). However there is snow on the top of the mountain. WHY?
5. In the case of high mountains, which is a more important factor; latitude or altitude?
6. Why do coastal regions (like Santa Monica) have mild temperatures most of the year (not too hot and not too cold)?
7. A. \_\_\_\_\_ climates have relatively warm winters and cool summers  
B. \_\_\_\_\_ climates have cold winters and hot summers.
8. What is the difference between these two climate types (in Question #7)?
9. In general, where do warm ocean currents carry warm water? From \_\_\_\_\_ to \_\_\_\_\_
10. In general cold currents carry cold water from \_\_\_\_\_ to \_\_\_\_\_
11. Why is the climate along the West Coast of the United States cooler than expected for its latitude? (look at the ocean currents in Figure #3)

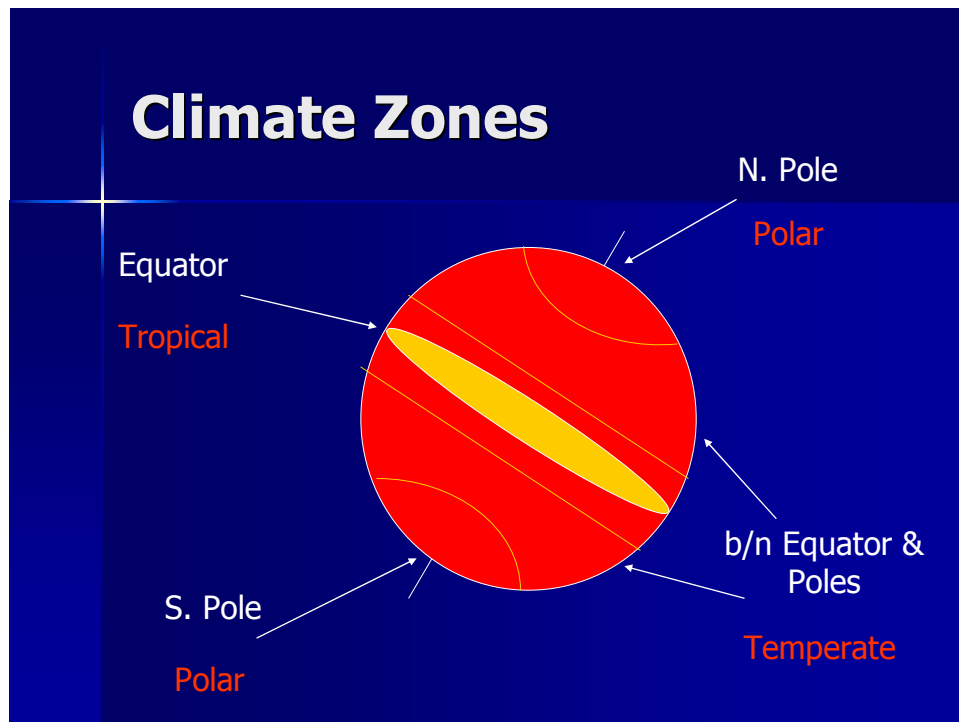
## What Causes Climate Worksheet p. 538-541

\*\* You must READ the pages in order to answer the questions. Please write the questions OR answer in complete sentences.

1. What is the difference between weather and climate? Weather is day-to-day conditions? Climate is year-after-year conditions?
2. What are the 2 main factors that help determine what the climate is like for a region on earth?  
Temperature and precipitation.
3. What is a climate region?  
A large area with similar conditions. Also called a biome.

### Factors Affecting Temperature

1. Name the 4 main factors that affect temperatures in a region.  
Latitude, Altitude, Distance from large bodies of water, and ocean currents.
2. Why are climates located farther from the equator cooler than those closer to the equator?  
Because the sun's rays hits the surface at the equator directly. As we move away from the equator they are getting more and more spread out.
3. Name the three main temperature zones on Earth and label them on an Earth drawing (like the one here)



4. Mt. Kilimanjaro is a mountain located close to the equator (which would seem to make it warm). However there is snow on the top of the mountain. WHY?  
Because the altitude and there are less molecules bumping into each other, which means less heat is being produced.

5. In the case of high mountains, which is a more important factor; latitude or altitude?  
Altitude
6. Why do coastal regions (like Santa Monica) have mild temperatures most of the year (not too hot and not too cold)?  
Because we live next to the ocean, which produces wind.
7. A. Marine climates have relatively warm winters and cool summers  
C. Continental climates have cold winters and hot summers.
8. What is the difference between these two climate types (in Question #7)?  
Marine climate is mild and continental climate is extremes.
9. In general, where do warm ocean currents carry warm water? From equator to poles.
10. In general cold currents carry cold water from poles to equator.
11. Why is the climate along the West Coast of the United States cooler than expected for its latitude? (look at the ocean currents in Figure #3)  
The cold California Current keeps us cooler.