



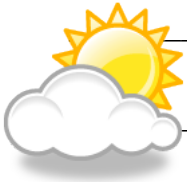
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## Unit 6: Meteorology Study Guide

### Unit Test Study Guide:



### Atmosphere & Weather

Use the summary points below as a resource to help you study for our unit test Monday!

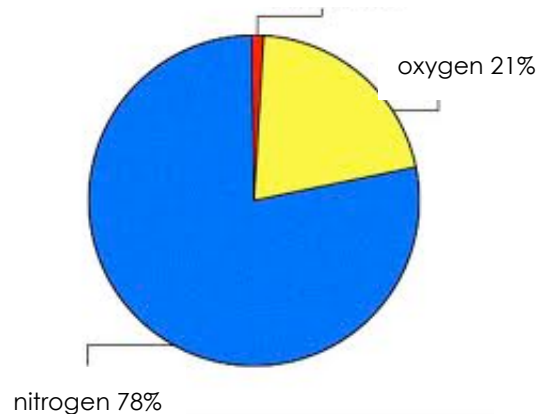
#### EARTH'S ATMOSPHERE:

- Weather comes from Earth's atmosphere! It is the condition of Earth's atmosphere at a particular time and place.
- There is a certain part of our atmosphere that is "home" to our weather, it's called the troposphere.
- As you go from the ground towards the sky in the troposphere, the temperature decreases.
- Our **atmosphere** is the envelope of gases that surrounds the planet.
- Our atmosphere is divided into four main layers. The stratosphere is a layer that is home to the ozone layer.

#### ATMOSPHERIC COMPOSITION:

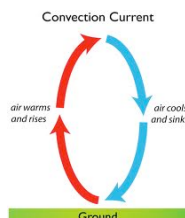
- Earth's atmosphere is made up of nitrogen, oxygen, carbon dioxide, water vapor, and many other gases, as well as particles of liquids and solids.
- Here is a breakdown of the gases represented in Earth's atmosphere:

Other gases: water vapor, CO<sub>2</sub>, etc. 1%



#### HOW HEAT MOVES:

**Convection** is the circular movement of heat. It takes place only in liquids and gases (usually air or water). If Earth's surface is warmer than the air, energy will be transferred from the ground to the air. As the air becomes warmer, it becomes less dense. The air is pushed upward and out of the way by cooler, denser air that is sinking. As the warm air rises, it cools and becomes more dense and begins to sink back toward Earth's surface. This cycle moves energy through the atmosphere.



## LAND VS. WATER (LOCAL WINDS):

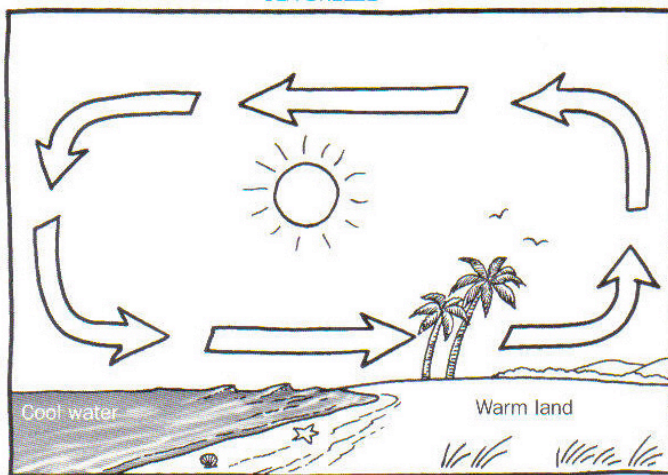
### Land and Sea Breezes

- The sun heats up land quicker since it only heats the surface and a small portion underneath.
- During the day, since land heats up quicker than water, the air above it warms and rises (low pressure) because it is less dense.
- As this air travels upward in the atmosphere, it cools (the upper part of the troposphere is cool, so it cools this warm air).
- As the air cools, it sinks, pressing the cool air below it down (high pressure). Since the warm air is rising over land, the cool air on the bottom being pressed over the sea rushes toward land to replace the warm air.
- The cool air that rushes toward land (from the sea or ocean) is called a sea breeze because of where it came from.

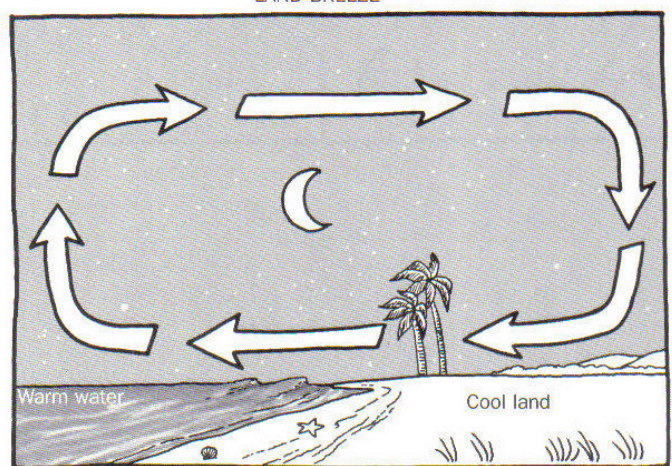
### Water and Land Breezes

- The sun heats up water at a much slower rate than land since water moves and the sun is able to heat so much more of it than land.
- During the night, since water cools less quickly than land, the air above water warms and rises (low pressure) because it is less dense.
- As this air travels upward in the atmosphere, it cools (the upper part of the troposphere is cool, so it cools this warm air).
- As the air cools, it sinks, pressing the cool air below it down (high pressure is now on land since land cools more quickly than water). Since the warm air is rising over the ocean, the cool air on the bottom being pressed rushes toward land to replace the warm air.
- The cool air rushes toward the sea and is called a land breeze because of where it came from.

SEA BREEZE



LAND BREEZE

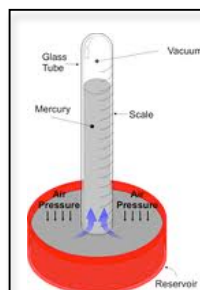


## METEOROLOGIST TOOLS:



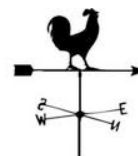
ANEMOMETER

can measure  
air speed and  
air pressure



BAROMETER

measures air  
pressure



← WIND VANE

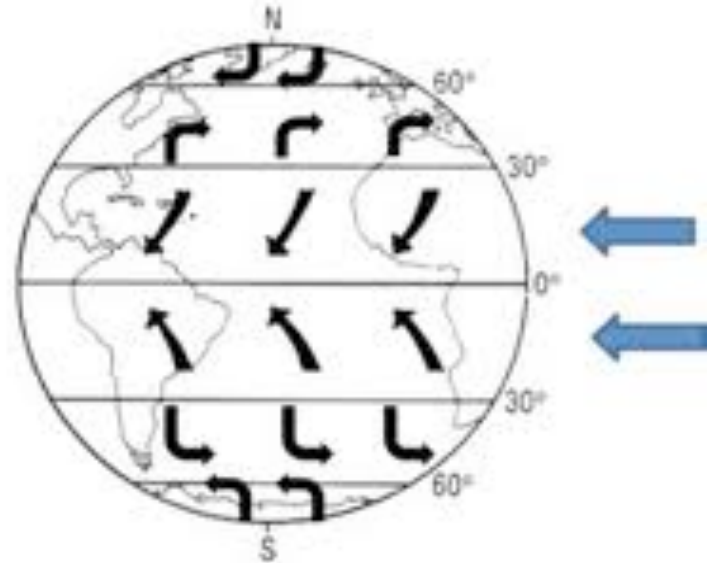
both of these  
measure wind  
direction



← WIND SOCK

## GLOBAL WINDS:

- A global wind is a wind that blows steadily over long distances. A global wind blows from the same direction every time.
- Warm rises from the equator and cool air sinks from the poles, creating global winds.
- The **Coriolis Effect** makes global winds and ocean currents curve. It makes the winds in the Northern Hemisphere **curve** to the right, while winds in the Southern Hemisphere curve to the left.
- Trade winds blow between the equator and 30 degrees latitude. They blow toward the equator and to the west.
- Prevailing westerlies are winds that blow from the west toward the east. These winds bring us most of our weather.
- Polar easterlies are winds that blow from the east to the west. These winds originate from the poles
- High speed winds called jet streams blow from west to east and also influence our weather.



## AIR MASSES:

- Scientists classify air masses based on:

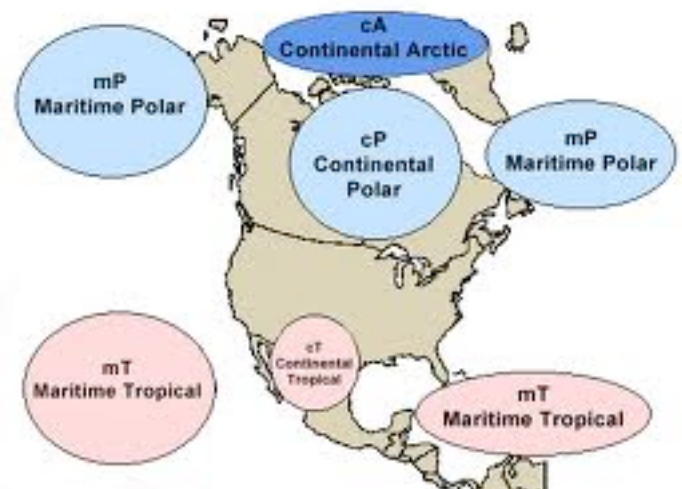
**TEMPERATURE**

and

**HUMIDITY**

**WARM COLD WET DRY**

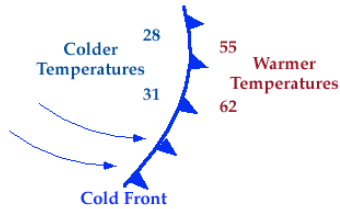
- An air mass is a large body of air. This body of air has the same temperature and humidity all throughout it.
- There are four types of air masses that form in certain areas and have a certain humidity.
- Continental tropical (cT) – forms over land and is warm
- Continental polar (cP) – forms over land and is cold
- Maritime tropical (mT) – forms over water and is warm
- Maritime polar (mP) – forms over water and is cold



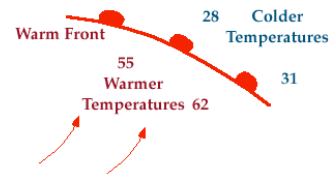
## AIR MASSES:

- A front is a boundary or the place where two air masses meet. Storms, clouds and other types of weather are associated with fronts.

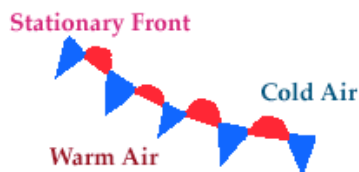
Types of fronts:



A cold front happens when a cold air mass slides under a warm air mass. Thunderstorms and clouds can occur at a cold front.



A warm front forms when a warm air mass moves over a cold air mass. Light rain, clouds or snow may fall.



A stationary front happens when cold and warm air meet, but neither air mass moves over or under the other. The air masses face each other in a "stand off". The weather may bring fog, clouds or rain.



An occluded front happens when a warm air mass is caught between two cooler air masses. The weather may turn cloudy and rain or snow may fall.

- The front symbols on a weather map indicate that the air masses are moving in the direction the symbols point in...Therefore, the picture of the warm front above would mean the front is moving up (north) and tilted toward the east (to the right).
- As the front moves, the locations under the air masses experience the weather from the front and the temperatures of each air mass as they pass over the specific locations. For example, using the cold front above...if the front is moving from Tennessee (TN) it would go eastward. North Carolina (NC) would experience warm temperatures then thunderstorms followed by cold temperatures.



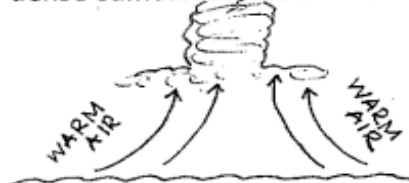


## SEVERE WEATHER

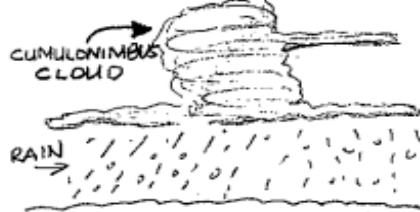
### Thunderstorms (heavy rain and frequent thunder and lightning)

- Thunderstorms form in large cumulonimbus clouds. Most cumulonimbus clouds form on a hot, humid afternoon. They also form when warm air is forced upward along a cold front.

**Step 1:** Warm humid air rises rapidly. This air cools forming dense cumulonimbus clouds.



**Step 2:** Heavy rain falls sometimes along with hail.



**Step 3:** In the cumulonimbus cloud there are strong upward and downward and upward wind (density).



- During the storm, areas of positive and negative electric charges build up in the cumulonimbus clouds. Lightning is the sudden spark, or electric discharge, as these positive and negative charges jump between nearby clouds and the ground.
- Thunder is caused when lightning bolts heat the air. The rapid heating expands the air explosively. Thunder is the sound of that explosion.

### Tornadoes

(a rapidly whirling, funnel-shaped cloud that reaches down from a storm cloud that reaches down to touch Earth's surface)

- Tornadoes form in large cumulonimbus clouds (the same clouds that bring thunderstorms).

**Step 1:** Warm, moist air flows in at the bottom of a cumulonimbus cloud and moves upward. A low pressure area forms inside the cloud.



**Step 2:** The warm air begins to rotate as it meets winds blowing in different directions at different altitudes.



**Step 3:** A tornado forms as a part of the cloud reaches down to earth in a funnel shape.

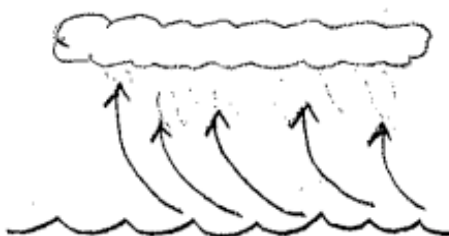


- Tornadoes can form anywhere in the U.S., but are very common to the middle of the U.S. We call that area "tornado alley", since it makes a column across those states.

### Hurricanes (a tropical cyclone that has winds of 119km/hr or higher)

- Tornadoes form in large cumulonimbus clouds (the same clouds that bring thunderstorms).

**Step 1:** Warm, moist air rises over water and forms clouds.



**Step 2:** As the warm air rises more air is drawn into the forming hurricane of heavy rain and wind. Wind spirals inward toward the low center.



**Step 3:** Air flows outward near the top of the hurricane. Cool, dry air sinks in the eye, the center of the hurricane.



- Hurricanes often bring water from the ocean as they come ashore. We call this flooding a storm surge.

# GLOBAL WARMING

## Greenhouse Effect

- Our atmosphere temperature is increasing because of human activities like deforestation (cutting down of trees, burning of fossil fuels (gas and coal)).
- These human activities add gases like water vapor, CO<sub>2</sub>, methane and nitrous oxide. These gases are called greenhouse gases because like a greenhouse, they trap heat.
- If there were no greenhouse gases, the heat would escape into space and Earth would be colder.

## Global Warming

- Global warming is the gradual increase in the temperature of Earth's atmosphere.
- Global warming will cause a change in global weather patterns, global sea levels, and life on Earth because of these increased temperatures.

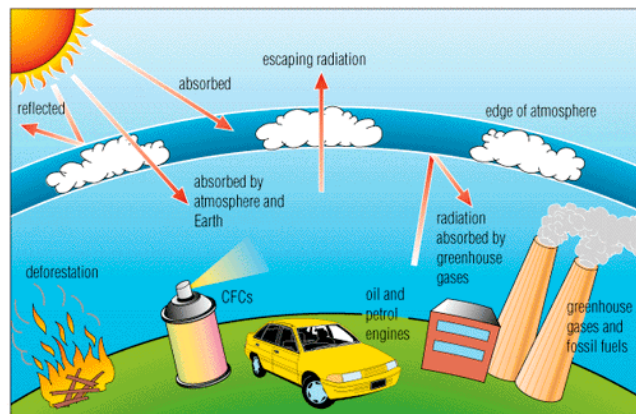


## Think Clean and Green: Reducing the Impact of Global Warming

- Plant trees (to offset deforestation)
- Reduce the use of fossil fuels
  - Drive less, carpool or ride a bike,
  - recycle (reusing reducing energy use)
  - switch to nonpolluting energy sources
- Increasing energy efficiency (energy efficient means energy saving or energy conservation)
  - Turning off lights
  - replacing light bulbs with energy efficient light bulbs



Energy efficient light bulbs

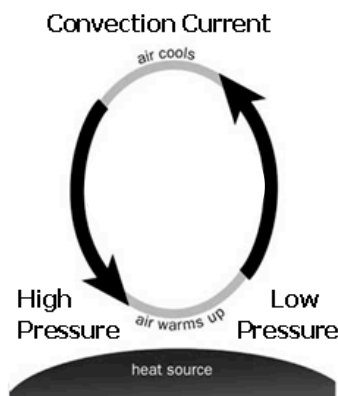


A big picture of the activities that impact global warming



recycling allows us reuse resources instead of making them over from scratch

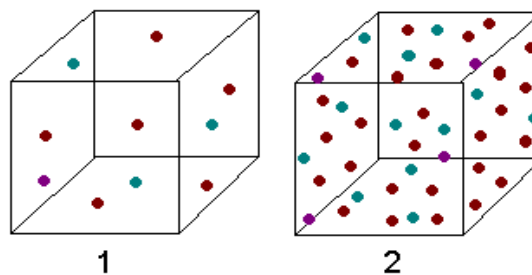
1. What is the best definition for Earth's atmosphere?
  - a. The layer of water covering most of Earth's surface.
  - b. The layer of mixed gases that surround the earth.
  - c. The layer of gases in which weather occurs.
  - d. The layer of gases in which the ozone layer can be found.
  
2. In which layer of the atmosphere would a thunderstorm develop?
  - a. troposphere
  - b. stratosphere
  - c. mesosphere
  - d. thermosphere
  
3. What two gases together make up about 99% of Earth's atmosphere?
  - a. Carbon dioxide and nitrogen
  - b. Carbon dioxide and oxygen
  - c. Nitrogen and oxygen
  - d. Nitrogen and helium



4. Why do convection currents form?
  - a. Cold air is less dense than warm air.
  - b. Cold air is more dense than warm air.
  - c. Warm air is more dense than humid air.
  - d. Warm and cold air have the same density.

5. Mrs. Jones teaches in room 121. There are 20 students in her first period science class, and 30 students in her second period science class. When is the density of people in the room highest?
  - a. During first period, because there are fewer people in the room.
  - b. During first period, because there are more empty desks in the room.
  - c. During second period, because there are more people in the room.
  - d. During second period, because it is later in the day.

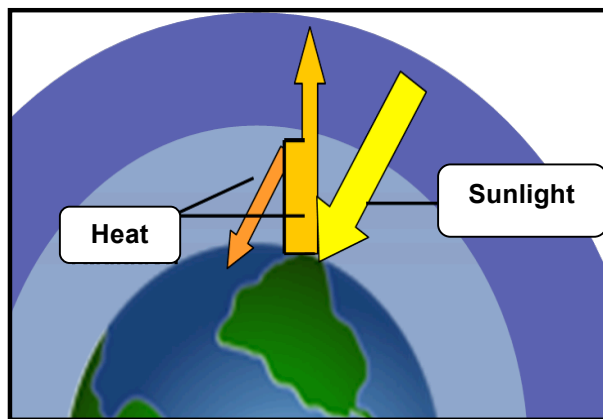
The diagram below shows two cubes of equal volume filled with different amounts of air. Think about the density and pressure in each box. Use the diagram to answer question 6.



6. What is the relationship between air pressure and the density of air?
  - a. Air pressure and density are always equal to each other.
  - b. As air pressure increases, density decreases.
  - c. As air pressure decreases, density increases.
  - d. As air pressure increases, density also increases.
  
7. How do the particles in a hot cup of coffee compare to the particles in a glass of iced water?
  - a. The particles in the coffee move slower than the particles in the water.
  - b. The particles in the coffee move faster than the particles in the water.
  - c. The particles in the coffee have less energy than the particles in the water.
  - d. The particles in the coffee are smaller than the particles in the water.

8. How do radiation and conduction compare to each other?
- Radiation happens only in fluids, while conduction happens in solids.
  - Conduction happens only in fluids, while radiation happens in solids.
  - Radiation does not need a material to travel through, while conduction requires two materials to be touching.
  - Conduction does not need a material to travel through, while radiation requires two materials to be touching.

The diagram below shows how sunlight is radiated back into the Earth's atmosphere as heat (infrared radiation). Use the diagram to help you answer question 9.



9. The diagram shows how Earth's atmosphere traps heat from the sun. What is the process called?
- Conduction
  - Greenhouse Effect
  - Precipitation
  - Scattering

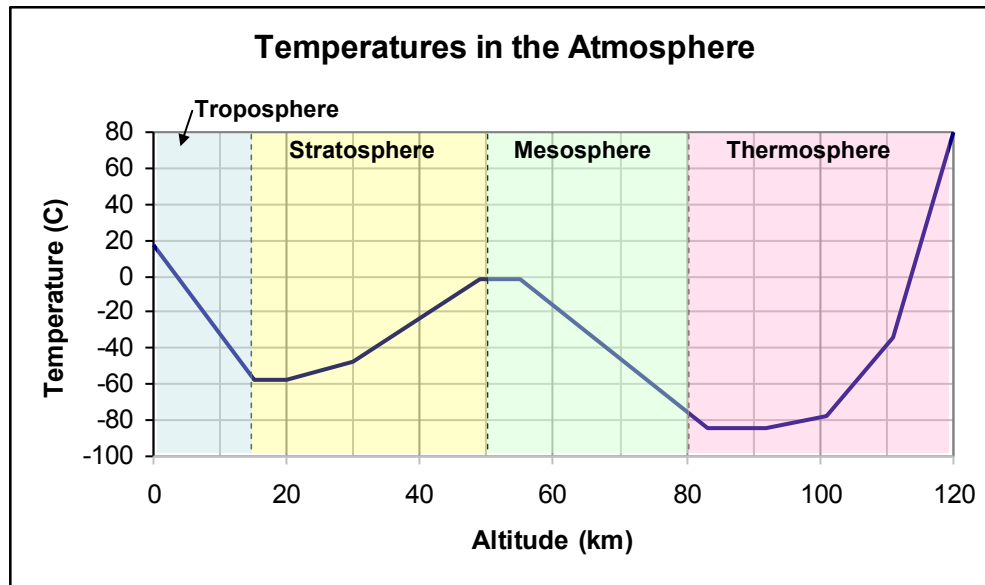
The table below shows air pressure measurements taken at set altitudes above sea level. Use this table to answer questions 10 – 11.

Altitude Above Sea Level (Feet)	Atmospheric Pressure (hPa)
0	1013.3
10,000	696.4
20,000	466.1
30,000	301.3
40,000	188.2
50,000	116.5
100,000	11.2

10. What fact about Earth's atmosphere best explains this data?
- As altitude increases in the atmosphere, temperature changes from layer to layer.
  - At higher altitudes, there is less air pushing down from above, which decreases the pressure.
  - As altitude increases, the composition of the atmosphere changes so that lighter-weight gases make up the majority of the air.
  - At higher altitudes, there is less water vapor in the air which changes the air pressure.
11. Which weather tool was used to take these air pressure measurements?
- Anemometer
  - Barometer
  - Hygrometer
  - Thermometer
12. Why does it tend to be more humid in the summer than in the winter?
- Hot air can hold more water vapor than cold air.
  - You sweat more in the summer, so the air around you is more moist.
  - Cool air can hold more water vapor than hot air.
  - You wear jackets in winter, which prevent moisture from leaving your body.
13. A student used a psychrometer and found that the relative humidity outside was 60%. What does this measurement mean?
- The atmosphere was made up of 60% water when the measurement was taken.
  - The air was holding 60% of the water vapor that it could possibly hold.
  - Clouds covered approximately 60% of the sky when the measurement was taken.
  - The temperature was 60% of the normal value for that day and time.



The graph below shows how temperatures in the atmosphere change with altitude. Use the graph to answer questions 14 and 15.







14. Why does the air temperature rise in the stratosphere?

- a. The stratosphere is the layer at the highest altitude, so it gets hit with more sunlight than the other layers.
- b. The stratosphere is the most dense layer of the atmosphere, so it is able to hold more heat than the other layers.
- c. The stratosphere contains the ozone layer, which absorbs energy from the sun and converts it to heat.
- d. The stratosphere is where airplanes fly, and the fuel they release increases the temperature of this layer.

15. What causes the rapid rise in temperatures within the thermosphere?

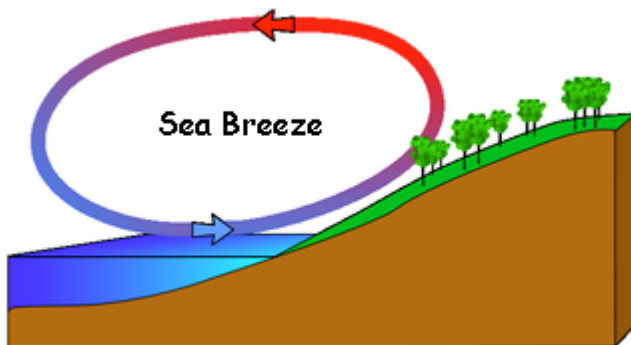
- a. The thermosphere is at ground level, so cars and people heat this layer.
- b. The thermosphere is the outermost layer of our atmosphere, so it gets hit by direct sunlight.
- c. The thermosphere contains 100% carbon dioxide, which holds heat because it is a greenhouse gas.
- d. The thermosphere contains satellites which release fuel into this layer, increasing its temperature.

The diagram below shows a cloud and weather journal that a student kept for four days. Use the diagram to answer questions 16–18.

MONDAY	TUESDAY	WEDNESDAY	THURSDAY
 High, feathery clouds	 Tall, dark clouds	 Layered, gray clouds	 FOG
WEATHER: mostly sunny, cool	WEATHER:	WEATHER: Rainy all day.	WEATHER: Foggy in the morning; clear afternoon.

16. What type of clouds did the student observe on Monday?
  - a. Cirrus
  - b. Cumulus
  - c. Cumulonimbus
  - d. Stratus
17. The student saw fog on Thursday morning. What can we infer about the air temperature during the night before?
  - a. The air temperature must have been exactly 0°C.
  - b. The air temperature must have been exactly 25°C.
  - c. The air temperature must have stayed above the dew point.
  - d. The air temperature must have fallen below the dew point.
18. The student forgot to write down the weather for Tuesday. Based on her drawing and description of the clouds that day, what type of weather did she most likely see?
  - a. Partly cloudy and dry.
  - b. Drizzly rain that lasted all day.
  - c. Thunderstorms.
  - d. Snow and ice.
19. What two conditions are required for clouds to form?
  - a. Cooling of the air and the presence of wind.
  - b. Cooling of the air and the presence of particles in the air.
  - c. The presence of wind and the presence of particles in the air.
  - d. The presence of particles in the air and a temperature above 0°C.

The diagram below shows a sea breeze. Use the diagram to answer questions 20–21.



20. What does the circular air path shown in the diagram above represent?
  - a. A convection current
  - b. A global wind belt
  - c. The prevailing westerlies
  - d. The jet stream
21. Sea breezes usually happen during the day. What statement *best* explains this fact?
  - a. Land heats up faster than water.
  - b. Land heats up slower than water.
  - c. Land cools off faster than water.
  - d. Land cools off slower than water.

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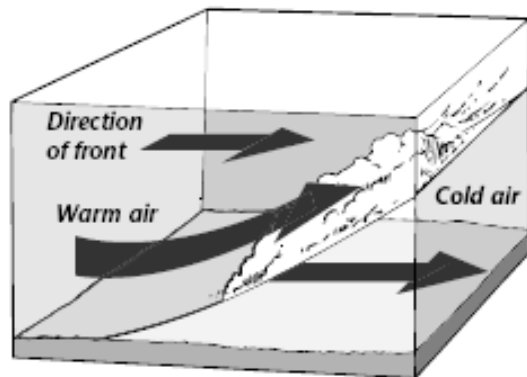
24. As D moves east, what will happen to the temperature over the Great Lakes?
  - e. Temperature will fall.
  - f. Temperature will rise.
  - g. Temperature will stay the same.
  - h. Temperature will be about 50°F.
25. Which weather conditions are typically found along a weather front?
  - a. Clear, cool weather
  - b. Clouds and precipitation
  - c. Violent storms
  - d. Sunny, warm weather
26. A rapidly moving cold air mass meets a slowly moving warm air mass and forms a front. What will most likely occur at this front?
  - a. The two air masses will mix together and become the same temperature.
  - b. Warm air will slide under the cold air. The cold air will rise and get warmer.
  - c. The less dense warm air will sink and cool. Clouds will form.
  - d. Cold air will slide under the warm air. Warm air will rise and cool. Clouds will form.

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A map of North America showing several weather fronts labeled A through F. Front A is a cold front (indicated by triangles pointing south) located in the northern United States and southern Canada. Front B is a warm front (indicated by semicircles pointing north) extending from the southwest towards the Great Lakes. Front C is a cold front (triangles pointing south) on the west coast of North America. Front D is a cold front (triangles pointing south) near the Great Lakes. Front E is a cold front (triangles pointing south) in the southern United States. Front F is a warm front (semicircles pointing north) in the Gulf of Mexico. A line labeled '1016 millibars' is shown in the Gulf of Mexico, and a line labeled '50°F' is shown in the eastern United States. The Great Lakes are labeled.

27. The prevailing westerlies and the jet stream are major wind belts over the continental U.S. Which direction do they generally move air masses?
- a. East to West
  - b. North to South
  - c. South to North
  - d. West to East

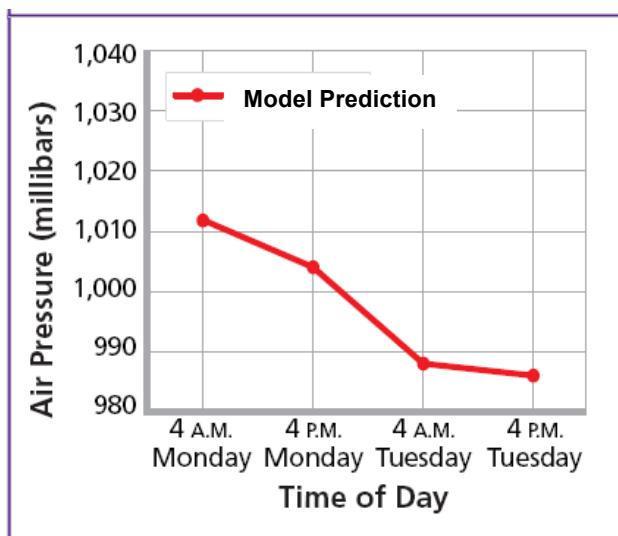
The diagram below shows two colliding air masses. Use the diagram to answer question 28 & 29.



28. What type of weather front is shown in the diagram above?
- Cold Front
  - Stationary Front
  - warm front
  - occluded front

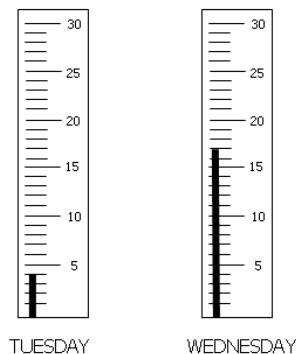
29. Why do clouds form along this front?
- There are particles along the front, around which water can condense.
  - Warm air cools as it rises, causing water vapor in the air to condense.
  - The cold air rises causing water vapor in the air to condense.
  - The warm air mass pushes the water vapor out of the cold air mass.

Meteorologists use computer models to forecast weather. The graph below shows the predicted air pressure from a computer model. Use the graph to answer questions 31 and 32.



31. What weather would you forecast for Monday and Tuesday based on this computer model?
- An approaching low-pressure area could bring precipitation.
  - An approaching high-pressure area could bring clear skies.
  - The temperature will probably drop and bring snow.
  - The temperature will probably rise and bring hot, sunny weather.

32. A student used a Celsius thermometer to measure the air temperature for two days.



What most likely happened with the weather to produce these results?

- A cold front moved through the area.
  - A warm front moved through the area.
  - The humidity of the air decreased.
  - The air pressure rose gradually.
33. A drop of food coloring spreads out slowly in cold water, and quickly in hot water. What best explains this fact?
- The cold water freezes the food coloring.
  - Hot water molecules move faster than cold water molecules.
  - Hot water molecules move slower than cold water molecules.
  - Air pressure pushes on the hot water more than the cold water.