**Lesson Two**

**Answer the following questions orally:**

1. What are the common factors to be considered in meteorology?

2. Can you enumerate any extreme weather conditions that have bad impact on flight safety and aircraft performance?

4. What is the composition of atmosphere?

5. What are the names and features of the atmospheric layers?

6. What causes convection currents and how do they affect global circulation?

7. What is Coriolis force? How does it affect wind direction?

**Pitot-Static System**

The pitot-static system supplies power to three [basic aircraft instruments](http://aviation.about.com/od/Pilot-Training/a/Basic-Flight-Instruments.htm): The [airspeed indicator](http://aviation.about.com/od/Aircraft/a/Basic-Flight-Instruments-The-Airspeed-Indicator.htm), [altimeter](http://aviation.about.com/od/Aircraft/a/Basic-Flight-Instruments-The-Altimeter.htm) and [vertical speed indicator](http://aviation.about.com/od/Aircraft/a/Basic-Flight-Instruments-The-Vertical-Speed-Indicator-vsi.htm).

**Components**

**Pitot Tube and Line:** The pitot tube is an L-shaped device located on the exterior of the aircraft that is used to measure airspeed. It has a small opening in the front of the tube where ram air pressure (dynamic pressure) enters the tube and a drain hole on the back of the tube. Some types or pitot tubes have an electronic heating element inside of the tube that prevents ice from blocking the air inlet or drain hole

**Static Port(s) and Lines:** The static port is a small air inlet, usually located on the side of the aircraft, flush against the fuselage. The static port measures static (non-moving) air pressure, which is also known as ambient pressure or barometric pressure. Some aircraft have more than one static port and some aircraft have an alternate static port in case one or more of the ports becomes blocked.

**Instruments:** The pitot-static system involves three instruments: The airspeed indicator, altimeter and vertical speed indicator. Static lines connect to all three instruments and ram air pressure form the pitot tube connects to only the airspeed indicator.

**Alternate Static Port (if installed):** A lever in the cockpit of some aircraft operates alternate static port in the event that the main static port experiences a blockage. Using the alternate static system can cause slightly inaccurate readings on the instruments, since pressure in cabin can is usually higher than the main static ports measure at altitude.

**Normal Operation**

The pitot static system works by measuring and comparing static pressures and in the case of the airspeed indicator, dynamic pressure.

The airspeed indicator is a sealed case with an aneroid diaphragm inside of it. The case surrounding the diaphragm is fed static pressure and the diaphragm is supplied with both static and dynamic pressure to it. When airspeed increases, the dynamic pressure inside of the diaphragm increases as well, causing the diaphragm to expand.

Through mechanical linkage and gears, the airspeed is depicted by a needle pointer on the instrument face.

The altimeter acts as a barometer and also supplied with static pressure from the static ports. The altimer is a sealed instrument case with a stack of sealed aneroid wafers inside. The wafers are sealed with an internal pressure calibrated to 29.92" Hg, or standard atmospheric pressure. They expand and contract as the pressure rises and falls in the surrounding instrument case. A Kollsman window inside of the cockpit allows the pilot to calibrate the instrument to the local altimeter setting to account for nonstandard atmospheric pressure.

The vertical speed indicator has a thin sealed diaphragm connected to the static port. The surrounding instrument case is also sealed and supplied static air pressure with a metered leak at the back of the case. This metered leak measures pressure change more gradually, which means that if the airplane continues to climb, the pressure will never quite catch up to each other, allowing for rate information to be measured on the instrument face. Once the aircraft levels off, the pressures from both the metered leak and the static pressure from inside the diaphragm equalize, and the VSI dial returns to zero to show level flight.

**Errors and Abnormal Operation**

The most common problem with the pitot-static system is a blockage of the pitot tube, static ports, or both.

If the pitot tube becomes blocked, and its drain hole remains clear, the airspeed will read zero.

If the pitot tube and its drain hole is blocked, the airspeed indicator will act like an altimeter, reading higher airspeeds with an increase in altitude. This situation [can be dangerous](http://www.scientificamerican.com/article.cfm?id=what-is-a-pitot-tube) if not recognized immediately.

If the static port(s) become blocked and the pitot tube remains operable, the airspeed indicator will barely work and indications will be inaccurate. The altimeter will freeze in place where the blockage occurred and the VSI will indicate zero.

**Wind and Pressure Gradient Force**

Wind is the movement of air across the Earth’s surface and is produced by differences in air pressure between one place to another. Wind strength can vary from a light breeze to hurricane force and is measured with the [Beaufort Wind Scale](http://weather.about.com/od/imagegallery/ig/Weather-Map-Symbols/Beaufort-Wind-Scale.htm).

Winds are named from the direction from which they originate. For example, a westerly is a wind coming from the west and blowing toward the east. [Wind speed](http://weather.about.com/od/lessonplanshighschool/a/landoceanwind.htm) is measured with an [anemometer](http://weather.about.com/od/a/g/anemometer.htm) and its direction is determined with a wind vane.

Since wind is produced by differences in air pressure, it is important to understand that concept when studying wind as well. Air pressure is created by the motion, size, and number of gas molecules present in the air. This varies based on the temperature and density of the air mass.

In 1643, Evangelista Torricelli, a student of Galileo developed the [mercury barometer](http://weather.about.com/od/b/g/Barometers.htm) to measure [air pressure](http://weather.about.com/od/weatherinstruments/a/barometers.htm) after studying water and pumps in mining operations. Using similar instruments today, scientists are able to measure normal sea level pressure at about 1013.2 millibars (force per square meter of surface area).

**The Pressure Gradient Force and Other Effects on Wind**

Within the atmosphere, there are several forces that impact the speed and direction of winds. The most important though is the Earth’s gravitational force. As gravity compresses the Earth’s atmosphere, it creates air pressure- the driving force of wind. Without gravity, there would be no atmosphere or air pressure and thus, no wind.

The force actually responsible for causing the movement of air though is the pressure gradient force. Differences in air pressure and the pressure gradient force are caused by the unequal heating of the Earth’s surface when incoming [solar radiation](http://geography.about.com/od/physicalgeography/a/solarradiation.htm) concentrates at the equator.

Because of the energy surplus at low latitudes for example, the air there is warmer than that at the poles. Warm air is less dense and has a lower barometric pressure than the cold air at high latitudes. These differences in barometric pressure are what create the pressure gradient force and wind as air constantly moves between areas of high and [low pressure](http://weather.about.com/od/pressureandtemperature/a/What-Is-A-Low-Pressure-Area.htm).

To show wind speeds, the pressure gradient is plotted onto weather maps using [isobars mapped](http://weather.about.com/od/i/g/isobars.htm) between areas of high and low pressure. Bars spaced far apart represent a gradual pressure gradient and light winds. Those closer together show a steep pressure gradient and strong winds.

Finally, the [Coriolis force](http://geography.about.com/od/physicalgeography/a/coriolis.htm) and friction both significantly affect wind across the globe. The [Coriolis force](http://weather.about.com/od/wind/a/coriolislesson.htm) makes wind deflect from its straight path between high and low pressure areas and the friction force slows wind down as it travels over the Earth’s surface.

**Upper Level Winds**

Within the atmosphere, there are different levels of air circulation. However those in the middle and upper [troposphere](http://geography.about.com/od/physicalgeography/p/layeratmosphere.htm) are an important part of the entire atmosphere's air circulation. To map these circulation patterns upper air pressure maps use 500 millibars (mb) as a reference point. This means that the height above sea level is only plotted in areas with an air pressure level of 500 mb. For example, over an ocean 500 mb could be 18,000 feet into the atmosphere but over land it could be 19,000 feet. By contrast, surface weather maps plot pressure differences based at a fixed elevation, usually [sea level](http://geology.about.com/od/oceanandmarinegeology/fl/whatis-sealevel.htm).

The 500 mb level is important for winds because by analyzing upper level winds, meteorologists can learn more about weather conditions at the Earth’s surface. Frequently, these upper level winds generate the weather and wind patterns at the surface.

Two upper level wind patterns that are important to meteorologists are Rossby waves and the [jet stream](http://geography.about.com/od/climate/a/jetstream.htm). Rossby waves are significant because they bring cold air south and warm air north, creating a difference in air pressure and wind. These waves develop [along the jet stream](http://weather.about.com/od/j/g/jetstream.htm).

**Local and Regional Winds**

In addition to low and upper level global wind patterns, there are various types of local winds around the world. Land-sea breezes that occur on most coastlines are one example. These winds are caused by the temperature and density differences of air over land versus water but are confined to coastal locations.

Mountain-valley breezes are another localized wind pattern. These winds are caused when mountain air cools quickly at night and flows down into valleys. In addition, valley air gains heat quickly during the day and it rises upslope creating afternoon breezes.

Some other examples of local winds include Southern California’s warm and [dry Santa Ana Winds](http://geography.about.com/od/hazardsanddisasters/a/Santa-Ana-Winds.htm), the cold and dry mistral wind of France’s Rhône Valley, the very cold, usually dry bora wind on the eastern coast of the Adriatic Sea, and the Chinook winds in North America.

Winds can also occur on a large regional scale. One example of this type of wind would be katabatic winds. These are winds caused by gravity and are sometimes called drainage winds because they drain down a valley or slope when dense, cold air at high elevations flows downhill by gravity. These winds are usually stronger than mountain-valley breezes and occur over larger areas such as a plateau or highland. Examples of katabatic winds are those that blow off of Antarctica and Greenland’s vast ice sheets.

The seasonally shifting [monsoonal winds](http://geography.about.com/od/geographyglossarym/g/ggmonsoon.htm) found over [Southeast Asia](http://goasia.about.com/od/weather/a/Southeast-Asia-Weather.htm), Indonesia, India, northern Australia, and equatorial Africa are another example of regional winds because they are confined to the larger region of the tropics as opposed to just India for example.

Whether winds are local, regional, or global however, they are an important component to atmospheric circulation and play an important role in human life on Earth as their flow across vast areas is capable of moving weather, pollutants, and other airborne items worldwide.