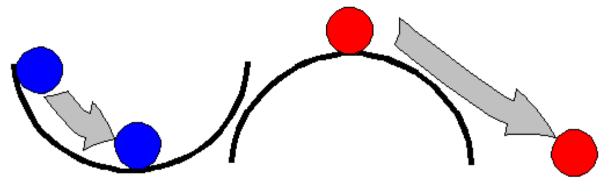
135 Bell-Irving Squadron

Level Three Handbook

PO 331 – Principles of Flight

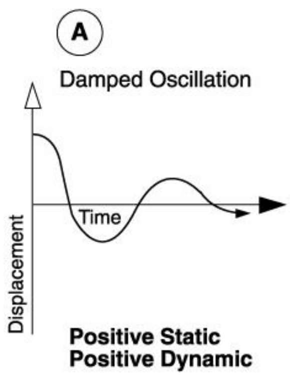
Part 1 – Characteristics of Stability

Stability: The tendency of an aircraft in flight to remain in straight, level, upright flight and to return to this attitude, if displaced, without corrective action by the pilot.



Static Stability: The initial tendency of an aircraft to return to its original attitude, if displaced.

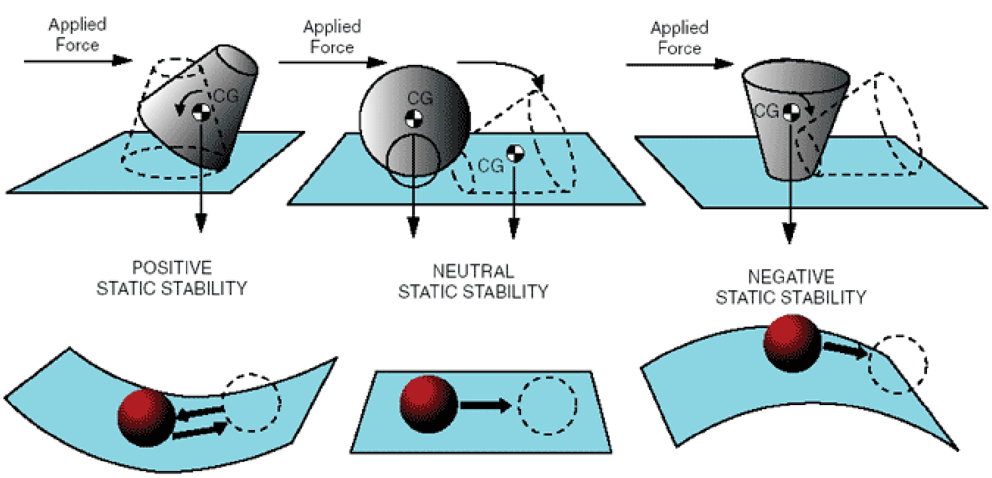
Dynamic Stability: The overall tendency of an aircraft to return to its original attitude.



Positive Stability: The aircraft is able to return to its original attitude without any corrective measure.

Neutral Stability: The aircraft will remain in the new attitude of flight after being displaced, neither returning to its original attitude, nor continuing to move away.

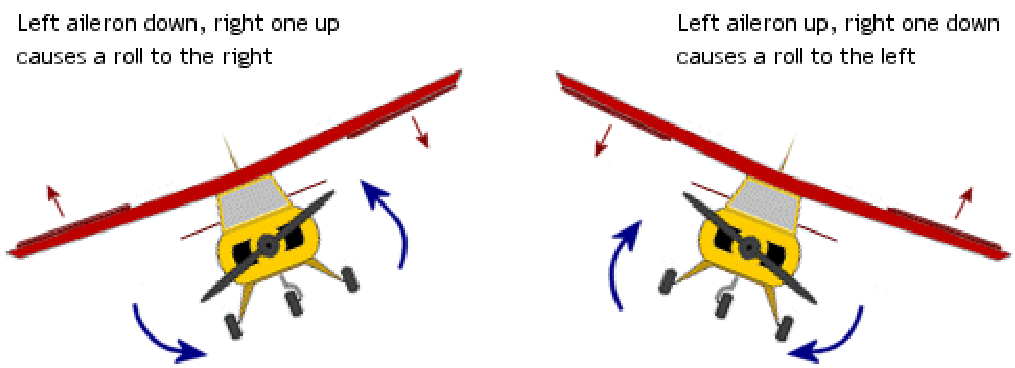
Negative Stability: The aircraft will continue moving away from its original attitude after being displaced.



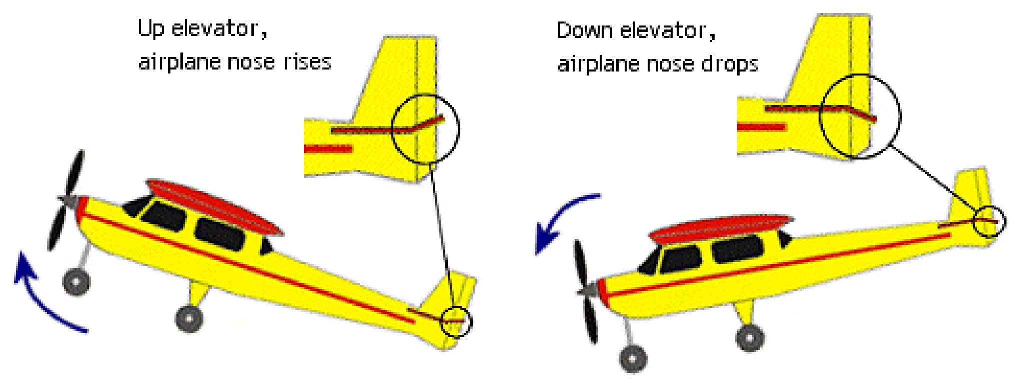
Part 2 – Axes of the Aircraft

Each axis is an imaginary straight line which runs through the aircraft in a particular direction. All three axes intersect at the centre of gravity.

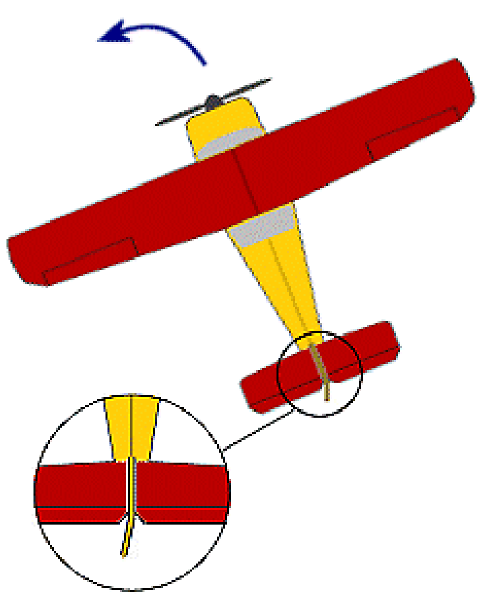
Longitudinal Axis: This axis runs the length of the aircraft from the tip of the nose to the end of the empennage. Movement around this axis is roll. Roll is controlled by the ailerons.



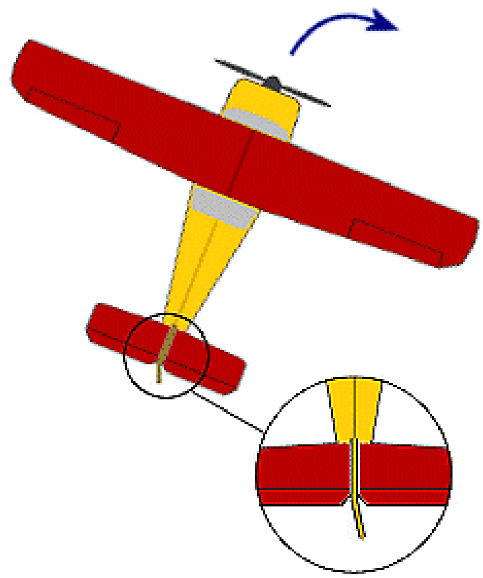
Lateral Axis: This axis runs through the aircrafts' wings, from wing tip to wing tip. Movement around this axis is pitch. Pitch is controlled by the elevator.



Normal (Vertical) Axis: This axis runs through the aircraft vertically top to bottom. Movement about this axis is yaw. Yaw is controlled by the rudder.

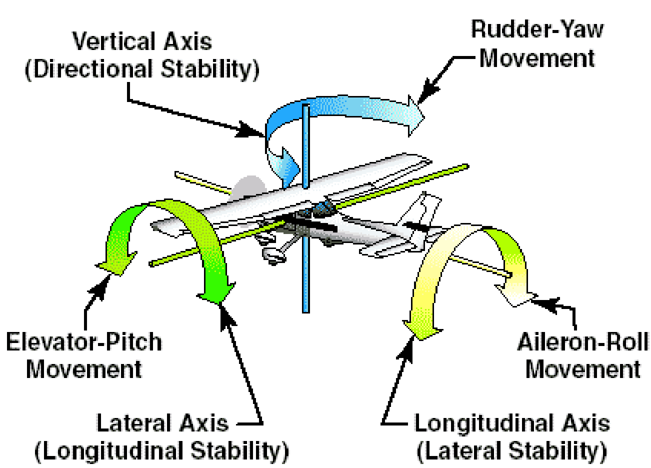


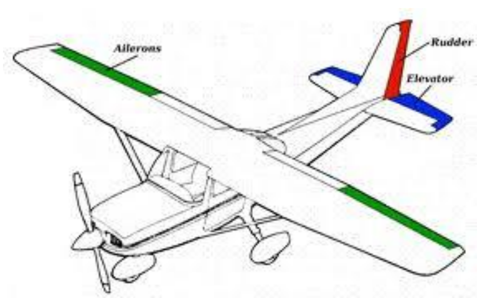
Left rudder cause left yaw

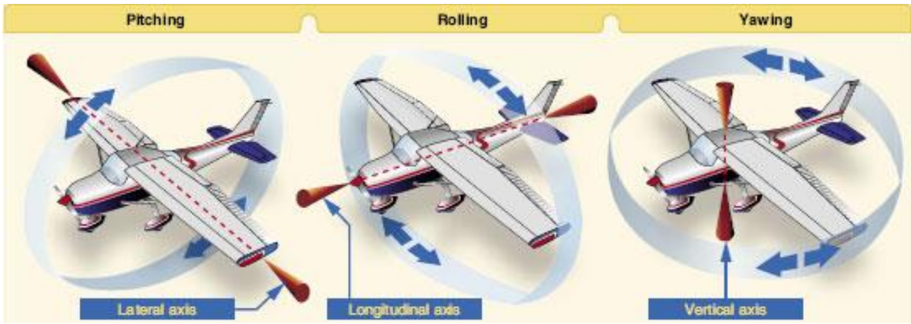


Right rudder cause right yaw

PRIMARY CONTROL SURFACE	AIRPLANE MOVEMENT	AXES OF ROTATION	TYPE OF STABILITY
Aileron	Roll	Longitudinal	Lateral
Elevator/ Stabilator	Pitch	Lateral	Longitudinal
Rudder	Yaw	Vertical	Directional



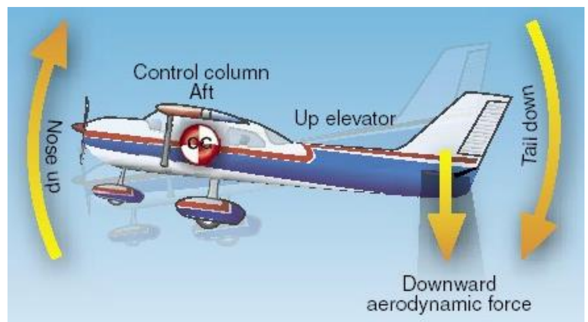




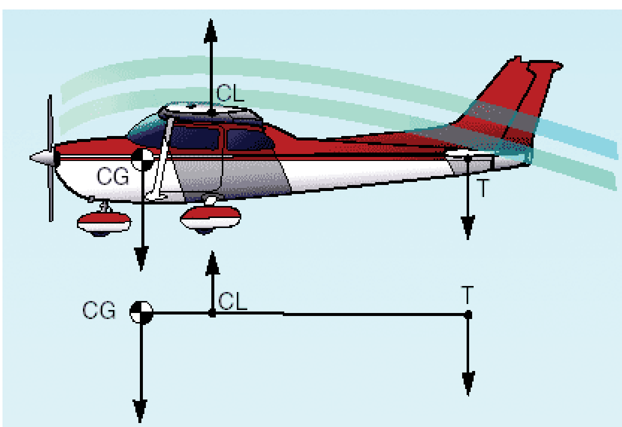
Part 3 – Longitudinal Stability

Longitudinal stability is stability around the lateral axis and is known as pitch stability. To achieve longitudinal stability, aircraft are designed to be nose heavy if loaded correctly.

Two principle factors influence longitudinal stability:



The Horizontal Stabilizer
The horizontal stabilizer is located at the tail end of the aircraft. Its function is similar to a counterweight at the end of a lever. When the nose of the aircraft is pushed up, this will force the tail down. Since the stabilizer now meets the airflow at a higher angle of attack, it will now produce more lift. This extra lift will counter the initial disturbance.



The Effects of the Centre of Gravity
The centre of gravity is an important factor in aircraft stability. Every aircraft has a naturally occurring centre of gravity which is inherent in its design. As the aircraft is loaded, the position of the centre of gravity can change. If this change is drastic, it can have an adverse affect on the stability of an aircraft.

If the centre of gravity is too far forward, it will produce a nose-down tendency. This will force the pilot to use excessive back pressure on the controls to maintain normal flight. If left uncorrected, the aircraft will speed up and lose altitude.

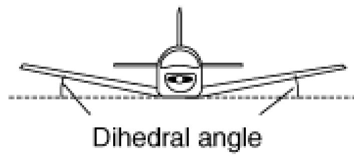
If the centre of gravity is too far aft, it will produce a nose-up tendency. This will force the pilot to use excessive forward pressure on the controls to maintain normal flight. Uncorrected, the aircraft will slow down and eventually stall.

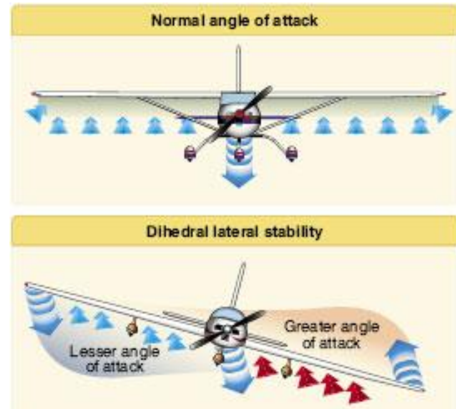
Part 4 – Lateral Stability

Lateral stability is stability around the longitudinal axis and is called roll stability. To achieve lateral stability certain design features are built into the aircraft. Three of these design features are:

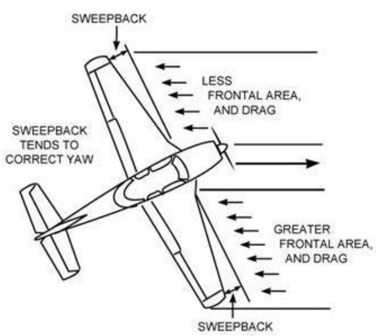
Dihedral and Anhedral

Dihedral is the angle that the wings make with the horizontal plane. As one looks at an aircraft from the front, the wings will slowly angle away from the ground so that the wing tip is higher than the wing root. This assists the aircraft in maintaining lateral stability by changing the angle that the leading edge makes with the airflow.





When an aircraft with dihedral wings is forced into a side-slipping motion, the down-going wing will meet the airflow at a right angle. This will increase the lift produced on that wing, forcing it back into place.



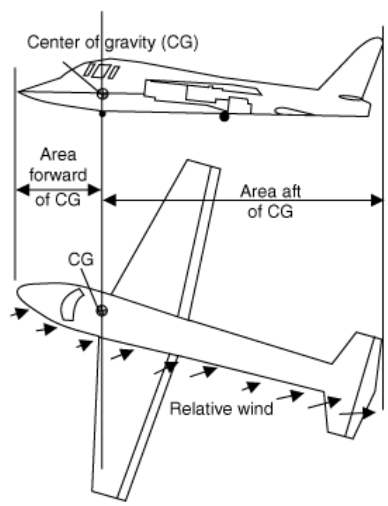
Sweepback

Similar to the dihedral, sweepback is a design feature where the wings sweep back instead of protruding straight out from the fuselage. This assists the aircraft in maintaining lateral stability by changing the angle that the leading edge makes with the airflow.

When an aircraft with sweepback is forced into a slipping motion, the down going wing will meet the airflow at a right angle. This will increase the lift produced by that wing forcing it back into place.

Keel Effect

While dihedral and sweepback are usually found on low-wing aircraft, high-wing aircraft have stability built-in. Since the bulk of the aircraft is below the plane of the wings, it acts as a keel. When a wing is forced up by a disturbance, the fuselage acts like a pendulum swinging the aircraft back into position.

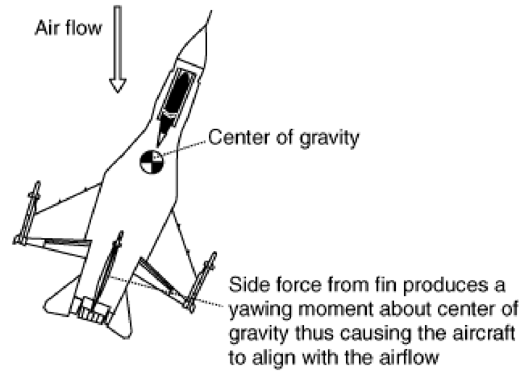


Part 5 – Directional Stability

Directional stability is stability around the vertical or normal axis. The principle factor influencing directional stability is:

The Fin

Aircraft, specifically airplanes, have a tendency of always flying head-on into the relative airflow. This tendency, called weather vaning, is a direct result of the vertical tail fin. If the aircraft yaws away from its course, the airflow strikes the fin from the side, forcing it back into position. This will only work if the side area of the aircraft is greater aft of the centre of gravity than the area forward of the centre of gravity.



Practice Questions

1. What is longitudinal stability?
2. What does the horizontal stabilizer act like?
3. What is the danger of an aft centre of gravity?
4. What is lateral stability?
5. What are three design features which provide lateral stability?
6. How does keel effect work?
7. What is directional stability?
8. What is the principle factor influencing directional stability?
9. What is the effect of the fin?

PO 336 – Meteorology

Part 1 – Composition of the Atmosphere

The atmosphere is composed of a mixture of invisible gases. These gases make up the majority of the atmosphere. There are also small particles of dust and debris in the lower levels of the atmosphere.

The Breakdown of the Major Gases
At altitudes of up to 250 000 feet above sea level (ASL), the atmosphere is composed primarily of nitrogen, oxygen, argon, carbon dioxide, hydrogen, water vapour, and several other gases. Each of these gases comprises a certain percentage of the atmosphere.

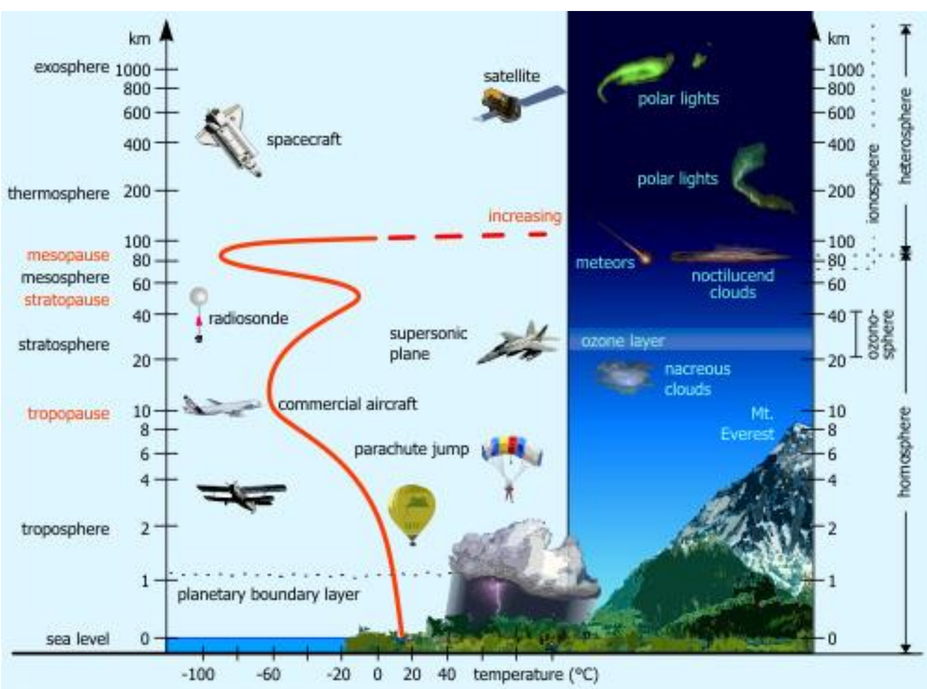
- **Nitrogen.** Nitrogen is the most abundant gas by percentage of the atmosphere at 78 percent.
- **Oxygen.** Oxygen is the second most abundant gas by percentage of the atmosphere at 21 percent.
- **Other.** The rest of the gases make up approximately 1 percent of the atmosphere.

The Importance of Water Vapour
Water vapour is found only in the lower layers of the atmosphere. The amount of water in the atmosphere is never constant, but it is the most important of the gases from the standpoint of weather. It can change from a gas into water droplets or ice crystals and is responsible for the formation of clouds.

Part 2 – Divisions of the Atmosphere

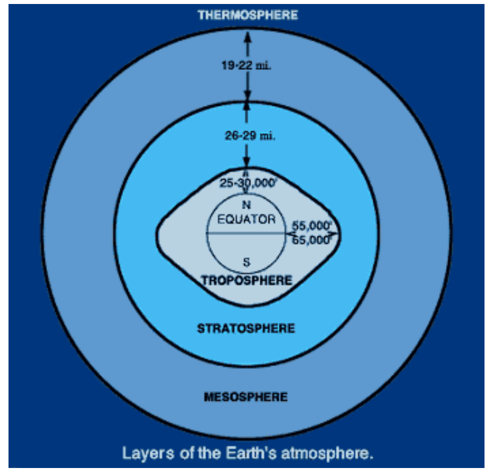
The atmosphere is divided into four distinct layers which surround the earth for many hundreds of miles. These layers are the:

- troposphere,
- stratosphere,
- mesospehere, and
- thermosphere.



The exosphere is not actually a layer of the atmosphere; it is actually the first vestiges of outer space.

The Troposphere



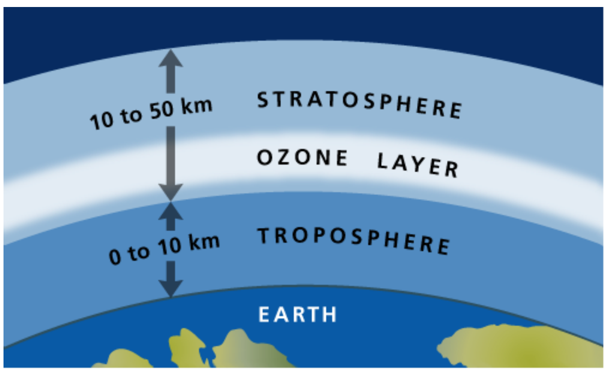
The troposphere is the lowest layer of the atmosphere. The troposphere starts at ground level and extends to varying heights ASL. Within the troposphere air pressure, density and temperature decrease with altitude.

Temperature will drop to a low of -56°C. Most weather occurs in this layer of the atmosphere due to the presence of water vapour as well as strong vertical currents caused by terrestrial radiation. Terrestrial radiation causes the troposphere to extend to varying altitudes. There is more radiation at the equator than at the poles.

The phenomenon known as the jet stream exists in the upper parts of the troposphere.

The top of the troposphere is known as the tropopause, which acts as a boundary between the troposphere and the stratosphere.

The Stratosphere



The stratosphere extends 50,000 feet upwards from the tropopause. The pressure continues to decrease in the stratosphere. The temperature will gradually rise to 0°C. It is in the stratosphere that the bulk of the ozone layer exists. This prevents the more harmful solar radiation from reaching the earth's surface, which explains the rise in temperature.

The top of the stratosphere is called the stratopause, which acts as a boundary between the stratosphere and the mesosphere.

The Mesosphere

The mesosphere is characterized by a decrease in temperature. The temperature will reach a low of -100°C at 275,000 feet ASL. It is in the mesosphere that meteorites will usually burn up.

The top of the mesosphere is known as the mesopause, which acts as a boundary between the mesosphere and the thermosphere.

The Thermosphere

The highest of the four layers, the thermosphere is so named due to its intense temperatures. This is the first layer to be affected by solar radiation and what few oxygen molecules there are in this layer will absorb a high amount of that radiation. The actual temperature will vary depending on solar activity, but it can exceed 15,000°C.

Part 3 – ICAO Standard Atmosphere

The decrease in temperature, pressure and density with altitude is not constant, but varies with local conditions. For the purposes of aviation, it is required that an international standard be set. Different regions have different standards.

The Basis of ICAO Standards in North America

The ICAO standard for North America is based on the summer and winter averages for 40 degrees north latitude. These averages include air pressure, air density and air temperature.

The Assumptions for Standard Atmosphere in North America

ICAO standards for North America assume the following conditions:

1. the air is a perfectly dry gas;
2. a mean sea level pressure of 29.92 inches of mercury;
3. a mean sea level temperature of 15°C; and
4. temperature decreases with altitude at a rate of 1.98°C per 1 000 feet.

Part 4 – Properties of the Atmosphere

The properties of the atmosphere allow for various weather conditions. There are three principle properties:

- **Mobility.** This property is the ability of the air to move from one place to another. This is especially important as it explains why an air mass that forms over the arctic may affect places in the south.
- **Capacity for Expansion.** The most important of the three properties. Air is forced to rise for various reasons. As the air pressure decreases, the air will expand and cool. This cooling may be enough for condensation to occur and clouds to form, creating precipitation.
- **Capacity for Compression.** The opposite of expansion, compression occurs when the air has cooled and becomes denser. The air will sink, decreasing in volume and increasing in temperature.

Factors Affecting the Properties of the Atmosphere

There are three factors which affect the properties of the atmosphere: temperature, density and pressure. Temperature changes air density which creates the vertical movement of the air, causing expansion and compression. The vertical movement creates pressure differences, which causes mobility across the surface as the air moves horizontally to fill gaps left by air that has moved vertically.

Part 5 – Cloud Classification

Clouds are classified based on type of formation and cloud height.

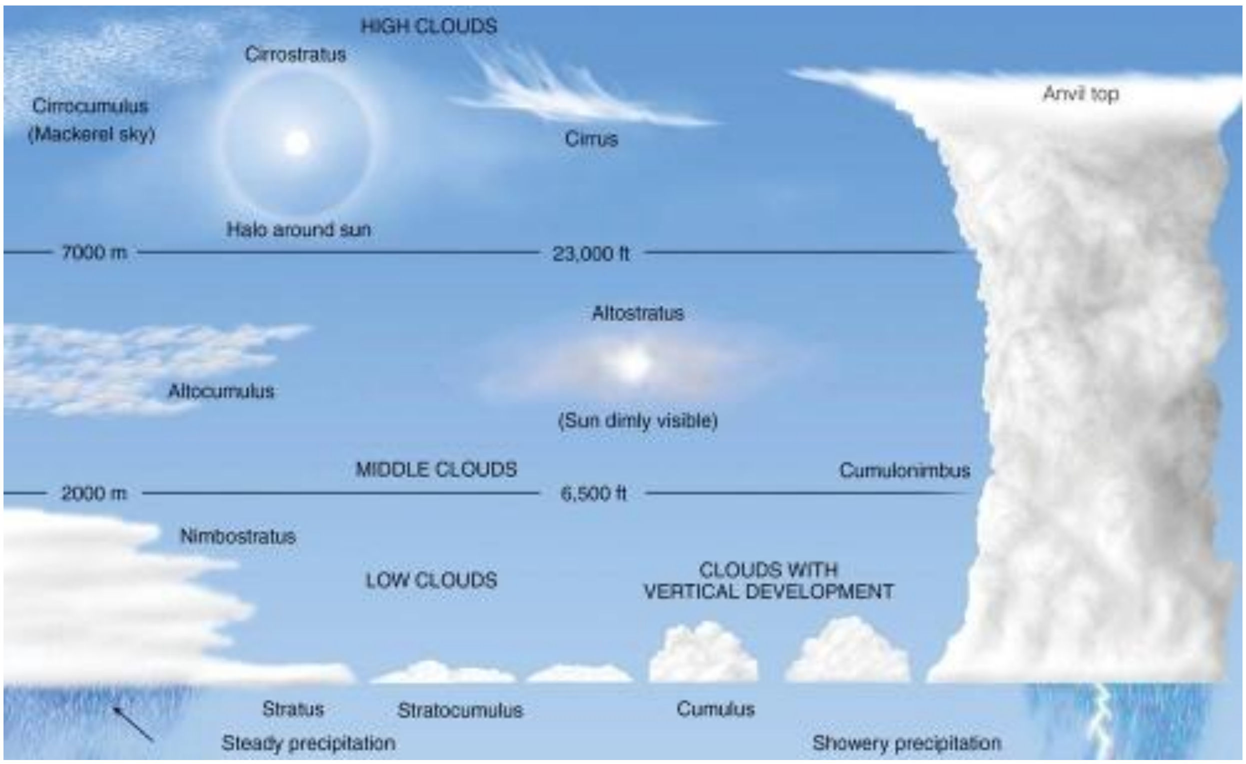
There are two main types of cloud formations:

- **Cumulus.** Cumulus clouds are formed by air that is unstable. They are cottony or puffy, and are seen mostly during warmer seasons. Cumulus clouds may develop into storm clouds.
- **Stratus.** Stratus clouds are formed in air that is stable. They are flat and can be seen year round, but are associated with colder temperatures.

Cloud Height

Clouds are also classified based on their height above ground level (AGL). There are four main categories:

- **Low Clouds.** The bases of low clouds range from the surface to a height of 6,500 feet AGL. Low clouds are composed of water droplets and sometimes ice crystals. Low clouds use the word stratus as either a prefix (eg, stratocumulus) or a suffix (eg, nimbostratus).
- **Middle Clouds.** The bases of middle clouds range from 6 500 to 23 000 feet AGL. They are composed of ice crystals or water droplets, which may be at temperatures above 0°C. Middle clouds use the prefix of “alto” (eg, altocumulus).
- **High Clouds.** The bases of high clouds range from 16 500 to 45 000 feet, with an average of 25 000 feet in the temperate regions of the earth. High clouds are composed of ice crystals. High clouds use the prefix of “cirrus” or “cirro” (eg, cirrocumulus).
- **Clouds of Vertical Development.** The base of these clouds may be as low as 1 500 feet AGL and may rise as high as the lower reaches of the stratosphere. They may appear as isolated clouds or may be seen embedded in layers of clouds. Clouds of vertical development are associated with thunderstorms and other phenomena which occur during the summer months.



The following chart includes a brief description of the more common cloud types.

Cloud Name	Cloud Family	Cloud Description
Cirrus	High	High, thin, wispy clouds blown by high winds into long streamers. Cirrus clouds usually move across the sky from west to east. They generally indicate pleasant weather.
Cirrocumulus	High	Appear as small, round white puffs. The small ripples in the cirrocumulus sometimes resemble the scales of a fish. A sky with cirrocumulus clouds is sometimes referred to as a “mackerel sky.”
Altocumulus	Middle	Appear as grey, puffy masses, sometimes in parallel waves or bands. The appearance of these clouds on a warm, humid summer morning often means thunderstorms will occur by late afternoon.

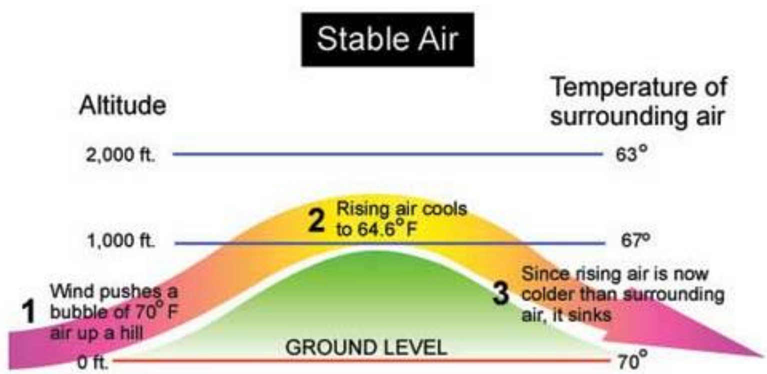
Altostratus	Middle	A grey or blue-grey layer cloud that typically covers the entire sky. In the thinner areas of the cloud, the sun may be dimly visible as a round disk. This cloud appears lighter than stratus clouds.
Stratus	Low	Uniform grey layer cloud that often covers the entire sky. They resemble fog that does not reach the ground. Usually no precipitation falls from stratus clouds, but sometimes they may drizzle.
Nimbostratus	Low	Dark grey layer clouds associated with continuously falling rain or snow. They often produce precipitation that is usually light to moderate.
Stratocumulus	Low	A series of rounded masses that form a layer cloud. This type of cloud is usually thin enough for the sky to be seen through breaks.
Cumulus	Vertical Development	Puffy clouds, which are thick, round, and lumpy. They sometimes look like pieces of floating cotton. They usually have flat bases and round tops.
Cumulonimbus	Vertical Development	Thunderstorm clouds that form if cumulus clouds continue to build. Violent vertical air currents, hail, lightning, and thunder are associated with the cumulonimbus clouds.

Part 6 – Air Stability

At the surface, the normal flow of air is horizontal. Disturbances may occur, which will cause vertical currents of air to develop. This is normally caused by a change in temperature. If the air that is displaced resists the change, then it is said to be stable. If it does not resist the change then it is unstable. When air rises, it expands and cools.

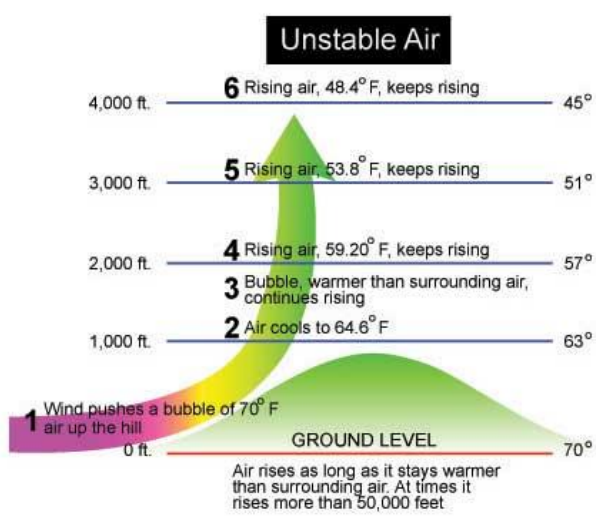
Stable Air. If a mass of rising air is cooler than the air that it comes in contact with, then it will sink back to its original position. Stable air may have the following affects on flight characteristics:

- poor low-level visibility (fog may occur),
- stratus type cloud,
- steady precipitation,
- steady winds, which can change greatly with height, and
- smooth flying conditions.



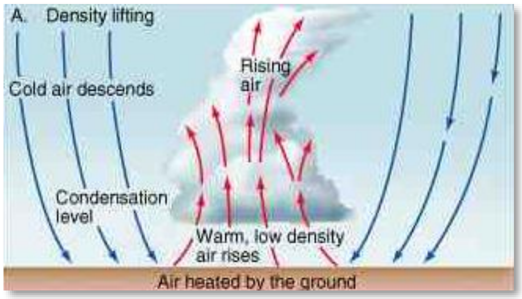
Unstable Air. If a mass of rising air is still warmer than the new air around it, then the air mass will continue to rise. Unstable air may have the following affects on flight characteristics:

- good visibility (except in precipitation),
- cumulus type cloud,
- showery precipitation,
- gusty winds, and
- moderate to severe turbulence.

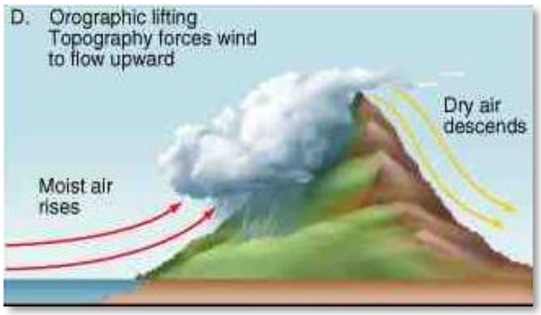


Part 7 – Lifting Agents

Rising currents of air affect many weather conditions. There are five conditions that provide the lift required to initiate rising currents of air.

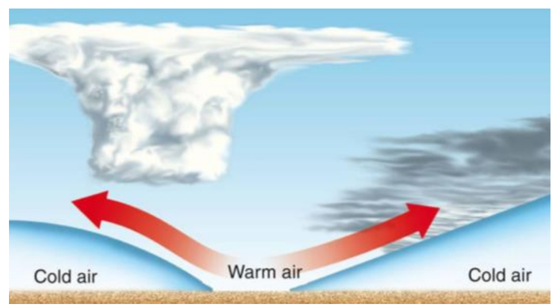


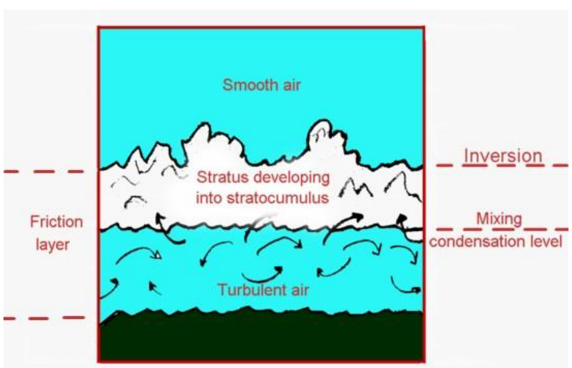
Convection. The air is heated through contact with the earth's surface. As the sun heats the surface of the earth, the air in contact with the surface warms up, rises, and expands. Convection may also occur when air moves over a warmer surface and is heated by advection.



Orographic Lift. Orographic lift occurs when the sloping terrain forces the air upward. This process can be exaggerated if the air mass is already.

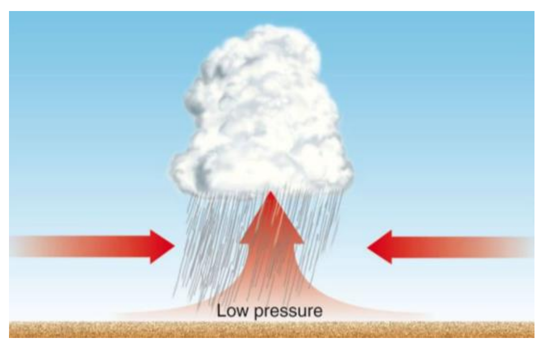
Frontal Lift. When different air masses meet, the warmer air is forced upwards by the denser cold air. This process may be exaggerated if the warm air mass becomes unstable.





Mechanical Turbulence. Air moving over the ground may be affected by terrain that is not as pronounced as mountains. Forests, buildings, large ditches and quarries also affect the air through friction. This friction causes eddies, which are usually confined to the first few thousand feet of the troposphere. This process may be exaggerated if the air mass becomes or is already unstable.

Convergence. In a low pressure system, the wind blows toward the centre of the system. The excess air that collects here is forced upward to higher altitudes.



Part 8 – Cloud Formation

Clouds are formed by the lifting agents and air stability.

Clouds are formed in two ways. Either the temperature drops to the saturation point of the air or the temperature is constant but the amount of water in the air increases.

Relating Lifting Agents to Air Stability

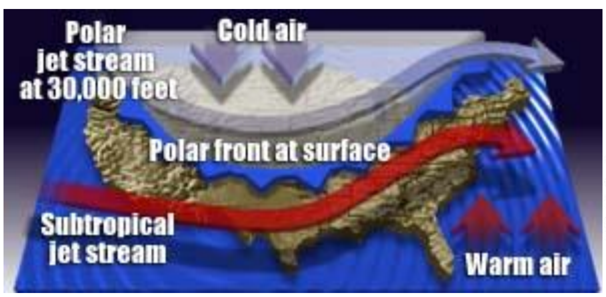
Each of the lifting agents described have an effect on, or is affected by, air stability. Convection, for example, is normally associated with unstable air since heat causes the convection, and is also a source of instability in the air.

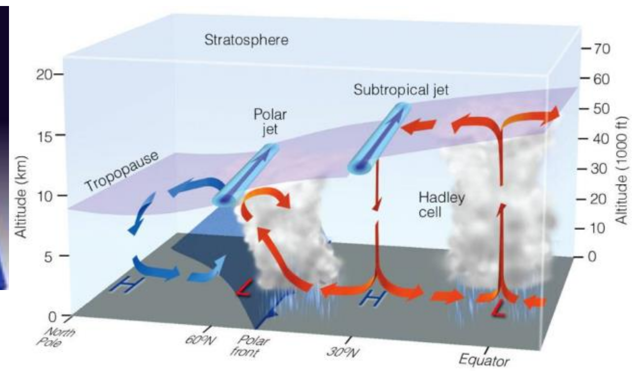
Another example would be orographic lift, which is usually associated with stable air. After the air has been forced up by the terrain, it cools and becomes dense. The effect is similar to positive stability in an airplane.

Relating Air Stability to Types of Formation

Air stability will have a direct affect on cloud formation. Clouds created in stable air will form as stratus-type clouds. Clouds formed in unstable air will form as cumulus-type clouds.

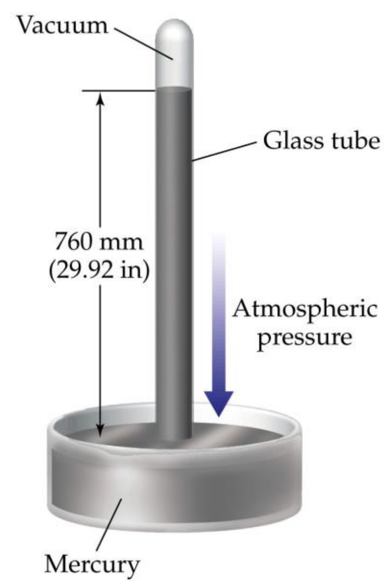
Part 9 – Polar Front Theory & Atmospheric Pressure





The Polar Front theory was conceived by Norwegian meteorologists, who claimed that the interaction between the consistently high pressure area over the Arctic (and Antarctic) and the relatively lower pressure areas over the lower latitudes may provide force to the movement of air.

Definition of Atmospheric Pressure

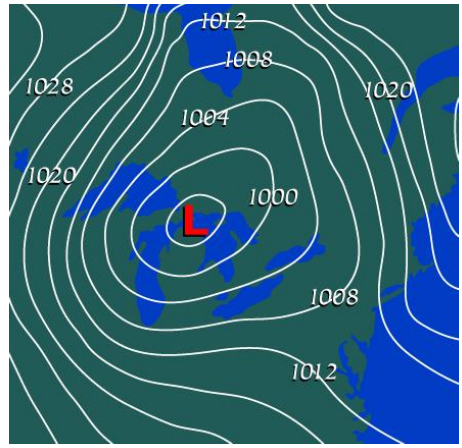


Atmospheric Pressure. The pressure of the atmosphere at any point due to the weight of the overlying air. Pressure at the surface of the earth is normally measured using a mercury barometer and is expressed in mm of mercury (mm Hg) or inches of mercury ("Hg). The barometer is essentially an upside-down graduated, test tube that is partially immersed in a bowl of mercury. As the pressure of the air over the bowl increases, the mercury is forced further up the test tube, providing a higher reading.

Pressure is a force and, in meteorological work, it is common to use ectopascals (hPa) to measure pressure. One hectopascal is 1 000 dynes (a unit of force) of force exerted on a 1cm^2 area. The average pressure of the atmosphere at sea level is normally expressed as 760 mm Hg (29.92 "Hg), which is the same as 1013.2 hPa. Public radio and television weather broadcasts (such as the

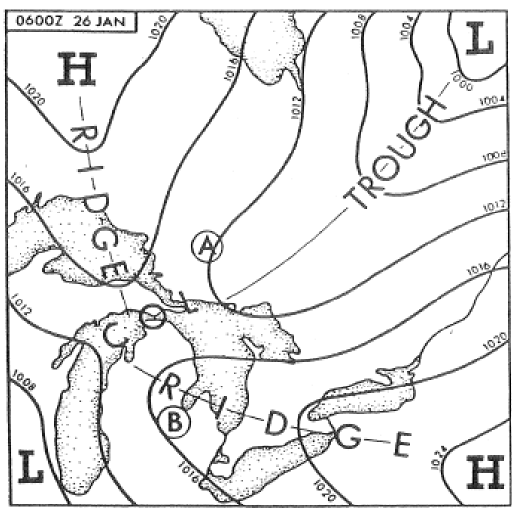
Weather Network or Environment Canada) will express pressure in kilopascals (kPa). One kPa is equal to 10 hPa, so that 1013.2 hPa would be equal 101.32 kPa.

Pressure Systems
There are pressure reading stations all over North America. Each station will send its readings to a main forecasting office, which will plot the information on a weather map.



Isobars: Areas of like pressure are joined by lines called isobars (from Greek *isos* [same] and *baros* [weight]). On a weather map, isobars will look similar to contour lines found on a topographical map. The isobars form roughly concentric circles, each circle being four hPa different than the circles before and after it. Groups of isobars will indicate areas of relatively high pressure, or relatively low pressure.

Low Pressure Areas: Low pressure areas (often called lows, cyclones, or depressions) are areas of relatively lower pressure, with the lowest pressure in the centre. Lows will normally move in an easterly direction at an average rate of 800 km per day during the summer and 1 100 km per day in the winter. Lows are associated with thunderstorms and tornadoes, and do not stay in one place for very long. In the northern hemisphere, air moves around a low pressure in a counter-clockwise direction.



High Pressure Areas: High pressure areas (often called anti-cyclones) are areas of relatively higher pressure, with the highest pressure in the centre. Winds are usually light and variable. High pressure areas move very slowly, sometimes staying stationary for days at a time. In the northern hemisphere, air moves around a high in a clockwise direction.

An Air Mass Over the Polar Regions. Polar air is typically cold and dry.

An Air Mass Over the Equatorial Regions. The air over the equator is tropical, therefore warm and moist.

Movement at the Polar Front
The transition zone between the polar air and the equatorial air is known as the polar front. Due to the differences in the properties of the two air masses, many depressions (low pressure areas) form along the polar front. The cold air moves from north-east to south-west in the northern hemisphere, while the warm air moves in the opposite direction. The result is constant instability as the cold air bulges south and the warm air bulges north. The cold air moves faster than the warm air and eventually envelopes it. The movement of the air at the polar front is thought to be a cause for the circulation of air in the troposphere.

Part 10 – Properties of an Air Mass

Weather forecasts used to be based solely on the existence and movement of pressure systems. Meteorologists currently base their predictions on the properties of air masses, of which pressure is only one factor.

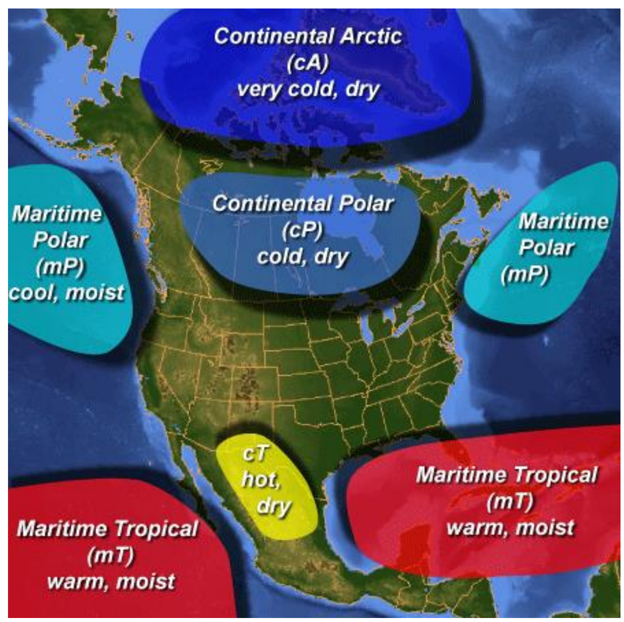
An air mass may be defined as a large section of the troposphere with uniform properties of temperature and moisture along the horizontal plane. This means that if a horizontal cross-section was taken of an air mass, one would see layers within the air mass where the temperature and the amount of moisture would be the same throughout.

An air mass will take on the properties of the surface over which it has formed. An air mass, which has formed over the Arctic would be cold and dry, while one, which formed over the Gulf of Mexico would be warm and moist.

Air masses may be described as:

- **Continental Air Mass.** Since the air mass formed over land, this will be a dry air mass.
- **Maritime Air Mass.** Since the air mass formed over water, this will be a moist air mass.
- **Arctic Air Mass.** Since the air mass formed over the Arctic, this will be a cold air mass.
- **Polar Air Mass.** Since the air mass formed over the Polar region, this will be a cool air mass.
- **Tropical Air Mass.** Since the air mass formed over the Tropical region, this will be a warm air mass.

These types of air masses are usually combined to describe the properties of temperature and moisture.



For example, over Atlantic Canada one might find a maritime polar air mass, which will be cool and moist. Meanwhile prairie winters usually see continental polar or continental arctic, which will be either cool and dry or cold and dry. The five air masses in North America include:

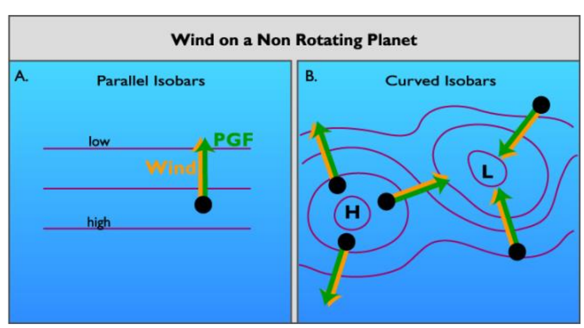
- Continental Arctic (cA),
- Maritime Arctic (mA),
- Continental Polar (cP),
- Maritime Polar (mP), and
- Maritime Tropical (mT).

Part 11 - Wind

Wind is a major factor in flight planning and flight characteristics. Pilots must constantly be aware of the direction and speed of wind during all parts of the flight, but especially during the landing sequence.

The Definition of Wind

Wind. The horizontal movement of air within the atmosphere. Wind normally moves parallel to the isobars of a pressure system. Since isobars are not straight lines, this means that the wind direction will vary at different locations along the pressure system. Wind also moves in different directions based on whether the pressure is a low or high system.



Pressure Gradient

The pressure gradient is the rate of change of pressure over a given distance measured at right angles to the isobars. If the isobars are very close together, the rate of change will be steep and the wind speed will be strong. If the isobars are far apart, the rate of change will be shallow and the wind speed will be weak.

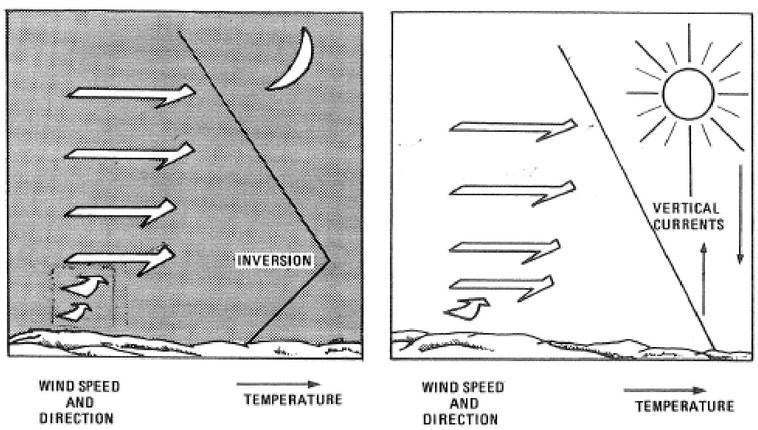
Land and Sea Breezes

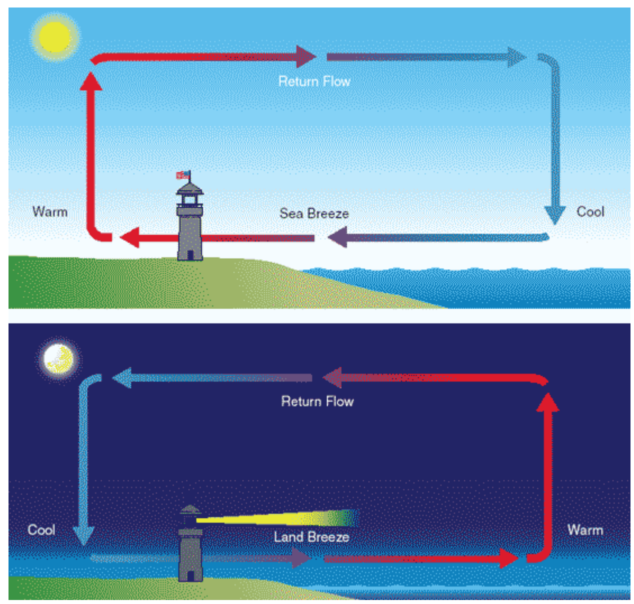
Land and sea breezes are caused by the differences in temperature over land and water.

The sea breeze occurs during the day when the land heats up more rapidly than the water. This creates a lower pressure area over the land. The pressure gradient caused by this change is usually steep enough to create a wind from the water.

The land breeze occurs at night when the land cools down faster than the water. This creates a higher pressure over the land. The pressure gradient now moves the air from the land to the water.

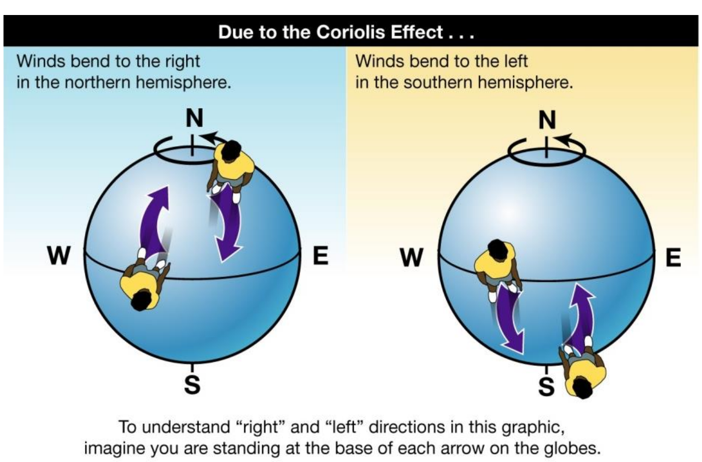
Land and sea breezes are local and affect a small area only.





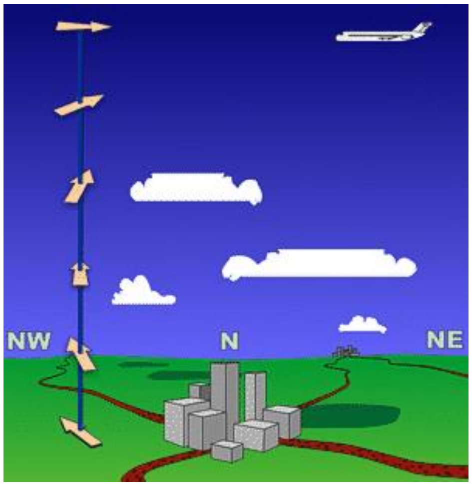
Diurnal Variation

Surface winds are generally stronger during the day than at night. This is due to the heating processes, which occur during the day, creating vertical currents and pressure gradients. At night, when the heating processes cease, the vertical currents diminish and the pressure gradients become shallower.



Coriolis Force

As air moves from a high pressure system to a low pressure system, the air will not flow directly from one to the other. The rotation of the earth causes a deflection to the right (in the northern hemisphere). This force is known as Coriolis Force. Coriolis Force also explains why air moves clockwise around a high, and counterclockwise around a low pressure system.



Veering and Backing

Veering is a change in wind direction clockwise relative to the cardinal points of a compass while backing is a change in wind direction counter-clockwise. For example, when the wind veers it will increase in direction from 090° to 100°; when it backs it will decrease in direction from 100° to 090°.

Veering and backing normally occur with changes in altitude. An increase in altitude will normally see a veer in wind direction and an increase in wind speed. A decrease in altitude will normally see a backing in wind direction and a decrease in wind speed. These changes are due to an increase in friction with the surface of the earth in the lower altitudes, and a decrease is friction in the higher altitudes.

Part 12 – Relationship between Pressure Systems & Wind

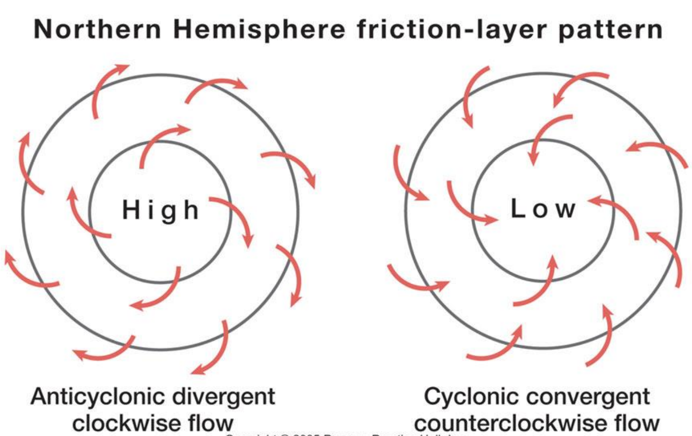
Pressure and wind are interrelated, with one being the cause of the other.

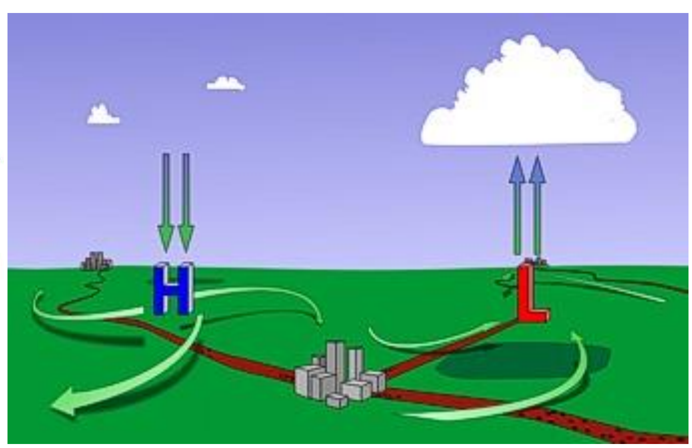
Low Pressure Areas

Low pressure areas are the cause of all air movement as described by the Polar Front theory. Wind blows in a counter-clockwise direction around the low, and inwards to the centre of the system. Wind tends to be strong in a low as the pressure gradient is relatively steep causing the system to move fast over the ground. Low pressure systems are generally associated with brief periods of poor weather, as the inward flow of air acts as a vacuum.

High Pressure Areas

The wind in a high pressure areas blows in a clockwise direction around the high and outwards from the centre of the system. Wind tends to be weak in a high as the pressure gradient is normally relatively shallow causing the system to move slowly over the ground. High pressure systems are usually associated with fair weather, as the outward flow of air acts as a shield against bad weather.





Part 13 - Humidity

Humidity is a representation of the moisture or water vapour, which is present in an air mass. While water vapour is a small percentage of the overall atmosphere, it is the only gas which can change into a solid or a liquid in ordinary atmospheric conditions. It is this characteristic which causes most weather to develop.

The moisture in an air mass originates from a body of water over which the air mass forms or passes. This body of water may be a pond or an ocean. The size of the body of water determines how much water is available for the air mass to collect, while the rate of evaporation will determine how much of that water is collected by the air mass. Water may exist in the atmosphere in two forms: invisible (gaseous) or visible (water droplets [liquid] or ice crystals [solid]).

Condensation

Condensation is a process by which a gas changes into a liquid by becoming denser. This is usually caused by a cooling process. The air is cooled to a certain temperature at which the water vapour will condense into water.

Sublimation

Sublimation is a process by which a gas changes into a solid without first becoming a liquid. This is usually caused by freezing. Sublimation occurs whenever snow, ice or hail fall from the sky. This process usually occurs in the winter, but may occur during exceptional summer storms.

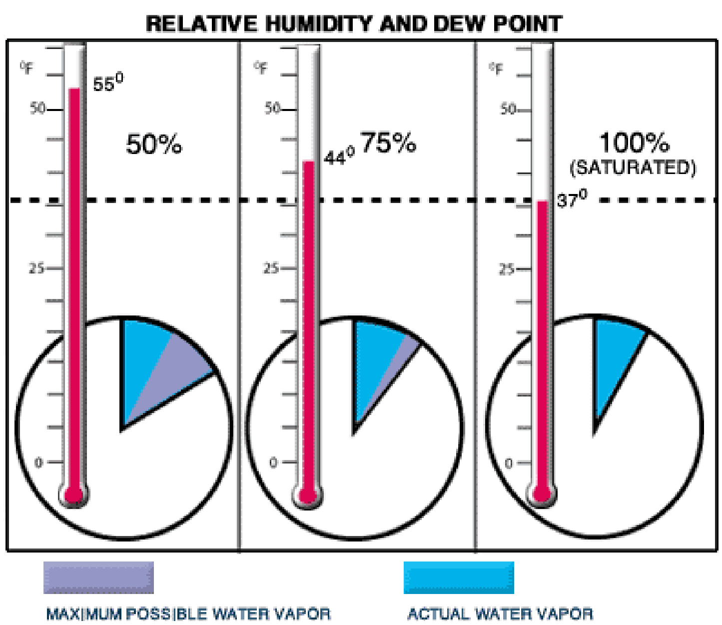
Dew Point

Dew point is the temperature to which unsaturated air must be cooled, at a constant pressure, in order to become saturated. The temperature and dew point are responsible for the creation of clouds and precipitation.

If the difference between the temperature and the dew point is small, then the air is considered to be nearly saturated and a small drop in temperature will see the formation of clouds or precipitation.

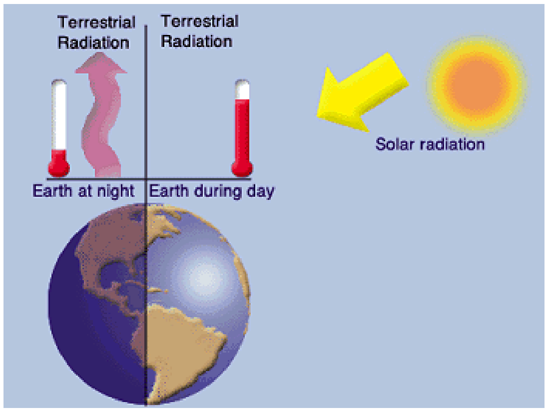
Relative Humidity

Relative humidity is the ratio of the actual amount of water present in the air compared to the amount of water which the same volume of air would hold if it were saturated. Temperature and pressure must remain the same, otherwise the relative humidity will change. Saturated air will have a relative humidity of 100 percent, while perfectly dry air will have a relative humidity of zero percent.



Part 14 - Temperature

Temperature represents the amount of heat in a given object, such as the human body or air. Temperature is measured using a thermometer. In aviation weather reports, temperature is normally expressed in °C.



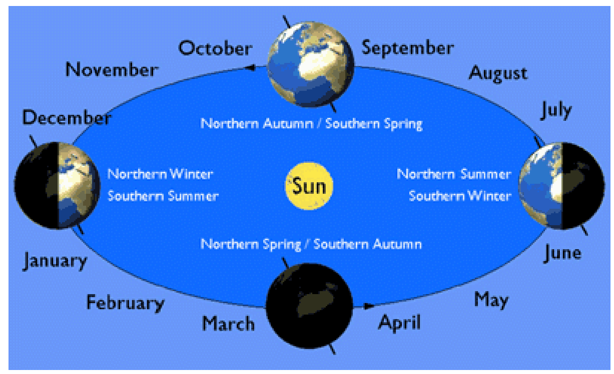
The Source

The source of the energy which warms the earth and its atmosphere is the sun. Solar radiation is transmitted to the earth and its atmosphere. Some of the solar radiation is absorbed by the stratosphere, while the rest passes through to be absorbed by the earth's surface. The earth then radiates heat into the troposphere through terrestrial radiation. It is terrestrial radiation that heats the troposphere, and is why the further one gets from the surface of the earth, the lower the temperature will be in the troposphere.

The atmosphere is heated from below not from above.

Diurnal Variation

During the day, the solar radiation exceeds the terrestrial radiation and the surface of the earth becomes warmer. At night, solar radiation ceases, and the terrestrial radiation causes the surface of the earth to cool.
This is called diurnal variation and causes the heating and cooling of the atmosphere.

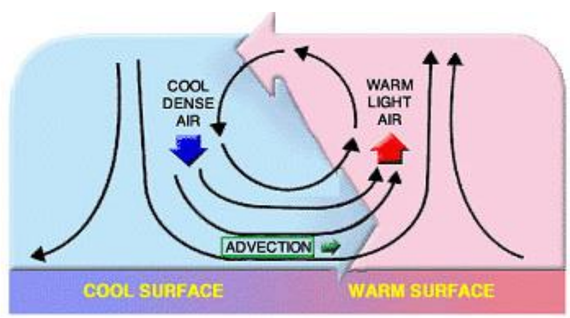


Seasonal Variation

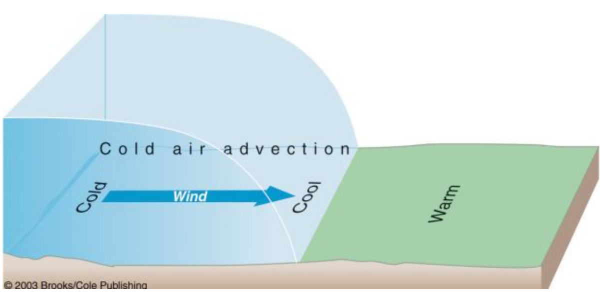
The axis around which the earth rotates is tilted compared to the plane of orbit around the sun. The result is that the amount of solar radiation that strikes the surface of the earth varies from season to season. In the northern hemisphere, the months of June, July, and August are warm, while the months of December, January, and February are cold.

The Heating Process

Air is a poor conductor of heat. The following are four processes which assist in getting warm air into the higher levels of the atmosphere:

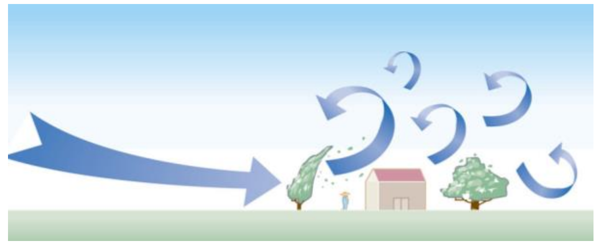


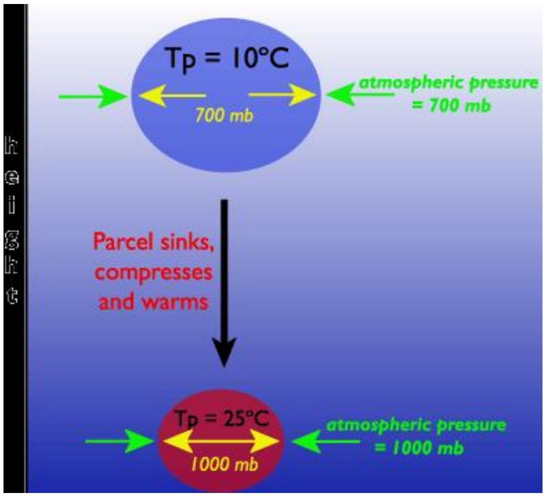
Convection. Air over a warm surface becomes buoyant and rises, allowing cooler air to move into the vacant location. This vertical current of air distributes the heat to the higher levels.



Advection. Horizontal movement of cool air over a warm surface allows the cool air to be heated from below.

Turbulence. Turbulence created as the result of friction with the surface of the earth causes a mixing process which moves the heated air to other areas of the atmosphere.

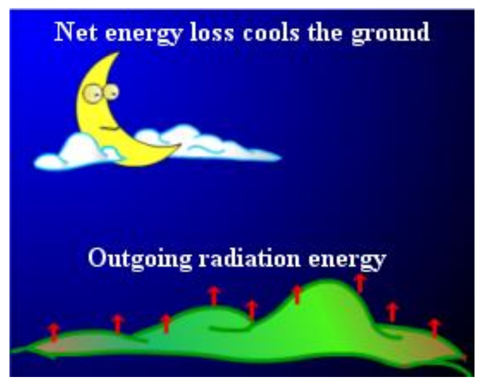




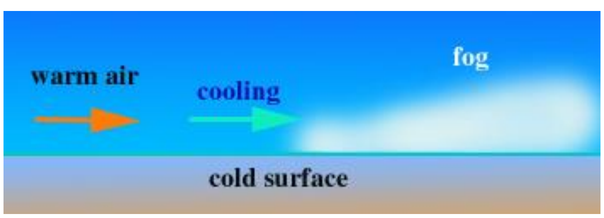
Compression. There are instances where air masses are forced down, such as air moving down the leeward side of a mountain. The air pressure increases as the air mass moves further down, compressing the air mass. This compression forces the particles together, creating heat. This phenomenon is also called subsidence.

The Cooling Process

Since the atmosphere is heated from below, the temperature usually decreases with altitude. The rate of temperature change is known as a lapse rate. The lapse rate is only a guideline as there is a variation in air masses and cooling processes. The following are three main cooling processes:

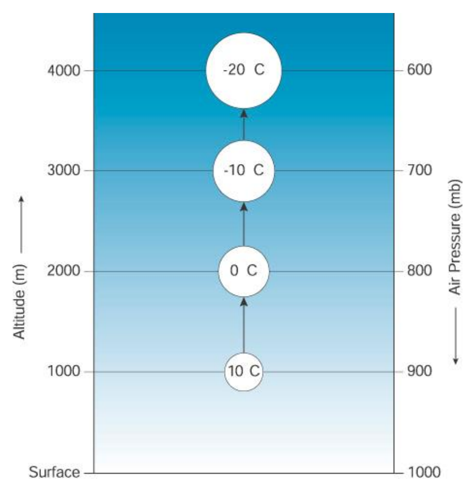


Radiation Cooling. At night the temperature of the earth decreases with terrestrial radiation and cools the air in contact with the ground. Radiation cooling only affects the lower few thousand feet of the atmosphere.



Advection Cooling. Air from a warm region moves over a cold region and cools the air.

Adiabatic Process. As air is warmed it will begin to rise and as it rises it will expand and cool. In a rising current of air, the temperature decreases at a rate that is entirely independent of the surrounding, non-rising air.



Part 15 – The Effects of Temperature on Relative Humidity

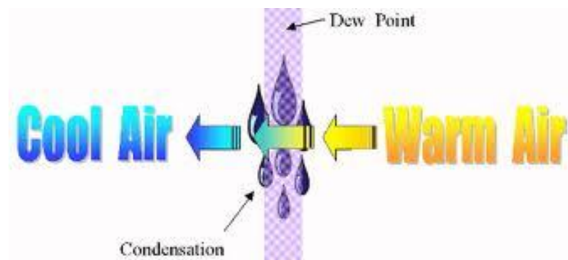
Temperature will affect the relative humidity of an air mass by changing the volume of the air mass.

As the temperature of the air mass increases, the air mass will expand increasing the volume of the mass. The result is that the relative humidity will decrease, as the air mass has a higher capacity for water. This assumes that there is no change in the amount of water in the air mass.

As the temperature of the air mass decreases, the air mass will contract, decreasing the volume of the mass. The result is that the relative humidity will increase, as the air mass has a lower capacity for water. This assumes that there is no change in the amount of water in the air mass.

Part 16 – The Effects of Temperature and Humidity on Weather

Temperature and humidity have a major effect on the weather. Together they will determine cloud formation and precipitation.



Dew Point
The temperature of the air mass will change during the heating and cooling processes. As the temperature nears the dew point, the air will become more saturated. This increases the relative humidity and allows clouds to form.

Relative Humidity
As the relative humidity increases, the weight of the air mass also increases. When the dew point is reached, the air will become saturated, and clouds will form. Once the air mass has reached 100 percent relative humidity, any addition of water or drop in temperature will cause precipitation.

Precipitation
Precipitation may be solid or liquid, depending on the temperature of the air mass. Snow will occur if the air mass has a temperature below freezing. Rain will occur in an air mass which has a temperature above freezing.

The temperature in the air mass will change with altitude, so that the water may freeze at higher levels of the air mass. Frozen precipitation such as hail and even snow has been seen in the summer months.

Part 17 – Types of Precipitation

There are seven main categories of precipitation listed by the World Meteorological Organization (WMO). Each one is created depending on temperature and cloud type. Types of precipitation include:

Drizzle. Precipitation in the form of small water droplets which appear to float. In temperatures near freezing, water droplets may freeze on contact with objects. This is known as freezing drizzle.

Rain. Precipitation in the form of large water droplets. Freezing rain will occur when water droplets, which have retained their liquid form in freezing conditions, make contact with an object and freeze.

Hail. Formed in clouds, which have strong vertical currents (such as thunderstorms), hail is the result of a water droplet which has been prevented from exiting the cloud by the vertical currents, until it has reached a particular mass. The stronger the vertical currents, the larger the hailstones. Softball-sized hailstones have been seen in the Prairies and tropical areas, where large thunderstorms commonly occur.

Snow Pellets. If the water region where the cloud is receiving water from is shallow, then the droplet will not form the hard shell that a hailstone would have. The pellet falls as a soft pellet of snow.

Snow. Snow is the result of sublimation. Flakes are an agglomeration of ice crystals and are usually in the shape of a hexagon or star.

Ice Prisms. Created in stable air masses at very low temperatures. Ice prisms are tiny ice crystals in the form of needles. They can form with or without clouds. Sometimes confused with ice fog.

Ice Pellets. Ice pellets are raindrops, which are frozen before contacting an object (as opposed to freezing rain, which freezes after contact with an object). They generally rebound after striking the ground.

Practice Questions

1. How much of the atmosphere is composed of nitrogen?
2. How much of the atmosphere is composed of oxygen?
3. From the standpoint of weather, which gas is the most important?
4. Name the four layers of the atmosphere.
5. In which layer does most weather occur?
6. In which layer is the ozone layer found?
7. Why is there an international standard atmosphere?
8. What is the basis for ICAO standard atmosphere in North America?
9. What are the four assumptions used in the ICAO standard atmosphere for North America?
10. What are the three properties of the atmosphere?
11. Which is the most important property of the atmosphere?
12. What are the three factors affecting the properties of the atmosphere?
13. How are clouds classified?
14. What are the two types of cloud formations?
15. What are the four categories of cloud height?
16. What may create vertical currents?
17. What is stable air?
18. What is unstable air?
19. Explain how convection (as a source of lift) occurs.
20. Explain orographic lift.
21. Explain frontal lift.
22. What are the two ways in which a cloud forms?
23. How does orographic lift relate to air stability?
24. What cloud type will form in stable air?

25. What is a hectopascal?
26. Which direction does the air move around a low pressure in the northern hemisphere?
27. What is the transition zone between the polar air and the tropical air known as?
28. What is the definition of an air mass?
29. Where does an air mass obtain its properties from?
30. What are five air masses in North America?
31. Define pressure gradient.
32. Why do sea breezes occur?
33. What is veering?
34. What direction does the wind blow around a low pressure system in the northern hemisphere?
35. What direction does the wind blow around a high pressure system in the northern hemisphere?
36. Define condensation.
37. Define dew point.
38. Define relative humidity.
39. How is the atmosphere heated?
40. Identify the four heating processes.
41. Identify the three cooling processes.
42. What is the effect of dew point on weather?
43. How does relative humidity affect the creation of precipitation?
44. How is it possible for hail or snow to occur in the summer months?
45. What are the seven types of precipitation?
46. What process creates snow?
47. What is the difference between ice pellets and freezing rain?

PO 301 – Service Groups within Canada

Community service is defined as activities which help cadets develop attributes of good citizenship. Through active involvement in these activities, cadets will have a positive impact on local communities, contributing to community strength and vibrancy.

Purposes of Community Service Groups

The purposes of community service groups are very diverse; however, they are all similar in that they fulfill a need or set of needs within the community.

- **Providing Community Service.** The primary purpose of community service groups is to fulfill a need or set of needs in the community. Citizens donate money and goods, and volunteer to help others, which helps to create a sense of community between those helping and those being helped.

- **Developing Better Citizens.** Through active participation in the community, people gain a sense of ownership. This sense of ownership fosters a positive attitude toward a person's community and their role within it. The result is the development of better citizens. Some groups actively promote citizenship as one of their goals.

- **Creating a Sense of Belonging and Acceptance.** Community service groups, through their work, create a sense of belonging and acceptance. Citizens, who are actively involved within their community, gain a sense of belonging and acceptance through their investment in the community. Those helped by a community service group, witness the efforts made on their behalf and gain a sense of belonging and acceptance; they feel that they are valued members of the community. It is common for those who are helped to help their community when they can.

Types of Community Service Groups

The types of community service groups are very diverse; however, they may be categorized by their emphasis and their sphere of influence.

Emphasis

Each community service group places emphasis on different aspects of the community, whether it is a group of people or a community need.

- **Age:** One important area of emphasis is age groups. Many community service groups support youth programs, from building playgrounds to sponsoring cadet units. Community service groups may support programs for senior citizens, from grass cutting to assisting with healthcare needs.

- **Fundraising:** One thing almost all community service groups do is fundraising, whether it is for themselves or for others.

- **Interest:** Many community service groups were formed with a specific interest. One of the more common areas of interest is feeding those in need, usually through soup kitchens and food banks.

- **Religion:** Most religions have an obligation to assist those in need. Many religion-based groups have been formed to fulfill this obligation to help and work in all areas emphasized.

- **Service:** Some groups are simply based on service to the community. Kin Canada members (the Association of Kinsmen, Kinette and Kin clubs) work at enhancing the quality of life in their communities by promoting service, fellowship, positive values and national pride.

- **Special Need:** Community service groups sometimes form to fulfill a special need. Polio is a disease, whose victims are mainly children, that is highly contagious and has left thousands paralyzed. The March of Dimes in Canada was founded in 1951, to raise money to help those stricken with polio and to help fund research for a cure. A vaccine was found in 1955 and now polio may become only the second disease to be officially eradicated. As polio is no longer an issue, the March of Dimes now assists the disabled.

Sphere of Influence

A community service group's sphere of influence is the geographical area where the group operates or has an effect.

- **Local:** Many groups' sphere of influence is at the local level. A squadron may assist their community through cleaning up a park or assisting their local veterans association's Poppy Campaign. Some groups help within their community through a food bank, soup kitchen or a homeless shelter.

- **Regional:** Regional groups usually provide local groups with expertise, especially in operations and administration. This allows a local group to focus more on community service and less on the administrative aspects of their work.

- **National:** Many national groups focus on fundraising and creating awareness of the needs of communities and how to help. Most local groups are affiliated with a national group, usually through a regional group, in order to coordinate and administer their operations.

- **International:** At the international level, groups work toward goals such as fighting poverty and disease, saving endangered species, and meeting other global needs. Many groups raise funds to be used in areas of the world in need. Like national groups, their main focuses are on fundraising and creating awareness.

Answer the following questions on a separate piece of paper, using the information above.

1. When discussing community service groups, what is meant by sphere of influence?
2. List 3 community service groups that you know of or have heard about? Identify the purpose of these groups.
3. In your own words, what is your definition of a community service group?

PO 307 – Serve in an Air Cadet Squadron

Part 1 – Year Three Summer Training Opportunities

Areas of Interest of CTC Training Opportunities

- **Fitness & Sports:** Cadets will improve individual fitness and sport knowledge and skills. Activities will focus on: officiating, fitness instruction, sports leadership, coaching, rules and regulations of sports, and personal fitness.

- **Music**
  - **Military Musician:** Cadets will develop music knowledge and skills. Activities will focus on: music theory; playing an instrument as part of an ensemble; playing an instrument as part of a military band; and developing individual music skills.
  - **Pipe and Drum Musician:** Cadets will develop music knowledge and skills. Activities will focus on: music theory; playing an instrument as part of an ensemble; playing an instrument as part of a pipe and drum band; and developing individual music skills.

- **Marksmanship:** Cadets will develop the knowledge and skills required to improve marksmanship and coaching abilities. Activities will focus on: recreational and competitive air rifle marksmanship, various marksmanship techniques, firing positions, duties of a range assistant, and basic duties of a marksmanship coach.

- **Leadership:** Cadets will develop the knowledge and skills required to improve leadership abilities in a peer and small group setting. Activities will focus on: leadership, supervision, team-building, instructional techniques, effective communication, problem solving, and ceremonial drill.

- **Aviation:** Cadets will develop the knowledge and skills required to improve their understanding of the fundamentals of aviation. Depending on the course chosen, activities will focus on: meteorology, aero engines, air navigation, airmanship, principles of flight, navigation, pilot decision making, air law, flight safety, and aviation medicine.

- **Aviation Technology:** Cadets will develop knowledge and skills required to improve their understanding of the fundamentals of aviation technology. Activities will focus on: aerodrome operations, aircraft fabrication, aircraft construction, and aircraft maintenance.

- **Aero Space:** Cadets will develop knowledge and skills required to improve their understanding of the fundamentals of aerospace science. Activities will focus on: theoretical and practical principles of space science, simulations of life in space, familiarization with recognized space missions, and history of space exploration.

- **Aircrew Survival:** Cadets will develop the knowledge and skills required to improve aircrew survival skills. Activities will focus on: instructional techniques in the field, map and compass for ground navigation, leadership in a field setting, fire construction, shelter construction, signal construction, and food and water collection.

Six-Week Courses Offered in Areas of Common Interest

- **Fitness and Sports Instructor:** The aim of the Fitness and Sports Instructor course is to enhance skills developed on the Basic Fitness and Sports course, to develop leadership and instructional skills in fitness and sports settings, and to stimulate further interest in personal fitness and healthy living.

- **Air Rifle Marksmanship Instructor:** The aim of the Air Rifle Marksmanship Instructor course is to enhance skills developed during proficiency level training, the General Training course, and some year two CSTC courses. As well, cadets will develop leadership, coaching, and instructional skills in a marksmanship setting.

- **Intermediate Military Band Musician:** The aim of the Intermediate Military Band Musician course is to enhance knowledge and skills developed during the Military Band – Basic Musician course, and to develop leadership skills in a military band setting.

- **Intermediate Pipe Band:** The aim of the Intermediate Pipe Band course is to enhance knowledge and skills developed during the Pipe Band – Basic Musician course, and to develop leadership skills in a pipe band setting.

Six-Week Courses Offered in Elementally Specific Area

- **Survival Instructor:** The aim of the Survival Instructor course is to enhance survival skills developed on the Basic Survival course and proficiency level training; to develop new survival skills, and to develop leadership and instructional skills in a survival/field setting.

- **Advanced Aerospace:** The aim of the Advanced Aerospace course is to enhance aerospace knowledge developed on the Basic Aviation Technology and Aerospace course, and proficiency level training; develop new knowledge and skills, and further stimulate an interest in the aerospace/astronomy communities.

- **Advanced Aviation Technology – Airport Operations:** The aim of the Advanced Aviation Technology - Airport Operations course is to enhance knowledge developed on the Basic Aviation Technology and Aerospace course, and proficiency level training; develop new knowledge and skills, and further stimulate an interest in airport operations.

- **Advanced Aviation Technology – Aircraft Maintenance:** The aim of the Advanced Aviation Technology - Aircraft Manufacturing course is to enhance knowledge developed on the Basic Aviation Technology and Aerospace course, and proficiency level training; develop new knowledge and skills, and further stimulate an interest in aircraft maintenance.

- **Glider Pilot Scholarship (GPS):** The aim of the GPS is to train the successful applicant to the standard as defined in the A-CR-CCP-242/PT-005 *Air Cadet Gliding Manual*. Upon graduation from the course, cadets will be awarded their Air Cadet Glider wings and a Transport Canada Pilots Licence - Glider.

- **Three-Week Advanced Aviation Course:** The Advanced Aviation course is the only three-week course offered with the completion of Proficiency Level Three. The aim of this course is to enhance the cadet’s knowledge of aviation subjects and to further stimulate an interest in becoming a pilot.

Prerequisites for each Three- & Six-Week Course

For all courses other than the GPS, the cadet must:

- be undergoing Proficiency Level Three training by the application deadline;
- successfully complete Proficiency Level Three by June 30 of the year the cadet wishes to attend the CTC;
- be physically fit;
- complete a CF 51;
- have parental consent; and
- be recommended by the squadron Commanding Officer.

Answer the following questions on a separate piece of paper, using the information above.

1. Which areas of interest in summer training appeal to you?
2. What specialty areas are you interested in pursuing? Why?
3. What are the four 6-week courses offered in areas of common interest?
4. What are the prerequisites for three- and six-week courses other than the GPS?

Part 2 – Partnership between the Air Cadet League of Canada (ACLC) & Department of National Defense (DND)

Three Levels of the ACLC

There are three levels in organization of the ACLC. Each of the levels has its own area of responsibility and cooperates with DND at a comparable level.

- **National:** The national level of the ACLC is a board of governors composed of 15 Canadians representing all provinces and territories. The board meets annually, choosing a president, vice-presidents, the executive committee, and other committees of importance. There is also an advisory board made up of past-presidents of the ACLC. The Board of Governors maintains a full-time administrative headquarters in Ottawa, Ont. This office works closely with National Defence Headquarters (NDHQ) in providing year-round supervision and administration of the ACLC and the approximate 450 air cadet squadrons in Canada.

- **Provincial:** There are 12 provincial committees. The committees are comprised of all local Sponsoring Committee Chairpersons, plus others that may be elected, such as prominent local citizens. Provincial committees supervise the activities of all air cadet squadrons in their respective areas and are financed by public fundraising and the support of their member squadrons and drill competitions. The provincial committees own all gliders, tow aircraft, winches, and vehicles used in support of air cadet glider pilot training and glider familiarization flying activities. The provincial committees work with the respective Region Cadet Support Unit (RCSU) to provide supervision and assistance to squadrons within their area.

- **Local:** Air cadet squadrons are supported through various organizations which provide volunteers, financial contributions, extra activities, and material assistance. Three distinct groups may provide this support: sponsor, sponsoring committee, and supporter. The sponsor may be a club (Royal Canadian Legion or Rotary Club of Canada), an association (Air Force Association of Canada), or a group of interested people (parents committee). The sponsor is responsible for the creation of a sponsoring committee, which is the basic unit of the ACLC.

The sponsoring committee has many responsibilities to fulfill at the squadron, which include but are not limited to:

- providing training aids and equipment not provided by DND;
- arranging recreational activities for the cadets;
- providing transportation when not provided by DND; and
- providing input to cadets' applications for summer training.

The squadron may also receive support from other organizations and individuals not associated with the
- sponsoring committee. These are recognized as supporters of the squadron, and usually provide assistance
- through periodic financial donations.

Responsibilities of the ACLC

The ACLC has a partnership with DND. The responsibilities of delivering the Air Cadet Program are divided between these two partners. The ACLC and its members at all three levels have the following responsibilities:
- making recommendations for the formation or disbandment of squadrons;
- providing financial support to squadrons as required;
- supervising squadron sponsoring committees;
- overseeing, in cooperation with DND, the effective operation of air cadet squadrons and their sponsoring committees;
- administering trust accounts set up for awards to outstanding cadets;
- identifying and providing other appropriate awards to recognize commendable cadets' and volunteers' performances;
- selecting scholarship recipients;
- selecting cadets for national summer training courses; and
- participating in the cadet selection process for national courses and exchange programs.

Responsibilities of DND

DND has a partnership with the ACLC. The responsibilities of delivering the Air Cadet Program are divided between these two partners. DND and its representatives are responsible for providing the following:
- supervision and administration of cadet squadrons;
- materiel to squadron IAW the scale of issue;
- training, pay and allowances for Cadet Instructor Cadre (CIC) officers;
- funds for payment of annual funding allocations (operation and maintenance) and training bonuses;
- transportation for directed training;
- facilities and staff for cadet summer training centres (CSTCs);
- syllabi and training aids;
- medical care as authorized by regulations;
- liaison with cadet squadrons;
- officers or appropriate civilians for annual ceremonial reviews; and
- policy regarding CIC officers, civilian instructors, and cadets.

Answer the following questions on a separate piece of paper, using the information above.

1. Who is 135 Squadron's sponsoring committee chairperson?
2. Who is 135 Squadron's sponsor?
3. Name three responsibilities of the ACLC and three responsibilities of DND.

PO 320 – Canadian Forces Familiarization

Refer to the attached Annexes title “The Purpose of Canada’s Air Force”, “The Structure of Canada’s Air Force”, “Aircraft of Canada’s Air Force”, and “Activities of Canada’s Air Force” to complete the attached “Research Facts about Canada’s Air Force” worksheet and answer the following questions. Answer the following questions on a separate piece of paper.

1. Which roles of Canada’s Air Force do you think are most important? Why?
2. Which roles of Canada’s Air Force are newest?
3. Which roles of Canada’s Air Force are oldest?
4. How might the role of Canada’s Air Force change in the future?

PO 340 – Aerospace

Part 1 – Canadian Astronauts

Training of Canada's astronauts began in 1983 and Canada's first astronaut, Marc Garneau, visited space in October 1984, when, among many other mission accomplishments, the Canada Experiment (CANEX) payload performed important experiments. Those early CANEX experiments were:

- Auroral Photography Experiment (APE),
- Radiation Monitoring Equipment (RME), and
- Thermoluminiscent Dosimeter (TLD).

Answer the following questions on a separate piece of paper, using the information above.

1. In what year did training of Canada's astronauts begin?
2. When did Canada's first astronaut visit space?
3. Who was Canada's first astronaut?

Refer to the attached Annex titled "Astronaut Chris Hadfield". Using the information from it, answer the following questions on a separate piece of paper.

1. In what missions did these astronauts take part?
2. What part did these astronauts play on these missions?
3. What education and experience did these astronauts bring to the missions?

Part 2 – Manned Space Exploration

The Mercury Program

Specific studies and tests conducted by the US government and industry, culminating in 1958, indicated the feasibility of manned space flight. The objectives of the Mercury program, as stated at the time of project commencement in November 1958, were:

- place a manned spacecraft in orbital flight around the earth;
- investigate man's performance capabilities and his ability to function in the environment of space; and
- recover the man and the spacecraft safely.

The US' first manned space flight project was successfully accomplished in less than five years, which saw more than 2,000,000 people from major government agencies and the aerospace industry combine their skills, initiative and experience into a national effort.

In this period, six manned space flights were accomplished as part of a 25-flight program. These manned space flights were accomplished with complete pilot safety and without change to the basic Mercury objectives. It was shown that man could function ably as a pilot-engineer-experimenter without undesirable reactions or deteriorations of normal body functions for periods up to 34 hours of weightless flight. Directing this large and fast moving project required the development of a management structure and operating mode that satisfied the requirement to mould the many different entities into a workable structure.

The Gemini Program

The Gemini program was a necessary intermediate step between the Mercury program and the Apollo program. It had four objectives:

- to subject astronauts to long duration flights – a requirement for projected later trips to the moon or deeper space;
- to develop effective methods for rendezvous and docking with other orbiting vehicles and to manoeuvre the docked vehicles in space;
- to perfect methods of re-entry and landing spacecraft at a pre-selected ground landing point; and
- to gain additional information concerning the effects of weightlessness on crew members and to record the physiological reactions of crew members during longer duration flights.

On May 25, 1961, three weeks after Mercury astronaut Alan Shepard became the first American in space, President John F. Kennedy announced the goal to send astronauts to the moon before the end of the decade. To facilitate this goal, NASA expanded the existing manned space flight program in December 1961 to include the development of a two-man spacecraft. The program was officially designated Gemini on January 3, 1962. Gemini, to a large degree, was the work of a Canadian – James Arthur Chamberlin of Kamloops, British Columbia, a mechanical engineer educated at the University of Toronto. Having served as the chief engineer for the Mercury program, Chamberlin was selected to be Gemini's Project Manager.

The Apollo Program

The Apollo's program objectives went beyond landing Americans on the moon and returning them safely to earth. The objectives also included:

- establishing the technology to meet other national interests in space;
- achieving pre-eminence in space for the United States;
- carrying out a program of scientific exploration of the moon; and
- developing man's capability to work in the lunar environment.

The Apollo program was the work of Owen E. Maynard of Sarnia, Ontario, chief of the systems engineering division in the Apollo Spacecraft Program Office. He was previously chief of the Lunar Module engineering office in the Apollo Program Office at the Manned Spacecraft Center in Houston. Maynard held an aeronautical engineering degree from the University of Toronto. His years at NASA were rewarded on July 20, 1969, when Apollo 11 commander Neil Armstrong stepped out of the lunar module (LM) and took one small step in the Sea of Tranquility, calling it a giant leap for mankind. Maynard remained in charge of Apollo systems engineering until he left NASA in 1970 following the successful achievement of Kennedy's lunar landing goal. Thereafter he returned to private industry.

The Apollo program used the Saturn family of launch vehicles. The command, service and lunar module made a small package, dwarfed at the top of the giant launch vehicle.

Six of the Apollo missions, Apollos 11, 12, and 14–17, landed on the moon, studying soil mechanics, meteoroids, seismic activity, heat flow, lunar ranging, magnetic fields and solar wind.

Apollos 7 and 9 tested spacecraft in earth orbit; Apollo 10 orbited the moon as the dress rehearsal for the first landing. An oxygen tank explosion forced Apollo 13 to scrub its landing, but the can-do problem-solving of the crew and mission control – and Maynard's systems engineering group – turned the mission into what was called a successful failure.

Answer the following questions on a separate piece of paper, using the information above.

1. How many manned missions were there in the Mercury program?
2. Who was the Gemini Project Manager?
3. Which family of launch vehicles were used for Project Apollo?

PO 370 – Aircraft Maintenance

Part 1 – Pitot Static System

Flight instruments enable an aircraft to be operated with maximum performance and safety. One set of flight instruments, those of the pitot static system, measure and utilize air pressure.

There are two major parts of the pitot static system:

- the static pressure vent and lines, and
- the pitot pressure, also called impact pressure, chamber and lines.

The static pressure line provides the source of normal outside air pressure for the operation of the altimeter, vertical speed indicator, and airspeed indicator, while the pitot pressure, or impact pressure line provides impact pressure to the airspeed indicator. The airspeed indicator is the only instrument that requires both air pressures.

Static Vent

The static vent is located where the air flowing past the aircraft will not disturb air pressure. The static vent provides undisturbed air pressure for the static line. The openings of the static vent must be checked during the pre-flight inspection to ensure that they are free from obstructions.

Static Line

Since the static line is vented to the free undisturbed air by the static vent, air pressure in the static line will change as the air pressure around the aircraft changes. As the aircraft gains altitude, air pressure in the static line will drop. This pressure change is transmitted through the static line to the instruments which utilize static air pressure. These instruments include the:

- altimeter,
- vertical speed indicator, and
- airspeed indicator.

Pitot Pressure Chamber

In the pitot static system, the impact air pressure (air striking the airplane because of its forward motion) is taken from a pitot tube. It is mounted in a location that provides minimum disturbance or turbulence caused by the motion of the aircraft through the air. Often, a pitot tube cover is placed over the pitot tube when the aircraft is parked to prevent foreign objects from entering the pitot static system.

As the aircraft moves through the air, the impact pressure on the open pitot tube affects the pressure in the pitot pressure chamber. Any change of pitot (impact) pressure in the pitot pressure chamber is transmitted through a line connected to the airspeed indicator, which uses impact pressure for its operation.

Pitot Line

Any change of pressure in the pitot chamber is transmitted through a pitot line (a hollow tube) to the airspeed indicator, which uses impact pressure as well as static pressure for its operation.

Operation of the Pitot Static System

As described above, the pitot static system of chambers and lines delivers two types of air pressure to flight Instruments – static pressure and pitot pressure.

When flight instruments are calibrated correctly, they will measure the air pressure that is delivered to them, relative to air pressure at sea level as well as impact pressure relative to static pressure. By measuring the air pressures in the static pressure and impact pressure lines, the calibrated instruments will present useful information about the aircraft's position to the pilot.

Airspeed Indicator
The airspeed indicator is a sensitive, differential pressure gauge, which measures and shows the difference between pitot, or impact, pressure and static pressure. These two pressures will be equal when the airplane is parked on the ground in calm air. When the aircraft moves through the air, the pressure in the pitot line becomes greater than the pressure in the static line. This difference in pressure is registered by the airspeed pointer on the face of the instrument, which is calibrated in miles per hour, knots, or both.

Vertical Speed Indicator
The vertical speed indicator (VSI), sometimes called a vertical velocity indicator (VVI), indicates whether the airplane is climbing, descending, or in level flight. The rate of climb or descent is indicated in thousands of feet per minute. If properly calibrated, the VSI indicates zero in level flight. Although the VSI operates solely from static pressure, it measures pressure difference; the pressure now relative to the pressure a moment ago.

Altimeter
The altimeter measures the height of the aircraft above sea level. Since it is the only instrument that gives altitude information, the altimeter is one of the most vital instruments in the aircraft. However, the altimeter is calibrated with respect to standard atmospheric conditions, while air will actually seldom meet those standard conditions. Variations in atmospheric pressure and temperature will introduce errors into the altimeter's measurements. To use the altimeter effectively, its operation and how atmospheric pressure and temperature affect it must be thoroughly understood.

A stack of sealed aneroid wafers comprises the main component of the altimeter. Aneroid wafers expand and contract with changes in atmospheric pressure, in this case, pressure from the static source. The mechanical linkage translates these changes into pointer movements on the indicator.

Answer the following questions on a separate piece of paper, using the information above.

1. What is the pitot static system used for?
2. How is static pressure change delivered to the instruments?
3. Which instrument measures pitot (impact) pressure?
4. What does an airspeed indicator measure?
5. What does a vertical speed indicator measure?

Part 2 – Aircraft Manufacturers

Cessna Aircraft Company
The Cessna Aircraft Company traces its history to June 1911, when Clyde Cessna, a farmer in Rago, Kansas, built a wood-and-fabric plane and became the first person to build and fly an aircraft between the Mississippi River and the Rocky Mountains. Over the years since 1911, Cessna has produced many different types of aircraft and many of the models had variations.

Diamond Aircraft Industries

The Diamond story began in 1981 when Hoffmann Flugzeugbau was founded in Friesach, Austria, to produce the newly certified H36 Dimona motorglider. In 1992, the company, then known as Dimona Aircraft, established a full production facility in London, Ont., with a view to supplying the US market with its new aircraft. Later, after modifying its name to Diamond, the company grew into an international manufacturer with over 46 000 sq m of modern production facilities, over 800 employees, five distinct product lines, and facilities on three continents. The company's operation at the London, Ont. airport has over 23 000 sq m of state-of-the-art production facilities to design, build and test aircraft.

Piper Aircraft, Inc.

Originally founded as the Taylor Brothers Aircraft Manufacturing Company in September 1927, the company was renamed Taylor Brothers Aircraft Corporation in April of 1928 and then Piper Aircraft Corporation in November 1937.

Now located at Vero Beach, Florida, Piper's manufacturing capabilities cover a wide variety of fabrication, assembly, paint and inspection processes. The company also designs and builds its own tooling.
Piper's engineering design work is also comprehensive, with separate engineering groups responsible for aircraft certification, production support, customer service engineering, product development, engineering administration and test operations.

Viking Air

Viking Air is a manufacturing, maintenance and leasing company located at the Victoria International Airport in North Saanich, B.C.

Viking Air holds the Type Certificates for the following de Havilland aircraft:

- DHC-1 Chipmunk,
- DHC-2 Beaver,
- DHC-3 Otter,
- DHC-4 Caribou,
- DHC-5 Buffalo,
- DHC-6 Twin Otter, and
- DHC-7 Dash 7.

Airbus

Airbus is one of the world's two leading aircraft manufacturers. The company employs 57,000 people and produces a comprehensive range of heavy commercial aircraft.

Manufacturing, production and sub-assembly of parts for Airbus aircraft are distributed around 16 sites in Europe, with final assembly in Toulouse, France and Hamburg, Germany. Airbus draws on a global network of more than 1,500 suppliers in over 30 countries. There are also centres for engineering design, sales and customer support in North America; and sales and customer support centres in Japan and China. Airbus has a joint engineering centre in Russia with Kaskol, a Russian aircraft manufacturer.

Around the world, Airbus has 5 spare parts centres, 160 field sites, 3 training centres in Toulouse, Miami and Beijing and one A320 maintenance training centre in Hamburg. Airbus has an agreement with CAE (formerly Canadian Aviation Electronics Ltd.) to provide Airbus-approved training courses in many other sites around the world.

The Boeing Company
Headquartered in Chicago, Illinois, Boeing employs more than 150 000 people across the United States and in 70 other countries, with major operations in the Puget Sound area of Washington State, southern California and St. Louis, Missouri.

For more than a century, Boeing has produced a vast number of aircraft types. Some Boeing aircraft had historical significance that extended well beyond aviation; they actually changed the world. For example, America entered the age of jet transport on July 15, 1954, when the Boeing 707 prototype, the model 367-80, made its maiden flight from Renton Field, south of Seattle, Washington. Forerunner of the more than 14,000 Boeing jetliners built afterwards, the prototype, nicknamed the "Dash 80," served 18 years as a flying test laboratory before it was turned over to the Smithsonian Air and Space Museum in May 1972. The Boeing 707 was a very successful aircraft type.

Other popular Boeing aircraft, that are commonly seen, include the:
- Boeing 737,
- Boeing 747,
- Boeing 767, and
- Boeing 777.

Different aircraft are suitable for different routes, depending on such things as traffic volume. A large carrier such as Air Canada requires a variety of aircraft to suit a variety of applications.

Answer the following questions on a separate piece of paper, using the information above.
1. In what year and in what country was Diamond Aircraft Industries founded?
2. Name 3 aircraft that Viking Air holds certificates for.
3. Where does final assembly for Airbus take place?
4. On what day did the Boeing 707 prototype make its maiden voyage?

Part 3 – Aircraft Inspection

An aircraft operating in Canada is subject to inspections that allow the aircraft to operate safely. There are two main types of inspections:
- inspections performed by the pilot prior to flight, and
- inspections performed by a certified Aircraft Maintenance Engineer (AME) at designated intervals appropriate to the aircraft.

Pilot's Inspection Prior to Flight
Prior to every flight, a pilot completes a thorough inspection of the aircraft, which include:
- The overall appearance of the aircraft
- Fuselage and empennage
- Wings
- Fuel
- Engine and propeller
- Instruments
- Emergency locator transmitter
- Seat belts
- Doors and windows

It is extremely important to carry out a thorough pre-flight inspection. Small clues indicating a malfunctioning or damaged component may easily be missed in a hurried pre-flight check. Be vigilant after maintenance, painting or a modification job has been performed on the airplane. It is possible for components to be reinstalled incorrectly.

Pilot's Cockpit Check Prior to Flight
A systematic and careful cockpit check will be carried out prior to flight. The cockpit check will be made deliberately without haste using a written checklist. A definite sequence will be followed, moving clockwise around the cockpit. Each control will be touched and named aloud. Always work from a written checklist, not a memorized list, no matter how small the aircraft.

Aircraft's Required Inspections

Certificate of Airworthiness (C of A): A Transport Canada (TC) C of A can be issued for an aircraft, which fully complies with all standards of airworthiness certification (for its applicable type).

Annual Airworthiness Information Report (AAIR): The owner of a Canadian must submit an AAIR using the prescribed report form. The aircraft owner will complete the annual report by entering all data required and signing the certification to vouch that the information supplied is correct.

Approved Maintenance Schedules: All Canadian aircraft shall be maintained in accordance with an approved maintenance schedule, approved by the Minister of Transport, which meets the Aircraft Equipment and Maintenance Standard. Approved maintenance schedules shall:

- be based upon data obtained from an approved maintenance review board (MRB) report; or
- where no current MRB report exists, be based upon data obtained from:
    - the current recommendations of the aircraft manufacturer,
    - a maintenance schedule approved by the Minister for use by another operator, or
    - any other data acceptable to the Minister.

Answer the following questions on a separate piece of paper, using the information above.

1. When does a pilot perform an inspection of the aircraft?
2. When does an AME perform an inspection of the aircraft?
3. What is used to guide a cockpit check?
4. How often must an AAIR be submitted?
5. Who approves a maintenance schedule?