

## WEATHER THEORY

### Temperature, Pressure And Moisture

Every physical process of weather is a result of a heat exchange.

The standard sea level temperature is 59 degrees F, or 15 degrees C. It decreases an average of 3 1/2 degrees F per 1000 ft, or 2 degrees C.

The standard sea level pressure is 29.92k Hg. Pressure decreases one inch per 1000 feet.

The amount of water vapor which air can hold largely depends on air temperature. Warm air can hold more moisture than cold air.

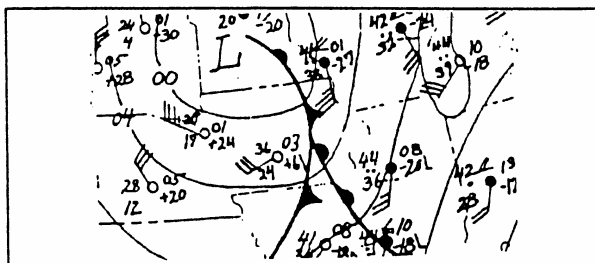
Dew point is the temperature to which the air must be cooled to become saturated. Relative humidity (given in percent) is the amount of moisture in the air compared to the amount the air could hold at that temperature.

Moisture is added to unsaturated air by the processes of evaporation and sublimation.

Clouds, fog or dew will always form when water vapor condenses. When the temperature-dew point spread decreases below 4 degrees F, you can expect decreasing visibility due to an obscuration, fog, low clouds or precipitation.

Determine the base of cumulus clouds by dividing the temperature-dew point spread by 4.4 degrees F.

### Pressure Systems



Variations in altimeter settings between weather reporting points is caused by unequal heating of the earth's surface.

Above 2000 AGL, wind flow is parallel to isobars. The difference in surface wind and winds aloft is primarily due to friction between the wind and the surface.

### Air Masses And Fronts

A front is a boundary between two masses of air that differ in temperature, pressure and/or moisture content.

When flying across a front, you will always encounter a change in wind and temperature. One of the most easily recognized discontinuities across a front is temperature.

### Stability

Stability of the atmosphere can be determined by the ambient (actual) temperature lapse rate.

Warming from below decreases the stability of an air mass.

In general:

Stability	Stable	Unstable
Characteristic	Warm air over cold surface.	Cold air over warm surface
Cloud type	Stratiform	Cumuliform
Smoothness	Smooth air	Turbulent
Frontal type	Warm front	Cold front
Precipitation	Steady rain	Showers and thunderstorms
Visibility	Poor	Good

Unstable air forced upward will cause clouds with considerable vertical development and associated turbulence. Moist, stable air flowing upslope will produce stratus type clouds.

Clouds are divided into four families, according to height. (Low, medium, high and those with extensive vertical development.)

### Temperature Inversions

A temperature inversion exists where there is an increase in temperature as altitude is increased.

Air is stable. Expect smooth air and poor visibility due to fog, haze, or low clouds.

The most frequent type of ground based inversion is that produced by terrestrial radiation on a clear, relatively still night.



### Lenticular Clouds

Standing lenticular clouds are stationary lens-shaped clouds that show little or no movement, but contain strong winds and turbulence.

Possible mountain wave turbulence can be anticipated when winds, of 40 knots or greater blow across a mountain ridge, and the air is stable.

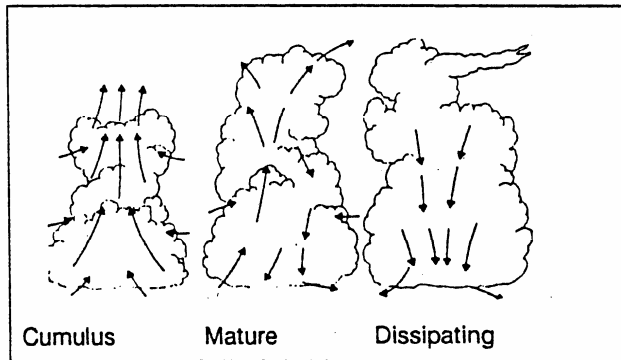
### Wind Shear

Wind shear is a change in wind direction and/ or speed in a horizontal or vertical direction, and occurs at all altitudes.

It may be encountered during periods of strong temperature inversion. Expect wind shear in an inversion when winds at 2000 to 4000 feet above the surface are at least 25 knots.

Upon encountering severe turbulence, attempt to maintain a level flight attitude.

### Cumulonimbus Clouds (Thunderstorms)



Towering cumulus clouds have convective turbulence, but have not yet become thunderstorms.

The suffix nimbus refers to a rain cloud. Cumulonimbus clouds have the greatest turbulence, and lightning is always associated with thunderstorms. The wind shear turbulence creates the most hazard.

The three ingredients needed to form a thunderstorm are unstable air, high humidity, and a lifting action

### Thunderstorms (Cont)

The thunderstorm has 3 stages or life cycles:

**CUMULUS (Building)** - Continuous updrafts extend from the earth to above the, cloud tops.

**MATURE** - Updrafts and downdrafts are present. This stage is recognized by rainfall at the surface. The thunderstorm reaches its greatest intensity.

**DISSIPATING** - Comprised of downdrafts.

Embedded thunderstorms are obscured by massive cloud layers and cannot be seen.

A squall line is a non-frontal narrow band of active thunderstorms that often develop ahead of a cold front. Squall line thunderstorms produce the most severe conditions, such as heavy hail and destructive winds.

### Structural Icing

Structural icing will not occur unless there is visible moisture.

The highest rate of accumulation of icing will be found in freezing rain.

Ice pellets at the surface are evidence that freezing rain exists at a higher altitude.

Frost will form if the temperature of the collecting surface is at or below the dew point of the adjacent air and the dew point is below freezing. It spoils the smooth flow of air over the wings, resulting in loss of lift, and may prevent an airplane from becoming airborne.

### Fog

Radiation fog occurs with warm, moist air over low, flatland areas on clear, calm nights.

Advection fog occurs when an air mass moves inland from the coast. It requires wind, as does upslope fog.

Low level turbulence and icing can occur in steam fog.

3206. H951

How will frost on the wings of an airplane affect takeoff performance?

- A)** Frost will disrupt the smooth flow of air over the wing, adversely affecting its lifting capability.
- B) Frost will change the camber of the wing, increasing its lifting capability.
- C) Frost will cause the airplane to become airborne with a higher angle of attack, decreasing the stall speed.

3381. I21

Every physical process of weather is accompanied by, or is the result of, a

- A) movement of air.
- B) pressure differential.
- C)** heat exchange.

3382. I21

What causes variations in altimeter settings between weather reporting points?

- A)** Unequal heating of the Earth's surface.
- B) Variation of terrain elevation.
- C) Coriolis force.

3383. I21

A temperature inversion would most likely result in which weather condition?

- A) Clouds with extensive vertical development above an inversion aloft.
- B) Good visibility in the lower levels of the atmosphere and poor visibility above an inversion aloft.
- C)** An increase in temperature as altitude is increased.

3384. I21

The most frequent type of ground or surface-based temperature inversion is that which is produced by

- A)** terrestrial radiation on a clear, relatively still night.
- B) warm air being lifted rapidly aloft in the vicinity of mountainous terrain.
- C) the movement of colder air under warm air, or the movement of warm air over cold air.

3385. I21

Which weather conditions should be expected beneath a low-level temperature inversion layer when the relative humidity is high?

- A)** Smooth air, poor visibility, fog, haze, or low clouds.
- B) Light wind shear, poor visibility, haze, and light rain.
- C) Turbulent air, poor visibility, fog, low stratus type clouds, and showery precipitation.

3386. H951

What are the standard temperature and pressure values for sea level?

- A)** 15 °C and 29.92 inches Hg.
- B) 59 °C and 1013.2 millibars.
- C) 59 °F and 29.92 millibars.

3395. I23

The wind at 5,000 feet AGL is southwesterly while the surface wind is southerly. This difference in direction is primarily due to

- A) stronger pressure gradient at higher altitudes.
- B)** friction between the wind and the surface.
- C) stronger Coriolis force at the surface.

3397. I24

What is meant by the term 'dewpoint'?

- A) The temperature at which condensation and evaporation are equal.
- B) The temperature at which dew will always form.
- C)** The temperature to which air must be cooled to become saturated.

3398. I24

The amount of water vapor which air can hold depends on the

- A) dewpoint.
- B)** air temperature.
- C) stability of the air.

3399. I24

Clouds, fog, or dew will always form when

- A)** water vapor condenses.
- B) water vapor is present.
- C) relative humidity reaches 100 percent.

3400. I24

What are the processes by which moisture is added to unsaturated air?

- A)** Evaporation and sublimation.
- B) Heating and condensation.
- C) Supersaturation and evaporation.

3401. I24

Which conditions result in the formation of frost?

- A) The temperature of the collecting surface is at or below freezing when small droplets of moisture fall on the surface.
- B)** The temperature of the collecting surface is at or below the dewpoint of the adjacent air and the dewpoint is below freezing.
- C) The temperature of the surrounding air is at or below freezing when small drops of moisture fall on the collecting surface.

**NOTE: CORRECT ANSWER IN IS BOLD ITALICS**



3402. I24

The presence of ice pellets at the surface is evidence that there

- A) are thunderstorms in the area.
- B) has been cold frontal passage.
- C) is a temperature inversion with freezing rain at a higher altitude.**

3403. I25

What measurement can be used to determine the stability of the atmosphere?

- A) Atmospheric pressure.
- B) Actual lapse rate.**
- C) Surface temperature.

3404. I25

What would decrease the stability of an air mass?

- A) Warming from below.**
- B) Cooling from below.
- C) Decrease in water vapor.

3405. I25

What is a characteristic of stable air?

- A) Stratiform clouds.**
- B) Unlimited visibility.
- C) Cumulus clouds.

3406. I25

Moist, stable air flowing upslope can be expected to

- A) produce stratus type clouds.**
- B) cause showers and thunderstorms.
- C) develop convective turbulence.

3407. I25

If an unstable air mass is forced upward, what type clouds can be expected?

- A) Stratus clouds with little vertical development.
- B) Stratus clouds with considerable associated turbulence.
- C) Clouds with considerable vertical development and associated turbulence.**

3408. I25

What feature is associated with a temperature inversion?

- A) A stable layer of air.**
- B) An unstable layer of air.
- C) Chinook winds on mountain slopes.

3409. I25

What is the approximate base of the cumulus clouds if the surface air temperature at 1,000 feet MSL is 70 °F and the dewpoint is 48 °F?

- A) 4,000 feet MSL.
- B) 5,000 feet MSL.
- C) 6,000 feet MSL.**

3410.

At approximately what altitude above the surface would the pilot expect the base of cumuliform clouds if the surface air temperature is 82 °F and the dewpoint is 38 °F

- A) 9,000 feet AGL.
- B) 10,000 feet AGL.**
- C) 11,000 feet AGL.

3412.

What are characteristics of a moist, unstable air mass?

- A) Cumuliform clouds and showery precipitation.**
- B) Poor visibility and smooth air.
- C) Stratiform clouds and showery precipitation.

3413.

What are characteristics of unstable air?

- A) Turbulence and good surface visibility.**
- B) Turbulence and poor surface visibility.
- C) Nimbostratus clouds and good surface visibility.

3414. H955 PVT

A stable air mass is most likely to have which characteristic?

- A) Showery precipitation.
- B) Turbulent air.
- C) Poor surface visibility.**

3415. I26

The suffix 'nimbus,' used in naming clouds, means

- A) a cloud with extensive vertical development.
- B) a rain cloud.**
- C) a middle cloud containing ice pellets.

3416. I26

Clouds are divided into four families according to their

- A) outward shape.
- B) height range.**
- C) composition.

3417. I26

An almond or lens-shaped cloud which appears stationary, but which may contain winds of 50 knots or more, is referred to as

- A) an inactive frontal cloud.
- B) a funnel cloud.
- C) a lenticular cloud.**

3418. I26

Crests of standing mountain waves may be marked by stationary, lens-shaped clouds known as

- A) mammatocumulus clouds.
- B) standing lenticular clouds.**
- C) roll clouds.

**NOTE: CORRECT ANSWER IN IS BOLD ITALICS**

3419. I26

What clouds have the greatest turbulence?

- A) Towering cumulus.
- B) Cumulonimbus.**
- C) Nimbostratus.

3420. I26

What cloud types would indicate convective turbulence?

- A) Cirrus clouds.
- B) Nimbostratus clouds.
- C) Towering cumulus clouds.**

3421. I27

The boundary between two different air masses is referred to as a

- A) frontolysis.
- B) frontogenesis.
- C) front.**

3422. I27

One of the most easily recognized discontinuities across a front is

- A) a change in temperature.**
- B) an increase in cloud coverage.
- C) an increase in relative humidity.

3423. I27

One weather phenomenon which will always occur when flying across a front is a change in the

- A) wind direction.**
- B) type of precipitation.
- C) stability of the air mass.

3424. I27

Steady precipitation preceding a front is an indication of

- A) stratiform clouds with moderate turbulence.
- B) cumuliform clouds with little or no turbulence.
- C) stratiform clouds with little or no turbulence.**

3425. I28

Possible mountain wave turbulence could be anticipated when winds of 40 knots or greater blow

- A) across a mountain ridge, and the air is stable.**
- B) down a mountain valley, and the air is unstable.
- C) parallel to a mountain peak, and the air is stable.

3426. H951

Where does wind shear occur?

- A) Only at higher altitudes.
- B) Only at lower altitudes.
- C) At all altitudes, in all directions.**

**NOTE: CORRECT ANSWER IN IS BOLD ITALICS**

3427. I28

When may hazardous wind shear be expected?

- A) When stable air crosses a mountain barrier where it tends to flow in layers forming lenticular clouds.
- B) In areas of low-level temperature inversion, frontal zones, and clear air turbulence.**
- C) Following frontal passage when stratocumulus clouds form indicating mechanical mixing.

3428. I28

A pilot can expect a wind-shear zone in a temperature inversion whenever the windspeed at 2,000 to 4,000 feet above the surface is at least

- A) 10 knots.
- B) 15 knots.
- C) 25 knots.**

3429. I28

One in-flight condition necessary for structural icing to form is

- A) small temperature/dewpoint spread.
- B) stratiform clouds.
- C) visible moisture.**

3430. I29

In which environment is aircraft structural ice most likely to have the highest accumulation rate?

- A) Cumulus clouds with below freezing temperatures.
- B) Freezing drizzle.
- C) Freezing rain.**

3431. I29

Why is frost considered hazardous to flight?

- A) Frost changes the basic aerodynamic shape of the airfoils, thereby decreasing lift.
- B) Frost slows the airflow over the airfoils, thereby increasing control effectiveness.
- C) Frost spoils the smooth flow of air over the wings, thereby decreasing lifting capability.**

3432.

How does frost affect the lifting surfaces of an airplane on takeoff?

- A) Frost may prevent the airplane from becoming airborne at normal takeoff speed.**
- B) Frost will change the camber of the wing, increasing lift during takeoff.
- C) Frost may cause the airplane to become airborne with a lower angle of attack at a lower indicated airspeed.

3433. I30

The conditions necessary for the formation of cumulonimbus clouds are a lifting action and

- A) unstable air containing an excess of condensation nuclei.
- B) unstable, moist air.**
- C) either stable or unstable air.

3434. I30

What feature is normally associated with the cumulus stage of a thunderstorm?

- A) Roll cloud.
- B) Continuous updraft.**
- C) Frequent lightning.

3435. I30

Which weather phenomenon signals the beginning of the mature stage of a thunderstorm?

- A) The appearance of an anvil top.
- B) Precipitation beginning to fall.**
- C) Maximum growth rate of the clouds.

3436. I30

What conditions are necessary for the formation of thunderstorms?

- A) High humidity, lifting force, and unstable conditions.**
- B) High humidity, high temperature, and cumulus clouds.
- C) Lifting force, moist air, and extensive cloud cover.

3437. I30

During the life cycle of a thunderstorm, which stage is characterized predominately by downdrafts?

- A) Cumulus.
- B) Dissipating.**
- C) Mature.

3438. I30

Thunderstorms reach their greatest intensity during the

- A) mature stage.**
- B) downdraft stage.
- C) cumulus stage.

3439. I30

Thunderstorms which generally produce the most intense hazard to aircraft are

- A) squall line thunderstorms.**
- B) steady-state thunderstorms.
- C) warm front thunderstorms.

3440. I30

A nonfrontal, narrow band of active thunderstorms that often develop ahead of a cold front is known as a

- A) prefrontal system.
- B) squall line.**
- C) dry line.

3452. I36

Which weather phenomenon is always associated with a thunderstorm?

- A) Lightning.**
- B) Heavy rain.
- C) Hail.

3441. I30

If there is thunderstorm activity in the vicinity of an airport at which you plan to land, which hazardous atmospheric phenomenon might be expected on the landing approach?

- A) Precipitation static.
- B) Wind-shear turbulence.**
- C) Steady rain.

3442. I30

Upon encountering severe turbulence, which flight condition should the pilot attempt to maintain?

- A) Constant altitude and airspeed.
- B) Constant angle of attack.
- C) Level flight attitude.**

3443. I31

What situation is most conducive to the formation of radiation fog?

- A) Warm, moist air over low, flatland areas on clear, calm nights.**
- B) Moist, tropical air moving over cold, offshore water.
- C) The movement of cold air over much warmer water.

3444. I31

If the temperature/dewpoint spread is small and decreasing, and the temperature is 62 °F, what type weather is most likely to develop?

- A) Freezing precipitation.
- B) Thunderstorms.
- C) Fog or low clouds.**

3445. I31

In which situation is advection fog most likely to form?

- A) A warm, moist air mass on the windward side of mountains.
- B) An air mass moving inland from the coast in winter.**
- C) A light breeze blowing colder air out to sea.

3446. I31

What types of fog depend upon wind in order to exist?

- A) Radiation fog and ice fog.
- B) Steam fog and ground fog.
- C) Advection fog and upslope fog.**

3447. I33

Low-level turbulence can occur and icing can become hazardous in which type of fog?

- A) Rain-induced fog.
- B) Upslope fog.
- C) Steam fog.**

**NOTE: CORRECT ANSWER IN IS BOLD ITALICS**