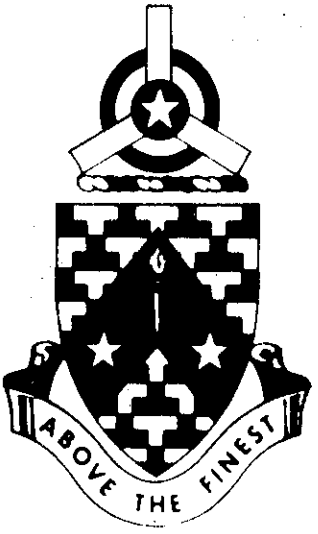
PROGRAMED TEXT

PRESSURE AND WINDS

AM-32I



OCTOBER 1968

UNITED STATES ARMY
PRIMARY HELICOPTER SCHOOL
FORT WOLTERS, TEXAS

PROGRAMED TEXT

PROGRAM TEXT

FILE NO: AM-32I

PROGRAM TITLE

PRESSURE AND WINDS

POI SCOPE: Explanation of the effects of pressure in the atmosphere to include altimeter error, identity of the standard reference plane, identity of and weather connected with high and low pressure systems plus associated winds.

INSTRUCTOR REFERENCES:

TM 1-300
Chap 2

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October 1968

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October 1968

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Pressure and Winds

PREFACE

The Army aviator frequently encounters problems associated with winds, pressure, and temperature. In order to cope with these problems and select the appropriate courses of action, the aviator must have a thorough understanding of the meteorological concepts involved.

This programed text is designed to acquaint you with these concepts and the flight procedures necessary to accomplish your mission.

Start with frame 1 and work each frame in succession. Each frame will usually ask you a question. The correct answer is printed on the top of the next frame. If you were incorrect, turn back and restudy the information before continuing on to the next frame. When you have finished the text, complete the self evaluation exercise. Now begin by studying the performance objectives on page 1.

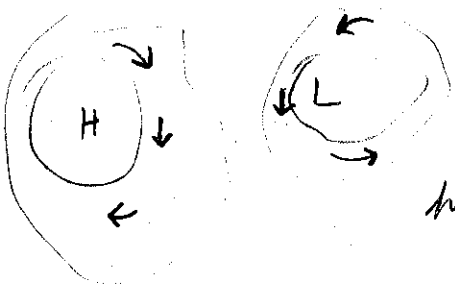
PERFORMANCE OBJECTIVES

Upon completion of this program, you will be able to:

1. Identify the effects of vertical pressure changes on the aircraft altimeter.
2. Identify the base or standard reference plane from which pressure and altitude are measured.
3. Identify low and high pressure systems and the weather associated with each.
4. Identify wind flow patterns in relation to isobars and pressure centers.

bad weather, clouds are extensive, bad

(4.) – high to a low pressure gradient. wind orientation isobar spac.



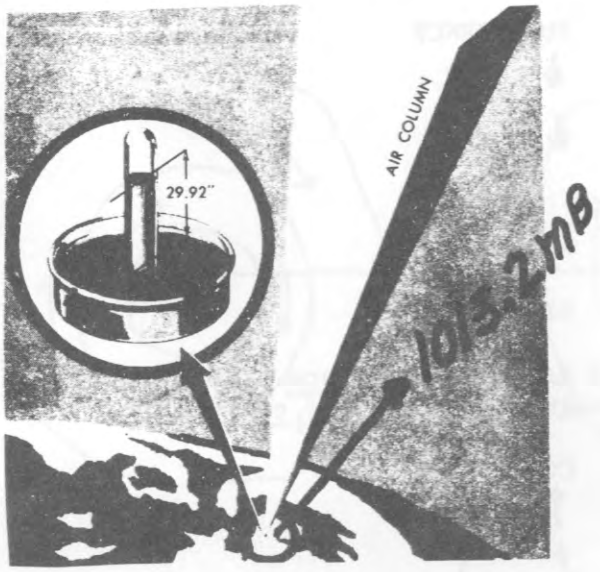
if a low is left the wind hits you in the back

if you drift right you are in a high and moving out.

FRAME 1

Pressure is defined as a force per unit area. (P=F/A)

Atmospheric pressure is the pressure exerted by the atmosphere as a result of gravitational attraction acting upon a column of air lying directly above a point on the surface of the earth.



In this diagram, the column of air is shown exerting a pressure over a specific point on the earth.

Pressure can be measured in pounds per square inch (psi), inches of mercury ("Hg), or millibars (mb).

On a standard day (15°C or 59°F), a column of air will exert a pressure equivalent to: 14.7 psi, 29.92 "Hg, or 1013.2 mb at mean sea level (MSL).

The United States uses inches of mercury (Hg) to express altimeter settings, but many foreign nations use the millibar reading.

To convert millibars to inches of mercury

1 inch "Hg" = 34 mb

1 mb = 0.03 inch "Hg"

Standard atmospheric pressure is

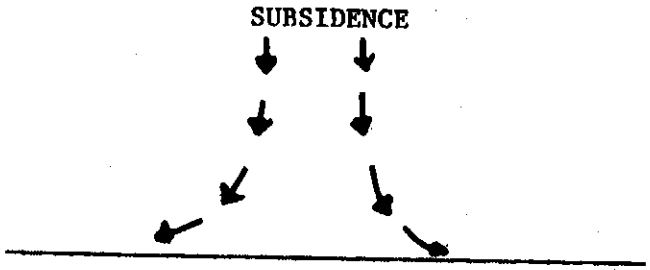
a. 15°C.
b. 17.4 psi.
c. 1013.2 mb.
d. 29.95 "Hg.

TURN TO PAGE 3 FOR FRAME 2

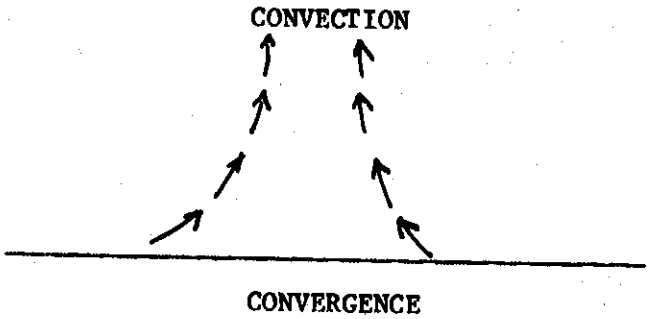
ANSWER: b. pressure gradient and coriolis.

FRAME 8.

The movement of air out of a High is called divergence. This air is replaced by air descending into the High from the upper atmosphere through the process of subsidence.



Air movement into a Low is called convergence. This air rises from the center of low pressure through the process of convection.



Two terms associated with high pressure systems are

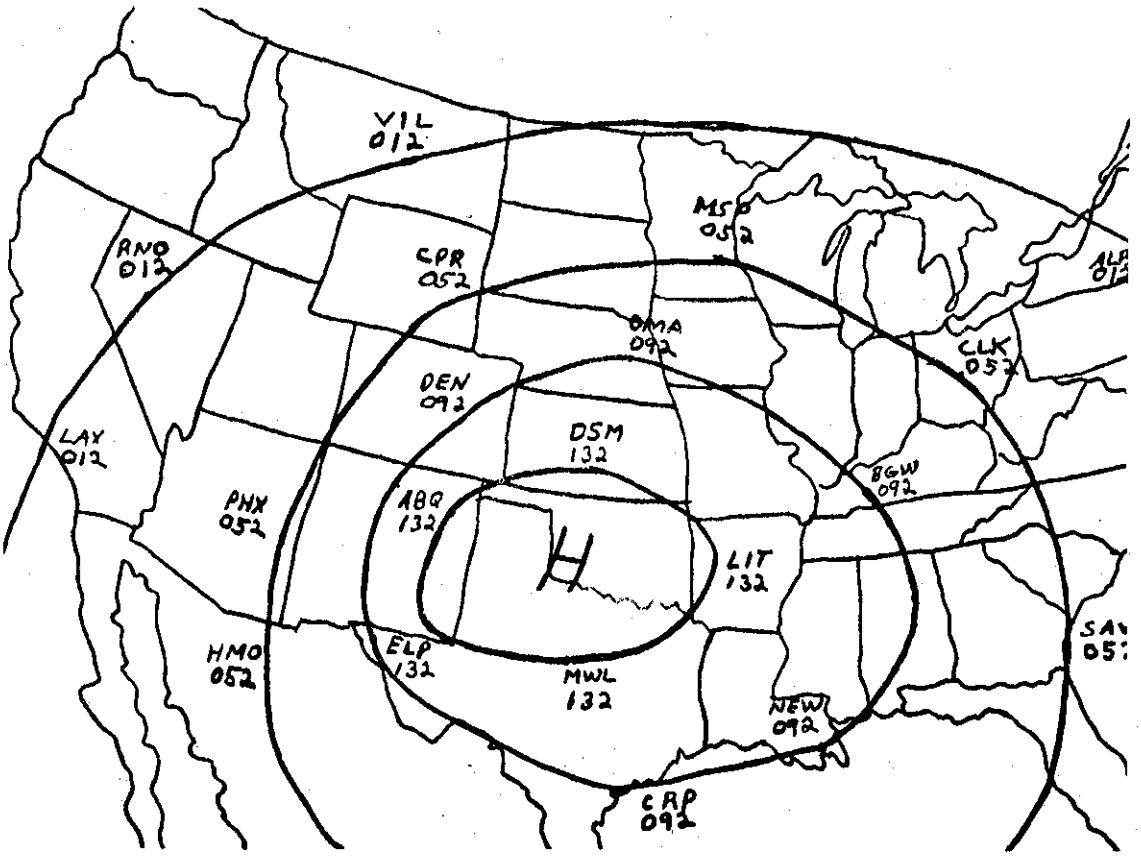
a. convergence and convections.
b. convergence and divergence.
c. divergence and convection.
d. divergence and subsidence.

TURN TO PAGE 4 FOR FRAME 9

ANSWER: c. 1013.2 mb

FRAME 2.

If the pressures, at various locations on the map, were measured and converted to mean sea level values, the locations reporting equal pressure values could be connected by lines called isobars. Standard procedure on maps of North America is to draw isobars 4 millibars apart. The isobars will then show the location, shape, and size of pressure systems.



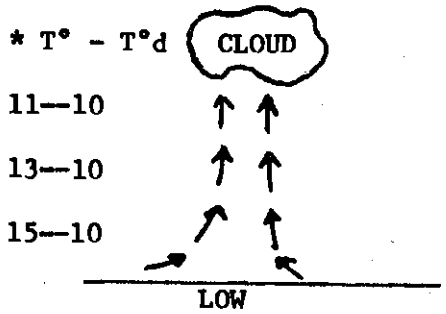
An isobar is defined as a

a. line connecting points of equal temperature.
b. line connecting points of equal MSL pressure.
c. line connecting points of equal station pressure.
d. line connecting points of equal relative humidity.

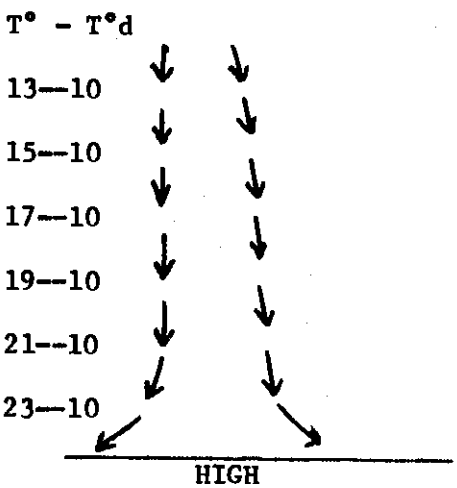
ANSWER: d. divergence and subsidence.

FRAME 9.

As a result of subsidence (descending air) in a high pressure system, and convection (rising air) in a low pressure system, good weather is generally associated with a High while poor weather often occurs in a Low.



Rising air cools causing its temperature to approach the dew point. Condensation occurs and clouds develop.



Descending air warms causing its temperature to rise farther above the dew point. As a result, condensation does not occur and clouds do not form.

	Ceiling	Visibility	Wind	Precipitation
High	none	good	light	no precipitation
Low	low	poor	strong	showers & rain

Flying from a High to a Low, you would expect

a. good weather enroute.
b. poor weather enroute.
c. good weather as you approach the Low.
(d.) poor weather as you approach the Low.

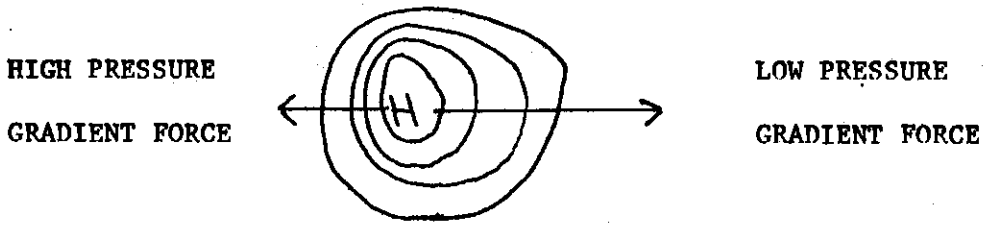
* T° = Temperature

T°d = dew point

ANSWER: b. line connecting points of equal MSL pressure.

FRAME 3.

The rate of pressure change, across the isobars, is called the pressure gradient. If the isobars are close together, the pressure gradient force will be greater than where the isobars are farther apart.



The pressure gradient force is the first physical force that affects the movement of air. The speed of air movement, or winds is dependent upon the intensity of the pressure gradient force.

If the isobaric pattern shows closely spaced isobars, you would expect the winds to be

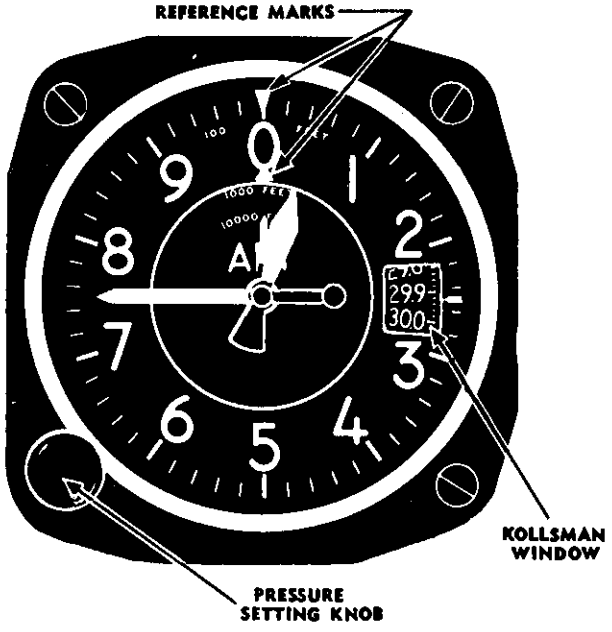
a. strong.
b. light.
c. moderate.
d. variable.

ANSWER: d. poor weather as you approach the low.

FRAME 10.

The altimeter in your aircraft is basically an aneroid barometer. It responds to pressure variations by varying the indicated altitude.

When the aviator places the correct mean sea level pressure in the Kollsman Window, the altimeter registers the aircraft's altitude above MSL. If the aircraft is on the ground, at an airport, the field elevation will be indicated on the altimeter.

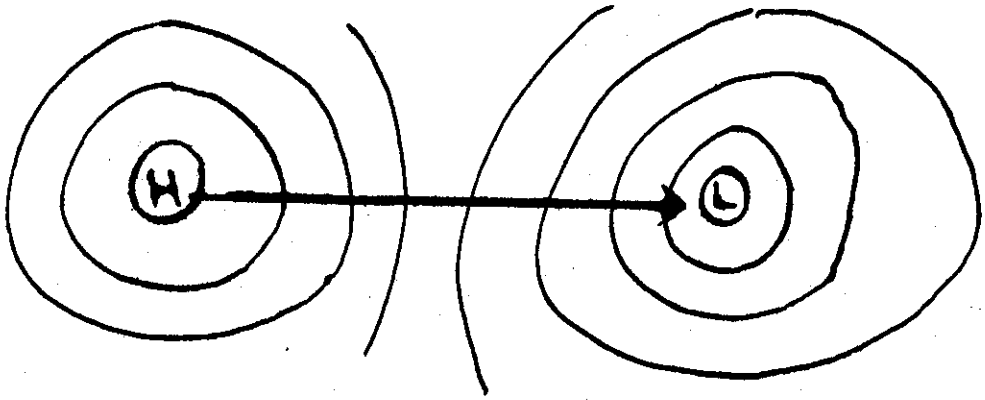


In the above diagram, the altimeter indicates that field elevation is 750 MSL ft.

ANSWER: a. strong.

FRAME 4.

Air tends to move from an area of high pressure to an area of low pressure, in accordance with the pressure gradient.



A high pressure area (H) is formed by an isobaric pattern in which the highest pressure exists at the center. It is also called anti-cyclone. In a low pressure area, the lowest pressure is found at the center and it is identified by the letter L. A low is often referred to as a cyclone.

Low Pressure Area = Low = L = cyclone
High Pressure Area = High = H = anticyclone

In flying from a high to a low, you would expect the pressure to

a. increase.
b. decrease.
c. remain the same.

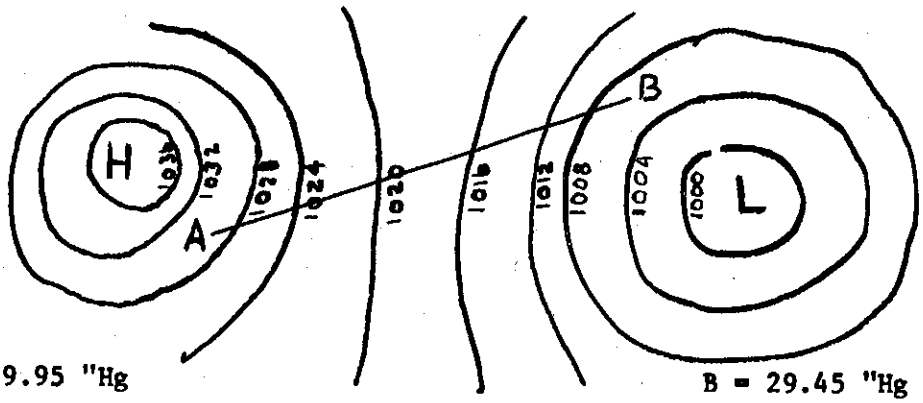
If the isobars are widely spaced, you would anticipate

a. light winds.
b. strong winds.
c. severe weather

ANSWER: 750 ft MSL

FRAME 11.

It is important that the altimeter setting, in the Kollsman Window, corresponds with the actual mean sea level pressure. In flight, an aircraft may enter an area of higher or lower atmospheric pressure if the aviator does not adjust his altimeter setting to the correct mean sea levle pressure, while enroute, his altimeter will not indicate the correct altitude.



Flying from an area of higher pressure to an area of lower pressure, an aircraft will be lower than the indicated altitude unless the altimeter setting is corrected to the new area.

From point A to point B (High Low) the aircraft will be lower than indicated altitude.

An aviator would do well to remember the general rule:

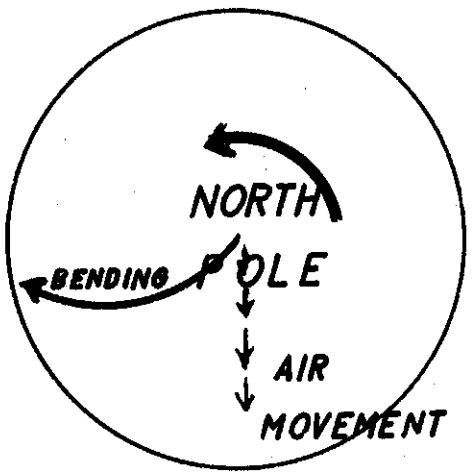
From a High to a Low, look out below;
From Low to High, clear the sky!

The pressure - altitude variation can be determined by using the conversion: 1"Hg = 1000 ft.

ANSWER: b. decrease
a. light winds

FRAME 5.

The second force, affecting air movement is called coriolis and is due to the rotation of the earth about its axis. A detailed explanation of coriolis is beyond the scope of this course. It is important for the Army aviator to remember that, as a result of coriolis force, all winds in the northern hemisphere are bent to the right.



COUNTERCLOCKWISE ROTATION OF THE EARTH

In the southern hemisphere, the winds are bent to the left since the earth rotates clockwise when viewed from the south pole.

Air moving eastward (from a High to a Low) across the United States

a. would not be affected by coriolis force.
b. would bend to the right.
c. would bend to the left.

FRAME 11 (Continued)

Example:

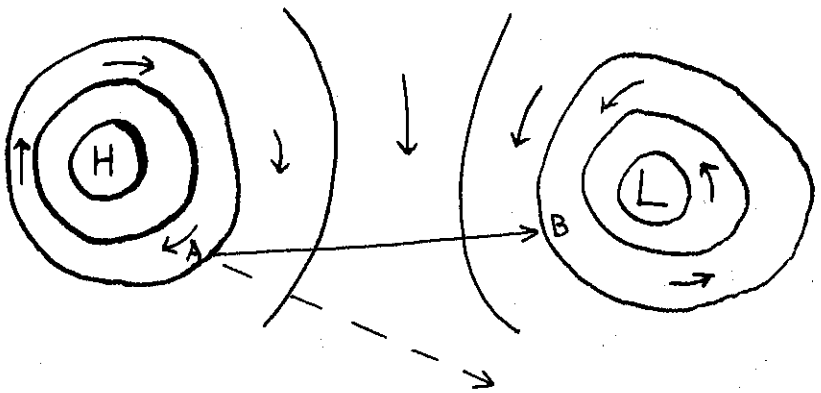
A _____ B

(Alt Set)-29.95 (Alt Set)-29.45

Pressure change = .5 "Hg
.5"Hg = 500 ft.

The aircraft would be 500 ft lower than the indicated altitude.

One method for determining whether you are flying to an area of different pressure is to observe drift tendencies.



You have already learned that the air circulation is clockwise around a High and counterclockwise around a Low, in the northern hemisphere.

Flying from point A to point B, you notice that you have been drifting to the right of your course. In all probability, you are flying from an area of higher to lower pressure. You should contact a flight service station, enroute, for an accurate altimeter setting.

From point B to point A, you would be drifting to theleft and, therefore, you are flying to an area of higher pressure.

With a direct headwind or tailwind, you would expect no significant pressure changes enroute.

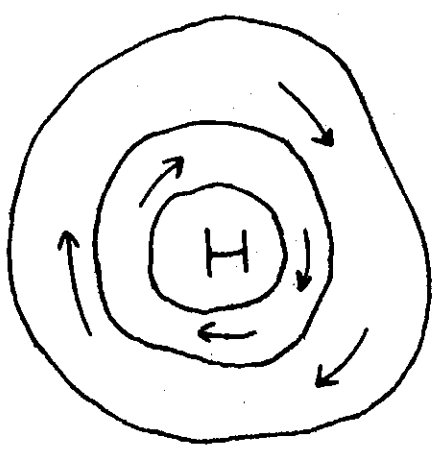
On a flight from MWL (Mineral Wells) to SHV (Shreveport), you are informed by the tower operator that the altimeter setting at MWL is 30.00"Hg. You decide to fly at an altitude of 2000 ft. Three miles out from SHV, you call for landing instructions and the tower operator gives an altimeter setting of 29.40"Hg. What is your actual altitude?

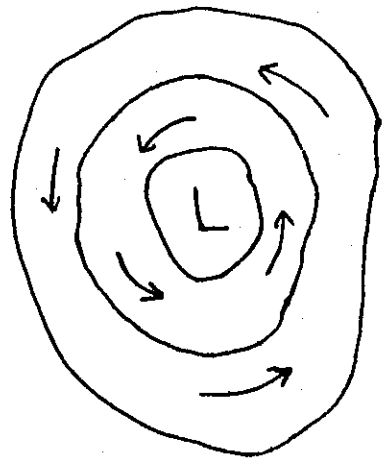
a. 2600 ft.
b. 2000 ft.
c. 1400 ft.
d. 2400 ft.

ANSWER: b. would bend to the right.

FRAME 6.

Air moving out of a high pressure center is bent to the right in the northern hemisphere and flows parallel to the isobars. The rotation around the High is clockwise.





In the northern hemisphere, air moving into a low pressure center would flow counterclockwise around the Low and parallel to the isobars as a result of coriolis force.

Coriolis force results in a change in the direction of the wind but does not affect wind speed.

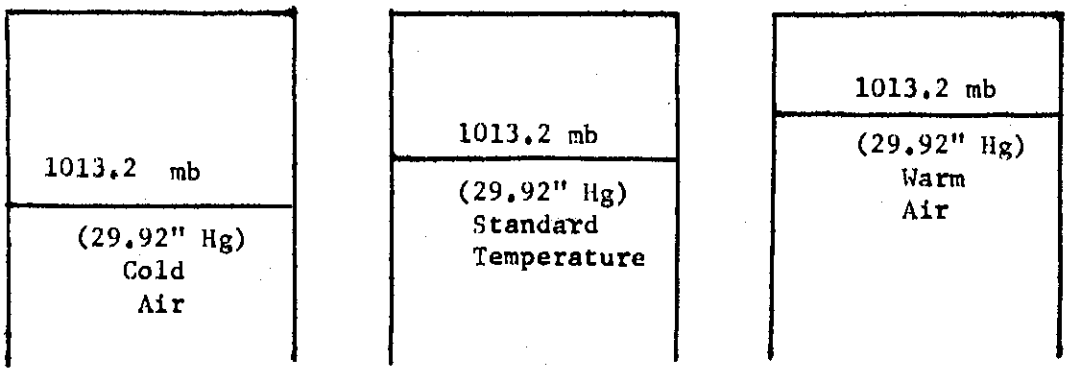
Cyclonic circulations refers to

a. clockwise rotation around a High.
b. counterclockwise rotation around a Low.
c. high intensity winds in a tornado.

ANSWER: c. 1400 ft.

FRAME 12.

Altimeter errors can also result from temperature changes. Increasing temperature results in decreased air density.



A specific millibar level will be higher than standard in warm air, and lower than standard in cold air.

Flying from an area of lower temperature to an area of higher temperature, you would be higher than your indicated altitude therefore, the same rule applies with temperature as with pressure:

From high to low (temp), look out below;
from low to high (temp), clear the sky!

Temperature errors cannot be corrected in the altimeter. Flying to an area of colder temperature, the aviator should be aware that he will be lower than indicated altitude. On an IFR flight he should select a sufficiently high altitude to avoid obstructions on the surface.

On a flight from point A to point B, you have insured that your altimeter setting is current. You have noticed from the outside air temperature gauge that the temperature has dropped 20°C. You are

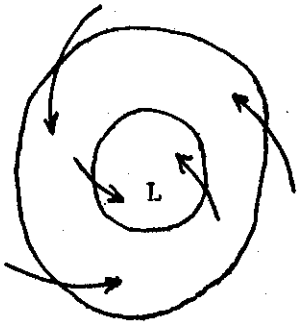
a. below your indicated altitude.
b. above your indicated altitude.
c. at your indicated altitude.
d. unable to determine what your altitude is.

ANSWER: b. counterclockwise rotation around a low.

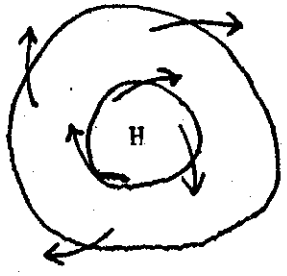
FRAME 7.

The third force affecting winds is friction and is the result of contact between the air and the earth's surface. Frictional force reduces wind speed and decreases the effect of coriolis. This causes another bending of the winds:

toward the center of low pressure.



away from the center of high pressure.



Frictional force is generally effective at altitudes to 2000 ft above the surface. Above this level, winds would tend to be parallel to the isobars.

At an absolute altitude of 5000 ft the forces affecting winds are:

a. pressure gradient, coriolis, and friction.
b. pressure gradient, and coriolis.
c. pressure gradient and friction.
d. coriolis and friction.

STOP - TURN TO FRAME 8 ON PAGE 2.

ANSWER: a. below your indicated altitude.

SUMMARY

Pressure = 1013.2 mb
29.92 "Hg
14.7 psi
Standard day

Isobars = lines connecting points of equal MSL pressure, drawn 4 mb apart.

Pressure gradient = rate of pressure change across the isobars

close spacing - strong pressure gradient = strong winds
wide spacing - weak pressure gradient = light winds

L = Low = low pressure area = cyclone
H = High = high pressure area = anticyclone

Coriolis = apparent force that bends the winds to the right in the northern hemisphere, to the left in the southern hemisphere.

Friction = Physical force, below 2000 feet, that reduces the effect of coriolis. Wind speed is reduced, and air moves across the isobars toward the center of low pressure and away from the center of high pressure.

Altimeter errors: pressure variations (including drift)
temperature variations

COMPLETE THE SELF EVALUATION EXERCISE ON PAGE 15.

PRESSURE AND WINDS
SELF EVALUATION EXERCISE

1. Pressure systems are

   a. temperature patterns over the earth's surface.
   b. isobaric patterns identified as either High or Low.
   c. wind patterns directed by coriolis forces.
   d. systems formed by differential relative humidities.

2. Three primary forces affecting winds are

   a. centrifugal, centripidal, and refraction.
   b. coriolis, friction, and refraction.
   c. vapor pressure, friction, and coriolis.
   d. pressure gradient, coriolis, and friction.

3. Air tends to move

   a. from a Low to a High.
   b. from a High to a Low.
   c. from a cold area to a warm area.
   d. from a warm area to a cold area.

4. When flying from a low pressure area to a high pressure area, you would expect to be

   a. lower than the indicated altitude.
   b. higher than the indicated altitude.
   c. at the altitude indicated on the altimeter.
   d. to the right of your course.

5. In the center of a high pressure system, you can normally expect

   a. strong surface winds and bad weather.
   b. strong surface winds and good weather.
   c. light surface winds and bad weather.
   d. light surface winds and good weather.

6. The spacing between the isobars is an indication of

   a. relative humidity.
   b. temperature.
   c. visibility.
   d. wind speed.

7. Cyclonic circulation in the northern hemisphere refers to

a. clockwise winds around a High.
b. counter clockwise winds around a High.
c. clockwise winds around a Low.
d. counter clockwise winds around a Low.

8. On a standard day, the atmospheric pressure at mean sea level is

a. 1012.3 millibars.
b. 29.92 inches of mercury.
c. 299.2 millibars.
d. 10.13 inches of mercury.

9. Flying from a warm area to an area reporting colder temperature, you would expect to be

a. higher than the indicated altitude.
b. lower than the indicated altitude.
c. at the indicated altitude.
d. either higher or lower depending on the season of the year.

10. The altimeter in your aircraft will register MSL altitude if

a. you place 29.92 in the Kollsman Window.
b. you place the current altimeter setting in the Kollsman Window.
c. you adjust the needles to "0" before take-off.
d. you adjust the Kollsman Window to the current station pressure.

ANSWER KEY ON PAGE 18

INTENTIONALLY LEFT BLANK

PRESSURE AND WINDS

KEY TO SELF EVALUATION EXERCISE

1. b
2. d
3. b
4. b
5. d
6. d
7. d
8. b
9. b
10. b

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