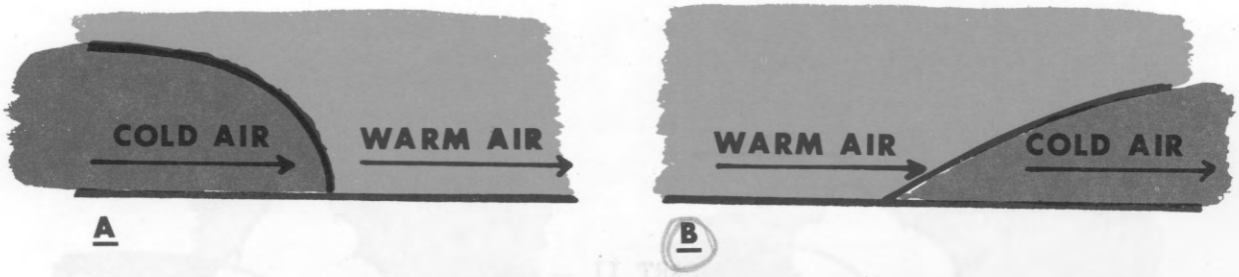
PART II

WARM FRONTS

WARM FRONTS

FRAME 1

A warm front is the boundary formed between the trailing edge of a retreating mass of cool air and the warm air mass moving in to replace it.



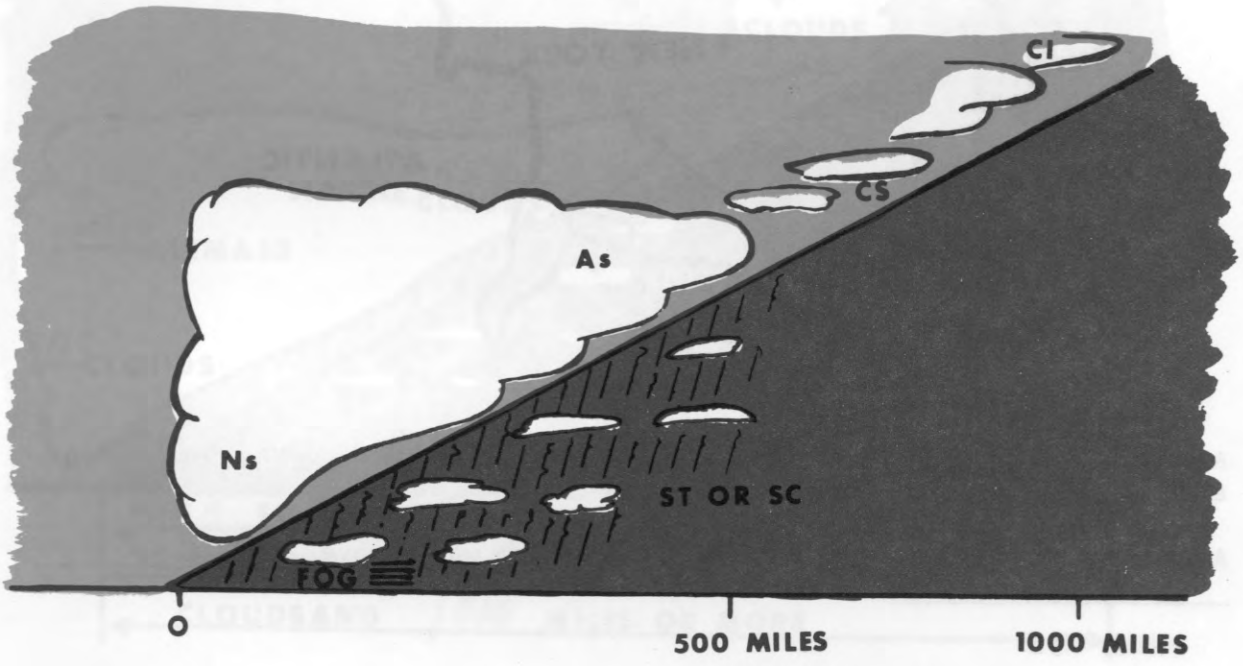
Check the diagram that best describes a warm front.

TURN TO FRAME 2 ON PAGE 28

ANSWER: B

FRAME 10

The cloud sequence of a typical warm front is distinctive. Flying from east to west you would encounter high cirrus clouds. These clouds appear as thin "whisps." As you proceed west they thicken and become cirrostratus. These cirrus clouds will produce a "halo effect" around the sun or moon. This "halo effect" forms the basis of the old-timer's theory -- "A ring around the sun or moon indicates the approach of bad weather."



1. A typical warm front is characterized by extensive clouds throughout the system.

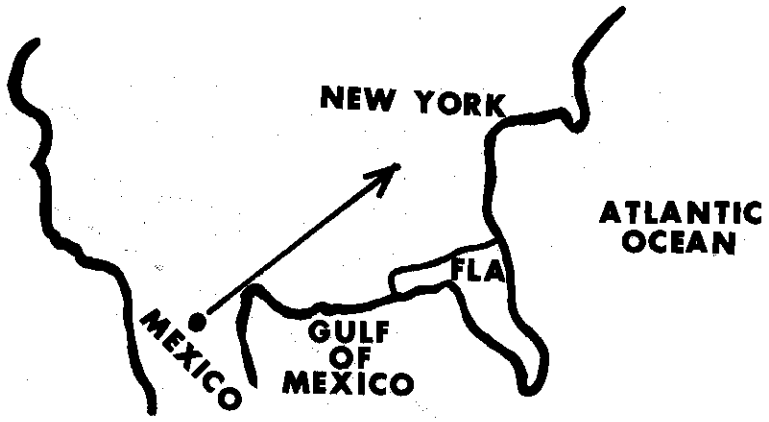
2. The weather is located ahead of the surface front.

3. A pilot flying east to west might encounter prefrontal clouds up to 1000 miles ahead of the front.

ANSWER: B

FRAME 2

Source regions for warm air masses are found in the south, and in the Northern Hemisphere warm fronts (warm air replacing retreating colder air) move generally toward the northeast at an average speed of 10 knots.



A warm front originating over Mexico would move forward to New York at an average speed of 10 knots.

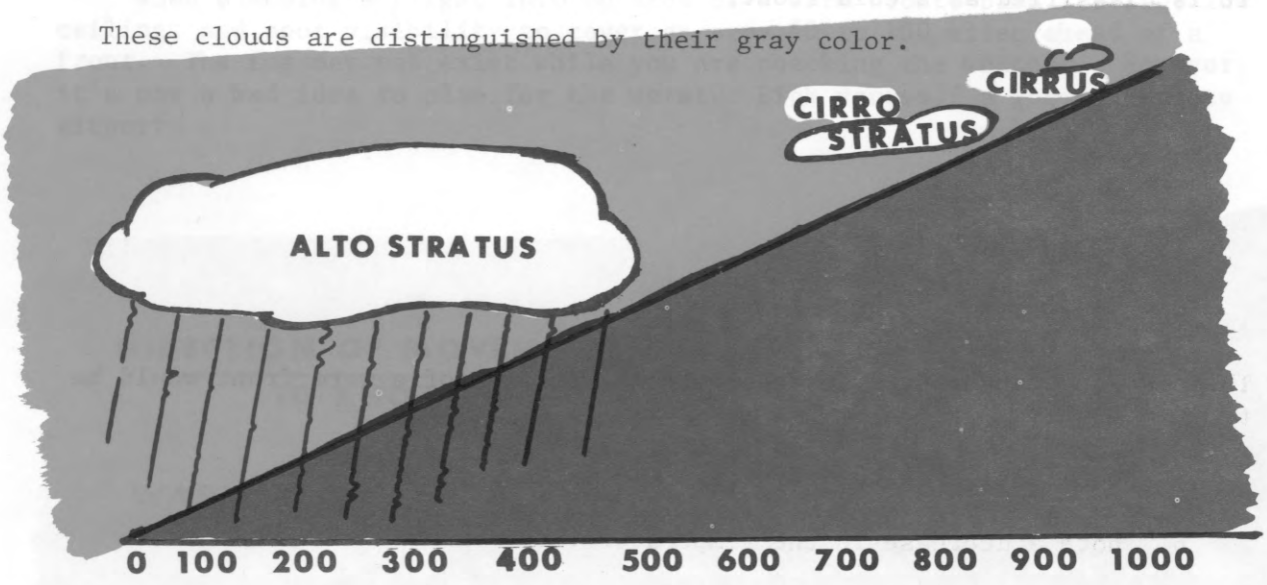
A warm front originating in the Gulf of Mexico would move North East over Fla. at 10 knots

ANSWERS: 1. Extensive 2. In front 3. 1000

FRAME 11

After encountering the cirrus clouds flying east to west, you would encounter altostratus type clouds.

These clouds are distinguished by their gray color.



Altostratus clouds will be the highest clouds which produce rain. How wide is the altostratus precipitation band ahead of the front?

0 - 500

ANSWER: across Florida into the Atlantic Ocean.

FRAME 3

Moving weather fronts are named for the temperature change that accompanies frontal passage. If the front passage brings a decrease in temperature, it is classified as a cold front.

The most accurate manner to determine the passage of a warm front would be to

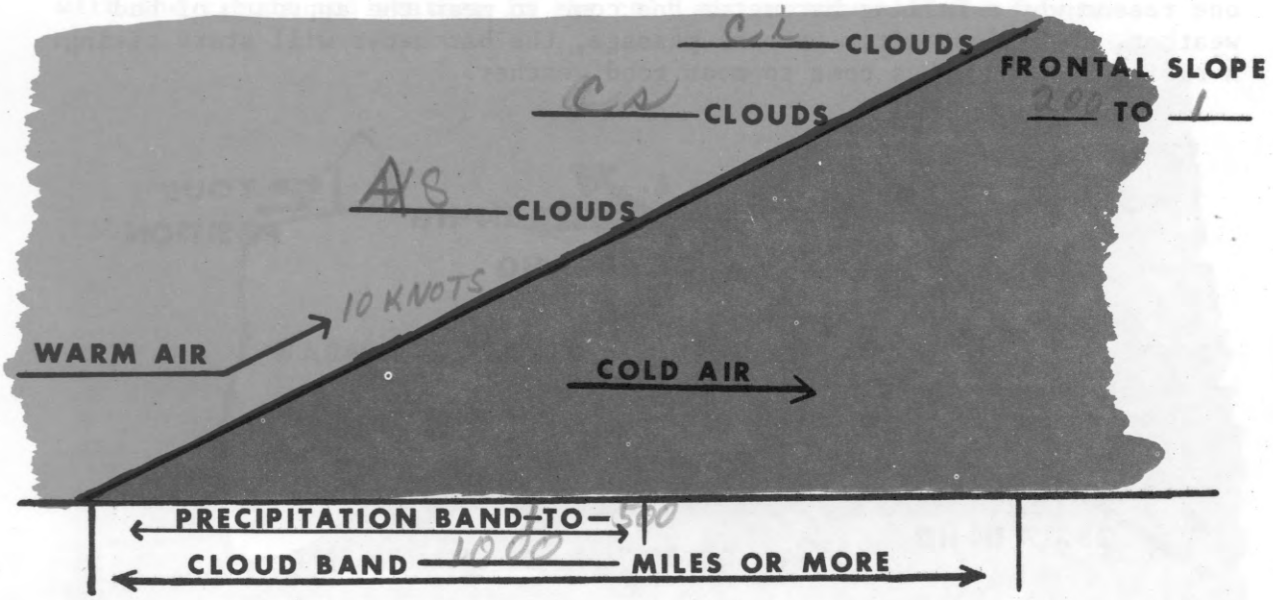
a. note a rise in the temperature.

b. note a decrease in the temperature.

Answer - 0 to 500 miles

FRAME 12

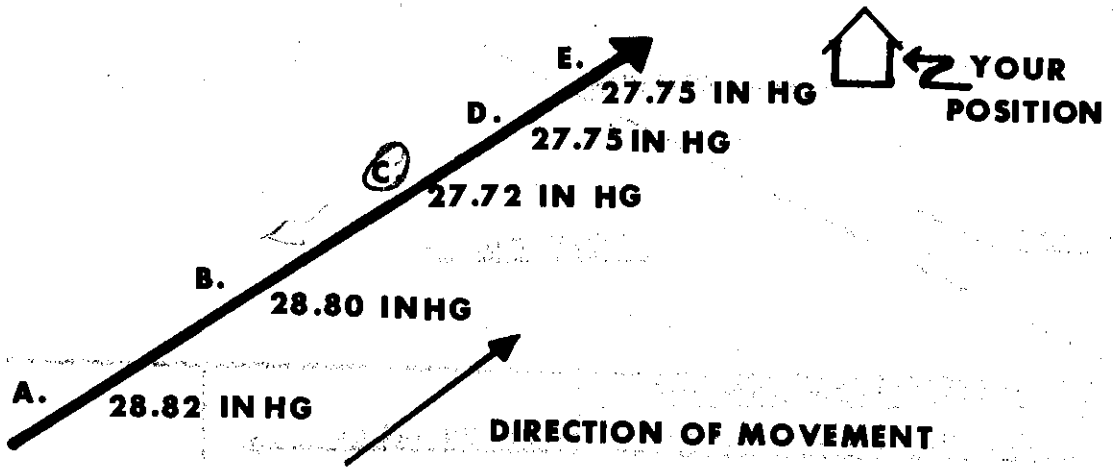
As a review, fill in the blanks on the diagram below:



ANSWER: a (NOTE: Temperature increases vary from a few degrees to more than 20°F).

FRAME 4

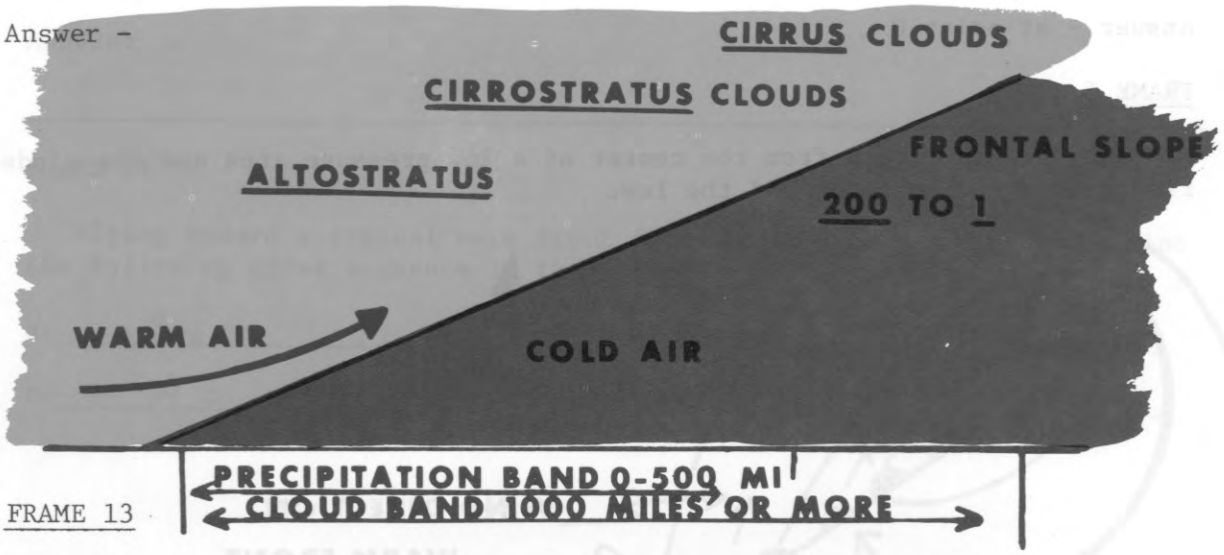
As a front approaches, the barometer (pressure measuring device) of a station located ahead of the approaching front will begin to fall. This is one reason why a falling barometer has come to mean the approach of bad weather. Likewise, after frontal passage, the barometer will start rising. A rising barometer has come to mean good weather.



Using the above diagram, determine the approximate position of the warm front moving northeast.

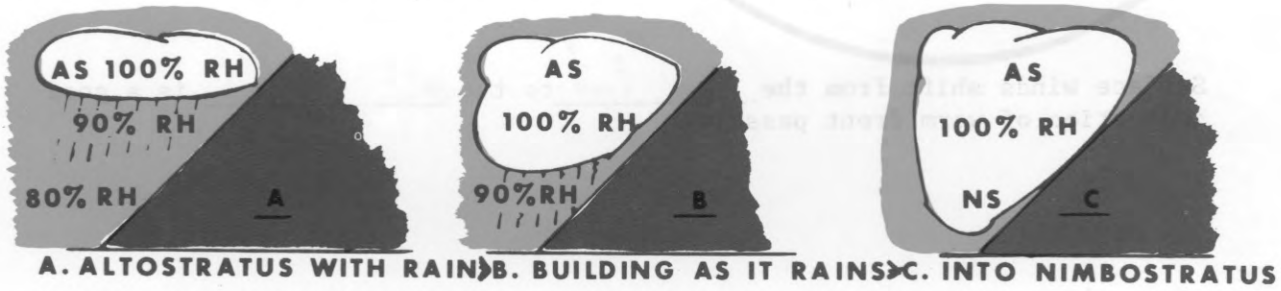
The warm front is located at C.

Answer -



FRAME 13

Nimbostratus clouds form in the warm air mass of a warm front as a result of evaporation of rain falling from the altostratus clouds above. This evaporation raises the relative humidity of the warm air below the altostratus clouds until it approaches or reaches 100%. When the relative humidity comes high enough, the nimbostratus clouds form.



A. ALTOSTRATUS WITH RAIN B. BUILDING AS IT RAINS C. INTO NIMBOSTRATUS

Select the correct answer that best describes the formation of nimbostratus clouds.

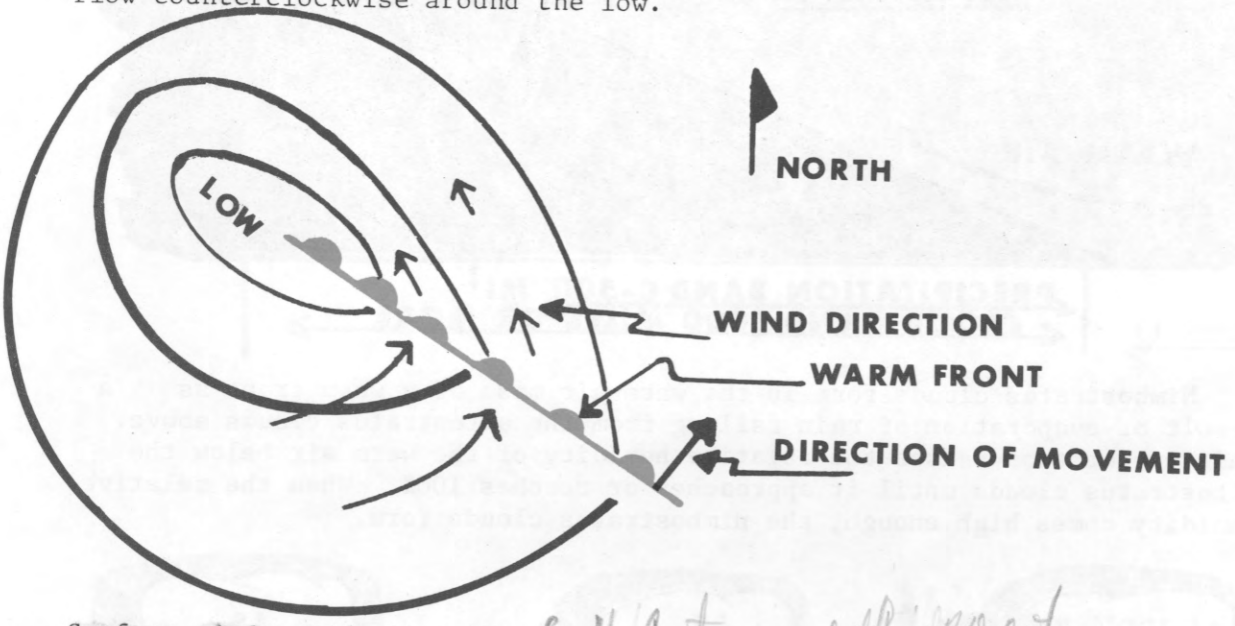
a. Nimbostratus build down from the altostratus clouds.

b. Nimbostratus aids in the formation of altostratus clouds.

Answer - at point C

FRAME 5

Warm fronts extend from the center of a low pressure area and the winds flow counterclockwise around the low.



Surface winds shift from the South East to the South West is a good indication of warm front passage.

ANSWER: A

FRAME 14

Flying toward a typical warm front from the east, the pilot would find the following cloud sequence in the warm air mass portion of the front.

a. Ci

b. CS

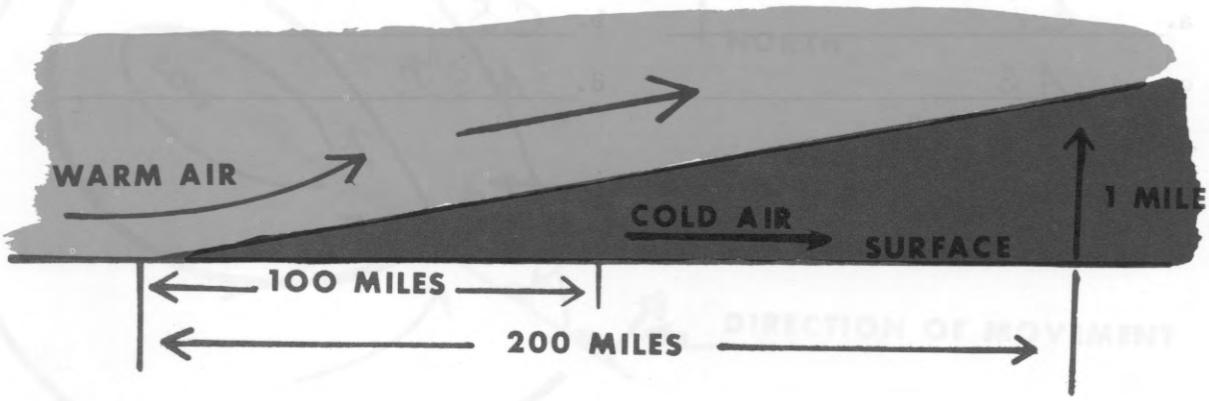
c. AS

d. NS

Answer - southeast to southwest.

FRAME 6

The zone of discontinuity between dissimilar air masses is a "frontal slope." The average warm front has a slope of 200 to 1.



1. What is the altitude of the front 100 miles from the surface front?

1/2 miles

2. What is the altitude of the front 200 miles from the surface front?

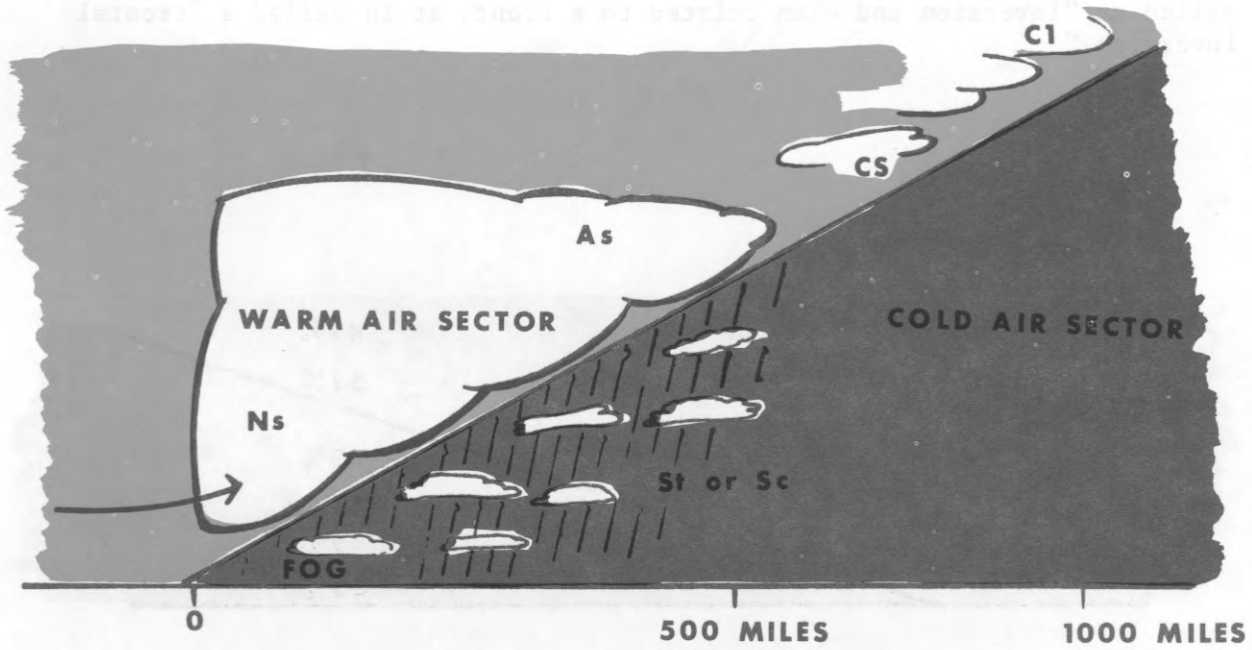
1 mile

NOTE: For this discussion, the slope is considered to be proportional.

ANSWERS: a. "cirrus" b. "cirrostratus"
c. "altostratus" d. "nimbostratus"

FRAME 15

So far we have discussed clouds which are located in the warm air sector of the warm fronts located above the frontal inversion. Now let us deal with the clouds and weather in the cold air portions of the front.



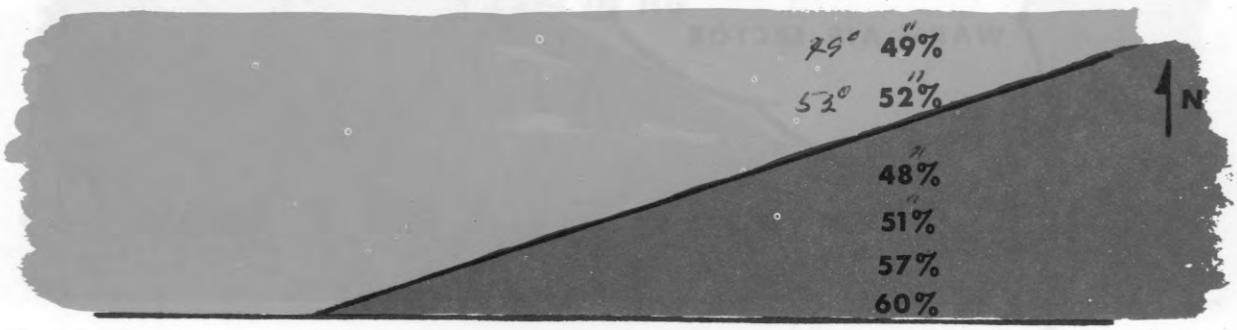
Well in advance of the surface front, all of the precipitation from the altostratus clouds is evaporating before it reaches the ground.

1. A pilot, flying through the cold air sector, could probably fly between layers of stratus clouds.
2. He would be flying in and out of precipitation areas with the ceiling lowering as he approached the front.
3. Drizzle, rain and fog covers a wide area ahead of the front.

Answers - 1. 1/2 mile
2. 4 miles

FRAME 7

The temperature of the air normally decreases with altitude. However, if we study a warm front, we find that the warm air has moved over cold air. Checking the diagram below, we found that the temperature increased at the frontal slope. This increase in temperature with an increase in altitude is called an "inversion and when related to a front, it is called a "frontal inversion."



Flying IFR (instrument flying), you are encountering freezing rain while approaching a typical warm front from the east at an altitude of 5000 feet, 200 miles to the east of the surface front.

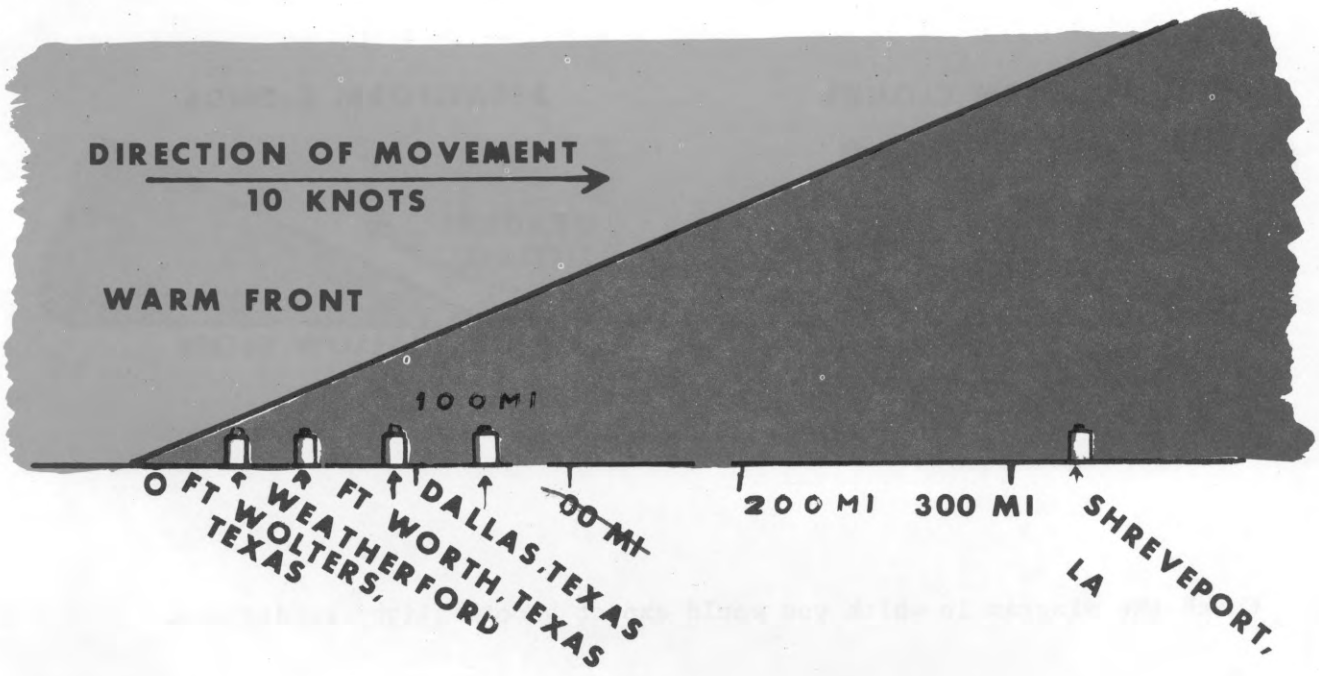
The best flight procedure to avoid the freezing rain would be to (select one or more answers)

A. Climb above the inversion into warmer air.
B. Maintain altitude and continue to destination.
C. Descend into warmer air if the freezing level does not extend to the surface.

Answers - 1. layers of stratus clouds
2. lowering
3. large, wide, etc.

FRAME 16

When planning a flight into an area of a warm front, plan for fog, low ceiling, and poor visibility to cover an area 50 to 100 miles ahead of a front. The fog may not exist while you are checking the weather. However, it's not a bad idea to plan for the worst. Pick yourself a good alternate airport.

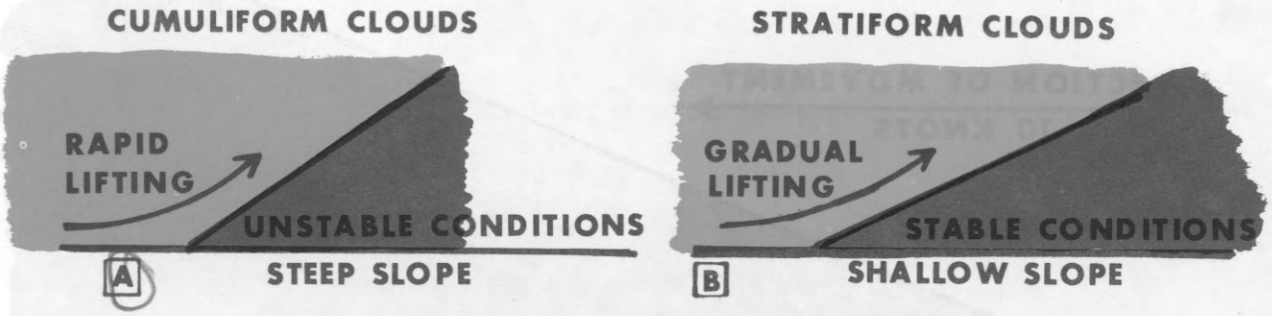


Flying from Shreveport to Fort Wolters with a warm front approaching Mineral Wells, Texas, you expect fog to form. The best alternate airports would be Dallas and Ft. Worth, 50 to 100 miles ahead of the front.

Answers - A, C

FRAME 8

The shallow slope of the warm front ensures gradual displacement of the overtaking warm air. The more gradual the vertical displacemdnt of air, the greater the possibility of maintaining stability within the air mass being lifted. The gradual vertical displacement of air gives rise to the typical types of clouds and flight conditions associated with the warm front.

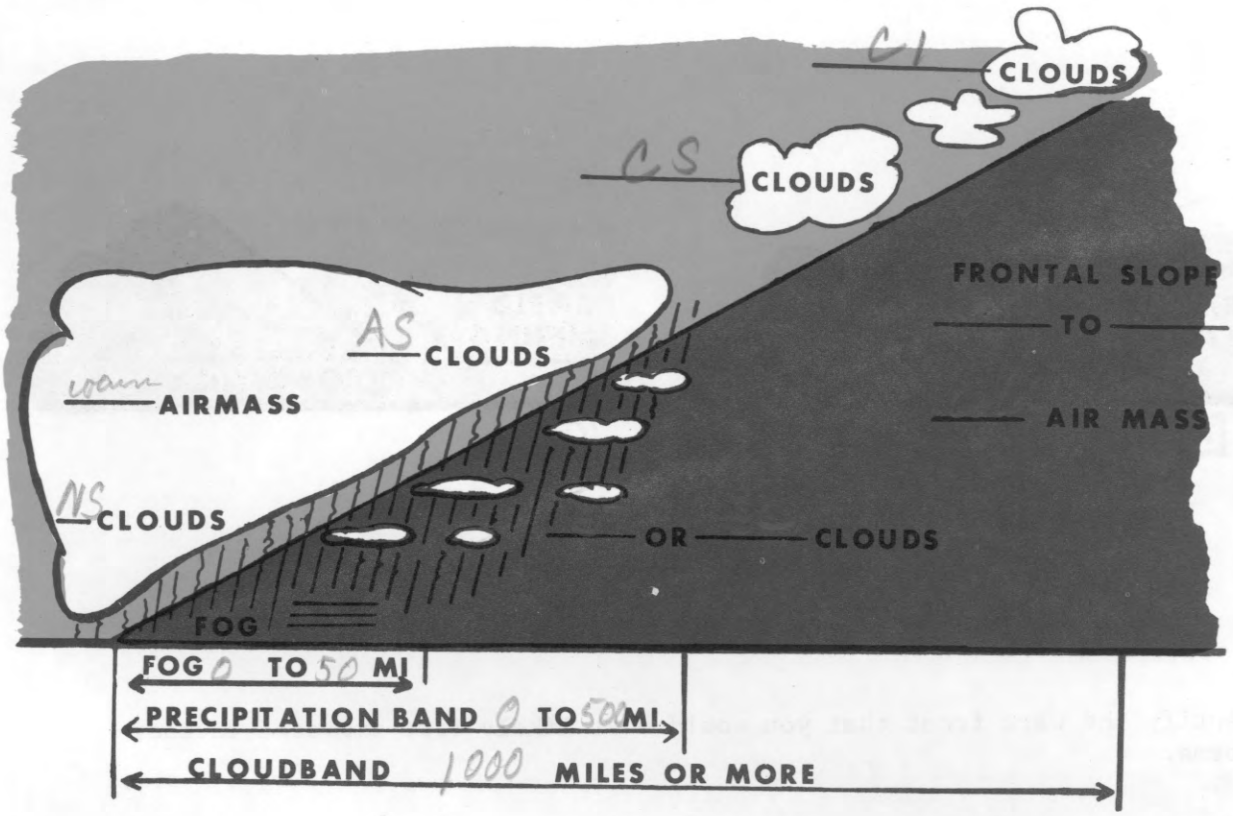


Check the diagram in which you would expect smooth flight conditions.

Answers - Ft. Worth and Dallas
50 to 100 miles

FRAME 17

Complete the following diagram.



Answer - B

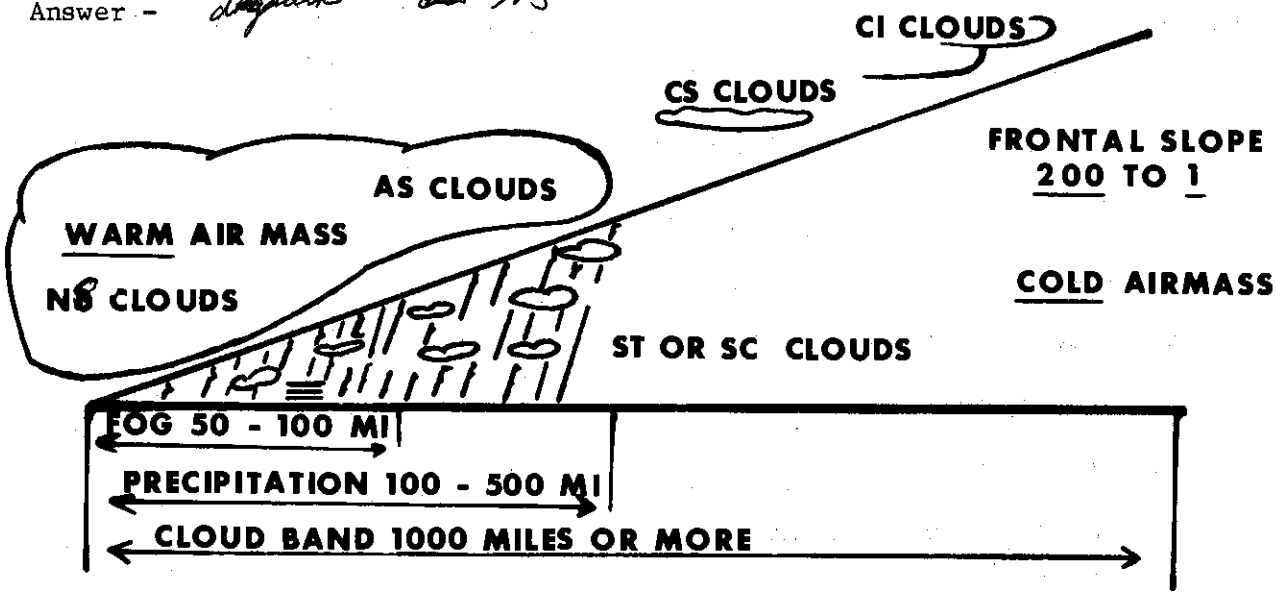
FRAME 9

Smooth flying conditions (stable air) and stratiform type clouds are characteristic of a warm front. However, with a fast moving warm front, (unstable and moving greater than 10 knots per hour), it is possible to have thunderstorms imbedded in the stratus clouds.

Identify the warm front that you would most likely find imbedded thunderstorms.

TURN TO FRAME 10 ON PAGE 27

Answer - diagram of NS



FRAME 18

Warm fronts are fairly stable, move relatively slow, and the bad weather covers a large area.

Check the weather conditions you would associate with a warm front.

(a) Precipitation over a large area.

X b. Very little precipitation.

(c) Fog.

(d) Drizzle.

X e. Rough flying conditions.

(f) Smooth flying conditions.

g. Good visibilities.

(h) Poor visibilities.

(i) Stratiform clouds.

j. Cumuliform clouds.

X (k) Imbedded thunderstorms.

ANSWER ON PAGE 44

ANSWER TO FRAME 18

a. precipitation over a large area

c. fog

d. drizzle

f. smooth flying conditions

h. poor visibilities

i. stratiform clouds

k. imbedded thunderstorms

Complete self evaluation exercise on page 46

SELF EVALUATION EXERCISE

WARM FRONT

1. Weather associated with a warm front

   a. covers an extensive area.
   b. consists of a narrow band of weather.
   c. contains mostly cumuliform type clouds.

2. The barometric pressure will

   a. increase as the front approaches.
   b. decrease as the front approaches and then increases as the front passes.
   c. increase as the front approaches and decrease as the front passes.

3. On a flight in a southwest direction you encounter the following clouds in order Ci, Cs, As, and Ns; you know you are flying

   a. away from a warm front into the cold air.
   b. toward a warm front from the cold air side.
   c. away from a cold front into the cold air side.

4. The average speed and direction of movement of a warm front is

   a. from the southwest at an average speed of 22 knots.
   b. from the southwest at an average speed of 10 knots.
   c. from the southeast at an average speed of 10 knots.

5. The typical weather associated with a warm front is

   a. good flying conditions, good visibility, and gusty winds.
   b. stratiform clouds, smooth flying, fog and drizzle.
   c. thunderstorms, hail, turbulence, and good visibility.

6. Between Fort Wolters and Austin, Texas, lies a warm front (south of us). Flying from Fort Wolters to Austin, you would expect to find

   a. good flying weather with an occasional shower.
   b. strong surface winds with low ceiling, but there should be little difficulty in reaching our destination.
   c. low ceilings, drizzle, and fog, and the possibility that you cannot reach your destination safely.

7. Flying toward a warm front from the cold air side, you would expect to find

a. low clouds, fog, and drizzle 50 to 100 miles ahead of the front.
b. no visibility restrictions.
c. thunderstorms and cumulus clouds.

8. The winds in a warm front would shift to the

a. northwest after frontal passage.
b. southeast after frontal passage.
c. southwest after frontal passage.

ANSWER KEY ON PAGE 64

PART III

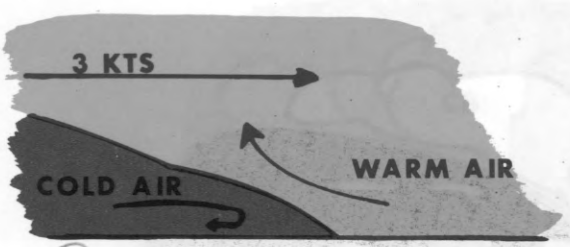
STATIONARY FRONTS

~~Answers - a, c, d, f, h, i, k~~

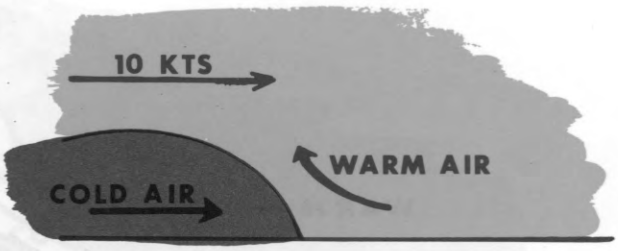
STATIONARY FRONTS

FRAME 1

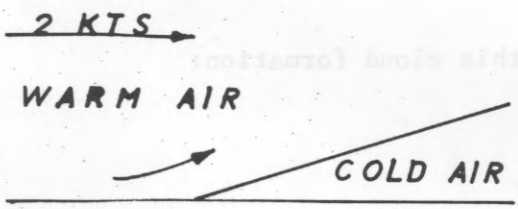
A warm front or cold front that slows down to five knots or less, or stops, is called a stationary front.



A



B



C

D

Check the figures that represent a stationary front.

TURN TO FRAME 2 ON PAGE 51

Answers - a. Ceiling good
b. Visibility good except in areas of precipitation
c. Precipitation heavy showers
d. Turbulence moderate to severe

FRAME 3

When a warm front becomes stationary, the stationary front's weather will have the characteristics of the original warm front, but will be less intense.

List the weather conditions associated with this cloud formation:

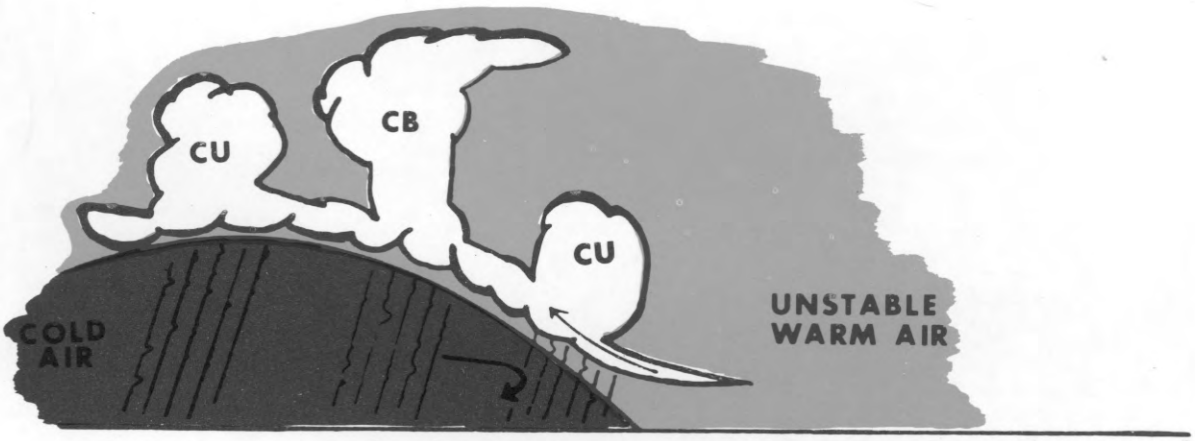
a. Ceiling low to high
b. Visibility increasingly poor
c. Precipitation light
d. Turbulence light none

Answer - A, C (Movement less than 5 kts)

FRAME 2

In a stationary front the warm air still has a tendency to rise and glide over the cold air.

When a cold front becomes stationary, the stationary front will retain the same weather characteristics as the original cold front. The weather, however, will be less severe.



List the weather associated with this cloud formation:

a. Ceiling low - to occas good

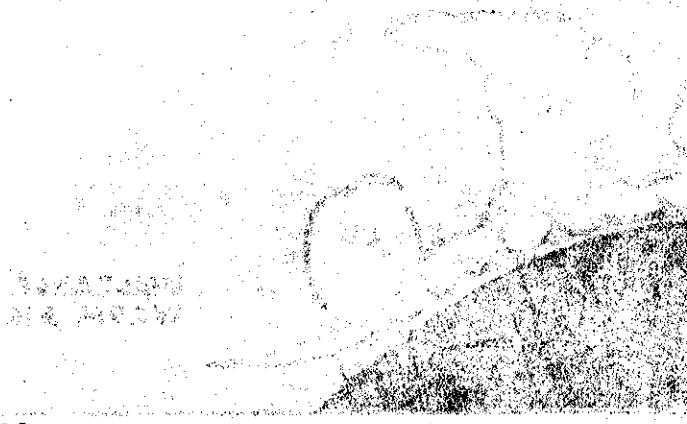
b. Visibility fair good except in showers

c. Precipitation heavy shower

d. Turbulence violent to mod

FRAME 3 ON PAGE 50

Answers - a. Ceiling Low
b. Visibility Poor in rain and fog
c. Precipitation Drizzle and rain
d. Turbulence None



Complete the self evaluation exercise on page 53

SELF EVALUATION EXERCISE

STATIONARY FRONTS

1. A stationary front moves at a rate of

   a. 10 knots.
   b. 15 knots.
   c. 22 knots.
   d. 5 knots or less.

2. Flying through a stationary front developed from a cold front, you would expect to encounter:

   a. Thunderstorms, moderate turbulence, and heavy showers.
   b. Very violent thunderstorms, turbulence, and a squall line.
   c. Low ceilings, drizzle, fog, and rain.

3. Flying through a stationary front developed from a warm front, you would expect to encounter:

   a. Very good weather.
   b. Low ceilings, drizzle, fog, and rain.
   c. Very intense layer of stratus clouds with steady rain covering a wide area.

ANSWER KEY ON PAGE 64

PART IV

OCCLUDED FRONTS

OCCLUDED FRONTS

FRAME 1

There are times when a cold front overtakes a warm front. As the closing of the warm and cold fronts occurs, the air in the warm front is lifted off the surface. This process is called an "occlusion" and when the warm air is totally lifted from the surface, it is known as an "occluded front."

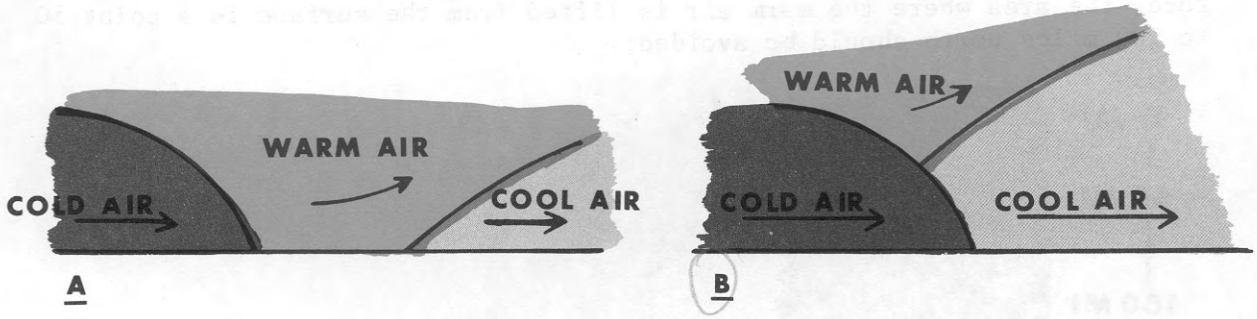


Figure B represents a cross section of an occluded front.

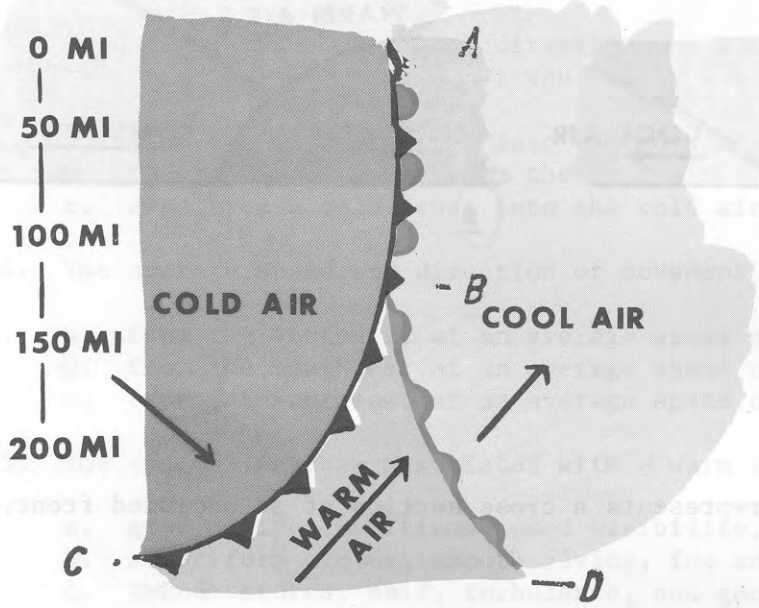
TURN TO FRAME 2 ON PAGE 57

Answers -

	WARM FRONT OCCLUSION	COLD FRONT OCCLUSION
1.	wide area (200-300 miles)	narrow area (50-75 miles)
2.	wide area (50-100 miles)	narrow area (25-50 miles)
3.	poor (fog and drizzle)	poor (fog and drizzle)
4.	imbedded	imbedded
5.	yes (Cu clouds)	yes (Cu clouds)
6.	poor	poor
7.	increase	decrease

FRAME 5

Weather is most violent during the early stages of the occlusion, therefore, the area where the warm air is lifted from the surface to a point 50 to 100 miles north should be avoided.



SURFACE MAP VIEW

The area of the occluded front to be avoided lies between points

a. B to C

b. A to D

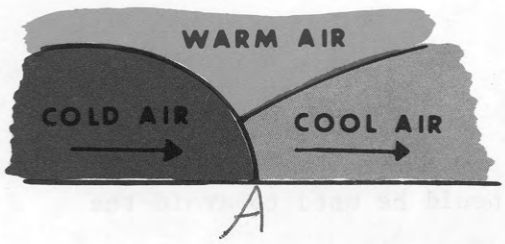
c. A to B

Answer - B

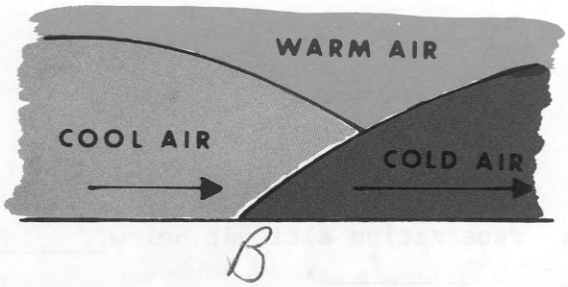
FRAME 2

There are two types of "occluded fronts", the cold front occlusion and the warm front occlusion. The type of occlusion depends on the relationship of the two cold air masses.

The air mass behind the occluded front identifies the type of front.



A



B

1. Figure A is cold front occlusion because the colder air is behind the front.

2. Figure B is warm front occlusion because the cool air is behind the front.

ANSWER: c. A to b

FRAME 6

The flight procedures for penetrating an occluded front combine those recommended for cold and warm fronts.

1. Penetration altitude below 6000 feet should be used to avoid the turbulence of imbedded thunderstorms.

2. An alternate airport should be selected because low ceiling, turbulence, visibility, and thunderstorms might make it impossible to reach your destination.

Answers - 1. cold
coldest
2. warm
cool

FRAME 3

Occlusions combine the weather of the warm and cold fronts into one extensive weather system.

The line of thunderstorms typical of a cold front merges with the stratus clouds, low ceiling and poor visibility of a warm front.

1. Weather associated with "occluded fronts" would be considered very poor flying weather and does/does not warrant special consideration.

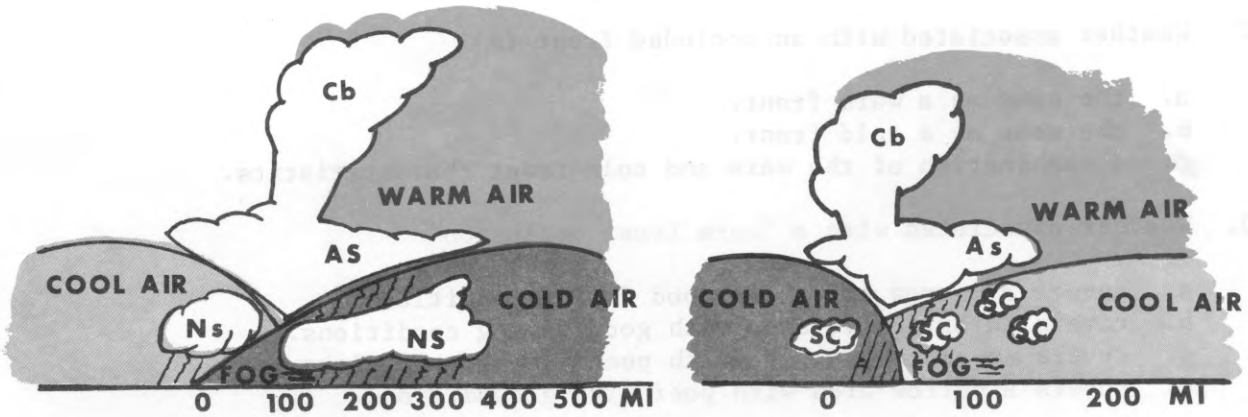
Answers - 1. 6000 feet
imbedded thunderstorms
2. low ceiling
restricted visibility
thunderstorms

COMPLETE THE SELF EVALUATION EXERCISE ON PAGE 62

Answer - hazardous, does

FRAME 4

Weather associated with a warm front occlusion covers an extensive area, when compared to a cold front occlusion.



Compare weather conditions associated with occluded fronts.

Warm Front Occlusion	Cold Front Occlusion
1. Rain covers a large area.	1. Rain covers a small area.
2. Fog covers a large area.	2. Fog covers a small area.
3. Visibility is poor.	3. Visibility is poor.
4. Thunderstorms imbedded.	4. Thunderstorms imbedded.
5. Turbulence yes.	5. Turbulence yes.
6. Flying conditions poor.	6. Flying conditions poor.
7. Temperature change after frontsl passage _____.	7. Temperature change after frontal passage _____.

TURN TO FRAME 5 ON PAGE 56

SELF EVALUATION EXERCISE

OCCLUDED FRONTS

1. A cold air mass overtakes a warm air mass, with a cool air mass ahead would form a

   a. warm front occlusion.
   b. cold front occlusion.
   c. cold front.

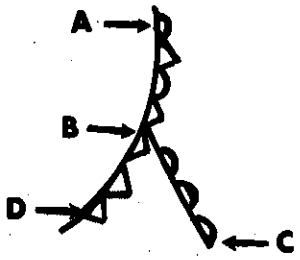
2. Weather associated with an occluded front is

   a. the same as a warm front.
   b. the same as a cold front.
   c. a combination of the warm and cold front characteristics.

3. Weather associated with a "warm front occlusion"

   a. covers a narrow area with good flying conditions.
   b. covers an extensive area with good flying conditions.
   c. covers an extensive area with poor flying conditions.
   d. covers a narrow area with poor flying conditions.

4. The most violent weather associated with an occlusion that should be avoided lies between points



   a. A to B.
   b. B to D.
   c. B to C.

5. Penetration of a occluded front cloud line should be made

   a. through the upper 2/3 of the cloud line.
   b. through the upper 1/3 of the cloud line.
   c. through the lower 1/3 of the cloud line which is normally 6000 feet above the surface or below.

6. When planning a flight with the airport 100 miles ahead of an occluded front

   a. expect no weather problems in reaching the destination.
   b. expect low ceiling, rain, and fog to exist at destination.
   c. expect the weather to improve within the next hour.

ANSWER KEY ON PAGE 64

INTENTIONALLY BLANK

SELF EVALUATION EXERCISE ANSWERS

PART I COLD FRONTS	PART II WARM FRONTS	PART III STATIONARY FRONTS	PART IV OCCLUDED FRONTS
1. a	1. a	1. d	1. b
2. c	2. b	2. a	2. c
3. b	3. b	3. b	3. c
4. c	4. b		4. a
5. c	5. b		5. c
6. b	6. c		6. b
7. b	7. a		
8. a	8. c		
9. c			
10. b			
11. b			
12. b			
13. c			

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