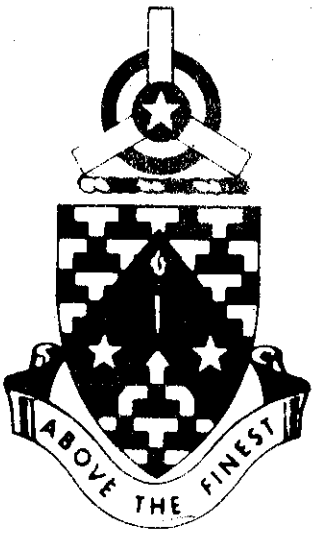
PROGRAMED TEXT

FRONTAL WEATHER

AM-27



DECEMBER 1968

UNITED STATES ARMY
PRIMARY HELICOPTER SCHOOL
FORT WOLTERS, TEXAS

PROGRAMED TEXT

PROGRAM TEXT

FILE NO: AM-27

PROGRAM TITLE FRONTAL WEATHER

POI SCOPE: Discussion of frontal weather systems to include identification, characteristics and flight techniques to be used when penetrating a given frontal system.

INSTRUCTOR REFERENCES:

TM 1-300, Chapter 7

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DATE: January 1969

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Frontal Weather

PREFACE

Army aviators must possess a thorough knowledge of the effects of weather to successfully complete, or to even attempt, many missions. The weather conditions that concern us most are associated with Frontal Weather Systems. This program will inform you of the factors which produce and control the weather.

Complete this programed text at your own rate of speed. Read the information presented in each frame and then answer the questions or solve the problems as required.

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 iv.

This is a four part text.

PERFORMANCE OBJECTIVES

Upon completion of this programed text, you will be able to:

1. Identify the four frontal weather systems by the association of air masses.

2. Identify characteristics and weather associated with the four types of frontal system.

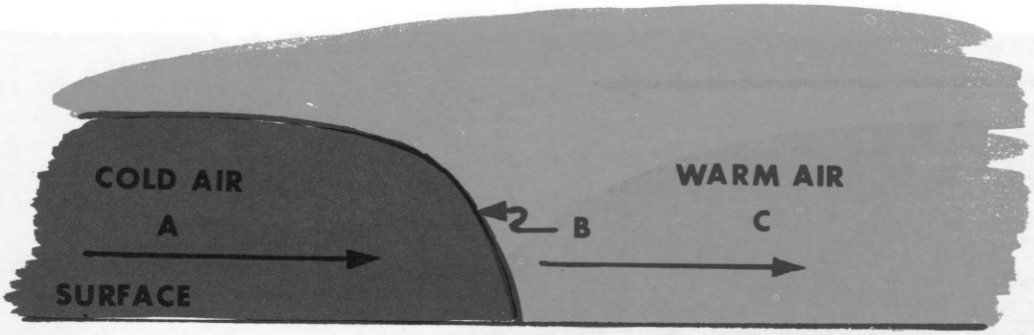
3. List flight techniques to be used when penetrating a given frontal system.

FRONTAL WEATHER

COLD FRONTS

FRAME 1

Fronts are boundaries between air masses that have different densities. The density of the air is primarily controlled by the temperature of the air.



A weather front exists at

a. Point A.

b. Point B.

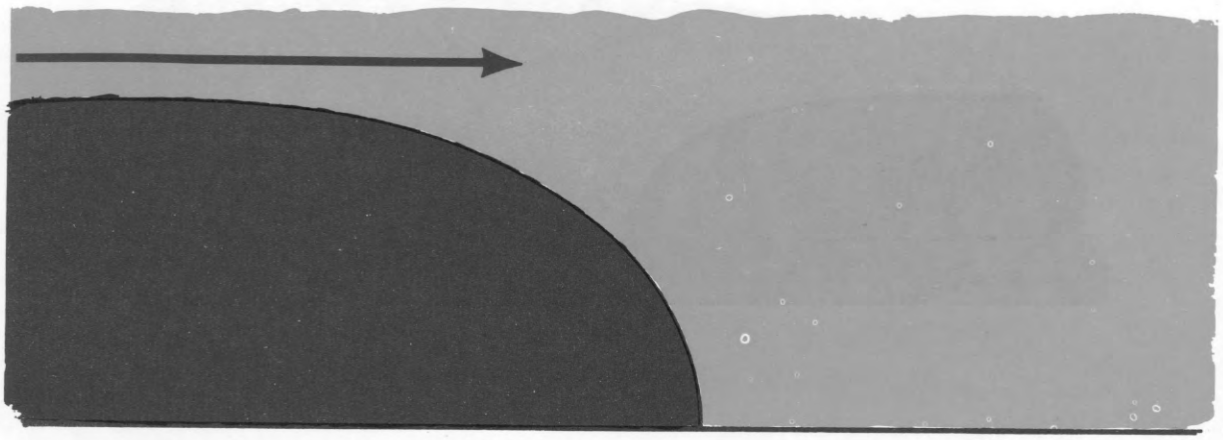
c. Point C.

TURN TO FRAME 2 ON PAGE 3.

Answer - Right of desired course
Left of desired course

FRAME 12

Temperature change during a cold front passage is another characteristic of a cold front, and one of the most accurate ways of determining that you have flown through a cold front.



1. Before the cold-frontal passage, the temperature will be higher than after cold-frontal passage because of the advancing cold air mass replacing the warm air mass.

2. Check the instrument that would give you the best indication of frontal passage.

   a. Airspeed indicator.

   b. Free Air temperature gauge.

   c. Attitude indicator.

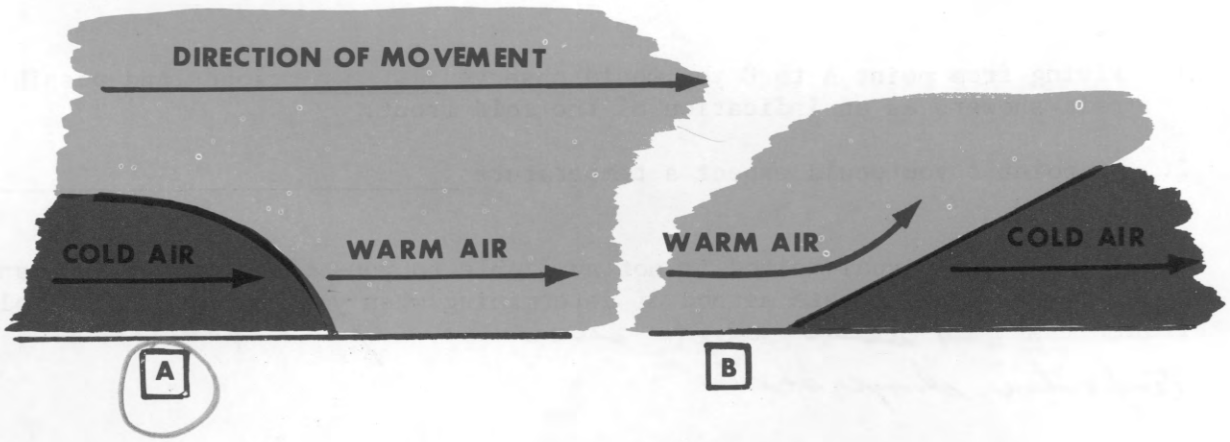
TURN TO FRAME 13 PAGE 4

Answer - b

FRAME 2

A cold front is the leading edge of an advancing mass of cold air.

Based on the definition, check the diagram that best describes a cold front.

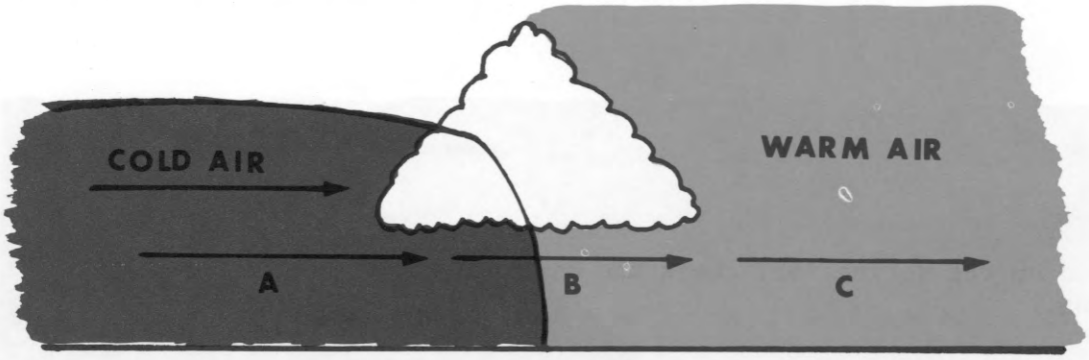


TURN TO FRAME 3 PAGE 5

Answers - 1. greater, higher, etc.
cold air
warm air
2. b

FRAME 13

The best visual method of determining whether you are approaching a cold front is to observe the clouds.



1. Flying from point A to C you would observe cumulus clouds and possible rain showers as an indication of the cold front.

2. At point B you would expect a temperature change, increase.

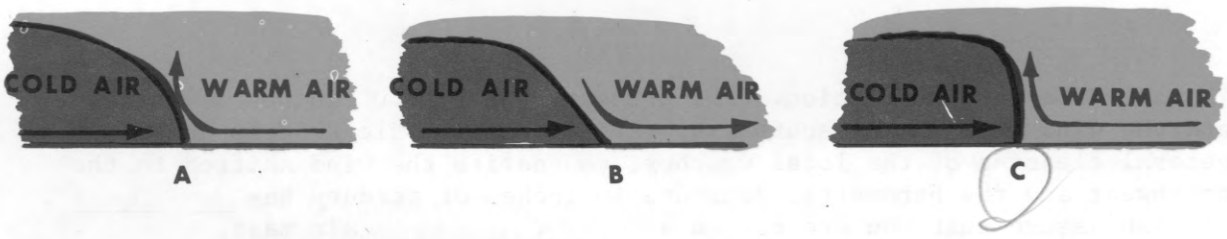
NOTE: When the visual method is not available to you, the temperature change will be the most accurate method of determining when you have crossed a cold front. a wind ~~change~~ shift should be expected after the temperature change occurs

Answer - A

FRAME 3

The vertical boundary between the warm and cold air masses is the frontal surface. The slope of the frontal surface depends on the speed at which the front moves over the surface.

When a cold front moves rapidly, the leading edge steepens. This lifts the warm air ahead of the front abruptly and cooling condenses the moisture from the warm air.



Due to the speed of the front, the most violent weather would be associated with cold front C.

Answers - Cumuliform clouds
increase

FRAME 14

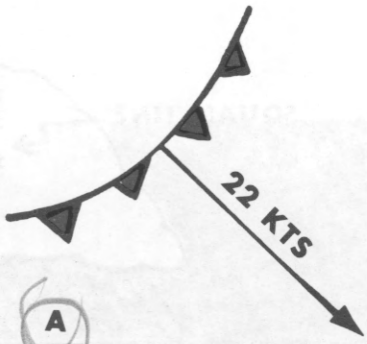
The last characteristic of the cold front is the pressure tendency involved with cold-frontal passage. On the warm air side of the front, the pressure will drop until frontal passage; then the pressure will rise again in the cold air. As an aid to remember this point; warm air rises (little pressure) and cold air falls (greater pressure).

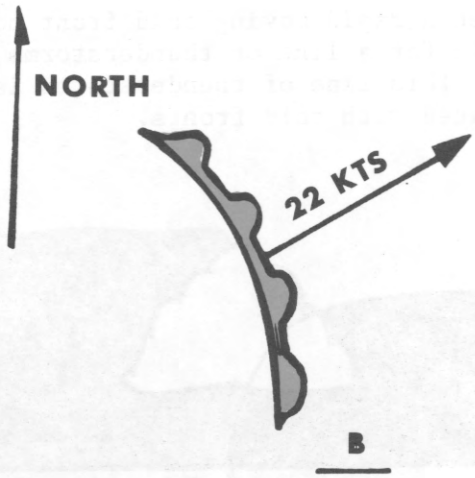
You are at a weather station. The pressure reads 29.00 inches of mercury and the wind is from the southwest. After considerable showers and a general clearing of the local weather, you notice the wind shifted to the northwest and the barometric pressure in inches of mercury has increased. You can assume that you are now in a cold air mass.

Answer - C

FRAME 4

Cold fronts normally move from the northwest to the southeast at an average speed of 22 knots.



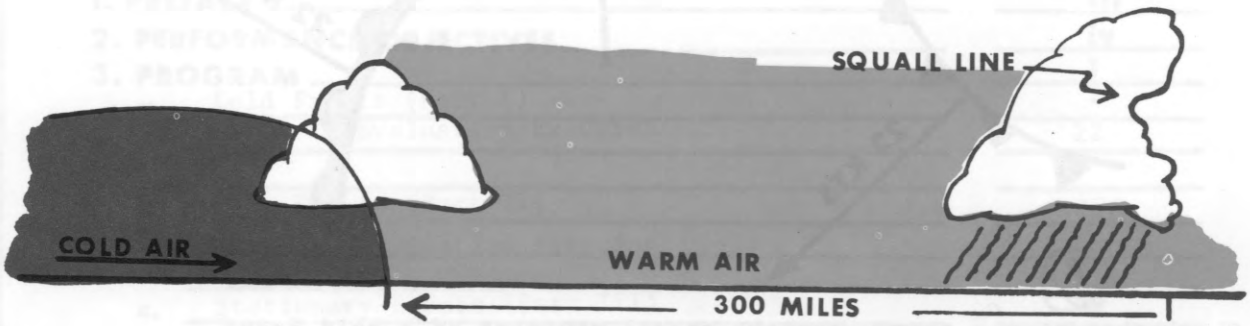


Check the diagram that shows the normal movement of a cold front.

Answers - increase
cold

FRAME 15

When a rapid moving cold front moves into moist unstable warm air, it is possible for a line of thunderstorms to form 75 to 300 miles ahead of the front. This line of thunderstorms is called a squall line and is only associated with cold fronts.



Select the answer that best describes a squall line.

a. A weather band consisting of stratus clouds moving parallel to the front and covers an area 300 miles wide.

b. A chain of violent thunderstorms moving parallel to and ahead of the surface front of rapid moving cold front.

Answer - A

FRAME 5

Cumuliform clouds associated with the cold front are created by rapidly rising warm air which condenses into clouds, and then into rain as it rises up into cooler air found at higher altitudes.

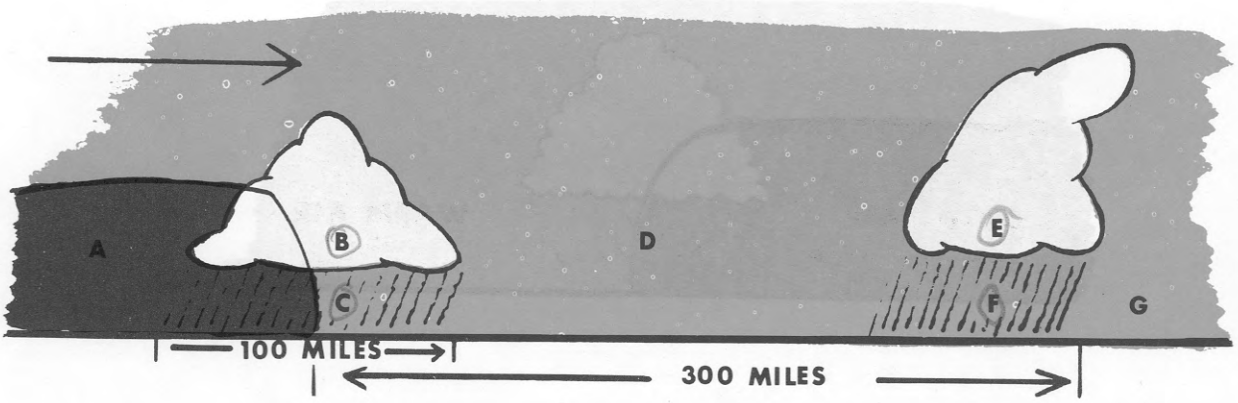
Precipitation in the form of heavy showers is characteristic of cold front.

Answer - b

FRAME 16

The chief hazards to an aircraft flying in the vicinity of a cold front are caused by the cumuliform clouds along the front of the prefrontal squall line ahead of the front.

Flight hazards involved with a cold front are turbulence, icing, lightning, gusty surface winds and poor visibility in rain showers or clouds.

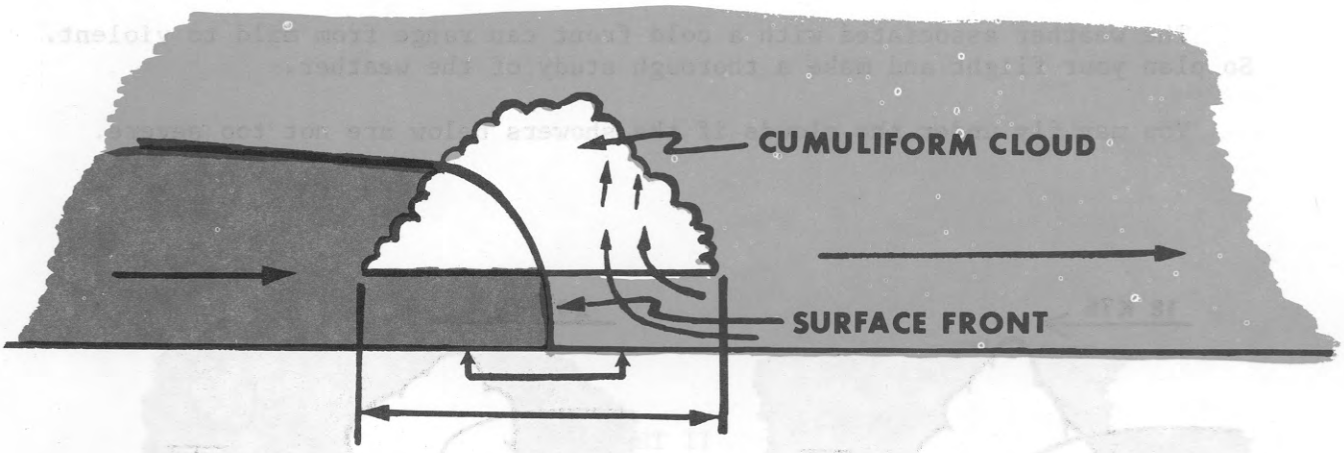


Circle the letters that represent the areas that you would expect the most hazardous weather.

Answer - Heavy showers

FRAME 6

The cumuliform clouds associated with a cold front extend 25-50 miles into the cold air mass and 25-50 miles into the warm air from where the two air masses contact the surface.



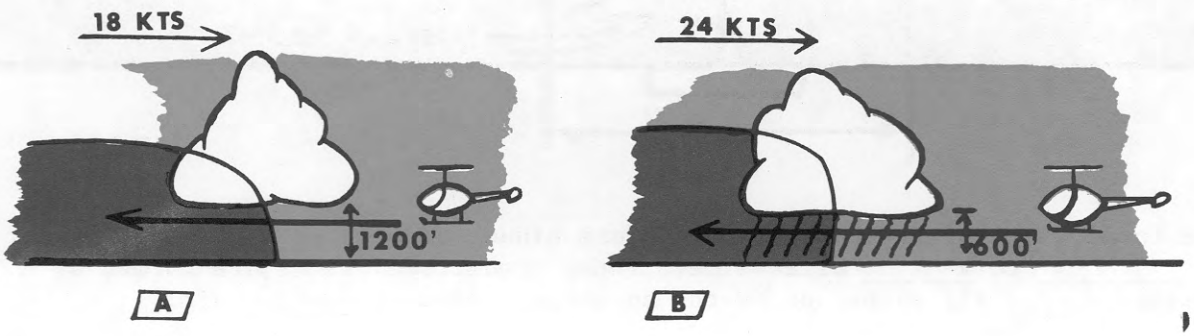
The total width of the band of cumuliform clouds associated with a cold front is 50 to 100 miles wide. These cumuliform clouds are formed by rising warm air pushed up by the advancing wedge of cold air.

Answers - B - Turbulence and icing conditions (0° to -10°C)
C - Rain (visibility restrictions) gusty winds
E - Thunderstorms with turbulence, lightning and icing conditions at temperatures 0 to -10°C
F - Rain (visibility restrictions) and gusty winds

FRAME 17

The weather associated with a cold front can range from mild to violent. So plan your flight and make a thorough study of the weather.

You may fly under the clouds if the showers below are not too severe.



Match diagram A and B with the appropriate statement.

A 1. Flight could be continued with no visibility restrictions.

B 2. Visibility restrictions can be expected due to rain.

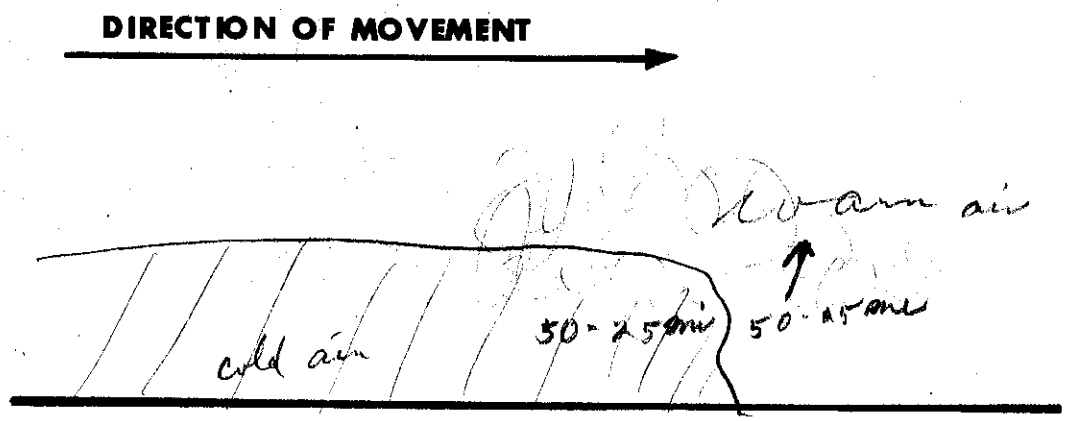
A, B 3. Turbulence and gusty winds can be expected.

B 4. The low clouds, rain and gusty surface winds require us to land and wait until the front passes our position.

Answers - 50 - 100 miles
Warm air
Cold air

FRAME 7

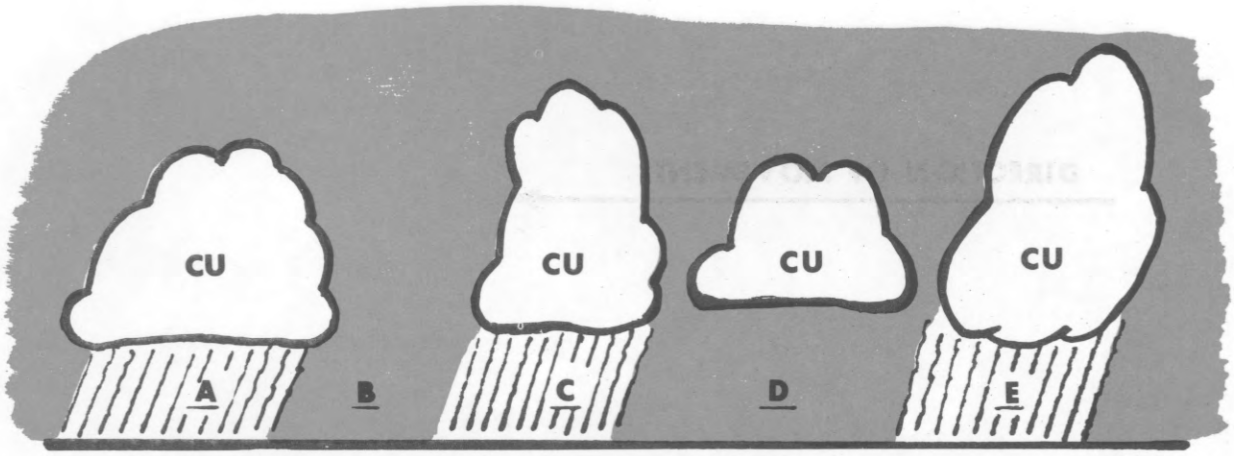
Draw a cross section of a cold front and include the cumuliform cloud cross section with its distances to either side of the surface front.



Answers - 1. A
2. B
3. A B
4. B

FRAME 18

Heavy rain showers associated with a cold front are not always one continuous line. You may often be able to go around (circumnavigate) an area of heavy precipitation.

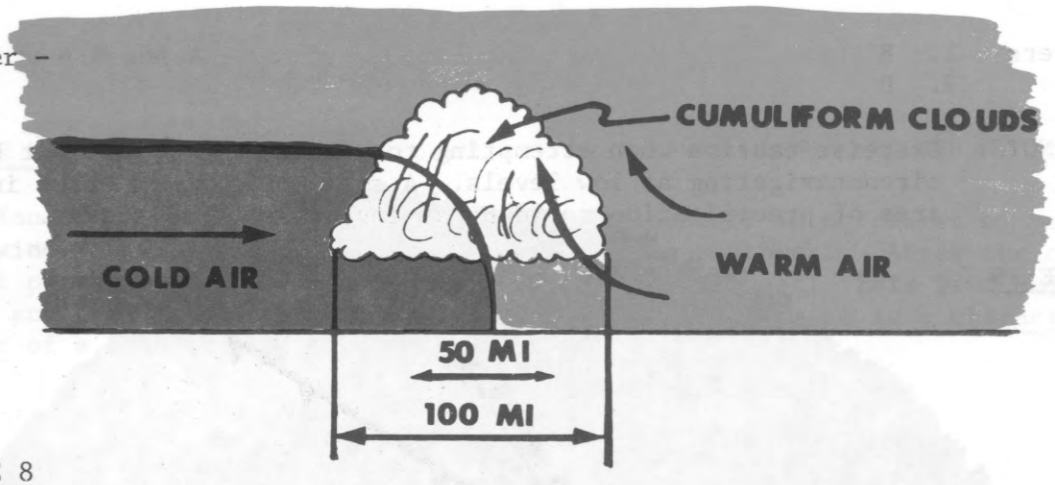


You are flying toward a cold front at a low altitude.

a. It would be best to penetrate at point B.

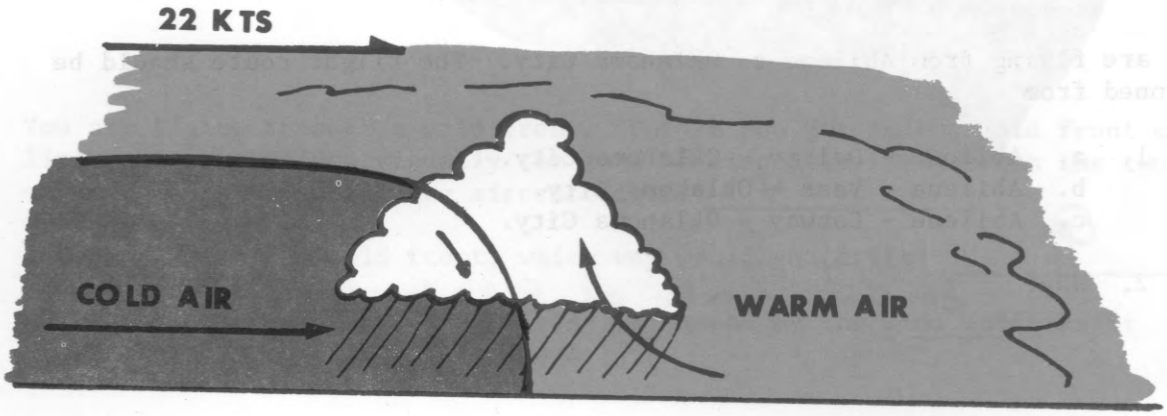
b. The next best penetration point would be D.

Answer –



FRAME 8

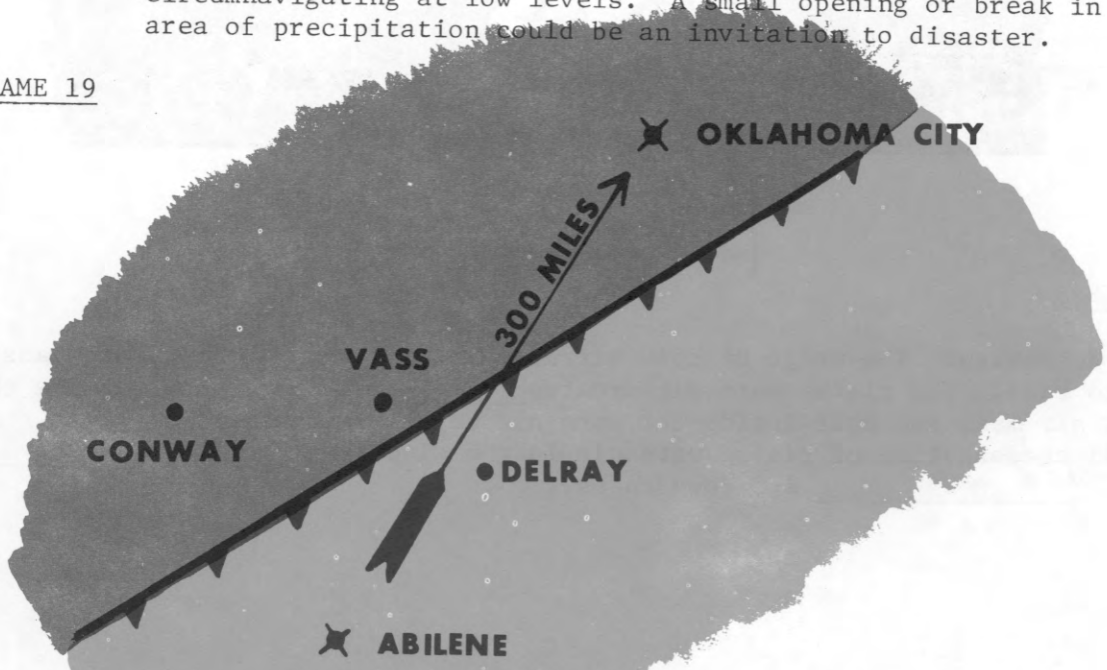
To review: The wedge of cold air advances under a warm air mass causing it to rise. The rising warm air creates cumuliform clouds, (half inside the cold air mass and half inside the warm air mass), at the surface front. The rapid condensation of rising warm air in the clouds creates heavy showers, turbulence and downdrafts.



Answers - 1. B
2. D

NOTE: Exercise caution when attempting to penetrate a cold front by circumnavigating at low levels. A small opening or break in an area of precipitation could be an invitation to disaster.

FRAME 19



You are flying from Abilene to Oklahoma City. The flight route should be planned from

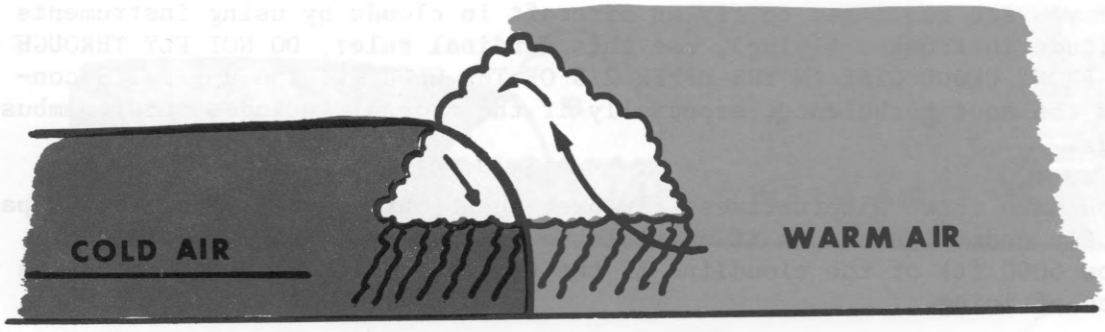
1. a. Abilene - Delray - Oklahoma City.
   b. Abilene - Vass - Oklahoma City.
   c. Abilene - Conway - Oklahoma City.

2. Why? penetrate fronts at 90° to their travel

Answers - 1. cumuliform 2. heavy showers

FRAME 9

Another characteristic of a cold front is its flight conditions. The rising warm air creates updrafts. As the air cools and condenses, it descends rapidly as cold air and rain.



Flying through a cold front with cumulus clouds, you would expect

a. a smooth flight.

b. Stable flight conditions.

c. Rough flying conditions.

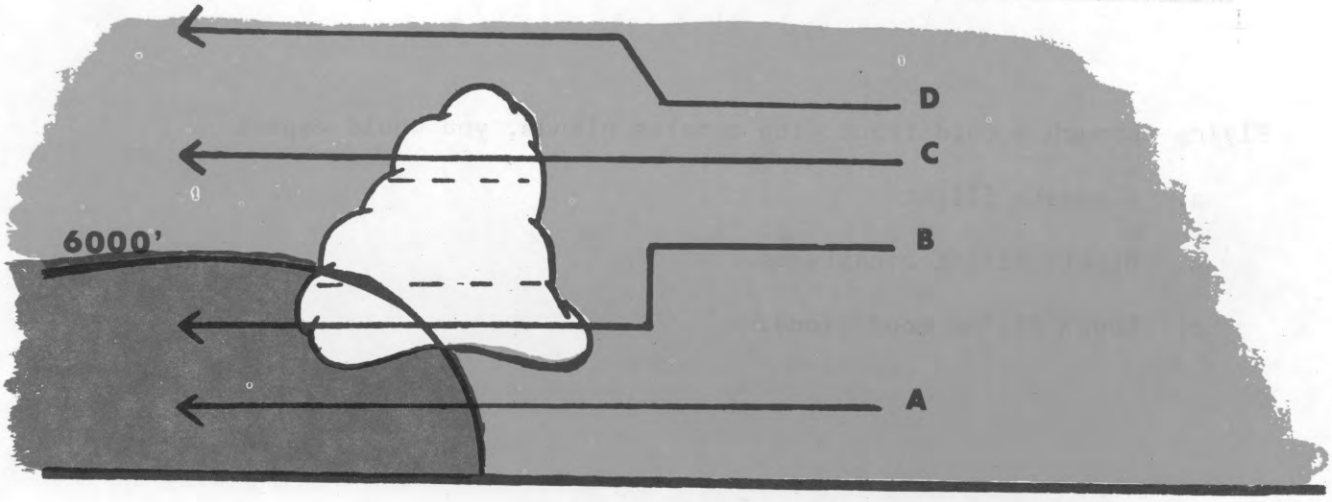
ANSWERS: 1. c

2. When necessary to penetrate a front, it should be made at a 90° angle to the front. This will provide passage through the weather band in the shortest possible time.

FRAME 20

If you are qualified to fly an aircraft in clouds by using instruments (attitude instrument flying), use this cardinal rule: DO NOT FLY THROUGH A COLD-FRONT CLOUD LINE IN THE UPPER 2/3 OF THE CLOUDS!. The upper 2/3 contains the most turbulence, especially if the frontal includes cumulonimbus clouds.

You have three alternatives; fly over the front if the aircraft is capable, fly under the clouds if possible, or fly through the lower third (below 6000 ft) of the cloudline if the turbulence is slight and there is no chance of icing.



Select flight courses recommended for penetrating a cold front.

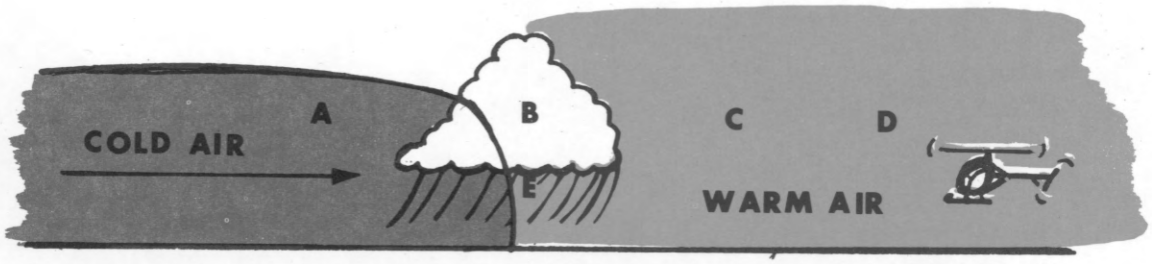
NOTE: Whether or not you are instrument qualified, if you feel a cold front will be violent, land and let it pass.

A, D, B, ~~C~~

ANSWER: c

FRAME 10

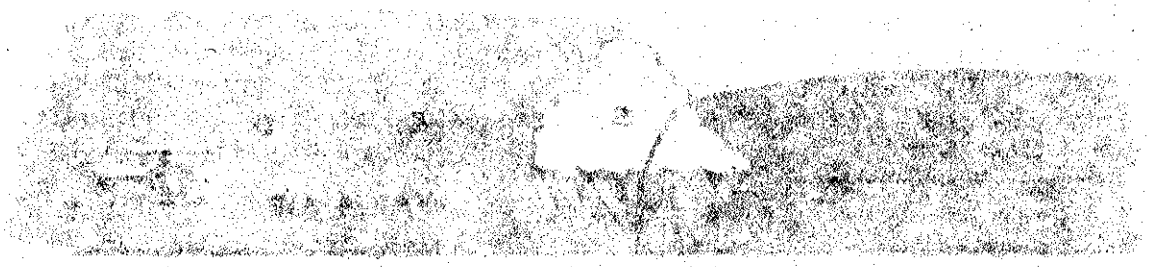
A cold front generally has good visibility and ceiling.



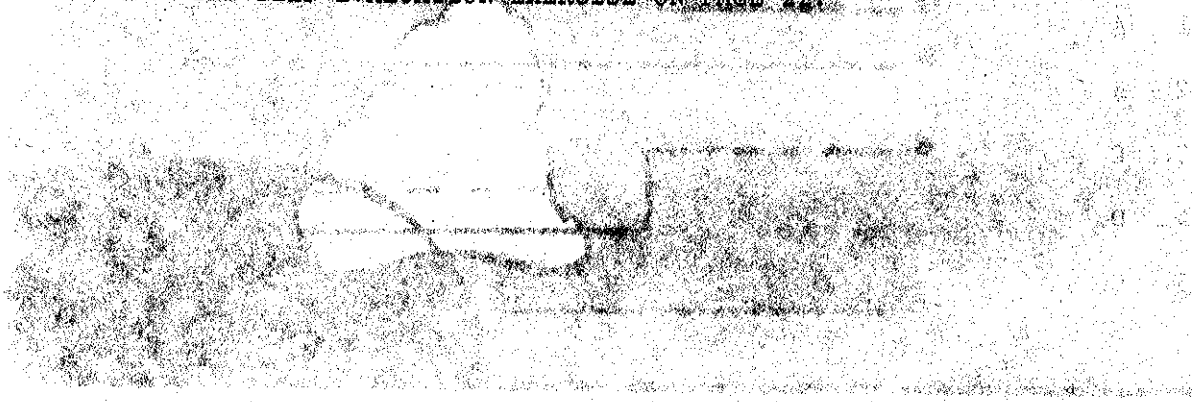
However, flying through a cold front, you would expect to find poor visibility in the vicinity of point(s)

1. A
2. B
3. C
4. D
5. E

Answers - A, B, and D



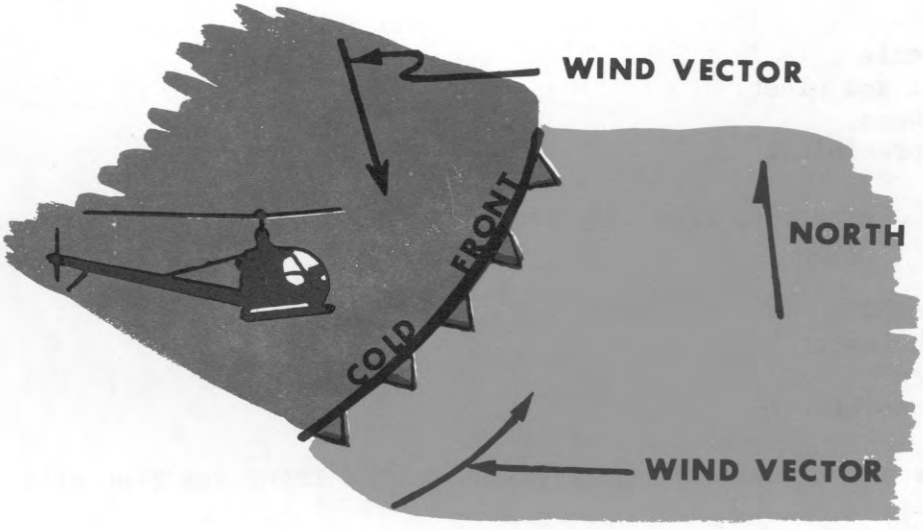
COMPLETE THE SELF-EVALUATION EXERCISE ON PAGE 22.



Answers - E and B

FRAME 11

You are at Fort Wolters, Texas, and a cold front is northwest of you. The wind you would experience would be from the southwest. After the cold front passed you, the wind would shift to the northwest. This wind shift from southwest to northwest at the time of frontal passage is a characteristic of a cold front.



You are flying through a cold front. Before you get to the cold front cloud line, which shows you visually the zone of discontinuity between the two air masses, which way would the aircraft drift? ↓

After you pass the cold front, which way would you drift? ↑

An aircraft's change in drifting is caused by the wind shift as it passes through the cold-front cloud line.

TURN TO PAGE 2 FOR FRAME 12

SELF EVALUATION EXCERSIE
COLD FRONTS

1. Clouds associated with a cold front are of the

   a. Cumuliform type and covers an area 50 to 100 miles wide.
   b. Stratus type and covers an area 50 to 100 miles wide.
   c. Cumuliform type and covers an area 100 to 500 miles wide.

2. Below the base of the Cumuliform cloud in the summer you would expect to find

   a. drizzle
   b. hail and sleet.
   c. showers.
   d. no precipitation.

3. You would expect to find flight conditions in and around a cold front to be

   a. smooth.
   b. turbulent.
   c. clear.
   d. impossible.

4. Ceilings and visibility in and around a cold front are generally

   a. good everywhere.
   b. poor under the clouds.
   c. good except in areas of intense showers.
   d. bad everywhere.

5. If a cold front was between Fort Worth and Dallas, the winds in Fort Worth would be from the

   a. southeast.
   b. southwest.
   c. northwest.
   d. east.

6. As the cold front approached Dallas, the temperature in Dallas would

   a. decrease and then increase.
   b. be warmer than after the cold front passes.
   c. be colder and then rise.
   d. be no change in temperature.

7. The average cold front travels

   a. in a southwest direction at 10 knots.
   b. in a southeast direction at 22 knots.
   c. in a northerly direction at 22 knots.

8. After a cold front passes a ground weather station

   a. the barometric pressures rise.
   b. the barometric pressure falls.
   c. remains steady.

9. Which is not a recommended method of crossing a cold front?

   a. Climb over the front if the aircraft is capable.
   b. Penetrate the lower 1/3 of the clouds to avoid areas of severe turbulence.
   c. Penetrate the upper 2/3 of the clouds.
   d. Fly under the clouds and avoid areas of heavy precipitation.

10. A squall line is associated

   a. with all weather fronts.
   b. only with cold fronts.
   c. with warm fronts and cold fronts.

11. A squall line is

   a. a line of clouds behind a front.
   b. a line of thunderstorms 75 to 300 miles ahead of a cold front.
   c. an area of mild weather ahead of a cold front.

12. The greatest dangers associated with a cold front

   a. are in the lower levels of a front.
   b. are in the upper 2/3 of the cold front and anywhere in the squall line.
   c. are found in the top 1/3 of the front.

13. Flying low level and not instrument flight qualified, the procedure recommended in passing through a violent cold front would

   a. be to remain on course and continue to destination at all cost.
   b. circumnavigate areas of heavy precipitation and continue to destination.
   c. land, allow the front to pass, and then proceed to destination.
   d. fly beneath the clouds and be alert for turbulent conditions and gusty winds.

ANSWER KEY ON PAGE 64

NOW TURN TO PAGE 25 FOR PART II

WARM FRONTS