USAAVNS PT 12

PROGRAMED TEXT

RMI

APRIL 1966

DEPARTMENT OF FIXED WING TRAINING
UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA

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UNITED STATES ARMY AVIATION SCHOOL
Fort Rucker, Alabama

PROGRAMED TEXT

TITLE: RMI Programed Text SUBJECT NO. 633-1
SCOPE: Navigation with the Radio Magnetic Indicator.
INSTRUCTOR REFERENCES: TM 1-225, dated April 1965, chapter 12
MATERIALS ISSUED TO STUDENTS: RMI Programed Text RMI Programed Answer Sheet
PREPARED BY: William C. Whisnant DATE: April 1966
APPROVED BY: Colonel D. H. Boardman, Jr. Director DATE: April 1966

CONTENTS

PREFACE

The Radio Magnetic Indicator (RMI) has proven over a period of years to be a valuable instrument for radio navigation. However, many aviators have never had the opportunity to use the RMI.

This book is designed for the student who has an understanding of basic VOR and ADF procedures. It will teach you the RMI and its application in navigation problems.

To obtain maximum benefit from this book:

1. Read carefully and understand subject matter.

2. Do not skip pages. Request assistance if necessary. Skipping a page or not understanding points covered on one page may affect understanding of points on following pages.

3. Write answers on a separate sheet of paper.

4. After completing each page, compare your answers with those on back of page. Should your answers differ with those given, review points in question before continuing to next page.

PERFORMANCE OBJECTIVES

RMI

(Reference: TM 1-225, dated April 1965, chapter 12)

1. KNOWLEDGES:

   a. Given RMI indications, student will be able to write:

      (1) Heading.

      (2) Shortest direction of turn to another given heading.

      (3) Headings (using reference marks) that are 45° and 90° right and left from present heading.

      (4) Heading (using reference mark) that is 180° from present heading.

      (5) Direction to station(s).

      (6) Direction from station(s).

      (7) Location of aircraft with respect to station(s) (e.g., N, NE, E, etc.).

      (8) Radial on which aircraft is located.

   b. Given data for fixing a specific intersection, RMI indications and a chart or diagram, student will be able to write the position of the aircraft with respect to the intersection.

   c. Given an interception problem and RMI indications, student will be able to write:

      (1) Aircraft position with respect to desired course.

      (2) Heading to use in order to intercept desired course at a specified angle.

      (3) Heading to use in order to intercept desired course using the "double the angle" method.

d. Given a course to maintain, several RMI indications and a tracking diagram, student will be able to match each aircraft position shown in the diagram with the correct indication.

e. Given aircraft heading and an RMI with a compass card that is inoperative, student will be able to interpret the indications and write:

(1) Direction to the NDB (No. 1 needle).

(2) Direction to the VOR (No. 2 needle).

2. SKILLS: None.

The ID 250 - Radio Magnetic Indicator (RMI) below has a rotating compass card which shows the heading of the aircraft under the heading index. It also has two needles which give you radio navigation information, but we will talk about them later.

The indicator below shows that the heading of the aircraft is 251°.

ANSWER

251°

In figure 1 below, the aircraft heading is 270°.

In figure 2, the aviator has turned 50° right. Aircraft heading in this case is 320°.

Figure 1

Figure 2

ANSWER

320°

Determining the shortest direction to turn when changing heading is simplified when using RMI. Mentally divide the instrument into left and right halves. If the desired heading is in the right half, turn right. If the desired heading is in the left half, turn left.

The indicator below shows that the aircraft heading is 295 °. To turn to a new heading of 125° in the shortest direction, you would turn left (right, left).

ANSWER

295°, left

The indicator below shows that the heading of the aircraft is

155 °. To turn to a new heading of 325° in the shortest direction,

you would turn right (right, left).

ANSWER

155°, right

From the heading shown on the RMI below, fill in the blanks to indicate the shortest direction of turn to the headings given.

Heading	Left/right
345°	right
160°	left
215°	left
080°	right
010°	right

ANSWER

Heading	Left/right
345°	right
160°	left
215°	left
080°	right
010°	right

There are many situations which call for right or left turns to new headings which are 45°, 90°, or 180° from your present heading.

Reference marks at 45° intervals around the face of the RMI can help you determine these new headings.

You plan to turn right 45°. Read the new heading under the reference mark that is 45° right of the heading index. In this case, the new heading is 293 °.

ANSWER

295°

You have the indications below and want to turn left 90°. By looking under the reference mark which is 90° left of the heading index, you see that your new heading will be 136 °.

ANSWER

136°

Use the reference marks to determine that a heading 90° right of the heading on the instrument below is 90 °.

ANSWER

050°

Use the indicator below and complete the following statements:

1. The "reciprocal" of the present heading is 150 °.
2. The heading 90° to the left is 240 °.
3. The heading 45° to the left is 285 °.
4. After completing a turn of 45° to the right, your heading would be 15 °.

ANSWER

1. 150°

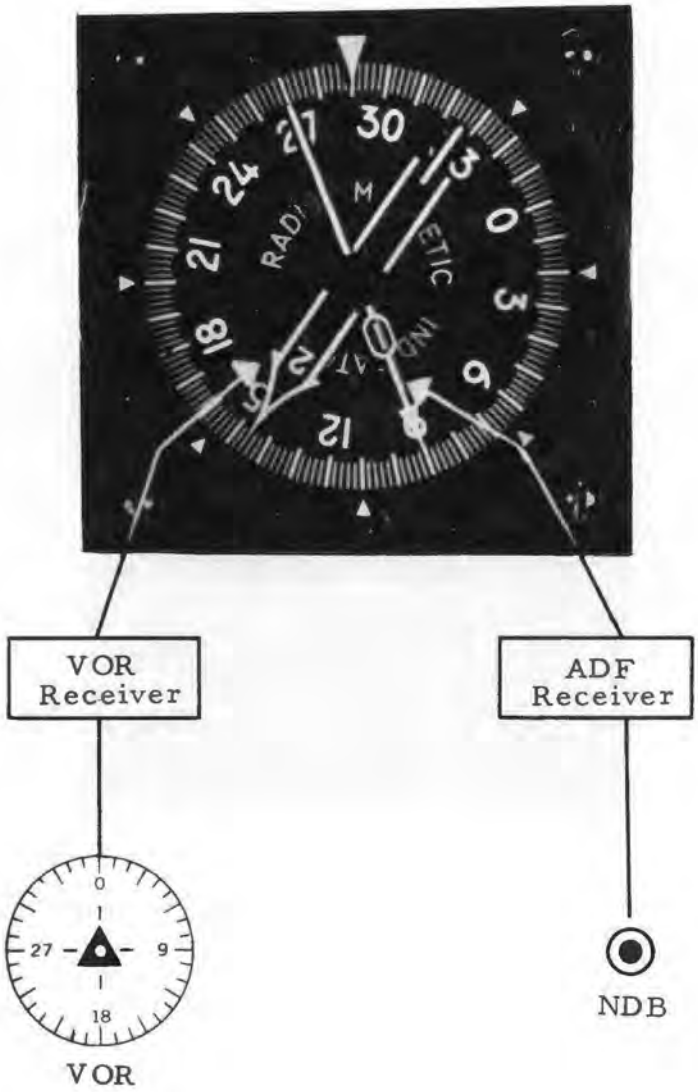
2. 240°

3. 285°

4. 015°

If you scored well using the RMI as a compass, you are ready to begin using the needles for radio navigation.

Throughout this book use needle No. 1 for NDB or LOM navigation and needle No. 2 for VOR navigation as shown in the diagram below. This is normally true in aircraft with only one ADF receiver and one VOR receiver. In aircraft having dual ADF and/or dual VOR receivers, switches are provided for receiver selection.



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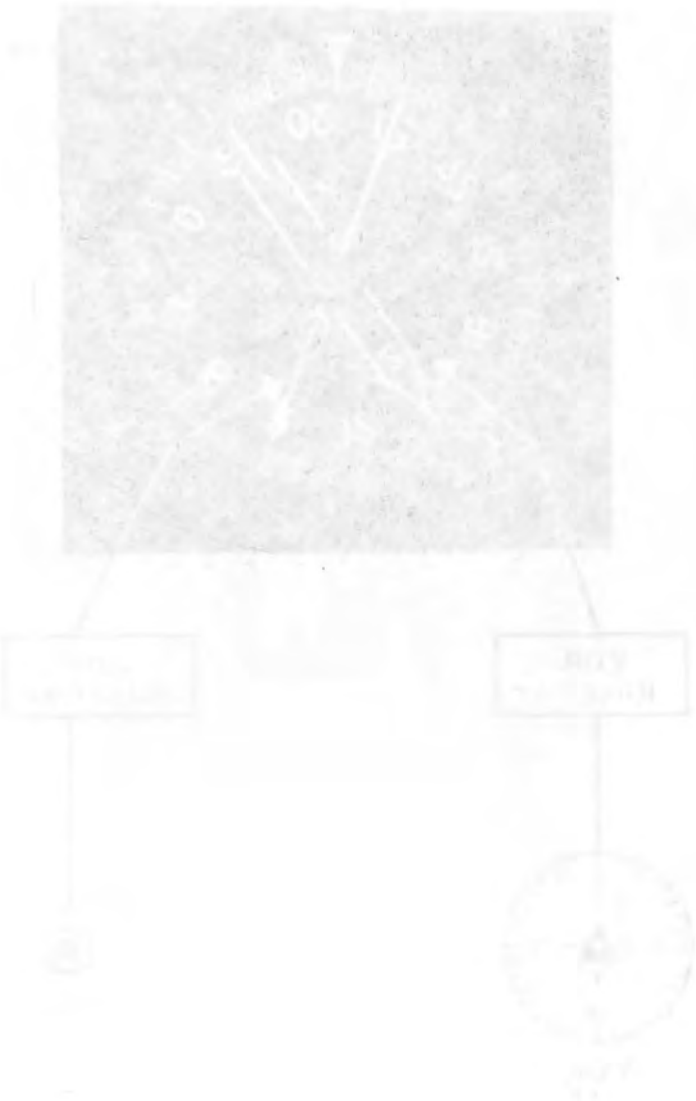
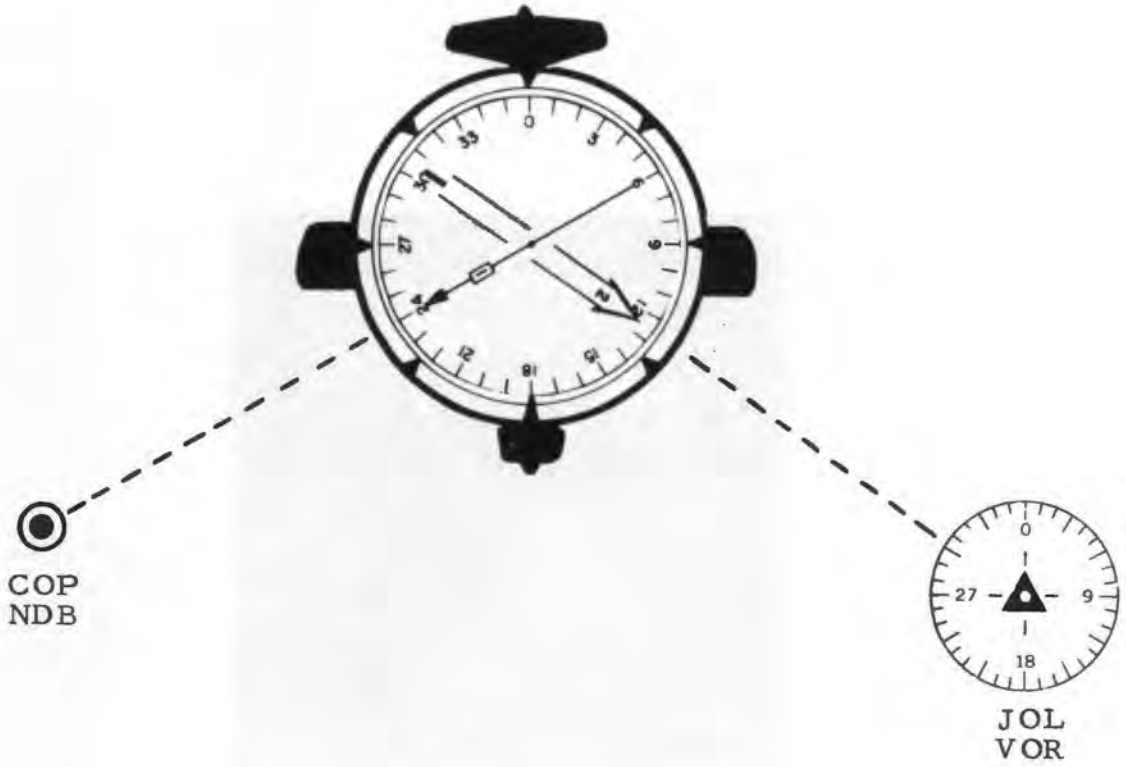


Always read magnetic direction to a VOR or ADF station under pointed end of the needles.

In the illustration below, needle No. 1 is tuned to COP NDB and needle No. 2 is tuned to JOL VOR.



Magnetic direction to COP NDB is 240°.

Magnetic direction to JOL VOR is 125°.

ANSWER

240°, 125°

The indicator below shows a heading of 70 °.

Direction to the NDB is 346 °.

Direction to the VOR is 10 °.

ANSWER

070°, 346°, 010°

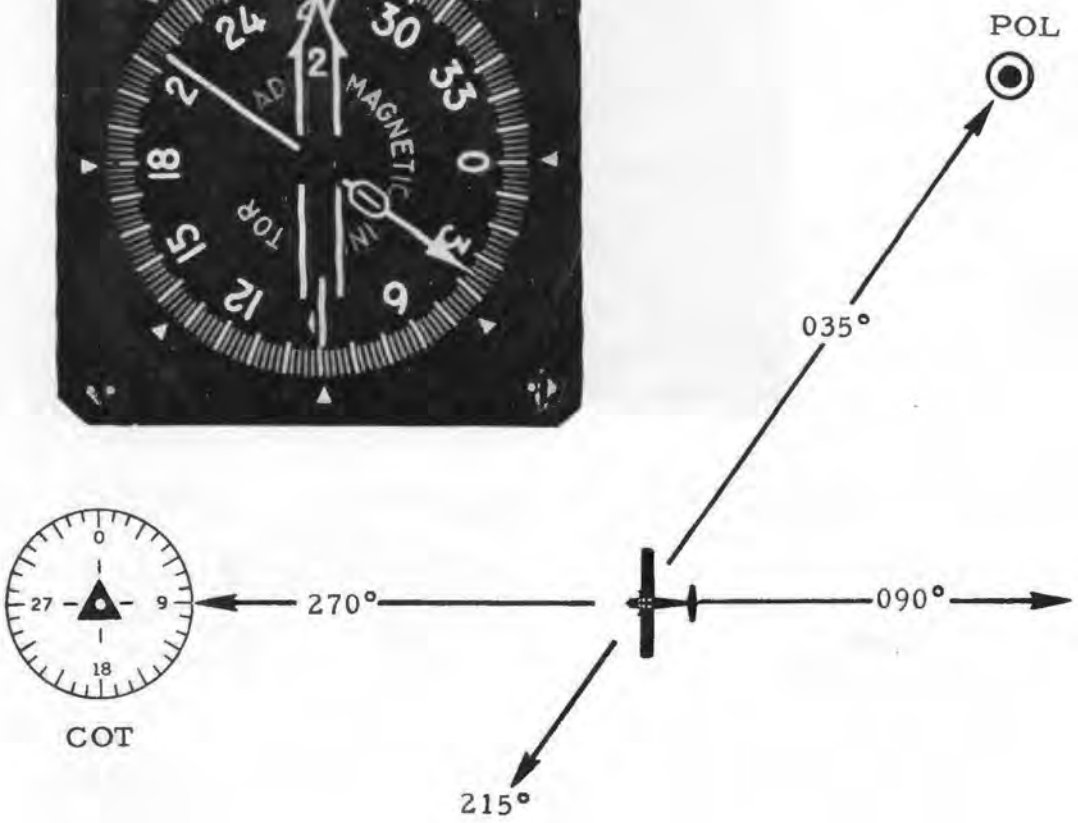
NOTE: Remember, for this text, needle No. 1 will be used with ADF and needle No. 2 with VOR.

To turn inbound to the VOR, with the indications below, you would turn right (right, left) to a heading of 330°.

ANSWER

Right, 330°

The blunt end of any needle is opposite to, or the reciprocal of, the pointed end; therefore, you can see that with the pointed end of an RMI needle pointing to a station, the blunt end will be the reciprocal or outbound direction from that station.



The indicator above shows an outbound direction from POL NDB of 215 °.

The direction from COT VOR is 90 °.

ANSWER

215°, 090°

NOTE: Read direction from either ADF or VOR stations under the blunt end of an RMI needle.

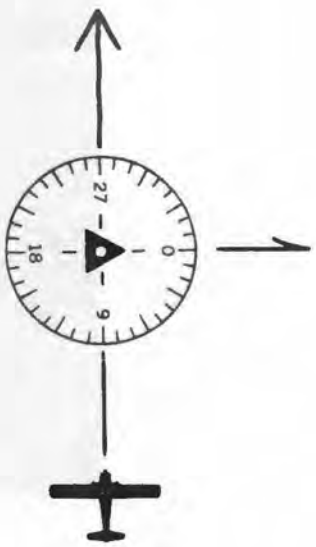
The RMI will present a map-like display of any situation if you think of the compass card as a compass rose around a station and let the needle hub become the station. The blunt end of the needle is your position.

The RMI needle hub represents the station.

The blunt end of the needle is your aircraft.

Therefore, in the example below, you would be east (north, east, south, west) of the VOR.

Pilot sees this.



Pilot visualizes this.

ANSWER

Station

Position (aircraft)

East

A map-like display on an RMI is a <u>forward view</u> as if the compass card were painted on the ground around the station. You see the compass card over the nose of the aircraft or in the direction of flight.

With the indications below, north is to your right (right, left).

The VOR is to your right (right, left).

The VOR is north (north, east, south, west) of the aircraft.

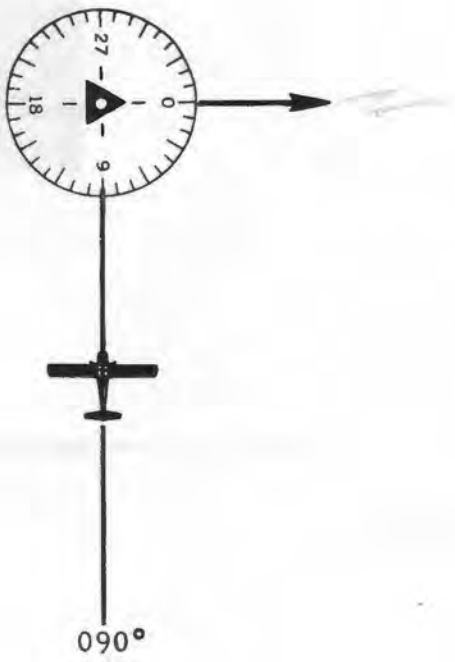
ANSWER

Right, right, north

NOTE: In this text, displays are shown, when appropriate, with aircraft heading toward top of page as you would visualize them on the RMI. Check vectors for magnetic north.

The term "radial" represents position around a VOR station measured as a direction from the station. Therefore, the radial is under the blunt end of the RMI No. 2 needle which is coupled to the VOR receiver in this text.

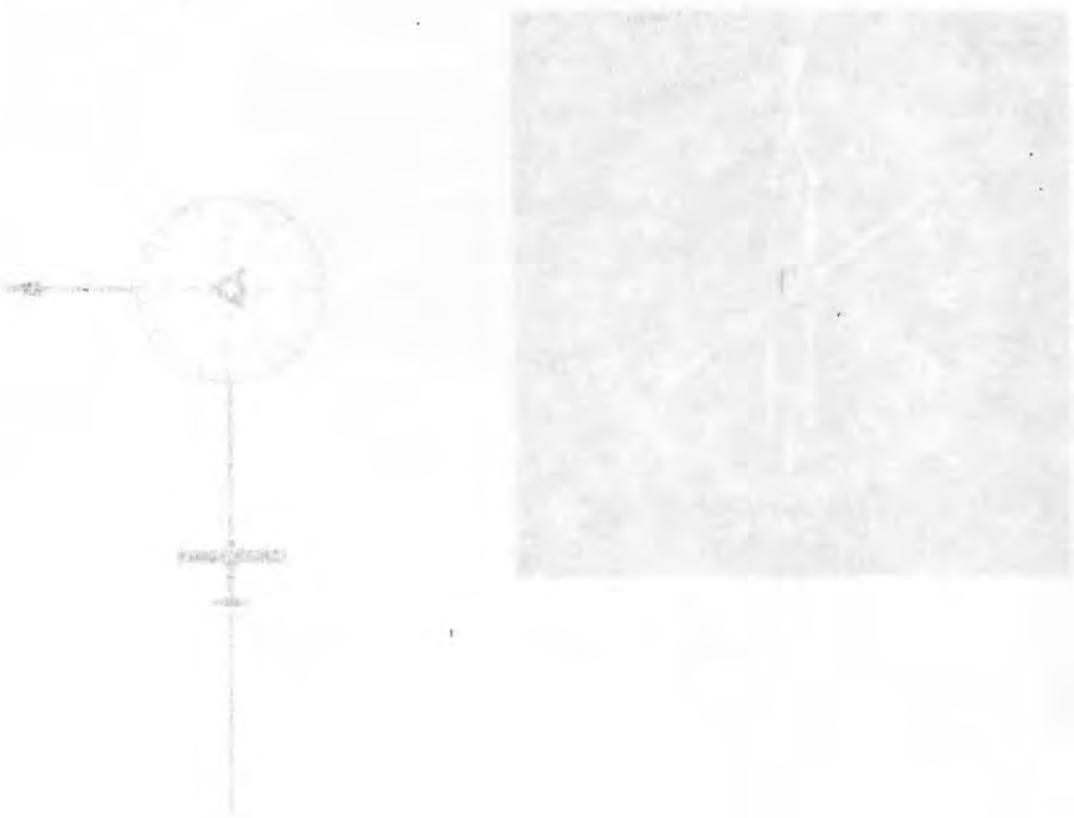
With the indications below, you are located east (north, east, south, west) of the VOR inbound on the 90° radial.



ANSWER

East, 090

NOTE: The blunt end of a VOR needle indicates the radial, regardless of heading; therefore, it is easy to determine when you are crossing a given radial.



With the indications below, the aircraft is _____ (north, east, south, west) of the VOR crossing the _____ radial heading north.

ANSWER

East, 090

Use the blunt end of No. 2 needle to visualize your position on the compass card and complete the following statements:

In figure 1 you are located on the 165° radial of the VOR.

In figure 2 you are on the 225 radial of the VOR. Therefore, in figure 2 the aircraft is SW (NE, SE, SW, NW) of the VOR.

Figure 1

Figure 2

ANSWER

165, SW

The blunt end of needle No. 1 (ADF) also shows aircraft position relative to the NDB to which it is tuned.

The indicator below shows that the aircraft is south (north, east, south, west) of the NDB flying a heading of 240°.

ANSWER

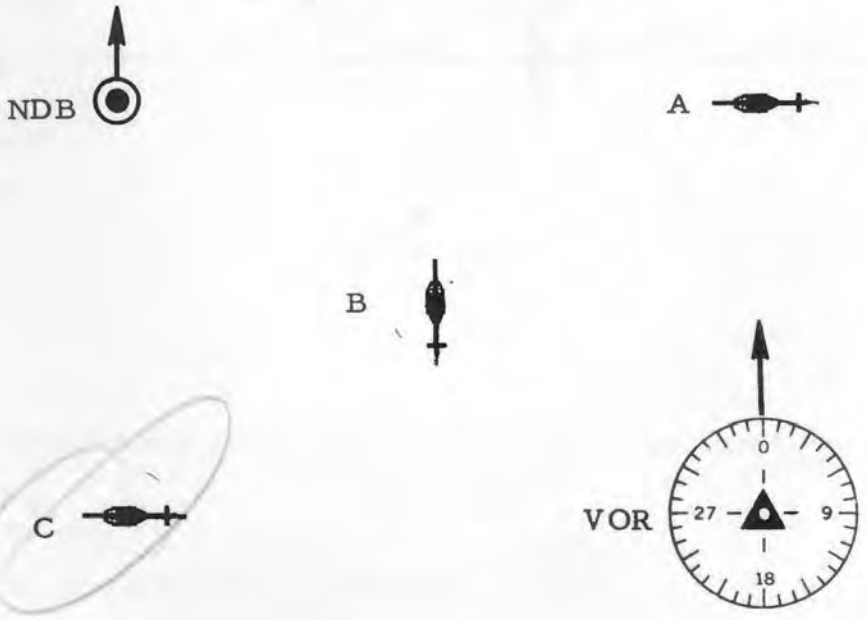
East, 240°

Use the RMI indicator below and complete the following statements:

The aircraft is S (N, E, S, W) of the NDB.

The aircraft is West (N, E, S, W) of the VOR.

Therefore, in the diagram below, aircraft position is C (A, B, C).

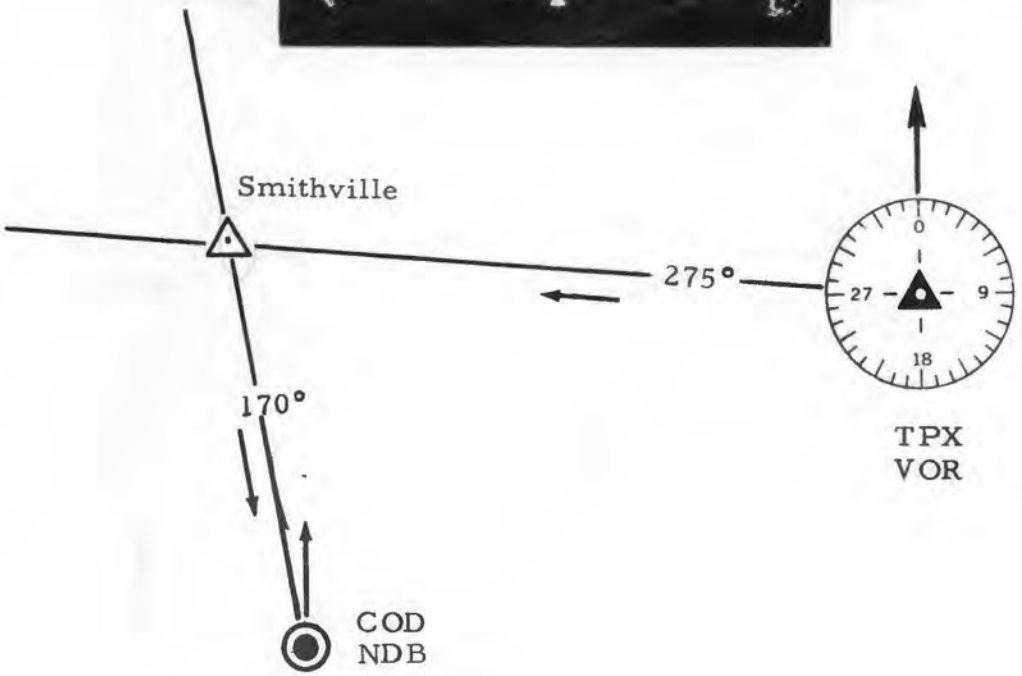


ANSWER

South, west, C

With the indications below, you are inbound (inbound, outbound) on the 275 radial of TPX VOR.

Needle No. 1 indicates you are (east of, over, west of) Smithville intersection.



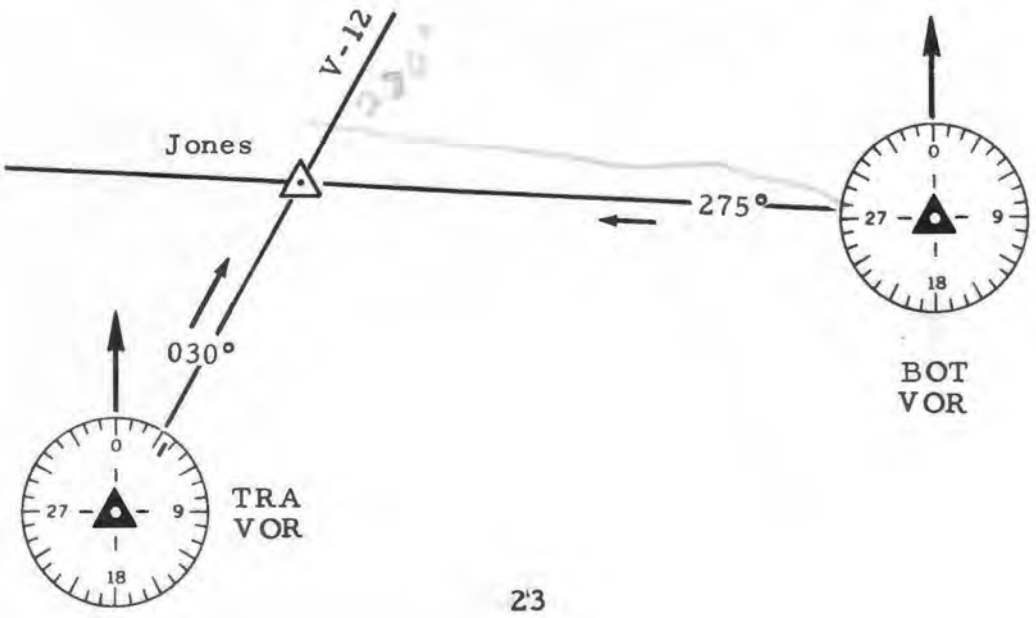
ANSWER

Inbound, over

You are flying southwest on V-12 and tune the VOR receiver to BOT VOR to fix Jones intersection.

After checking the indicator below, you know that you are crossing the _____ radial.

Your position with respect to Jones intersection is _____ (NE, over, SW).

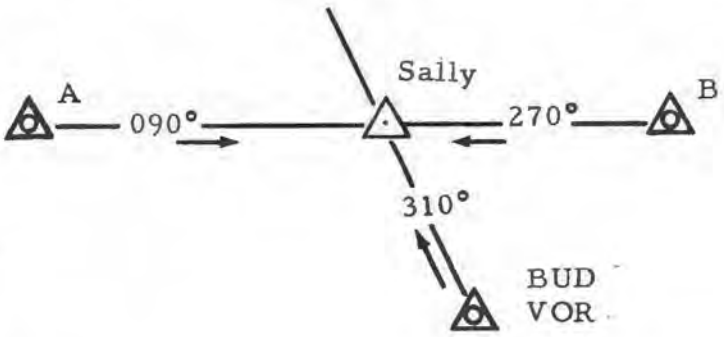


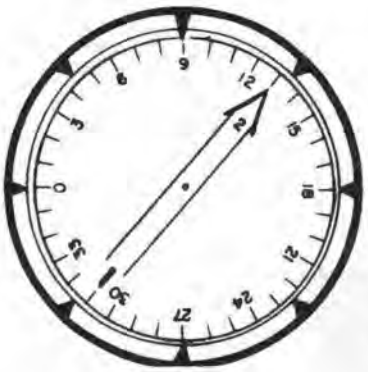
ANSWER

280, NE

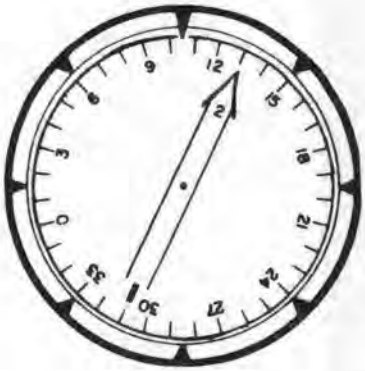
You are maintaining the 90° track from A to B. You tune the VOR receiver to BUD VOR to fix Sally intersection.

Indicate your position with respect to Sally intersection for each RMI indication below.



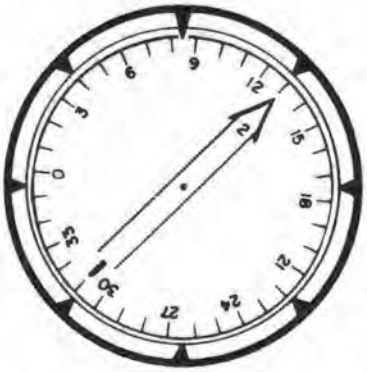


1. _____ (east, over, west)



NOTE: Wind correction.

2. _____ (east, over, west)



NOTE: Wind correction.

3. _____ (east, over, west)

ANSWER

1. Over

2. Over

3. Over

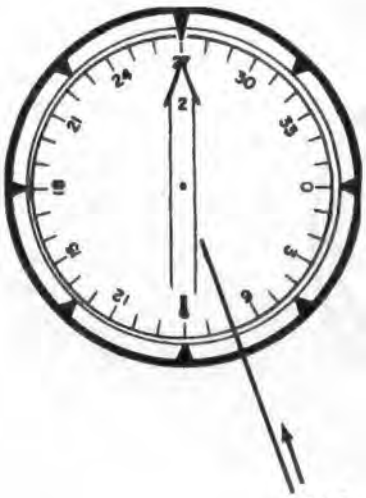
NOTE: Drift corrections have no effect on indications of the RMI needles.

When making interceptions, visualize your position in relation to the desired course and any possibility of error is minimized.

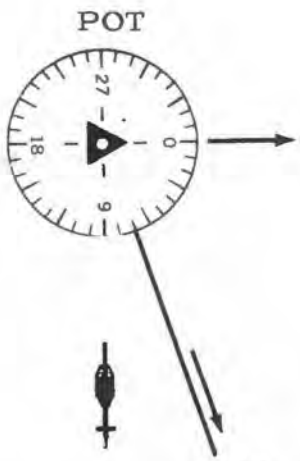
In the example below, you have been cleared to POT VOR via the 070 radial.

You are W (N, E, S, W) of the VOR flying inbound.

You are 20° left (left, right) of the desired course.



250°
Course to
VOR
(See note)



070°
Radial

NOTE: The desired course is shown on the instrument as you would visualize it.

ANSWER

East, 20°, left

NOTE: The blunt end of an RMI needle will show your position in relation to a desired course visualized on the compass card, regardless of heading. Therefore, it is unnecessary to parallel.

You plan to intercept the 240 radial at a 45° angle and track inbound; therefore, the desired course is 060°.

Your position as shown on the indicator below will require an intercept heading that is 45° right of the desired course. The intercept heading is 105 °.

ANSWER

105°

NOTE: The intercept heading is always desired course, plus or minus the intercept angle.

You desire to track inbound on the 300 radial.

With the indications below, you are 250 ° right (left, right) of the desired course.

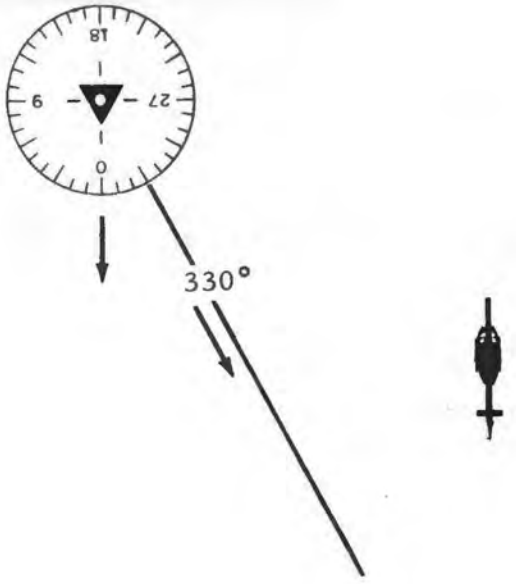
In order to intercept at an angle of 45°, you would turn left to a heading of 75 °.

ANSWER

25°, right, 075°

NOTE: The course heading is 120° for tracking inbound on the 300 radial. The intercept heading would be 45° left of course heading.

In order to intercept the 330 radial at an angle of 45° and track inbound, you would turn right (right, left) to a heading of 106°.



ANSWER

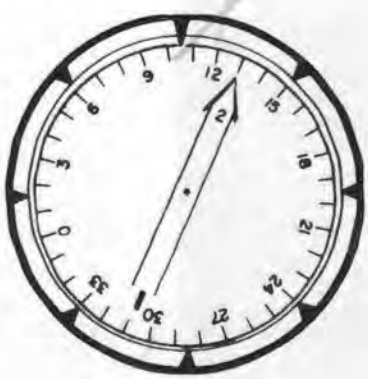
Left, 105°

In the figures below, you are intercepting the 330 radial to track inbound.

The angle of interception is 45° °.

In figure 1, you are 10° ° off the desired course.

In figure 2, you are _____ (short of, over, past) the desired course.



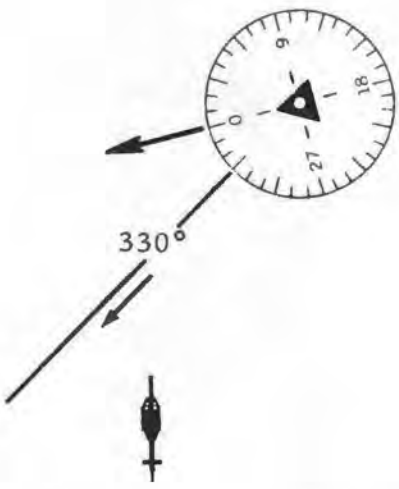


Figure 1

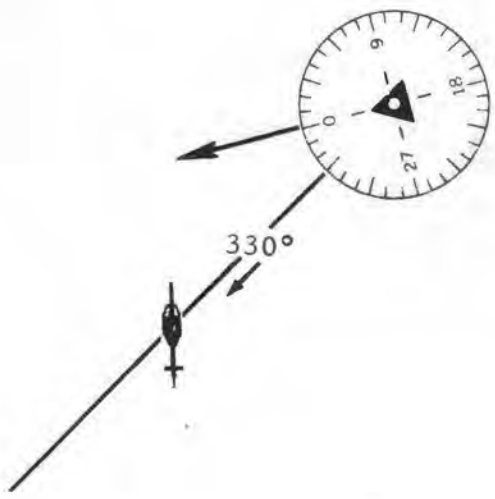


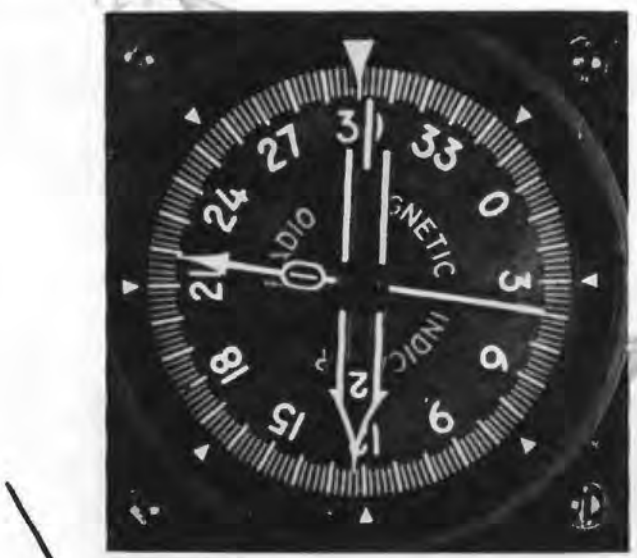
Figure 2

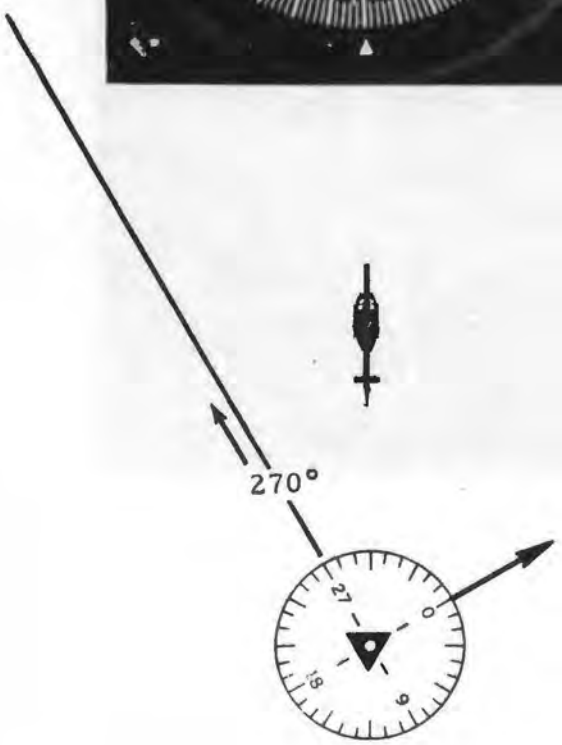
ANSWER

45°, ~~20°~~ 10°, over

You plan to intercept and track <u>outbound</u> on the 270 radial, using a 45° angle for interception.

You would turn _____ (right, left) to an intercept heading of _____°.





ANSWER

Left, 225°

You are cleared outbound from the VOR via the 330 radial.

With the indications below, you are 24° off course.

To intercept at a 45° angle, you would turn right (right, left) to an intercept heading of 15°.

You would be on course when No. 2 needle reads 150°.

ANSWER

26°, right, 015°, 330° under blunt end or 150° under pointed end.

Most interceptions are made using a 45° angle. Use a 90° angle when told to expedite. It is also advisable to use a 90° angle for inbound interceptions where the aircraft is more than 30° off the desired course.

To intercept the 165 radial and track to the VOR with the indications below, you would use a 90 ° angle.

ANSWER

90°

NOTE: Using a 45° angle in this problem, you would not intercept until at or near the VOR.

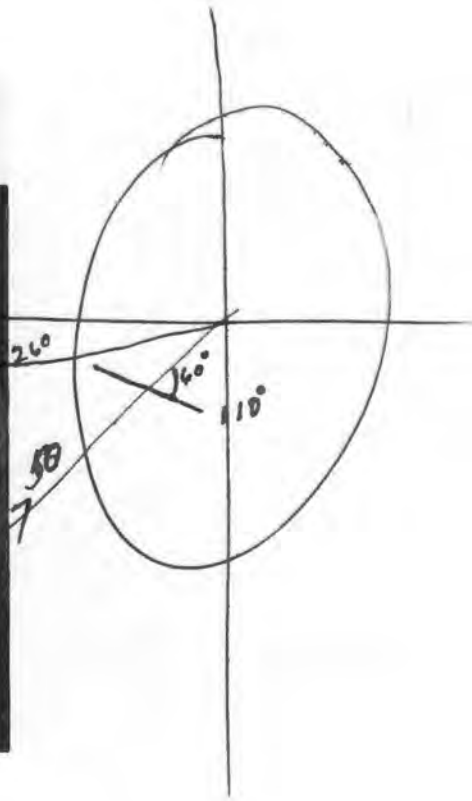
Another method, "double the angle", is also used for making interceptions. First, determine the angular distance off course and double this angular distance to arrive at the intercept angle. Never use less than 20° or more than 90°.

Use needle No. 2 on the instrument below and apply the "double the angle" method to intercept and track inbound via the 230 radial.

You are 30 ° off course.

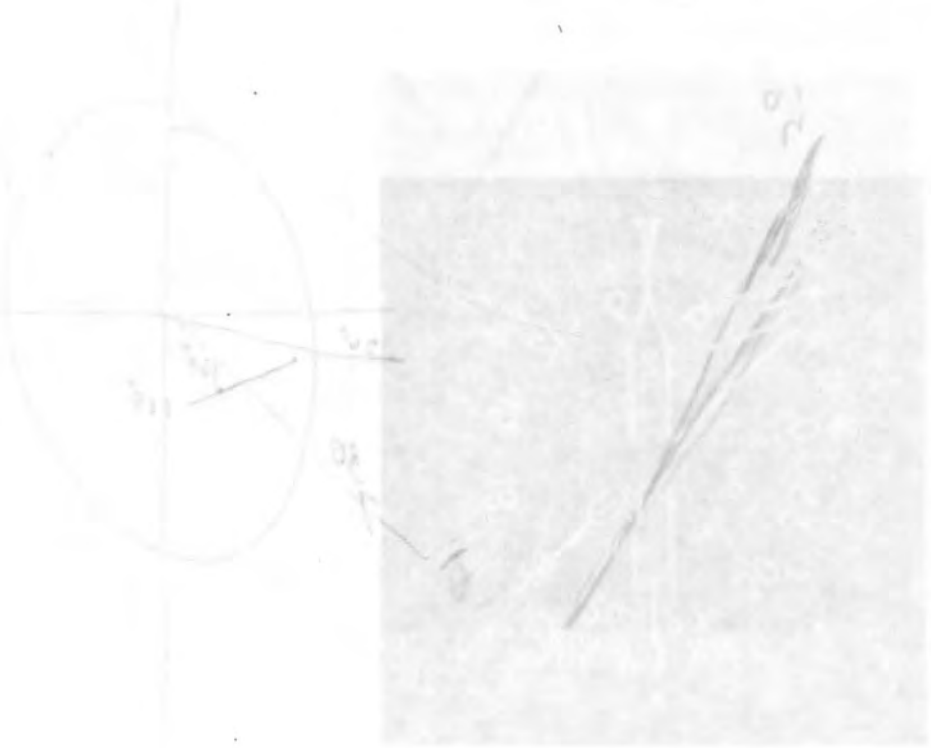
The angle for interception is 60 °.

The intercept heading is 110 °.



ANSWER

30°, 60°, 110°



Procedures used for interceptions are the same when using either the VOR or ADF needle. However, different phraseology is used in the clearances. Make sure you visualize the course correctly on the compass card.

After receiving clearance to ETP NDB via the 040 magnetic course, you note the indications below and determine that the intercept heading is 040°.

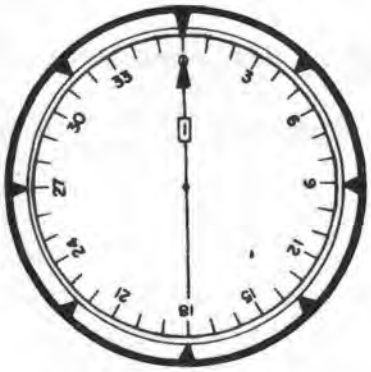
ANSWER

085° (45° angle)

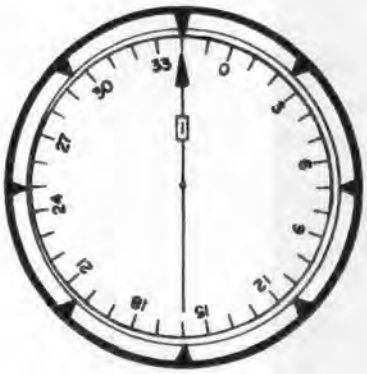
080° ("double the angle")

In the illustration below, you are intercepting the 340 course to the NDB. Indicate your position (A, B, C, D) in the diagram under each indication below.

1. C .

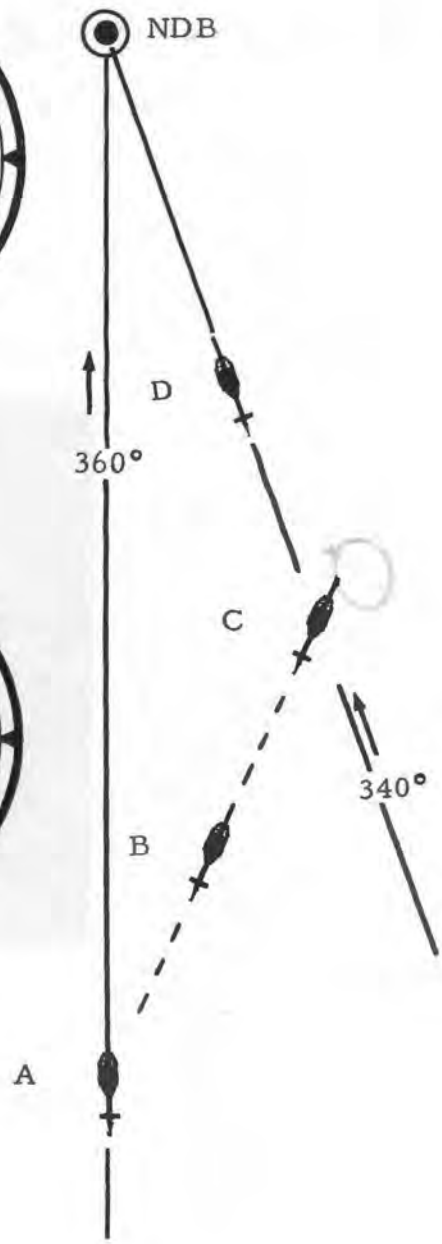


2. A .



3. D .

4. B .



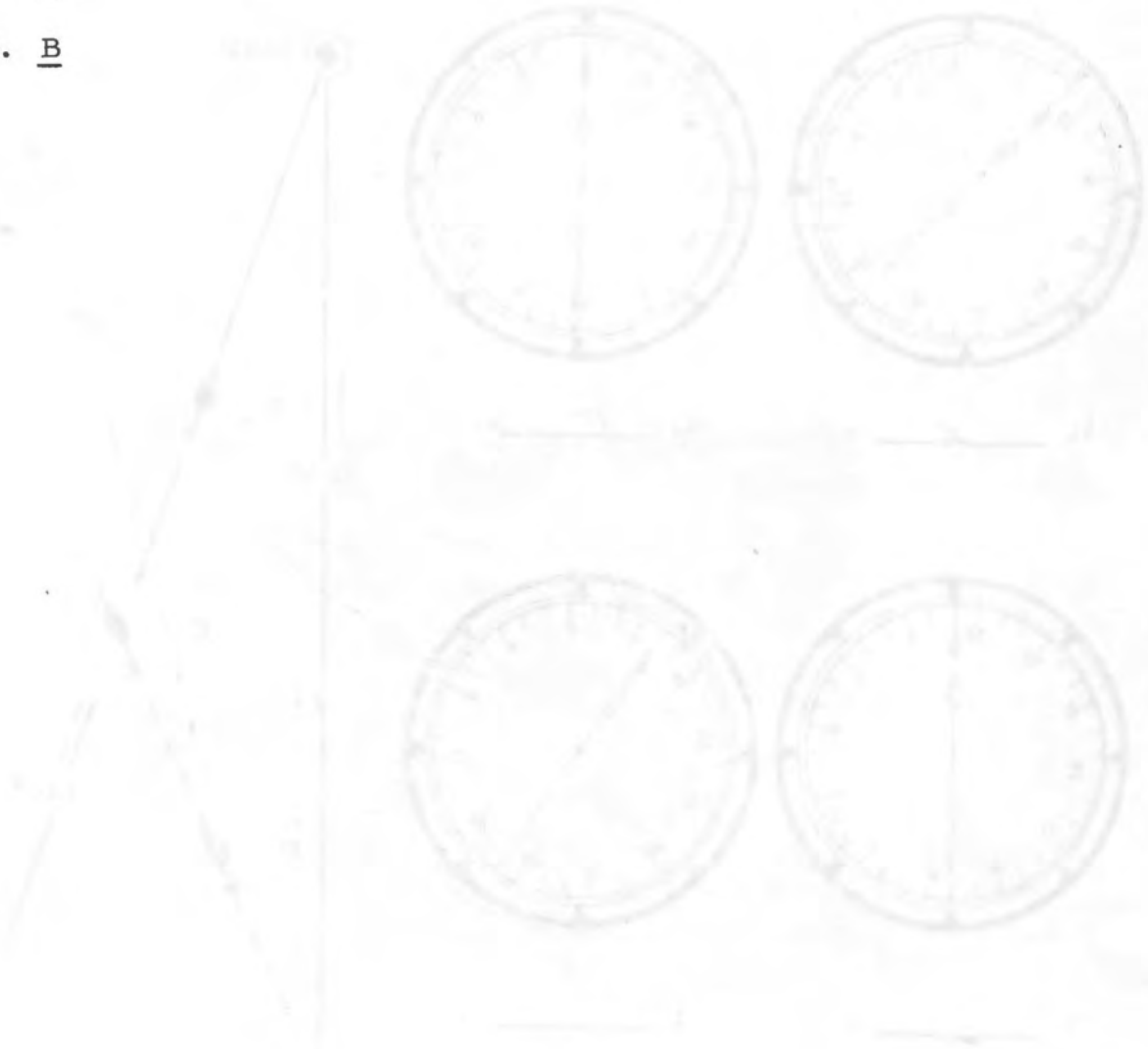
ANSWER

1. C

2. A

3. D

4. B

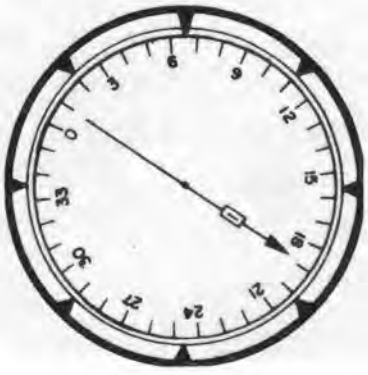


You are intercepting the 020° bearing from the NDB. Indicate your position in the diagram under each indication below.

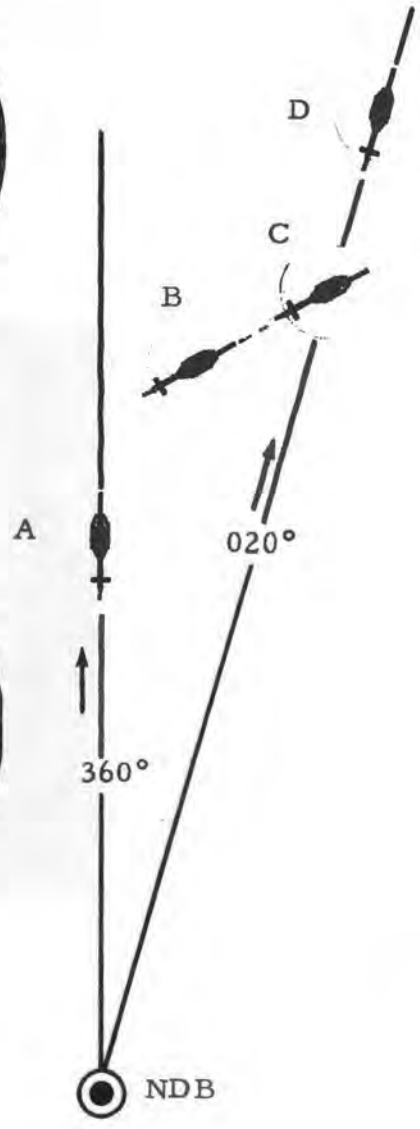
1. C.

2. D.

3. A.



4. B.



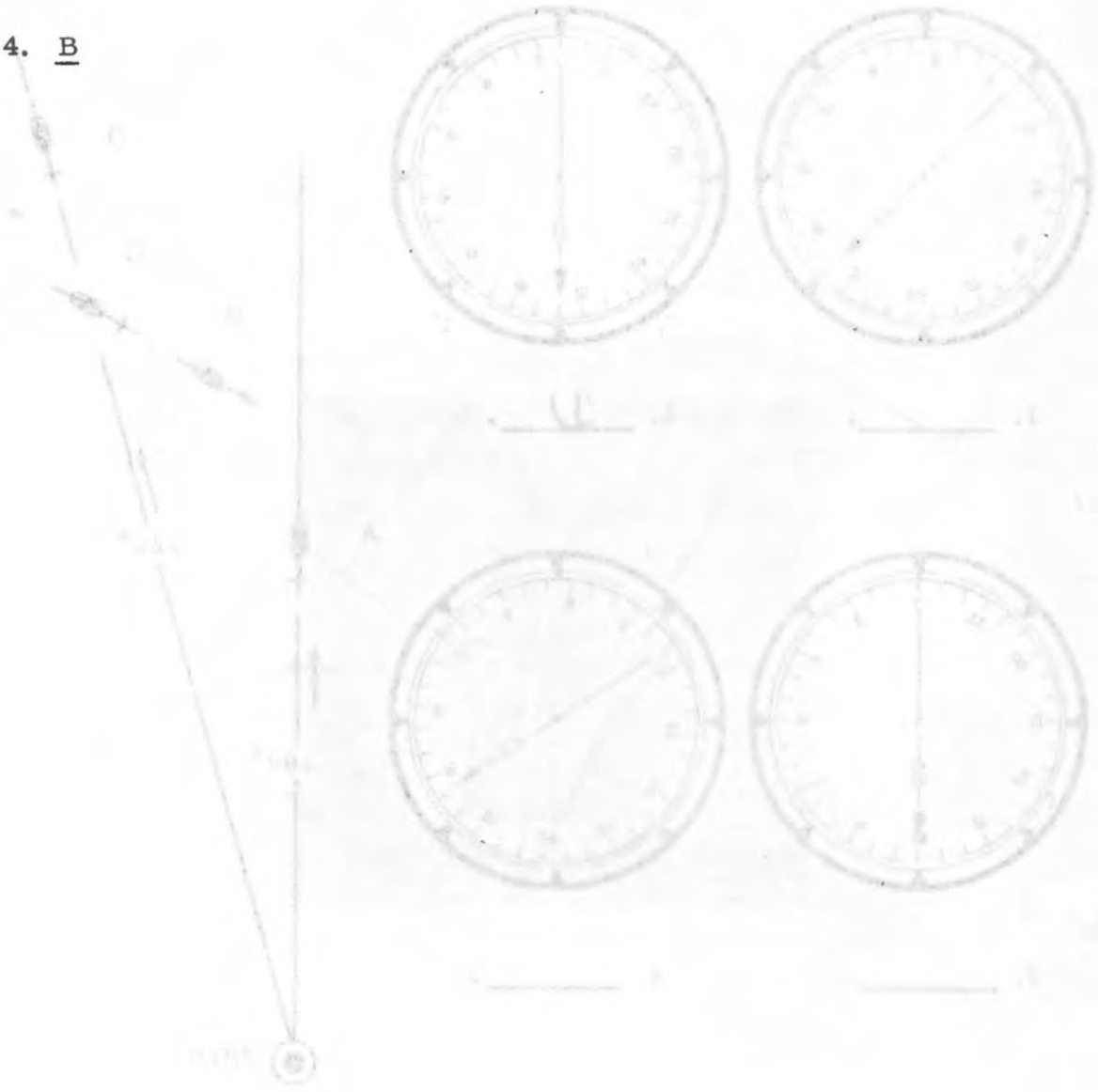
ANSWER

1. C

2. D

3. A

4. B

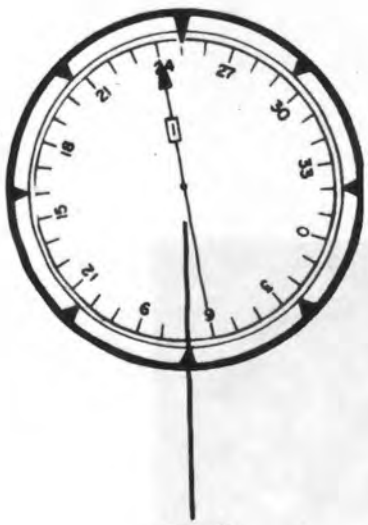


Either the pointed or blunt end of an RMI needle can be used for tracking. You have seen how the blunt end gives you a planned view of your position in relation to a course that you visualize on the compass card. Let's use the blunt end and this planned view for tracking.

Visualize a 250° course to an NDB on the indicator below and check the blunt end of No. 1 needle to determine your position is 10° right (right, left) of course.

ANSWER

Right, as shown in diagram below.



250°
Course
to NDB

You are tracking inbound to an NDB via the 360° course which is shown on the instruments below as you would visualize it.

No. 1 needle in figure 1 shows that you have drifted right (right, left) of course.

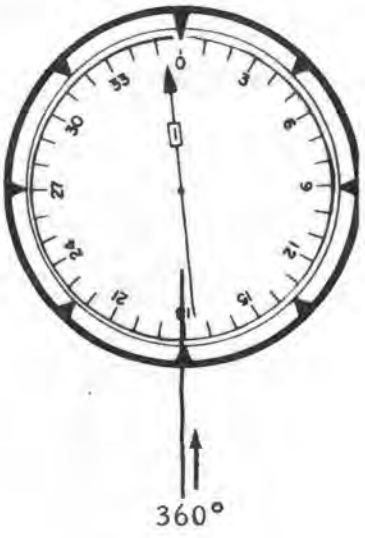


Figure 1

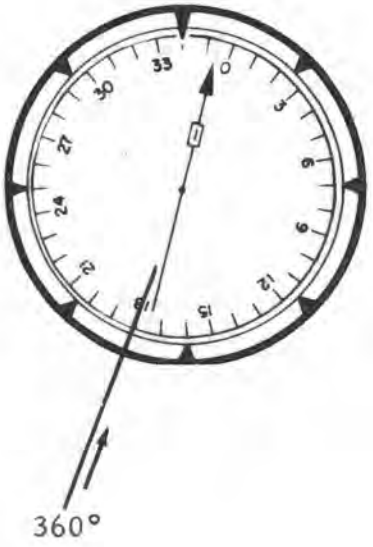


Figure 2

Figure 2 shows that you have turned 20° toward the 360° course.

Figure 2 also shows that you are 20 ° right (right, left) of the 360° course.

ANSWER

Right, 5, right

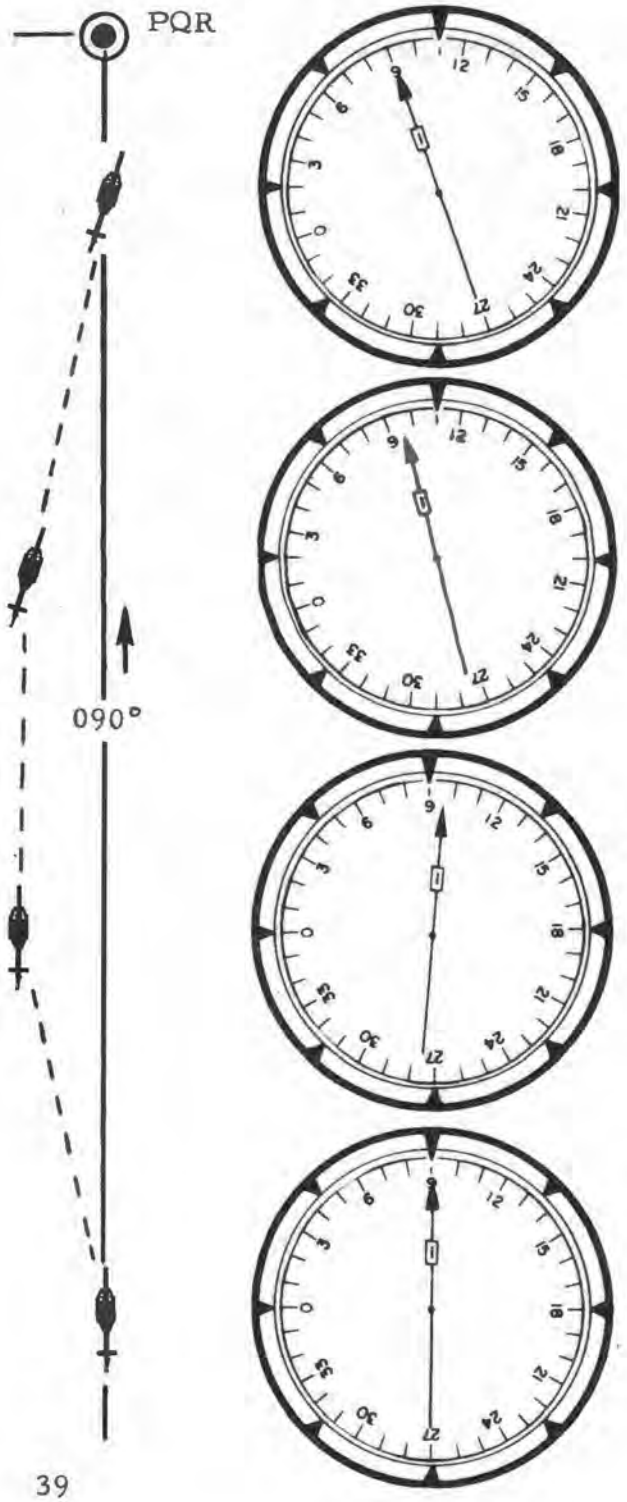
Visualize a 090° course to PQR NDB on the indicators below and complete the statement by each step in the tracking diagram. START AT BOTTOM OF PAGE.

4. Aircraft is _____ (right of, left of, on) course.

3. Aircraft has turned 20° _____ (right, left).

2. Aircraft is _____ (right, left) of course; therefore, you should turn 20° _____ (right, left).

1. Aircraft is _____ (right of, left of, on) course.



ANSWER

1. On

2. Left, right

3. Right

4. On

You observe the indications below while tracking via an inbound course of 065° to ETP NDB.

1. Figure 1 shows that you are _____ (right of, left of, on) course.

2. Figure 2 shows that you are _____ (right of, left of, on) course.

3. In figure 3, you have turned 20° _____ (right, left) and you are now _____ (right of, left of, on) course.

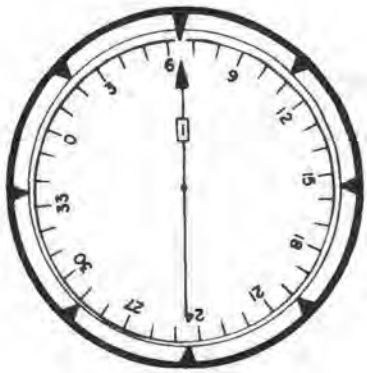


Figure 1

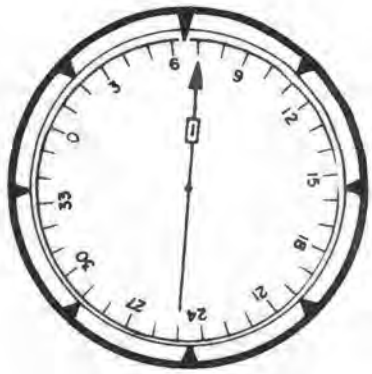


Figure 2

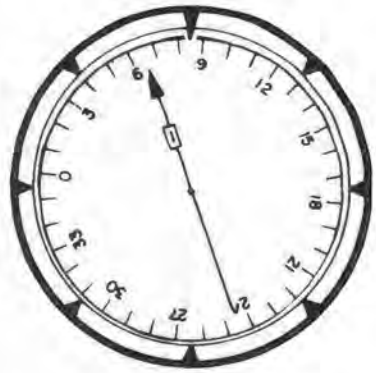


Figure 3

ANSWER

1. On

2. Left

3. Right, on

Use the same techniques for tracking outbound that you used for tracking inbound. The blunt end of an RMI needle will show your position with respect to an outbound course that you visualize on the compass card.

You are tracking outbound from an NDB via the 130 bearing. After maintaining a 130° heading for several minutes, you have the indications shown below.

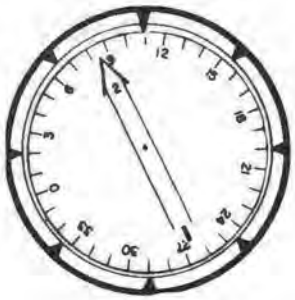
The wind is from your _____(right, left).

Using a 20° correction toward the course would require a _____ (right, left) turn to a heading of _____°.

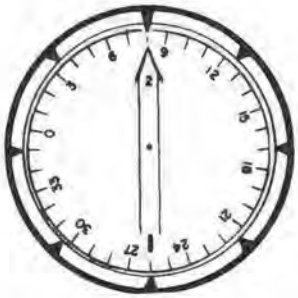
ANSWER

Right, right, 150°

Helicopter 12345 is cleared to OZK VOR via the 260 radial. Under each instrument below fill in the correct position of the helicopter as shown in diagram at bottom of page.

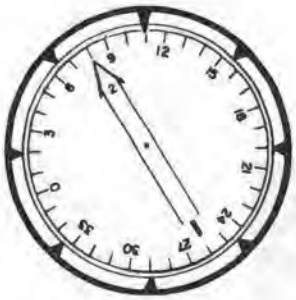


1. ____.



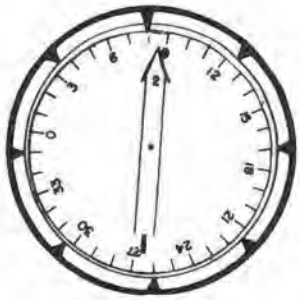
2. ____.

3. ____.

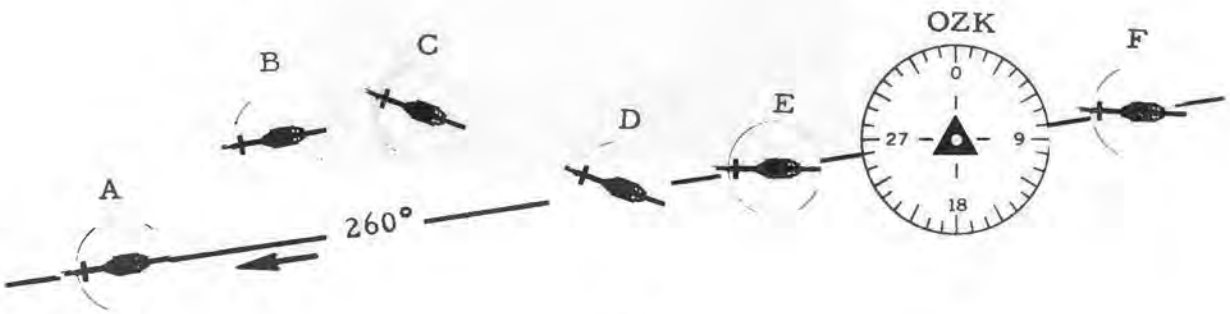


4. ____.

5. ____.



6. ____.



ANSWER

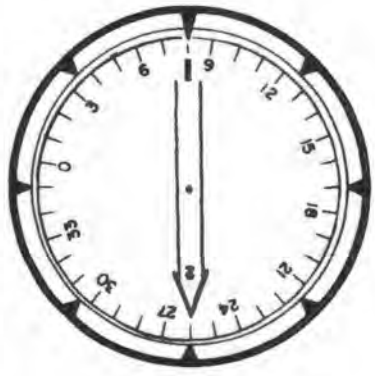
1. C
2. A
3. E
4. D
5. F
6. B

NOTE: Slow speed helicopters use 30° as an initial correction when returning to course and 15° as the first trial drift correction.

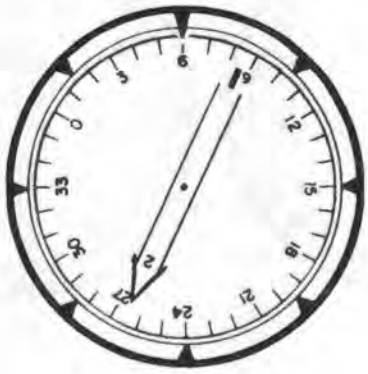
While tracking outbound from OZK VOR via the 080 radial, you received the indications below. Indicate under each instrument your position in the diagram which matches that indication.

1. _____.

2. _____.

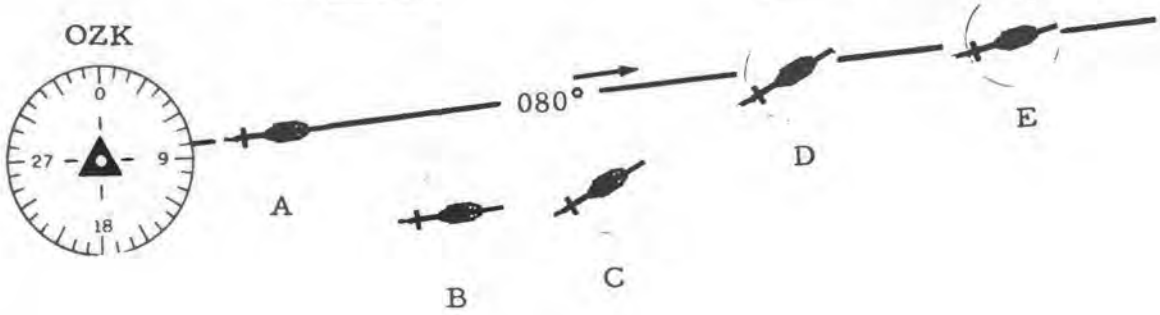


3. _____.



4. _____.

5. _____.



ANSWER

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

Up to now you have used the RMI with all components working properly. Since the RMI will provide useful information after a portion of the system has failed, let's have a look at the procedures for interpreting indications on the RMI after a component has failed.

Failure of only one of the needles (other components working properly) will not affect the operation of the remaining needle or the compass card.

No. 1 needle has failed but all other components are operating normally. Heading and No. 2 needle information is reliable and will be interpreted in the usual manner. _____ (true, false)

ANSWER

True

Should the compass card fail in slaved operation, it may operate as a DG in free operation. In free operation, there is no signal to maintain gyro erection to magnetic north. Therefore, you must manually correct compass card to agree with the magnetic compass and must periodically check for precession and correct the card as necessary.

All indications are normal when the needles are operating correctly and magnetic heading is under the heading index.

The RMI compass card failed in slaved operation but is showing correct heading information in free operation. In this case, normal procedures will be used for interpreting RMI indications. _____

(true, false)

ANSWER

True

The RMI compass card may fail to operate in either slaved or free operation. In this case, the compass card may be in any position; therefore, you lose the map-like display and must use the standby compass for heading information. VOR and ADF needles must be interpreted differently.

The VOR needle will continue to indicate relative to the compass card after the card has failed. Tune a VOR station and No. 2 needle will indicate direction to under the pointed end and direction from under the blunt end.

The compass card has failed in the indicator above. The magnetic compass shows your heading is 090°.

You are on the _____ radial.

Direction to the VOR is _____°.

ANSWER

350, 170°

The RMI compass card has failed. Tune an NDB and No. 1 needle needle will point to the NDB relative to the aircraft nose. Therefore, you must disregard the compass card and read relative bearing from the heading index clockwise to the pointed end of the ADF needle and compute for inbound or outbound direction.

The compass card has failed in the indicator above. Magnetic heading of the aircraft is 090°.

Direction to the NDB is _____.

ANSWER

150°

NOTE: Compute direction to the NDB as follows:

060° relative bearing
+090° heading
=150° to NDB

The compass card has failed. You check the magnetic compass and it reads 060°. With the indications below, magnetic direction to the NDB is _____°. Magnetic direction to the VOR is _____°.

ANSWER

030°, 001°