

FLIGHT NAVIGATOR WRITTEN EXAMINATION GUIDE



1967

FEDERAL AVIATION AGENCY

Federal Aviation Agency



AC NO: AC 63-2

CERTIFICATION:
CREWMEMBERS OTHER
THAN PILOTS

EFFECTIVE :

10/26/66

SUBJECT : FLIGHT NAVIGATOR WRITTEN EXAMINATION GUIDE

1. PURPOSE. This advisory circular is being issued to:

- a. Outline the scope of the basic aeronautical knowledge requirements for a Flight Navigator.
- b. Acquaint the applicant with source material that may be used to acquire this basic knowledge, and
- c. Present a sample examination, answers and explanations to the sample examination test items, and other data used in the current Flight Navigator Written Examinations.

2. HOW TO GET THIS PUBLICATION.

a. Order copies of this publication from:

Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

b. Identify the publication in your order as:

FAA Advisory Circular AC 63-2
Flight Navigator Written Examination Guide
Dated 10/26/66

- c. Send check or money order with your request, made payable to the Superintendent of Documents in the amount of \$.25 for each copy (add 25 percent for foreign mailing). No C.O.D. orders accepted.

Acting *W. E. Rogers*
Director
Flight Standards Service

TABLE OF CONTENTS

	<u>Page No.</u>
CHAPTER 1. NATURE OF THE WRITTEN EXAMINATION	1
1. Introduction.	1
2. Certificate Requirements.	1
3. Type of Examination.	1
4. Taking the Examination.	2
CHAPTER 2. STUDY OUTLINE FOR THE FLIGHT NAVIGATOR WRITTEN EXAMINATION	3
SECTION 1. FEDERAL AVIATION REGULATIONS	3
5. FAR 63 - Certification: Flight Crewmembers Other Than Pilots.	3
6. FAR 91 - General Operating and Flight Rules.	3
7. FAR 121 - Certification and Operations: Air Carriers and Commercial Operators of Large Aircraft.	4
SECTION 2. FUNDAMENTALS OF AIR NAVIGATION	5
8. Earth and Coordinate Systems.	5
9. Celestial Navigation.	5
10. Navigation Instruments.	6
11. Air Navigation Systems - Operating Principles.	6
12. Altimetry Procedures.	6
13. Flight Planning Procedures and Cruise Control.	6
SECTION 3. METEOROLOGY	7
14. Basic Weather Principles.	7
15. High Altitude Meteorology.	7
16. Aviation Weather Reports and Forecasts.	7
17. Weather Charts.	7
SECTION 4. PLOTTING AND COMPUTING	8
18. Flight Planning Procedures.	8
19. Positioning.	8
20. Special Solutions.	8

	<u>Page No.</u>
APPENDIX 1. RECOMMENDED STUDY MATERIALS	(2 pages) 1
SECTION 1. LIST OF STUDY MATERIALS	1
SECTION 2. HOW TO OBTAIN STUDY MATERIALS	2
APPENDIX 2. SAMPLE EXAMINATION	(14 pages) 1
SECTION 1. FEDERAL AVIATION REGULATIONS	1
SECTION 2. FUNDAMENTALS OF AIR NAVIGATION	3
SECTION 3. METEOROLOGY	5
SECTION 4. PLOTTING AND COMPUTING	7
SECTION 5. ANSWERS AND EXPLANATIONS TO SAMPLE EXAMINATION TEST ITEMS	10
APPENDIX 3. SUPPLEMENTAL MATERIALS	(7 pages) 1
SECTION 1. KEY TO AVIATION WEATHER REPORTS	1
SECTION 2. WEATHER CHARTS	3
SECTION 3. AIR ALMANAC PAGE	6
SECTION 4. SEGMENT OF PLOTTING SHEET	7

CHAPTER 1. NATURE OF THE WRITTEN EXAMINATION

1. INTRODUCTION. This study guide was prepared by the Flight Standards Service of the Federal Aviation Agency to assist applicants who are preparing for the Flight Navigator Written Examination.

The guide is not offered as a quick and easy way to obtain the necessary knowledge for passing the written examination. Rather, the intent of this guide is to define the scope and narrow the field for study to the basic knowledge required for the Flight Navigator Certificate.

2. CERTIFICATE REQUIREMENTS. The general qualifications for a Flight Navigator Certificate require of the applicant a combination of experience, knowledge, and skill. The applicant should, therefore, carefully review the applicable sections of Federal Aviation Regulations, Part 63, for detailed information on these basic qualifications.
3. TYPE OF EXAMINATION. The Flight Navigator Written Examination consists of the following four sections:
 - a. Federal Aviation Regulations.
 - b. Fundamentals of Air Navigation.
 - c. Meteorology.
 - d. Plotting and Computing.

In view of the scope and depth of knowledge required, the examination is administered in separate parts in the following format:

- a. PART I (Time allowance--3 Hours)
 - (1) Section 1 - Federal Aviation Regulations
 - (2) Section 2 - Fundamentals of Air Navigation
 - (3) Section 3 - Meteorology
- b. PART II (Time allowance--5 Hours)
 - (1) Section 4 - Plotting and Computing (First Half)
- c. PART III (Time allowance--5 Hours)
 - (1) Section 4 - Plotting and Computing (Second Half)

Examination test items are of the multiple choice type, similar to those shown in the sample examination in this guide.

The applicant marks his answers on a special answer sheet. He should read the directions very carefully before beginning the examination. Incomplete or erroneous personal information entered on the scoring sheet may delay the scoring process.

All answer sheets graded below passing (70 percent) are rechecked for verification before the results are mailed to the applicant on FAA Form 578-1. An applicant who receives a failing grade must present this form for reexamination.

4. TAKING THE EXAMINATION. In addition to being an exercise in the application and use of aeronautical knowledge, an examination is also an exercise in communication since it involves the use of written language. Communication between individuals through the use of such abstract symbols as words is indeed a complicated process; so complicated, in fact, that at times communication may either break down or mislead if care is not exercised. The same word often means different things to different people. Carefully read the information and instructions.

Always bear in mind the following facts when you are taking the examination:

- a. The test items are not trick questions. Each statement means exactly what it says. Read each test item stem and each alternate response carefully, but do not look for hidden meanings. The correct statement does not concern exceptions to the rule; it refers to the general rule. However, the incorrect responses are often based on the exceptions.
- b. First, carefully read the test item stem before you look at the alternate responses listed below it. Be sure that you understand what the question asks. Then decide what the correct answer should be or work out the problem to obtain the answer. Finally, look through the list of alternate responses or phrases and select the one that says the same thing as your answer. Be sure that the one you select answers the test item completely.
- c. Only one of the alternate responses given is completely correct. The others may be answers that result from incorrect procedure (in a problem, for example) or from lack of knowledge pertaining to the test item, or from popular misconceptions. Understand the test item and then select the response you consider to be the best answer.
- d. If you find that you have considerable difficulty with a particular test item, do not spend too much time on it, but continue with the examination and answer those test items which are less difficult. Then go back and reconsider the test items you have passed over. This procedure will enable you to use the total time available to maximum advantage in demonstrating your knowledge and understanding of the subject.

CHAPTER 2. STUDY OUTLINE FOR THE FLIGHT NAVIGATOR
WRITTEN EXAMINATION

SECTION 1. FEDERAL AVIATION REGULATIONS

5. FAR 63--CERTIFICATION: FLIGHT CREWMEMBERS OTHER THAN PILOTS

a. Subpart A - General

- (1) Certificates required (63.3)
- (2) Temporary certificate (63.13)
- (3) Duration of certificate (63.15)
- (4) Tests: general procedures (63.17)
- (5) Written tests: cheating--(63.18)
- (6) Change in address (63.21)

b. Subpart C - Flight Navigators

- (1) Eligibility requirements: general (63.51)
- (2) Knowledge requirements (63.53)
- (3) Experience requirements (63.55)
- (4) Skill requirements (63.57)
- (5) Retesting after failures (63.59)

6. FAR 91--GENERAL OPERATING AND FLIGHT RULES

a. Subpart B - Flight Rules

- (1) Right of way rules (91.67)
- (2) Compliance with ATC clearances and instructions (91.75)
- (3) Altimeter settings (91.81)
- (4) Flight plan; information required (91.83)
- (5) Minimum altitudes for IFR operations (91.119)
- (6) IFR cruising altitude or flight level (91.121)

7. FAR 121--CERTIFICATION AND OPERATIONS: AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT.

a. Subpart I - Airplane Performance Operating Limitations

- (1) Applicability (121.171)
- (2) General (121.173)
- (3) Transport category aircraft: reciprocating engine powered: weight limitations (121.175)
- (4) Transport category airplanes: turbine engine powered: landing limitations: destination airports (121.195)

b. Subpart M - Airman and Crewmember Requirements

- (1) Flight navigator: flag and supplemental air carriers and commercial operators (121.389)
- (2) Emergency and emergency evacuation duties (121.397)

c. Subpart N - Crewmember and Aircraft Dispatcher Training Program

- (1) Crewmember emergency training (121.416)
- (2) Flight navigator training (121.422)

d. Subpart O - Flight Crewmember Qualifications

- (1) Flight navigator qualification: flag and supplemental air carriers and commercial operators (121.451)

e. Subpart R - Flight Time Limitations: Flag Air Carriers

- (1) Flight time limitations: flight engineers and flight navigators (121.493)

f. Subpart U - Dispatching and Flight Release Rules

- (1) Dispatch or flight release over water, etc. (121.615)
- (2) Alternate airport for departure (121.617)

- (3) Alternate airport for destination: flag air carriers (121.621)
- (4) Alternate airport weather minimums (121.625)
- (5) Fuel supply (121.641; 121.643; 121.645)
- (6) Factors for computing fuel required (121.647)

g. Subpart V - Records and Reports

- (1) Dispatch release (121.687; 121.689)
- (2) Load manifest (121.691; 121.693)
- (3) Disposition of load manifest, etc. (121.695; 121.697)

SECTION 2. FUNDAMENTALS OF AIR NAVIGATION

8. EARTH AND COORDINATE SYSTEMS.

- a. Terminology
- b. Chart projections
- c. Direction measurement
 - (1) True
 - (2) Magnetic
 - (3) Compass
 - (4) Grid
- d. Distance units
- e. Dead reckoning procedures

9. CELESTIAL NAVIGATION.

- a. Terminology
- b. Elements of astronomical triangle
- c. Time and the Air Almanac
- d. Star identification

- e. LOP solutions
- f. Special solutions

10. NAVIGATION INSTRUMENTS.

- a. Compass systems
- b. Airspeed indicators and Machmeters
- c. Altimeters
- d. Thermometers
- e. Absolute Altimeters
- f. Sextants

11. AIR NAVIGATION SYSTEMS - OPERATING PRINCIPLES.

- a. Loran
- b. Doppler
- c. Inertial
- d. Other

12. ALTIMETRY PROCEDURES.

- a. Solution for drift
- b. Pressure Line of Position

13. FLIGHT PLANNING PROCEDURES AND CRUISE CONTROL.

- a. Route and altitude selection
- b. Cruise techniques
- c. Decision points - PNR/ETP

SECTION 3. METEOROLOGY

14. BASIC WEATHER PRINCIPLES.

- a. Air mass characteristics
- b. Winds and pressure systems
- c. Atmospheric stability
- d. Fronts
- e. Thunderstorms
- f. Fog

15. HIGH ALTITUDE METEOROLOGY.

- a. Jet stream characteristics
- b. Clear air turbulence
- c. Tropopause features
- d. Geostrophic wind
- e. Forecasting weather movement

16. AVIATION WEATHER REPORTS AND FORECASTS.

- a. Hourly sequence reports
- b. Terminal forecasts
- c. Area forecasts

17. WEATHER CHARTS.

- a. Surface
- b. Significant Weather
- c. Constant Pressure
- d. Tropopause/Vertical Wind Shear

SECTION 4. PLOTTING AND COMPUTING

18. FLIGHT PLANNING PROCEDURES.

- a. Enroute time
- b. Fuel requirements
- c. Weight particulars
- d. Decision points--ETP/PNR

19. POSITIONING.

- a. Dead reckoning procedures
- b. Fixing techniques
 - (1) Two and three star fixes -
 - (2) Loran fixes
 - (3) Combined methods--Celestial, Loran, Consol, PLOP
- c. Basic calculations
 - (1) Wind experienced between fixes--computer solution
 - (2) Wind experienced between fixes--air plot
 - (3) Headings--Compass/Grid
 - (4) ETA's

20. SPECIAL SOLUTIONS.

- a. Latitude by meridian altitude--upper and lower transit
- b. Latitude by Polaris
- c. Compass deviation
- d. Star identification--star diagrams
- e. Search patterns
- f. Date/time calculations

APPENDIX 1. RECOMMENDED STUDY MATERIALS

The applicant for a Flight Navigator Certificate will find the publications listed below helpful to him in his preparation for the examination.

The list identifies source material essential to preparing for the examination but does not include all available material on the subjects. Other excellent text books, audiovisual training aids, and instruction materials useful in preparing for the examination are available at bookstores and libraries.

It is the responsibility of each applicant to obtain the study materials appropriate to his needs.

NOTE: References listed were available at the time this publication went to press.

SECTION 1. LIST OF STUDY MATERIALS

1. FEDERAL AVIATION REGULATIONS:

- a. PART 63 - Certification: Flight Crewmembers Other Than Pilots (.30)
- b. PART 91 - General Operating and Flight Rules (.50)
- c. PART 121- Certification and Operations: Air Carriers and Commercial Operators of Large Aircraft (\$1.25)

- 2. AVIATION WEATHER, AC 00-6 (\$2.25). This excellent reference text treats many phases of meteorology of interest to the Flight Navigator. Aviation weather reports and forecasts are also covered in detail with respect to format and content.
- 3. AIR NAVIGATION, H. O. Pub. No. 216, U. S. Navy Hydrographic Office (\$7.50). An excellent reference text of sufficient depth and scope to be of interest to the Flight Navigator.
- 4. AIR NAVIGATION, AF Manual 51-40, Volume I (\$3.25). This U. S. Air Force publication is an excellent reference for basic navigation.
- 5. AIR NAVIGATION, AF Manual 51-40, Volume II (\$3.00). A continuation of Volume I on an advanced level, covering celestial navigation, pressure pattern flying, and polar navigation.
- 6. AIR NAVIGATION, AF Manual 51-40, Volume III (\$4.25). Developed as an inflight handbook, this publication contains many items of interest to the Flight Navigator.

SECTION 2. HOW TO OBTAIN STUDY MATERIALS

7. STUDY MATERIALS. All study materials listed may be obtained by remitting check or money order to:

U. S. Government Printing Office
Superintendent of Documents
Washington, D. C. 20402

APPENDIX 2. SAMPLE EXAMINATION

The following test items are presented to indicate the general form of those used in the official examination. They are included for one purpose--to familiarize you with the type of test items you may expect to encounter in FAA written examinations. Ability to answer these sample items does not indicate that you are fully prepared to take the examination since all topics on which you will be tested are not included.

You should concentrate on the section of this study guide entitled "Study Outline for the Flight Navigator Written Examination." A knowledge of all the topics mentioned in this outline--not just the mastery of the sample test items--should be used as the criterion for determining that you are properly prepared to take the written examination.

Correct answers to the sample test items, together with explanatory comments where applicable, are to be found in Section 5 of this Appendix. In some sample test items, reference will be made to certain charts or other data. This material will be found in Appendix 3 of this guide.

NOTE: References to regulations and other procedures in this guide are based on those in effect at the time of final editing. Test items in the official FAA examinations should always be answered in terms of current regulations and procedures.

SECTION 1. FEDERAL AVIATION REGULATIONS

TEST ITEM 1. A temporary Flight Navigator Certificate is effective for a period of

- 1- three calendar months.
- 2- six calendar months.
- 3- not more than 90 days.
- 4- not more than 30 days.

TEST ITEM 2. A Flight Navigator Certificate which is issued to a U. S. citizen is effective

- 1- only during the period in which the holder retains currency.
- 2- until it is surrendered, suspended, or revoked.
- 3- for no longer than 12 months after date of issue.
- 4- for a period of 24 calendar months.

TEST ITEM 3. What class of medical certificate is appropriate for an individual serving as Flight Navigator on an aircraft of U. S. registry?

- 1- First class only
- 2- Second class or higher
- 3- Third class
- 4- None required

TEST ITEM 4. An applicant for a Flight Navigator Certificate fails the flight test portion of the practical examination. Which of the following responses outlines a correct time period for reexamination?

- 1- Immediately without further instruction.
- 2- Only after receiving 5 hours of additional instruction.
- 3- After 30 days from the date of failure.
- 4- After receiving 5 hours of additional ground instruction attested to by a certificated Ground Instructor.

TEST ITEM 5. The proper altitude for an IFR flight in controlled airspace in the United States, below Flight Level 290, is

- 1- based upon aircraft heading.
- 2- the altitude filed in the flight plan.
- 3- based upon aircraft course.
- 4- the altitude assigned by Air Traffic Control.

TEST ITEM 6. The areas, routes, or route segments over which an air carrier or commercial operator is required to carry a Flight Navigator are specified in the

- 1- Airplane Flight Manual.
- 2- International Flight Information Manual.
- 3- Operations Specifications.
- 4- Federal Aviation Regulations.

TEST ITEM 7. An air carrier or commercial operator may not use a Flight Navigator unless he meets certain recency of experience requirements. Which of the following responses correctly outlines these requirements?

- 1- 50 flight navigation hours within preceding 12 calendar month period.
- 2- 50 flight navigation hours within preceding 6 calendar month period.
- 3- 30 flight hours in any flight function within preceding 6 months.
- 4- 50 flight hours in any flight function within 12 calendar month period.

TEST ITEM 8. An alternate airport for the departure point is required

- 1- at all times.
- 2- if weather conditions are below authorized landing minimums.
- 3- only when no destination alternate airport is available.
- 4- only when destination weather is marginal.

TEST ITEM 9. Where only one Flight Navigator is required in scheduled operations, he may not fly as a flight crewmember more than

- 1- 900 hours during any 12-month period.
- 2- 100 hours during any 30-day period.
- 3- 300 hours during any consecutive 90 days.
- 4- 1200 hours during any 12-month period.

TEST ITEM 10. A turbine powered aircraft (not turbo-prop) is cleared to a foreign destination airport which has no available alternate. Under the provisions of FAR 121, the required fuel reserve is

- 1- 3 hours.
- 2- 1 hour and 30 minutes.
- 3- 30 minutes plus 10 percent of the total flight time.
- 4- 2 hours.

SECTION 2. FUNDAMENTALS OF AIR NAVIGATION

TEST ITEM 11. Which of the following would you classify as a great circle?

- 1- Circle of equal altitude
- 2- Parallel of latitude
- 3- Diurnal circle
- 4- Hour circle

TEST ITEM 12. Which of the following factors is most significant with respect to the slight yearly variation in the tabulated declination and sidereal hour angle of a star?

- 1- Parallax
- 2- Precession of the equinoxes
- 3- Radial or line of sight motion
- 4- Apparent motion

TEST ITEM 13. The change in the tabulated GHA-Aries entry in the Air Almanac on successive days at the same time is produced by

- 1- precession of the equinoxes.
- 2- radial motion.
- 3- orbital motion of the earth.
- 4- rotation of the earth on its axis.

TEST ITEM 14. On a certain date at GMT 1300, the Greenwich Hour Angle (GHA) of the sun is 016° . You conclude that the time interval--referred to as the equation of time--between the true and the mean sun is

- 1- four minutes.
- 2- zero.
- 3- thirty minutes.
- 4- twelve minutes.

TEST ITEM 15. Sidereal time is defined as the

- 1- hour angle of the mean sun.
- 2- hour angle of a star.
- 3- hour angle of the First Point of Aries.
- 4- hour angle of the First Point of Aries plus 180° .

TEST ITEM 16. Consider the following data:

Lat: 60°N
GST: 1200
LST: 2000
SHA*: 180°

The star is located on the

- 1- upper branch of the observer's meridian.
- 2- lower branch of the Greenwich meridian.
- 3- upper branch of the Greenwich meridian.
- 4- lower branch of the observer's meridian.

TEST ITEM 17. The constellation of ORION is located on your meridian to the south. With respect to the "belt" of ORION, the star ALDEBERAN is oriented to the

- 1- north.
- 2- south.
- 3- southeast.
- 4- northwest.

TEST ITEM 18. A star is at lower transit on the observer's meridian. Determine the longitude of the observer based on the following data:

Lat: 60°N
GHA-ARIES: $152^{\circ}30'$
SHA-Star: $89^{\circ}30'$

- 1- 118°W
- 2- 62°W
- 3- 62°E
- 4- 118°E

TEST ITEM 19. Which of the following are controlled by the function switch on a Loran Indicator?

- 1- Illumination and focus
- 2- Signal strength and balance
- 3- Signal matching and amplitude balance
- 4- Scale expansion and signal magnification

TEST ITEM 20. An aircraft is cruising at 35,000 feet at True Airspeed 485 knots. The speed of sound at this altitude is 576.6 knots. What is the Mach Number?

- 1- 0.84
- 2- 0.86
- 3- 0.92
- 4- 1.00

SECTION 3. METEOROLOGY

TEST ITEM 21. A cold front may be defined as

- 1- a trough of low pressure.
- 2- a ridge of high pressure.
- 3- the trailing edge of an advancing air mass.
- 4- the leading edge of an advancing warm air mass.

TEST ITEM 22. Which of the weather conditions listed below do you normally associate with an extensive stratiform cloud formation?

- 1- Showers with good visibility
- 2- Steady precipitation with good ceilings and visibilities
- 3- Steady precipitation with low ceilings and visibilities
- 4- Showers with moderate turbulence and low visibility

TEST ITEM 23. Which of the following processes act to increase the stability of an air mass?

- 1- Warming from below
- 2- Upslope, or orographic lifting
- 3- Cooling from below
- 4- Addition of water vapor to lower layers

TEST ITEM 24. The movement of air in a surface low pressure system may be described as

- 1- diverging and subsiding.
- 2- converging and ascending.
- 3- converging and descending.
- 4- diverging and ascending.

TEST ITEM 25. A pronounced feature of the troposphere is the

- 1- isothermal lapse rate.
- 2- absence of wind.
- 3- absence of weather.
- 4- decrease of temperature with altitude.

TEST ITEM 26. The recorded temperature at an airport situated 6000 feet MSL, is $+12^{\circ}\text{C}$. Assuming the normal lapse rate, the freezing level will be at

- 1- 12,000 feet AGL.
- 2- 10,000 feet MSL.
- 3- 12,000 feet MSL.
- 4- 5,000 feet AGL.

TEST ITEM 27. The ceiling at an aviation weather reporting station is reported to be "measured 4000 feet, broken." How is this ceiling shown in the aviation weather sequence report?

- 1- W4 \oplus
- 2- M4 $\odot\odot$
- 3- M4 \oplus
- 4- W4 $\odot\odot$

TEST ITEM 28. The freezing level on the great circle route between San Francisco and Honolulu is (Appendix 3, page 3)

- 1- below 10,000 feet at 145°W .
- 2- above 15,000 feet near Honolulu.
- 3- on the surface near San Francisco.
- 4- above 5,000 feet at 135°W .

TEST ITEM 29. The true altitude of a flight maintaining Flight Level 310 on the great circle route from San Francisco to Honolulu will (Appendix 3, page 4)

- 1- remain constant.
- 2- increase after passing 135°W .
- 3- decrease after passing 140°W .
- 4- increase between 125°W . and 135°W .

TEST ITEM 30. Refer now to the Tropopause Vertical Wind Shear Chart, Appendix 3, page 5. A jet flight, maintaining flight level 290 on the great circle route between Gander, Newfoundland (CYQX) and Paris, France (LFPO) would be flying

- 1- above the tropopause on the entire route.
- 2- below, then above the tropopause.
- 3- below the tropopause between 43°W . and 20°W .
- 4- below the tropopause on the entire route.

SECTION 4. PLOTTING AND COMPUTING

TEST ITEM 31. The flight plan time on a certain 2700 n.m. route is 6 hours. Flight 100 arrives at the mid-point of the route at 2205 GMT. What True Airspeed must be maintained to arrive over the destination at the original ETA of 0105 GMT, based on the following conditions?

Flight Level	340
Desired True Course	120°
Wind	230°/110 kts.
Outside Air Temperature (Indicated)	-30°C
Temperature Correction	19°

- 1- 418 knots.
- 2- 425 knots.
- 3- 430 knots.
- 4- 450 knots.

TEST ITEM 32. What is the equivalent Mach Number for the True Airspeed computed under the conditions outlined in the previous test item?

- 1- .70
- 2- .75
- 3- .79
- 4- .73

TEST ITEM 33. What is the compass heading to be flown from the mid-point of the route in test item 31 (Variation 18°W; Deviation 3°E)?

- 1- 134°
- 2- 145°
- 3- 149°
- 4- 152°

TEST ITEM 34. On December 21, 1966, at 0330 GMT, the sun bears 180° true as it reaches the maximum altitude of 45°. The position of the observer is

- 1- 68°26.4N; 53°03.1E.
- 2- 21°33.6'N; 126°56.9'E.
- 3- 21°47.2'N; 127°08.5'E.
- 4- 21°33.6S; 126°53.9'W.

(See Appendix 3, page 6 for
Air Almanac Page)

TEST ITEM 35. Given the following altimetry readings with supporting data:

	<u>0315Z</u>	<u>0400Z</u>
Pressure Altitude:	25,150 feet	25,050 feet
Absolute Altitude:	24,750 feet	24,850 feet
LAT.	60°N	
TAS.	275 kts.	
GS	300 kts.	
TH	230°	

The aircraft is on a True Course of

- 1- 235°.
- 2- 228°.
- 3- 232°.
- 4- 225°.

TEST ITEM 36. The position of an aircraft is fixed at 2315 GMT in Latitude 5°N; Longitude 81°30'W. If the aircraft continues on a Grid Heading (D. G. Mode) of 247°, determine the ETA and Latitude at the 85th meridian based on the data below (see Chart Segment, Appendix 3, page 7):

Flight Level	350
Mach	0.75
Outside Air Temperature (Indicated)	-15°C
Temperature Correction	22°
W/V (True Direction)	177°/80 kts.
Average Convergence	33°

- 1- ETA/0007 GMT; Lat. 00°50'N.
- 2- ETA/0004 GMT; Lat. 01°00'N.
- 3- ETA/0000 GMT; Lat. 01°15'N.
- 4- ETA/2358 GMT; Lat. 01°25'N.

TEST ITEM 37. Compute the Magnetic Heading which is equivalent to the Grid Heading of 247° from the previous test item based on the following information:

Average Grivation (GV)	38°E.
Variation	5°E.
Deviation	4°W.
Convergence	33°

- 1- 220°.
- 2- 206°.
- 3- 209°.
- 4- 214°.

TEST ITEM 38. Listed below are intercepts and true bearings (Z_N) for three stars, resolved to a common time of 0005 GMT. Plot the fix from an assumed position of 01°N; 85°20'W.

	<u>1</u>	<u>2</u>	<u>3</u>
Intercept	20' TO	6' AWAY	28' TO
Z _N	180°	240°	120°
(Convergence:	34°)		

The position of the 0005 GMT fix is

- 1- 01°00'N; 85°00'W.
- 2- 00°30'N; 85°15'W.
- 3- 01°15'N; 84°50'W.
- 4- 00°40'N; 85°00'W.

TEST ITEM 39. Assuming no change in heading or TAS, what average wind (Grid Direction) has been experienced between the 2315 GMT and 0005 GMT fixes?

- 1- 210°/57 kts.
- 2- 230°/50 kts.
- 3- 200°/72 kts.
- 4- 180°/75 kts.

TEST ITEM 40. Consider the flight planning data outlined below:

<u>Zone</u>	<u>Flight Level</u>	<u>Wind Component</u>	<u>Mach</u>	<u>F'cst Temp</u>	<u>Dist.</u>
1	Climb*	+30 kts.	--	--	250
2	350	+80 kts.	.80	-30°C	550
3	350	+100 kts.	.80	-20°C	540
4	350	+90 kts.	.80	-25°C	530
5	Descent**	+50 kts.	--	--	180

NOTE: *Use Average TAS 370 kts.
**Use Average TAS 320 kts.

You determine the flight plan time to be

- 1- 3 hours, 49 minutes.
- 2- 3 hours, 52 minutes.
- 3- 3 hours, 55 minutes.
- 4- 3 hours, 59 minutes.

SECTION 5. ANSWERS AND EXPLANATIONS TO SAMPLE EXAMINATION TEST ITEMS

TEST ITEM 1 (Ans. 3). The reference is FAR 63.13.

TEST ITEM 2 (Ans. 2). The reference is FAR 63.15(a). Note the effective period for a certificate issued to a person other than a U. S. citizen.

TEST ITEM 3 (Ans. 2). The reference is FAR 63.3(b).

TEST ITEM 4 (Ans. 3). The reference is FAR 63.59. In this situation, the applicant may either wait for the 30-day period to elapse or present evidence that he has received 5 hours of additional in-flight instruction.

TEST ITEM 5 (Ans. 4). The reference is FAR 91.121(a). Note the distinction made between flight in controlled and uncontrolled airspace.

TEST ITEM 6 (Ans. 3). Refer to FAR 121.389(b). You should also review paragraph (a).

TEST ITEM 7 (Ans. 1). The reference is FAR 121.451(a). Note that the alternative procedure involves a check flight.

TEST ITEM 8 (Ans. 2). The reference is FAR 121.617(a). Note further the distance requirements specified with one engine inoperative in (a)(2).

TEST ITEM 9 (Ans. 3). The reference is FAR 121.493(a). In this situation, the limitations stated in FAR 121.483 are applicable.

TEST ITEM 10 (Ans. 4). The reference is FAR 121.645.

TEST ITEM 11 (Ans. 4). The hour circle in all cases qualifies as a great circle.

TEST ITEM 12 (Ans. 2). The equinoxes have a slow, westward motion at the rate of 50 seconds of arc per year, caused by the unequal gravitational force of the moon and other bodies on the earth. This motion--called precession of the equinoxes--alters the position of the reference circles which serve as the basis for measurements of declination and sidereal hour angle.

TEST ITEM 13 (Ans. 3). The daily eastward movement of the earth in its orbit about the sun--approximately 1° per day--is reflected in the equivalent westward movement of the First Point of Aries in the Air Almanac entry.

TEST ITEM 14 (Ans. 1). Civil, or mean time, is based on the motion of a fictitious mean sun, travelling at a uniform rate of speed along the equinoctial. The actual, or true sun travelling along the ecliptic at varying rates of motion may lead or lag the mean sun by as much as 4.1° (16.4 minutes). In this case, the GHA of the mean sun is 015° . The GHA of the true sun is 016° as reflected in the appropriate Air Almanac entry. The 1° difference in arc converts to a time difference of 4 minutes.

TEST ITEM 15 (Ans. 3). The reference point for sidereal time is the Vernal Equinox, or the First Point of Aries. Unlike solar time, the sidereal day starts when the reference point is on the upper branch of the celestial meridian. It is Greenwich Sidereal Time (GST) or Local Sidereal Time (LST) as the Greenwich or local celestial meridian is used as the origin for measurement of hour angle.

TEST ITEM 16 (Ans. 3). By the above explanation of sidereal time, you locate the First Point of Aries on the lower branch of the Greenwich meridian (GST: 1200). Sidereal Hour Angle of the star (SHA*: 180°) is measured westward from the hour circle of the First Point of Aries which, in this case, locates the star on the upper branch of the Greenwich meridian. A time diagram is most helpful in visualizing these relationships.

TEST ITEM 17 (Ans. 4). In this approximate meridian location, the belt of ORION has a general northwest/southeast orientation. To the northwest lies Aldebaran; to the southeast lies Sirius.

TEST ITEM 18 (Ans. 2). This test item, as well as those involving determination of latitude by upper or lower meridian transit, has no operational application. It is used merely to illustrate basic concepts. A time diagram, again, is most useful in visualizing the problem. In this case, the GHA* (242°) results from the combination of GHA-Aries and the SHA*. The longitude of 62°W . results from the expression $(\text{GHA}^* + 180^\circ) - 360^\circ$.

TEST ITEM 19 (Ans. 4). The function switch provides a means of electronic scale expansion and signal magnification to produce a suitably accurate reading.

TEST ITEM 20 (Ans. 1). Mach number is defined as the ratio of the true airspeed to the speed of sound which in this case produces the stated answer.

TEST ITEM 21 (Ans. 1). Fronts are usually found along a low pressure trough. The conventional definition describes the cold front as the leading edge of an advancing cold air mass.

TEST ITEM 22 (Ans. 3). Although there are exceptions, response 3 meets the requirements for the normal condition.

TEST ITEM 23 (Ans. 3). All of the processes, with the exception of the response 3 process, may act to produce a greater or steeper lapse rate when compared with the dry or moist adiabatic lapse rates and thus decrease the stability of the air mass.

TEST ITEM 24 (Ans. 2). The effect of surface friction contributes to the inward drift of air across the isobars toward low pressure. The converging air must then ascend.

TEST ITEM 25 (Ans. 4). The atmospheric layer adjacent to the earth is known as the troposphere. Most of the weather effecting aviation occurs in this layer, within which the temperature normally decreases with altitude.

TEST ITEM 26 (Ans. 3). The solution is based on the normal lapse rate of 2°C. per 1000 feet.

TEST ITEM 27 (Ans. 2). Refer to Appendix 3, Section 1--"Key to Aviation Weather Reports." Front and back sides of this card are reproduced on pages 1 and 2 of this section of the guide.

TEST ITEM 28 (Ans. 1). Refer to Significant Weather Prognostic Chart, Appendix 3, page 3.

TEST ITEM 29 (Ans. 2). Refer to the 300 Millibar Constant Pressure Chart, Appendix 3, page 4. An aircraft flying with a constant altimeter setting and a constant altitude indication will conform to the slope of the constant pressure surface and, in so doing, will change its true altitude.

TEST ITEM 30 (Ans. 4). The Tropopause Vertical Wind Shear Chart, when used in conjunction with the 300 millibar chart, provides wind and temperature information--vertically and horizontally--within the layer from 300 millibars to 150 millibars. The following data is shown on this chart:

- a. Intersections of the tropopause in 50-millibar intervals from 300 to 150. Standard heights of the pressure surfaces are given in the inset box at the bottom of the chart.
- b. Mean vertical wind shear for the layer from 300 to 150 millibars at intervals of 2 knots/1000 feet, shown by dashed lines. The mean vertical wind shear is an arithmetic mean of the forecast values of the shear below and above the layer of maximum wind. It is not drawn for values less than 2 knots.
- c. Tropopause and 150-millibar level temperatures are enclosed in rectangles and squares, respectively.

In this problem, the aircraft is flying at FL 290, or pressure altitude 29,000 feet. Over a portion of the route, the tropopause is shown to be slightly below the 250-millibar level (pressure altitude 34,000 feet). The flight will therefore be well below the tropopause over the entire route.

TEST ITEM 31 (Ans. 2). To arrive at the given ETA will require a Groundspeed of 450 knots. Solution yields the required TAS of 425 knots.

TEST ITEM 32 (Ans. 4). Solution will vary with the particular computer used. If you need True Air Temperature, you must apply the temperature correction to the Indicated Air Temperature to produce the desired value of -49°C .

TEST ITEM 33 (Ans. 3). Application of the Compass Error (15°W) to the True Heading in test item 31 (134°) produces Compass Heading (149°).

TEST ITEM 34 (Ans. 2). Again, the test item has little operational application but is used to illustrate basic concepts. In this case, the sun is to the south on the observer's meridian. The Zenith Distance is 45° ($90^{\circ}-45^{\circ}$) and when combined with the declination ($23^{\circ}26.4'\text{S}$.) yields the observer's latitude ($21^{\circ}33.6'\text{N}$). The GHA of the sun at the stated time is $233^{\circ}03.1'\text{W}$ which subtracted from 360° produces the longitude value of $126^{\circ}56.9'\text{E}$. A diagram of the plane of the meridian is helpful in visualizing the latitude solution.

TEST ITEM 35 (Ans. 4). The height difference of +200 feet produces a V_N of 24.0 n.m. This yields a drift angle of approximately 5°L . at the Groundspeed of 300 knots. True Course is, therefore, 225° .

TEST ITEM 36 (Ans. 2). You may wish to remove the chart segment in Appendix 3, page 7 for convenience in this plotting exercise. The steps in the solution are outlined below:

- a. Determine TAS. If your computer requires the use of true air temperature, convert the indicated temperature to true. using the correction given. True air temperature is -37°C . TAS is 450 knots.
- b. Convert true wind direction to grid direction ($177^{\circ} + 33^{\circ} = 210^{\circ}\text{G}$).
- c. Solve for Grid Course and Groundspeed based on the following data:

Grid Heading	247°
TAS	450 knots
W/VG	$210^{\circ}/80$ knots

Result

Grid Course	254°
Groundspeed	390 knots

- d. Plot Grid Course 254° from 2315 GMT fix position to 85th meridian. Latitude is $01^{\circ}00'N$; Distance is 320 n.m. which at Groundspeed 390 knots produces ETA 0004 GMT.

TEST ITEM 37 (Ans. 3). Grivation is the angle which results from the combination of convergence and variation. Stated in another way, it is the difference in direction between Grid North and Magnetic North. In this case, the Grivation (GV) of $38^{\circ}E$ is applied to the Grid Heading of 247° to produce the Magnetic Heading of 209° .

TEST ITEM 38 (Ans. 4). This is a simple plot of a celestial fix. In the official examination, you will be expected to perform all computations in addition to the required plotting. For this purpose, excerpts from the Air Almanac and Navigation Tables are provided in a separate booklet. Note that Coriolis Force is not significant at this latitude.

TEST ITEM 39 (Ans. 1). The following factors are known:

Grid Heading 247°
TAS 450 knots
Grid Course 252°
Groundspeed 405 knots

Computer solution yields grid wind of $210^{\circ}/57$ knots.

TEST ITEM 40 (Ans. 3). The solution is outlined below. In addition to flight time computations, you may be asked to determine fuel required based upon fuel flow values.

<u>Zone</u>	<u>TAS</u>	<u>GS</u>	<u>DIST</u>	<u>TIME</u>	<u>ACCUMULATED TIME</u>
1	370	400	250	38'	--
2	485	565	550	58'	1:36
3	495	595	540	55'	2:31
4	490	580	530	55'	3:26
5	320	370	180	29'	3:55

KEY TO AVIATION WEATHER REPORTS.....

LOCATION IDENTIFIER AND TYPE OF REPORT #	SKY AND CEILING	VISIBILITY AND WEATHER OBSTRUCTION TO VISION	SEA LEVEL PRESSURE	TEMPERATURE AND DEW POINT	WIND	ALTIMETER SETTING	RUNWAY	VISUAL RANGE	CODED PIREPS
MKC	150M250	4R-K	132	/58/56	/1807	/993	R04LVR	20V40	/055

SKY AND CEILING

Sky cover symbols are in ascending order. Figures preceding symbols are heights in hundreds of feet above station.

Sky cover symbols are:

- Clear: Less than 0.1 sky cover
- ① Scattered: 0.1 to less than 0.6 sky cover.
- ② Broken: 0.6 to 0.9 sky cover.
- ③ Overcast: More than 0.9 sky cover
- Thin (When prefixed to the above symbols.)
- X Partial obscuration: 0.1 to less than 1.0 sky hidden by precipitation or obstruction to vision (bases at surface)
- X Obscuration: 1.0 sky hidden by precipitation or obstruction to vision (bases at surface)

Letter preceding height of layer identifies ceiling layer and indicates how ceiling height was obtained. Thus:

A Aircraft	R Radiosonde Balloon or Radar.
B Balloon (Pilot or ceiling).	W Indefinite
D Estimated height of cirriform clouds on basis of persistency.	U Height of cirriform ceiling layer unknown.
	/ Height of cirriform non-ceiling layer unknown.
E Estimated heights of noncirriform clouds	"V" Immediately following numerical value indicates a varying ceiling.
M Measured	

VISIBILITY

Reported in Statute Miles and Fractions. (Variable)

WEATHER AND OBSTRUCTION TO VISION SYMBOLS

A Mist	F Fog	RW Rain Showers
AP Smell Mist	GF Ground Fog	S Snow
BD Blowing Dust	H Haze	SG Snow Grains
BH Blowing Sand	IC Ice Crystals	SP Snow Pellets
BS Blowing Snow	IF Ice Fog	SW Snow Showers
D Dust	K Smoke	T Thunderstorm
E Sleet	L Drizzle	ZL Freezing Drizzle
EW Sleet Showers	R Rain	ZR Freezing Rain

Precipitation intensities are indicated thus:

— Very Light; — Light; (no sign) Moderate; + Heavy

WIND

Direction in tens of degrees from true north. speed in knots. 0000 indicates calm. G indicates gusty. Peak speed of gusts follows G or Q when squall is reported. The contraction WSHT followed by local time group in remarks indicates wind shift and its time of occurrence. (Kts. = 1.15 = statute mi/hr.)

EXAMPLES: 3627 360 Degrees, 27 Knots;
3627G40 360 Degrees, 27 Knots Peak speed in gusts 40 knots.

ALTIMETER SETTING

The first figure of the actual altimeter setting is always omitted from the report.

RUNWAY VISUAL RANGE (RVR)

RVR is reported from some stations. Extreme values for 10 minutes prior to observation are given in hundreds of feet. Runway identification precedes RVR report.

CODED PIREPS

Pilot reports of clouds not visible from ground are coded with MSL height data preceding and/or following sky cover symbol to indicate cloud bases and/or tops, respectively.

DECODED REPORT

Kansas City: Record observation, 1500 feet scattered clouds, measured ceiling 2500 feet overcast, visibility 4 miles, light rain, smoke, sea level pressure 1013.2 millibars, temperature 58°F, dewpoint 56°F, wind 180°, 7 knots, altimeter setting 29.93 inches. Runway 04 left, visual range 2000 ft. variable to 4000. Pilot reports top of overcast 5500 feet.

TYPE OF REPORT

The omission of type-of-report data identifies a scheduled record observation for the hour specified in the sequence heading; the time of an out-of-sequence, special observation is given as "S" followed by a time group (14-hour clock GMT) e.g., "PTT 9 0715 -XM..." A special indicates a significant change in one or more elements. Local reports are identified by "LCL" and a time group. Locals are transmitted on local teletypewriter circuits only.

SECTION 1. KEY TO AVIATION WEATHER REPORTS

APPENDIX 3. SUPPLEMENTAL MATERIALS

U.S. DEPARTMENT OF COMMERCE • ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION • WEATHER BUREAU

Washington, D.C.

Revised April 1966

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 - Price 5 cents; \$2.25 per 100

GPO : 1966 O-211-765

KEY TO AVIATION WEATHER FORECASTS

TERMINAL FORECASTS contain information for specific airports on ceiling, cloud heights, cloud amounts, visibility, weather condition and surface wind. They are written in a form similar to the AVIATION WEATHER REPORT.

CEILING: Identified by the letter "C"
CLOUD HEIGHTS: In hundreds of feet above the station (ground)
CLOUD LAYERS: Stated in ascending order of height
VISIBILITY: In statute miles, but omitted if over 8 miles
SURFACE WIND: In tons of degrees and knots; omitted when less than 10.

EXAMPLE OF TERMINAL FORECASTS

C150	ceiling 1500', broken clouds	Q11/2GF	Clear, visibility one and one-half miles, ground fog.
200C70 @ 6K 3230G	Scattered clouds at 2000'; ceiling 7000' overcast, visibility 6 miles, smoke, surface wind 320 degrees 30 knots, gusty.	CSX1/4S	Sky obscured, vertical visibility 500., visibility one-fourth mile, moderate snow.

AREA FORECASTS are 12-hour forecasts plus 12-hour OUTLOOKS of cloud, weather and frontal conditions for an area the size of several states. Heights of cloud tops, icing, and turbulence are above SEA LEVEL; ceiling heights, ABOVE GROUND LEVEL; bases of cloud layers are MSL OR ABV GRND LVL, as indicated. Area Forecasts are amended by SIGMET and AIRMET.

SIGMET and AIRMET warn airmen in flight of potentially hazardous weather such as squall lines, thunderstorms, fog, icing, and turbulence. SIGMET's concern severe and extreme conditions of importance to all aircraft. AIRMET's concern less severe conditions which may be hazardous to some aircraft or to relatively inexperienced pilots. Both are broadcast by FAA on NAVAJD voice channels.

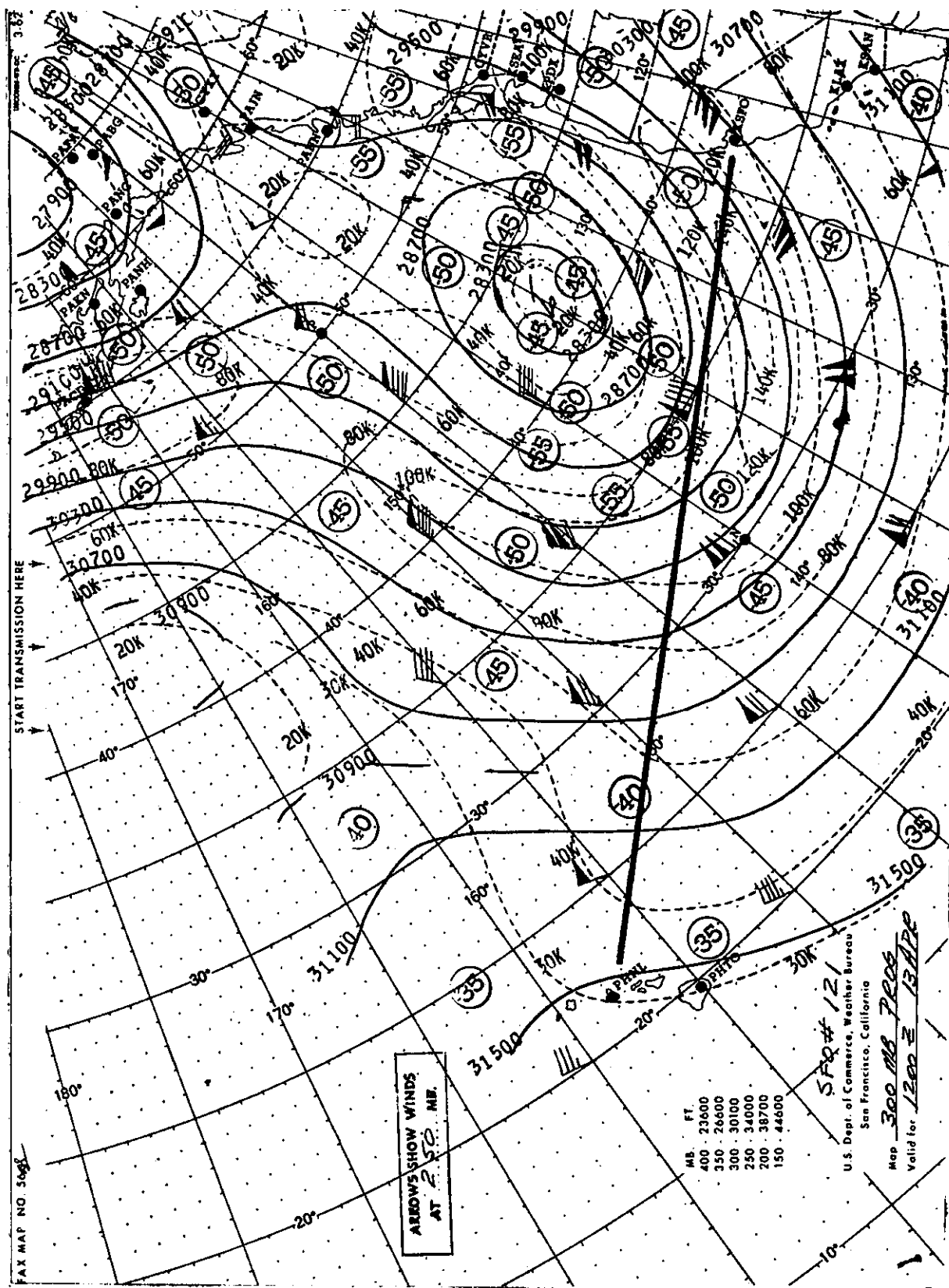
WINDS (AND TEMPERATURES) ALOFT FORECASTS are 6- and 12-hour forecasts of direction (nearest 10° true N) and speed (knots) for selected flight levels. Temperatures aloft (°C) are included for all but the lowest and 7000-foot levels.

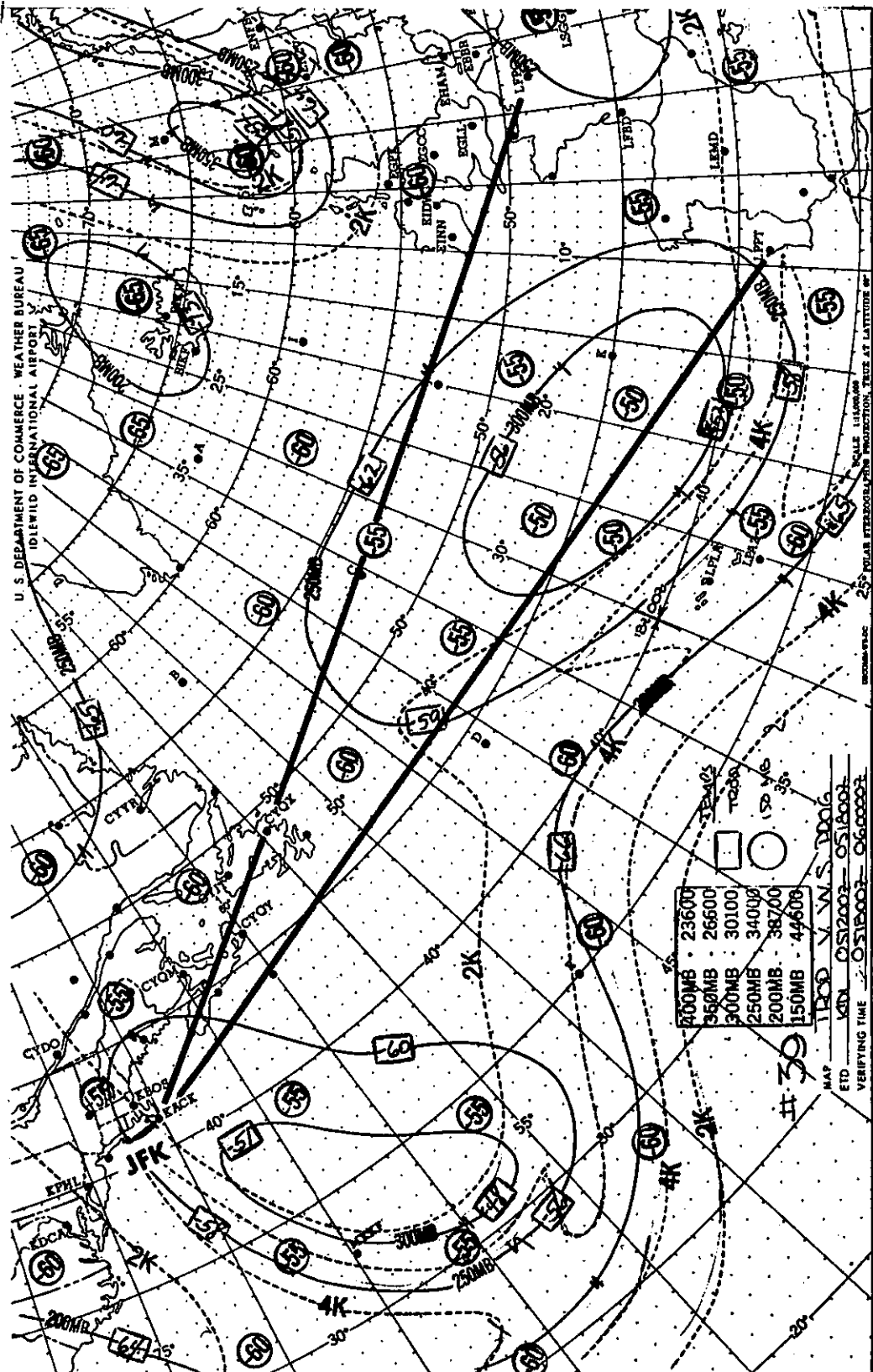
EXAMPLES OF WINDS ALOFT FORECASTS:

LVL 3000 5000 FT 7000 10000 FT
MLT 2925 2833400 2930 3030-06

At 5000 MSL wind from 280° at 33 knots
with temperature 0°Celsius

PILOTS report in-flight weather to nearest FSS





SECTION 3. AIR ALMANAC PAGE

GREENWICH A. M. 1966 DECEMBER 21 (WEDNESDAY)

GMT	☉ SUN		♈ ARIES		♊ MARS 1.2		♃ JUPITER - 2.1		♄ SATURN 1.3		☾ MOON		Lat.	Moon-rise	Diff.
	GHA	Dec.	GHA	Dec.	GHA	Dec.	GHA	Dec.	GHA	Dec.	GHA	Dec.			
h m													N	h m	m
00 00	180 34.2	S23 26.3	89 06.9	260 16 S 1 42	323 38 N19 55	94 14 S 4 41	78 18 N 1 28								
10	183 04.2	26.3	91 37.3	262 46	326 09	96 45	80 44	30						72	12 15 -15
20	185 34.1	26.3	94 07.7	265 16	328 39	99 15	83 10	32						70	12 21 -11
30	188 04.1	26.3	96 38.1	267 47	331 09	101 46	85 36	35						68	12 25 -08
40	190 34.0	26.3	99 08.5	270 17	333 40	104 16	88 02	37						66	12 29 -06
50	193 04.0	26.3	101 38.9	272 47	336 10	106 46	90 28	39						64	12 32 -03
01 00	195 33.9	S23 26.3	104 09.4	275 17 S 1 42	338 41 N19 55	109 17 S 4 41	92 54 N 1 42							62	12 35 -01
10	198 03.9	26.4	106 39.8	277 47	341 11	111 47	95 20	44						60	12 38 +01
20	200 33.8	26.4	109 10.2	280 18	343 42	114 17	97 46	46						58	12 40 02
30	203 03.8	26.4	111 40.6	282 48	346 12	116 48	100 12	48						56	12 42 03
40	205 33.7	26.4	114 11.0	285 18	348 43	119 18	102 38	51						54	12 44 05
50	208 03.6	26.4	116 41.4	287 48	351 13	121 49	105 04	53						52	12 46 06
02 00	210 33.6	S23 26.4	119 11.8	290 19 S 1 43	353 44 N19 55	124 19 S 4 41	107 30 N 1 55							50	12 47 07
10	213 03.5	26.4	121 42.2	292 49	356 14	126 49	109 56	1 57						45	12 50 09
20	215 33.5	26.4	124 12.6	295 19	358 44	129 20	112 22	2 00						40	12 53 11
30	218 03.4	26.4	126 43.0	297 49	1 15	131 50	114 48	02						35	12 56 12
40	220 33.4	26.4	129 13.5	300 19	3 45	134 21	117 14	04						30	12 58 13
50	223 03.3	26.4	131 43.9	302 50	6 16	136 51	119 40	06						20	13 02 16
03 00	225 33.3	S23 26.4	134 14.3	305 20 S 1 43	8 46 N19 55	139 21 S 4 41	122 06 N 2 09							10	13 05 18
10	228 03.2	26.4	136 44.7	307 50	11 17	141 52	124 32	11						0	13 08 20
20	230 33.2	26.4	139 15.1	310 20	13 47	144 22	126 58	13						10	13 12 22
30	233 03.1	26.4	141 45.5	312 50	16 18	146 53	129 24	16						20	13 15 24
40	235 33.1	26.4	144 15.9	315 21	18 48	149 23	131 50	18						30	13 19 27
50	238 03.0	26.4	146 46.3	317 51	21 18	151 53	134 16	20						35	13 21 28
04 00	240 33.0	S23 26.4	149 16.7	320 21 S 1 43	23 49 N19 55	154 24 S 4 41	136 42 N 2 22							40	13 24 30
10	243 02.9	26.4	151 47.2	322 51	26 19	156 54	139 08	25						45	13 27 32
20	245 32.9	26.4	154 17.6	325 22	28 50	159 25	141 34	27						50	13 31 34
30	248 02.8	26.4	156 48.0	327 52	31 20	161 55	144 00	29						55	13 35 35
40	250 32.8	26.4	159 18.4	330 22	33 51	164 25	146 26	31						54	13 38 37
50	253 02.7	26.4	161 48.8	332 52	36 21	166 56	148 52	34						56	13 41 39
05 00	255 32.7	S23 26.4	164 19.2	335 22 S 1 44	38 52 N19 55	169 26 S 4 41	151 18 N 2 36							60	13 45 41
10	258 02.6	26.4	166 49.6	337 53	41 22	171 57	153 44	38						60	13 48 41
20	260 32.6	26.4	169 20.0	340 23	43 53	174 27	156 10	40						60	13 51 41
30	263 02.5	26.5	171 50.4	342 53	46 23	176 57	158 36	43						60	13 54 41
40	265 32.5	26.5	174 20.8	345 23	48 53	179 28	161 02	45						60	13 57 41
50	268 02.4	26.5	176 51.3	347 53	51 24	181 58	163 28	47						60	14 00 41
06 00	270 32.4	S23 26.5	179 21.7	350 24 S 1 44	53 54 N19 55	184 29 S 4 41	165 54 N 2 50							60	14 03 41
10	273 02.3	26.5	181 52.1	352 54	56 25	186 59	168 20	52						60	14 06 41
20	275 32.3	26.5	184 22.5	355 24	58 55	189 29	170 46	54						60	14 09 41
30	278 02.2	26.5	186 52.9	357 54	61 26	192 00	173 12	56						60	14 12 41
40	280 32.1	26.5	189 23.3	0 25	63 56	194 30	175 38	59						60	14 15 41
50	283 02.1	26.5	191 53.7	2 55	66 27	197 01	178 04	3 01						60	14 18 41
07 00	285 32.0	S23 26.5	194 24.1	5 25 S 1 45	68 57 N19 55	199 31 S 4 41	180 30 N 3 03							60	14 21 41
10	288 02.0	26.5	196 54.5	7 55	71 27	202 01	182 56	05						60	14 24 41
20	290 31.9	26.5	199 25.0	10 25	73 58	204 32	185 22	08						60	14 27 41
30	293 01.9	26.5	201 55.4	12 56	76 28	207 02	187 48	10						60	14 30 41
40	295 31.8	26.5	204 25.8	15 26	78 59	209 32	190 14	12						60	14 33 41
50	298 01.8	26.5	206 56.2	17 56	81 29	212 03	192 40	14						60	14 36 41
08 00	300 31.7	S23 26.5	209 26.6	20 26 S 1 45	84 00 N19 55	214 33 S 4 41	195 06 N 3 17							60	14 39 41
10	303 01.7	26.5	211 57.0	22 57	86 30	217 04	197 32	19						60	14 42 41
20	305 31.6	26.5	214 27.4	25 27	89 01	219 34	199 58	21						60	14 45 41
30	308 01.6	26.5	216 57.8	27 57	91 31	222 04	202 24	23						60	14 48 41
40	310 31.5	26.5	219 28.2	30 27	94 02	224 35	204 50	26						60	14 51 41
50	313 01.5	26.5	221 58.7	32 57	96 32	227 05	207 16	28						60	14 54 41
09 00	315 31.4	S23 26.5	224 29.1	35 28 S 1 46	99 02 N19 55	229 36 S 4 41	209 42 N 3 30							60	14 57 41
10	318 01.4	26.5	226 59.5	37 58	101 33	232 06	212 08	33						60	15 00 41
20	320 31.3	26.5	229 29.9	40 28	104 03	234 36	214 34	35						60	15 03 41
30	323 01.3	26.5	232 00.3	42 58	106 34	237 07	217 00	37						60	15 06 41
40	325 31.2	26.5	234 30.7	45 28	109 04	239 37	219 26	39						60	15 09 41
50	328 01.2	26.5	237 01.1	47 59	111 35	242 08	221 52	42						60	15 12 41
10 00	330 31.1	S23 26.5	239 31.5	50 29 S 1 46	114 05 N19 56	244 38 S 4 40	224 17 N 3 44							60	15 15 41
10	333 01.1	26.5	242 01.9	52 59	116 36	247 08	226 43	46						60	15 18 41
20	335 31.0	26.5	244 32.3	55 29	119 06	249 39	229 09	48						60	15 21 41
30	338 01.0	26.5	247 02.8	58 00	121 36	252 09	231 35	51						60	15 24 41
40	340 30.9	26.5	249 33.2	60 30	124 07	254 40	234 01	53						60	15 27 41
50	343 00.9	26.6	252 03.6	63 00	126 37	257 10	236 27	55						60	15 30 41
11 00	345 30.8	S23 26.6	254 34.0	65 30 S 1 47	129 08 N19 56	259 40 S 4 40	238 53 N 3 57							60	15 33 41
10	348 00.8	26.6	257 04.4	68 01	131 38	262 11	241 19	4 00						60	15 36 41
20	350 30.7	26.6	259 34.8	70 31	134 09	264 41	243 45	02						60	15 39 41
30	353 00.6	26.6	262 05.2	73 01	136 39	267 12	246 11	04						60	15 42 41
40	355 30.6	26.6	264 35.6	75 31	139 10	269 42	248 37	06						60	15 45 41
50	358 00.5	26.6	267 06.0	78 01	141 40	272 12	251 03	09						60	15 48 41

☉ Sun SD16.3
Moon SD15
Age 9*

