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AC 63-2A

FLIGHT NAVIGATOR WRITTEN TEST GUIDE



REVISED

1969

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

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FEDERAL AVIATION ADMINISTRATION**

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CHAPTER 1. NATURE OF THE WRITTEN TEST

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

The guide is not offered as a quick and easy way to obtain the necessary knowledge for passing the written test. 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 TEST. The Flight Navigator Written Test 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 test 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)

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

b. NOTE: Familiarity with ICAO, Annex 2--Rules of the Air--is required as prescribed in FAR 91.1.

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)

h. NOTE: Familiarity with ICAO, Annex 6--Operation of Aircraft, is also recommended.

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 test.

The list identifies source material essential to preparing for the test 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 test are available at bookstores and libraries.

It is the responsibility of each applicant to obtain the study materials appropriate to his needs. Prices are subject to change.

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 (.35)
 - b. PART 91 - General Operating and Flight Rules (.70)
 - c. PART 121 - Certification and Operations: Air Carriers and Commercial Operators of Large Aircraft (1.50)
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 (\$4.00). This manual is a consolidation of the superseded Volumes I and II. The new Volume I develops the art of navigation from the simplest concepts to the most advanced procedures and techniques.
5. ICAO Annex 2--Rules of the Air (0.75).
6. ICAO Annex 6--Operation of Aircraft (1.00).

SECTION 2. HOW TO OBTAIN STUDY MATERIALS

7. STUDY MATERIALS. All study materials listed, except ICAO Annexes, may be obtained by remitting check or money order to the address listed below. To cover the cost of foreign mailing for those publications not showing a foreign price, add 25 percent to the publication's listed price. Remittances from a foreign country may be made by International Money Order or draft on a United States bank payable to the issuing Agency.

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8. ICAO Annexes may be obtained by remitting bank draft or post office money order in U.S. dollars or the currency of the country in which the order is placed, or in a freely convertible currency to:

International Civil Aviation Organization
(Attention: Distribution Officer)
International Aviation Building
1080 University Street
Montreal (Quebec), Canada.

9. Important Notice. The Federal Aviation Administration is reissuing the Federal Aviation Regulations (FAR) in a volume system to be sold on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The purchase of a FAR volume will establish your subscription service with the Superintendent of Documents for automatic receipt of changes to the volume as issued by FAA.

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III - - - - -	23, 25
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X - - - - -	151, 153, 155, 159, 165, 167
XI - - - - -	71, 73, 75, 77, 95, 97, 157, 169, 171

As each volume is issued, an availability notification providing price and an order form will be issued and distributed by the Superintendent of Documents. However, until all FAR Parts are grouped in their respective volumes and the volumes are available for sale from the Superintendent of Documents, the present system of obtaining individual FAR Parts and revision service to them will remain in effect.

APPENDIX 2. SAMPLE TEST

The following test items are presented to indicate the general form of those used in the official test. They are included for one purpose--to familiarize you with the type of test items you may expect to encounter in FAA written tests. Ability to answer these sample items does not indicate that you are fully prepared to take the test 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 Test." 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 test.

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 tests should always be answered in terms of current regulations and procedures.

SECTION 1. FEDERAL AVIATION REGULATIONS

TEST ITEM 1. An individual serving as a Flight Navigator on an aircraft of U. S. registry must have in his personal possession a

- 1- current medical certificate.
- 2- current Flight Navigator Certificate and a current second class, or higher, medical certificate.
- 3- Flight Navigator Certificate and valid passport.
- 4- first class medical certificate and current Flight Navigator Certificate.

TEST ITEM 2. 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- Airman's Information Manual.
- 2- Federal Aviation Regulations.
- 3- International Flight Manual.
- 4- Operations Specifications.

TEST ITEM 3. Temporary Flight Navigator Certificates, when issued, are valid for a period of not more than

- 1- 30 days.
- 2- 90 days.
- 3- 3 months.
- 4- 6 calendar months.

TEST ITEM 4. A Flight Navigator Certificate remains in effect

- 1- for one year.
- 2- for 12 calendar months.
- 3- for three years.
- 4- until surrendered, suspended, or revoked.

TEST ITEM 5. An applicant for a Flight Navigator Certificate fails the flight test portion of the practical test. Which of the following responses outlines a correct time period for retesting?

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

TEST ITEM 6. Aircraft "A" is overtaking Aircraft "B" on the same course and altitude. Which statement is correct?

- 1- Aircraft "B" must alter course to the right.
- 2- Each aircraft must alter course to the right.
- 3- Aircraft "B" has the right-of-way.
- 4- Aircraft "A" must alter course to the left.

TEST ITEM 7. Based on international rules of the air (ICAO, Annex 2), select the correct statement regarding a controlled flight which inadvertently deviates from its track.

- 1- Adjust heading to parallel track.
- 2- Adjust heading to regain track only if advised that a possible traffic conflict exists.
- 3- Immediately adjust heading for return to track in minimum time.
- 4- Adjust heading to return to track as soon as practicable.

TEST ITEM 8. 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- 30 flight hours in any flight function within preceding 6 months.
- 2- 50 flight hours in any flight function within 12 calendar-month period.
- 3- 50 flight navigation hours within preceding 12 calendar-month period.
- 4- 50 flight navigation hours within preceding 6 calendar-month period.

TEST ITEM 9. An alternate airport for the departure point is required

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

TEST ITEM 10. Where only one Flight Navigator is required in scheduled operations, he may not fly as a flight crewmember more than

- 1- 350 hours during any 90-consecutive days.
- 2- 100 hours during any 30-day period.
- 3- 1000 hours during any 12-month period.
- 4- 300 hours during 3 calendar months.

SECTION 2. FUNDAMENTALS OF AIR NAVIGATION

TEST ITEM 11. To determine latitude by an observation of Polaris, it is necessary to correct the observed altitude for

- 1- location of Polaris in diurnal circle.
- 2- erratic orbit of Polaris.
- 3- change in LHA of Aries.
- 4- Coriolis effect.

TEST ITEM 12. You note the difference in the tabulated GHA-Aries entry in the Air Almanac on successive days at the same time. The difference is produced by

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

TEST ITEM 13. The GHA-Aries at a particular time is $202^{\circ}30'$. The Greenwich Sidereal Time (GST) is

- 1- 1230.
- 2- 0130.
- 3- 1330.
- 4- 0030.

TEST ITEM 14. Which statement accurately summarizes a basic characteristic of an Inertial Navigation System?

- 1- System is self-contained and completely passive.
- 2- Position data must be up-dated with ground-based aids.
- 3- After initial alignment, the gyro-stabilized "platform" remains error-free.
- 4- System accuracy is effected only by computer errors.

TEST ITEM 15. The "sensor" portion of the Doppler system includes which of the following components?

- 1- Tracker and Navigation Computer.
- 2- Antenna, Doppler Indicator, and Navigation Computer.
- 3- Antenna, Transmitter/Receiver, and Tracker.
- 4- Navigation Computer, Tracker, Transmitter, and Control Unit.

TEST ITEM 16. In observing the upper limb of the moon, which one of the following sextant altitude corrections is always additive?

- 1- Semidiameter
- 2- Index
- 3- Parallax
- 4- Refraction

TEST ITEM 17. The first magnitude star approximately midway between Bellatrix and the Pleiades is

- 1- Elnath.
- 2- Pollux.
- 3- Capella.
- 4- Aldebaran.

TEST ITEM 18. Consider the following data:

Lat: 50°N.
GST: 1200
LST: 1600
SHA*: 180°

The star is located on the

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

TEST ITEM 19. Blinking of Loran signals in the receiver-indicator scope is an indication that the

- 1- receiver is in need of adjustment.
- 2- antenna coupler is defective.
- 3- left-right switch is inoperative.
- 4- transmitted signals are out of synchronization.

TEST ITEM 20. An aircraft is cruising at flight level 350 at True Airspeed 445 knots. The speed of sound at this level is 576.6 knots. What is the Mach Number?

- 1- 1.00
- 2- 0.77
- 3- 1.30
- 4- 0.80

SECTION 3. METEOROLOGY

TEST ITEM 21. A pronounced feature of the stratosphere is the

- 1- absence of wind.
- 2- absence of weather.
- 3- decrease of temperature with altitude.
- 4- rapid decrease in pressure with altitude.

TEST ITEM 22. A warm front may be defined as

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

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

- 1- Cooling from below.
- 2- Warming from below.
- 3- Removal of water vapor from lower layers.
- 4- Movement of air from mountains to lowlands.

TEST ITEM 24. Assuming straight isobars or contours, the geostrophic wind results from a balance between the

- 1- gradient and centrifugal forces.
- 2- gradient and friction winds.
- 3- Coriolis and friction forces.
- 4- Coriolis and gradient forces.

TEST ITEM 25. The recorded temperature at an airport situated 4,000 feet MSL is +20°C. Assuming that the normal lapse rate prevails, the freezing level will be at

- 1- 10,000 feet MSL.
- 2- 14,000 feet MSL.
- 3- 14,000 feet AGL.
- 4- 9,000 feet MSL.

TEST ITEM 26. The ceiling at an aviation weather reporting station is reported to be "indefinite 400 feet obscured." How is this ceiling shown in the aviation weather sequence report?

- 1- W4X
- 2- M4OX
- 3- W4@
- 4- M4@

TEST ITEM 27. The freezing level on the great circle route between San Francisco and Honolulu is (Appendix 3, page 3)

- 1- below 5,000 feet MSL at 140°W.
- 2- at 10,000 feet MSL near Honolulu.
- 3- at 5,000 feet MSL near San Francisco.
- 4- below 10,000 feet MSL over the entire route.

TEST ITEM 28. 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, then decrease after 140°W.
- 3- increase over the entire route.
- 4- decrease, then increase after 130°W.

TEST ITEM 29. The wind at the 300 millibar level over Honolulu is shown to be approximately (Appendix 3, page 4)

- 1- 280°/35 knots.
- 2- 300°/20 knots.
- 3- 260°/45 knots.
- 4- 280°/50 knots.

TEST ITEM 30. Refer to the 200 millibar and Tropopause Prognostic Chart, Appendix 3, page 5. A flight maintaining Flight Level 400 on the great circle route between San Francisco and Honolulu would be flying

- 1- below the tropopause on the entire route.
- 2- above the tropopause at 128°W.
- 3- above the tropopause at 143°W.
- 4- below the tropopause at 125°W.

SECTION 4. PLOTTING AND COMPUTING

TEST ITEM 31. On March 21, 1969, at 0420 GMT, the sun bears 360° true as it reaches the maximum altitude of 49° . The position of the observer is

- 1- $40^\circ 51'S$; $116^\circ 50'E$.
- 2- $41^\circ 00'S$; $116^\circ 10'E$.
- 3- $40^\circ 30'S$; $118^\circ 50'E$.
- 4- $41^\circ 09'N$; $63^\circ 10'E$.

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

TEST ITEM 32. Given the following altimetry readings with supporting data:

	<u>0430Z</u>	<u>0515Z</u>
Pressure Altitude:	25,060 feet	25,000 feet
True Altitude:	24,800 feet	25,100 feet

Lat $55^\circ S$.
TAS 480 kts.
GS 390 kts.
TH 220°

The aircraft is on a True Course of

- 1- 213° .
- 2- 216° .
- 3- 220° .
- 4- 224° .

TEST ITEM 33. The flight plan time on a certain 3,000 n.m. route is 6 hours. Flight 200 arrives at the mid-point of the route at 2340 GMT. What True Airspeed must be maintained to arrive over the destination at the original ETA of 0230 GMT, based on the following conditions:

Flight Level. 340
Desired True Course 145°
Wind. $270^\circ/110$ knots
Outside Air Temperature $-30^\circ C$.
Temperature Correction. 23°

- 1- 468 knots.
- 2- 472 knots.
- 3- 478 knots.
- 4- 485 knots.

TEST ITEM 34. What is the equivalent Mach Number for the True Airspeed computed under the conditions outlined in the previous test item?

- 1- .77
- 2- .82
- 3- .85
- 4- .88

TEST ITEM 35. What compass heading should be flown from the mid-point of the route in test item 33 (Variation 13°W.; Deviation 4°E.)?

- 1- 146°
- 2- 152°
- 3- 165°
- 4- 174°

TEST ITEM 36. 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	+50 kts.	.80	-30°C.	550
3	350	+80 kts.	.80	-20°C.	540
4	350	+60 kts.	.80	-25°C.	530
5	Descent**	+20 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, 59 minutes.
- 4- 4 hours, 05 minutes.

TEST ITEM 37. The position of an aircraft is fixed at 0815 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/0905 GMT; Lat. 00°55'N.
- 2- ETA/0903 GMT; Lat. 01°15'N.
- 3- ETA/0901 GMT; Lat. 01°05'N.
- 4- ETA/0907 GMT; Lat. 00°45'N.

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TEST ITEM 38. Compute the Magnetic Heading which is equivalent to the Grid Heading of 247° from the previous test item. Use the following data:

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

- 1- 202° .
- 2- 206° .
- 3- 209° .
- 4- 212° .

TEST ITEM 39. Listed below are intercepts and true bearings (Z_N) for three stars, resolved to a common time of 0906 GMT. Plot the fix from an assumed position of $01^\circ\text{N.}; 84^\circ40'\text{W.}$

	<u>1</u>	<u>2</u>	<u>3</u>
Intercept	$25'\text{T.O.}$	$14'\text{AWAY}$	$12'\text{AWAY}$
Z_N	310°	070°	190°
(Convergence: 34°)			

The position of the 0906 GMT fix is

- 1- $01^\circ15'\text{N.}; 85^\circ00'\text{W.}$
- 2- $01^\circ25'\text{N.}; 85^\circ15'\text{W.}$
- 3- $01^\circ05'\text{N.}; 84^\circ40'\text{W.}$
- 4- $01^\circ20'\text{N.}; 84^\circ35'\text{W.}$

TEST ITEM 40. Assuming no change in heading or TAS, what average wind (Grid Direction) has been experienced between the 0815 GMT and 0906 GMT fixes?

- 1- $200^\circ/90$ kts.
- 2- $212^\circ/110$ kts.
- 3- $218^\circ/132$ kts.
- 4- $225^\circ/100$ kts.

SECTION 5. ANSWERS AND EXPLANATIONS TO SAMPLE TEST ITEMS

TEST ITEM 1 (Ans. 2). The reference is FAR 63.3.

TEST ITEM 2 (Ans. 4). The reference is FAR 121.389(b). Review also paragraph (a).

TEST ITEM 3 (Ans. 2). The reference is FAR 63.13.

TEST ITEM 4 (Ans. 4). The reference is FAR 63.15.

TEST ITEM 5 (Ans. 4). 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 6 (Ans. 3). The reference is found in ICAO, Annex 2--Rules of the Air (Chapter 3, Section 3.2.2.3). It is also found in FAR 91.67.

TEST ITEM 7 (Ans. 4). The reference is found in ICAO, Annex 2--Rules of the Air (Chapter 3, Section 3.5.2.2.1a).

TEST ITEM 8 (Ans. 3). The reference is FAR 121.451(a). Note that the alternative procedure involves a flight check.

TEST ITEM 9 (Ans. 1). The reference is FAR 121.617(a). Note the distance requirements specified for the aircraft engine configuration.

TEST ITEM 10 (Ans. 3). The basic reference is FAR 121.493(a) which states that for this operation, the flight time limitations in FAR 121.483 are applicable.

TEST ITEM 11 (Ans. 1). Since Polaris is not located exactly at the north celestial pole, the observed altitude will vary according to its location in the diurnal circle. The entering argument in the Polaris Table is "LHA-First Point of Aries."

TEST ITEM 12 (Ans. 2). 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 Aries as shown in the Almanac entry.

TEST ITEM 13 (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 14 (Ans. 1). The system is completely self-contained, requiring no externally based aids and it is passive, since no energy is radiated from the aircraft.

TEST ITEM 15 (Ans. 3). The "sensor" portion of the Doppler Navigation System comprises the antenna, transmitter/receiver, and tracker, as well as the indicator and sensor control panel. The navigation computer operates continually, resolving inputs from the tracker unit into cross-track and along-track distance read-outs.

TEST ITEM 16 (Ans. 3). In observing the moon's upper limb, semidiameter is subtractive. Index correction may be either additive or subtractive and refraction is always subtractive. Parallax is always additive.

TEST ITEM 17 (Ans. 4). With the constellation of ORION located on your meridian to the south, a line extended to the northwest from Bellatrix to the Pleiades will pass close to Aldebaran at the approximate halfway point.

TEST ITEM 18 (Ans. 4). By the definition 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 19 (Ans. 4). Transmission of Loran signals is continuously monitored. If the signals get out of synchronization by as much as 2 microseconds, the master pulse, the slave pulse, or both, blink to warn the user of this condition. When blinking is seen, readings from the station should be avoided until synchronization is restored.

TEST ITEM 20 (Ans. 2). 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. 2). The stratosphere contains very little moisture and is, therefore, characterized by an absence of weather phenomena associated with the troposphere.

TEST ITEM 22 (Ans. 3). Warm air is overtaking and replacing colder air. The boundary between the advancing warm air mass and the colder air being displaced is said to be the frontal zone.

TEST ITEM 23 (Ans. 2). Warming from below may result from the advection of a cold air mass over a warmer surface or solar heating of the surface under the air mass. The other factors tend to increase the stability.

TEST ITEM 24 (Ans. 4). The tendency for air to flow from high pressure to low pressure is counterbalanced by the Coriolis force, resulting in a flow parallel to the isobars or contours.

TEST ITEM 25 (Ans. 2). The solution is based on the normal lapse rate of 2°C . per 1,000 feet.

TEST ITEM 26 (Ans. 1). 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 27 (Ans. 3). Refer to the Significant Weather Chart, Appendix 3, page 3.

TEST ITEM 28 (Ans. 3). Refer to the 300 MB. PROG, Appendix 3, page 4. An aircraft flying on a constant altimeter setting and a constant altitude indication will conform to the slope of the constant pressure surface. In this case, the true altitude would increase over the entire route. Note that contour heights are now recorded in "tens" of meters rather than feet. For example, the height of the 300 millibar contour over San Francisco is shown as "912" which is 9,120 meters.

TEST ITEM 29 (Ans. 1). Some indication of the wind flow is given by the contour line together with the 250 millibar wind arrows to the northeast and east-southeast of Honolulu. The wind speed is interpolated between the 20 and 40 knot isotachs which bracket Honolulu at the 300 millibar level.

TEST ITEM 30 (Ans. 2). The heavy dashed lines on the chart depict the height of the tropopause in 50-millibar increments. Temperatures at the 200-millibar level are enclosed in circles. When reported, temperatures at the tropopause are enclosed in squares. In this example, at 128°W ., the tropopause is shown to be at the 200-millibar level which is equivalent to 38,700 feet. At Flight Level 400, the aircraft will, therefore, be above the tropopause at this location.

TEST ITEM 31 (Ans. 1). The test item has little operational application but is used to illustrate basic concepts. In this case, the sun is to the north on the observer's meridian. The zenith distance is 41° ($90^{\circ}-49^{\circ}$) and when combined with the declination ($0^{\circ}09'\text{N}$.) yields the observer's latitude ($40^{\circ}51'\text{S}$.). The GHA of the sun at the stated time is $243^{\circ}10'\text{W}$. which subtracted from 360° produces the longitude value of $116^{\circ}50'\text{E}$. A diagram of the plane of the meridian is helpful in visualizing the solution.

TEST ITEM 32 (Ans. 4). The height difference of +360 feet produces a V_N of 26.2 n.m. This yields a drift angle of approximately 4° to the right since we are in the southern hemisphere.

TEST ITEM 33 (Ans. 2). To arrive at the original ETA will require a Ground-speed of 528 knots. Solution yields True Airspeed 472 knots.

TEST ITEM 34 (Ans. 2). Solution varies with the type of computer used. If you need True Air Temperature, apply the temperature correction to the Indicated Temperature to produce the value -53°C . (True).

TEST ITEM 35 (Ans. 3). Application of the Compass Error (9°W.) to the True Heading in test item 33 (156°) produces Compass Heading (165°).

TEST ITEM 36 (Ans. 4). The solution is outlined below. In addition to flight time computations, you may be asked to determine fuel requirements based on 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	:37.4	0:37.4
2	485	535	550	1:01.8	1:39.2
3	495	575	540	:56.3	2:35.5
4	490	550	530	:57.8	3:33.3
5	320	340	180	:31.8	4:05.1

TEST ITEM 37 (Ans. 1). 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:

- 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.
- Convert true wind direction to grid direction ($177^{\circ} + 33^{\circ} = 210^{\circ}\text{G}$).
- Solve for Grid Course and Groundspeed based on the following data:

Grid Heading	247°
TAS	450 knots
W/VG	210°/80 knots

Result

Grid Course	254°
Groundspeed	390 knots

- Plot Grid Course 254° from 0815 GMT fix position to 85th meridian. Latitude is $00^{\circ}55'\text{N.}$; Distance is 325 n.m. which at Groundspeed 390 knots produces ETA 0905 GMT.

TEST ITEM 38 (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°E. is applied to the Grid Heading of 247° to produce the Magnetic Heading of 209° .

TEST ITEM 39 (Ans. 1). This is a simple plot of a celestial fix. In the official test, 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 40 (Ans. 2). The following factors are known:

Grid Heading	247°
TAS.	450 knots
Grid Course	257°
Groundspeed	365 knots

Computer solution yields grid wind of $212^{\circ}/110$ knots.

APPENDIX 3. SUPPLEMENTAL MATERIALS
SECTION 1. KEY TO AVIATION WEATHER REPORTS

KEY TO AVIATION WEATHER REPORTS

LOCATION IDENTIFIER AND TYPE OF REPORT *	SKY AND CEILING	VISIBILITY WEATHER AND 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 B Balloon (Pilot or ceiling). D Estimated height of cirriform clouds on basis of persistency. E Estimated heights of noncirriform clouds M Measured R Radiosonde Balloon or Radar. W Indefinite U Height of cirriform ceiling layer unknown. / Height of cirriform non-ceiling layer unknown. "y" Immediately following numerical value indicates a varying ceiling.		VISIBILITY Reported in Statute Miles and Fractions. (V=Variable) WEATHER AND OBSTRUCTION TO VISION SYMBOLS A Mist AP Smell Mist BD Blowing Dust BM Blowing Sand BS Blowing Snow D Dust E Sleet EW Sleet Showers F Fog GF Ground Fog H Haze IC Ice Crystals IF Ice Fog K Smoke L Drizzle R Rain RW Rain Showers S Snow SG Snow Grains SP Snow Pellets SW Snow Showers T Thunderstorm ZL Freezing Drizzle 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 WSHFT followed by local time group in remarks indicates wind-shift and its time of occurrence. (Kts. x 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 (24-hour clock GMT) e.g., "PIT 8 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.				

U.S. DEPARTMENT OF COMMERCE • ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION • WEATHER BUREAU Washington, D.C.

Revised AUG. 1967

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

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 tens of degrees and knots; omitted when less than 10.

EXAMPLE OF TERMINAL FORECASTS

C150	Ceiling 1500', broken clouds	O11 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** (18 hour outlook in FA valid at 1300Z) 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 (ASL)**; ceiling heights, **ABOVE GROUND LEVEL (AGL)**; bases of cloud layers are ASL unless indicated. Area Forecasts are amended by **SIGMET's** or **AIRMET's**.

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

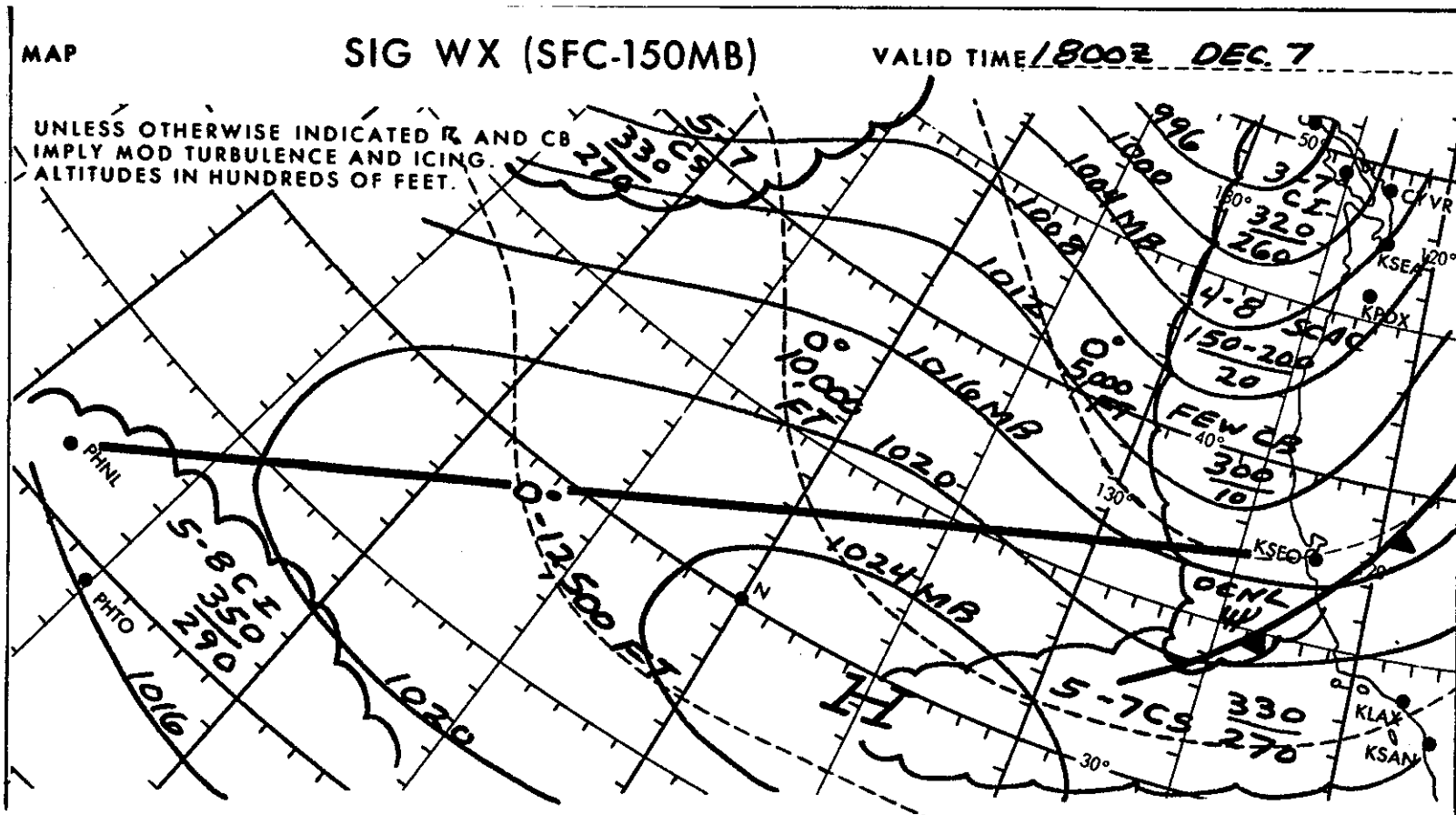
EXAMPLES OF WINDS ALOFT FORECASTS:

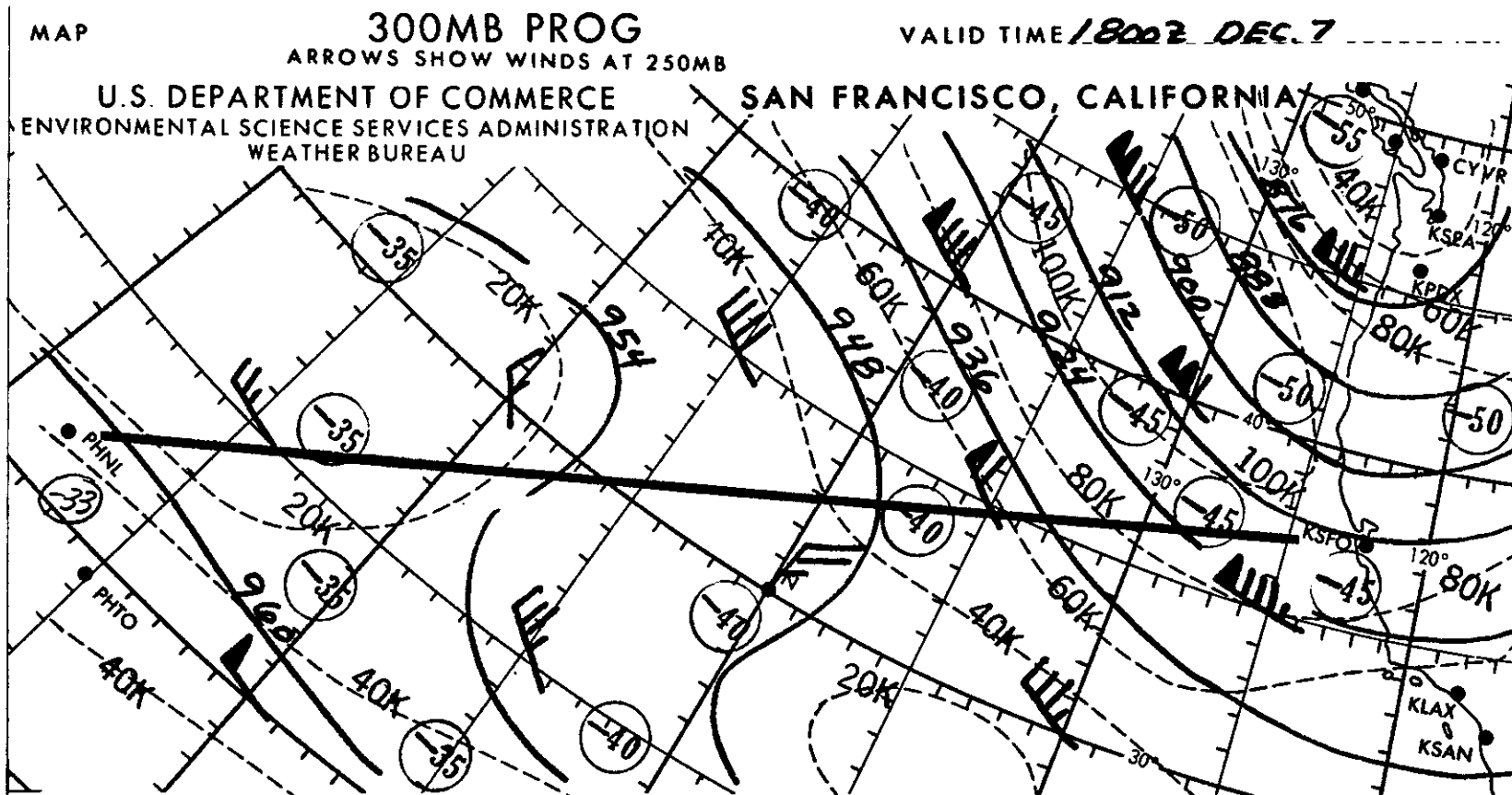
LVL 3000 5000 FT 7000 10000 FT
MLT 2925 2833+00 2930 3030-06

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

PILOTS report in-flight weather to nearest FSS

SECTION 2. WEATHER CHARTS



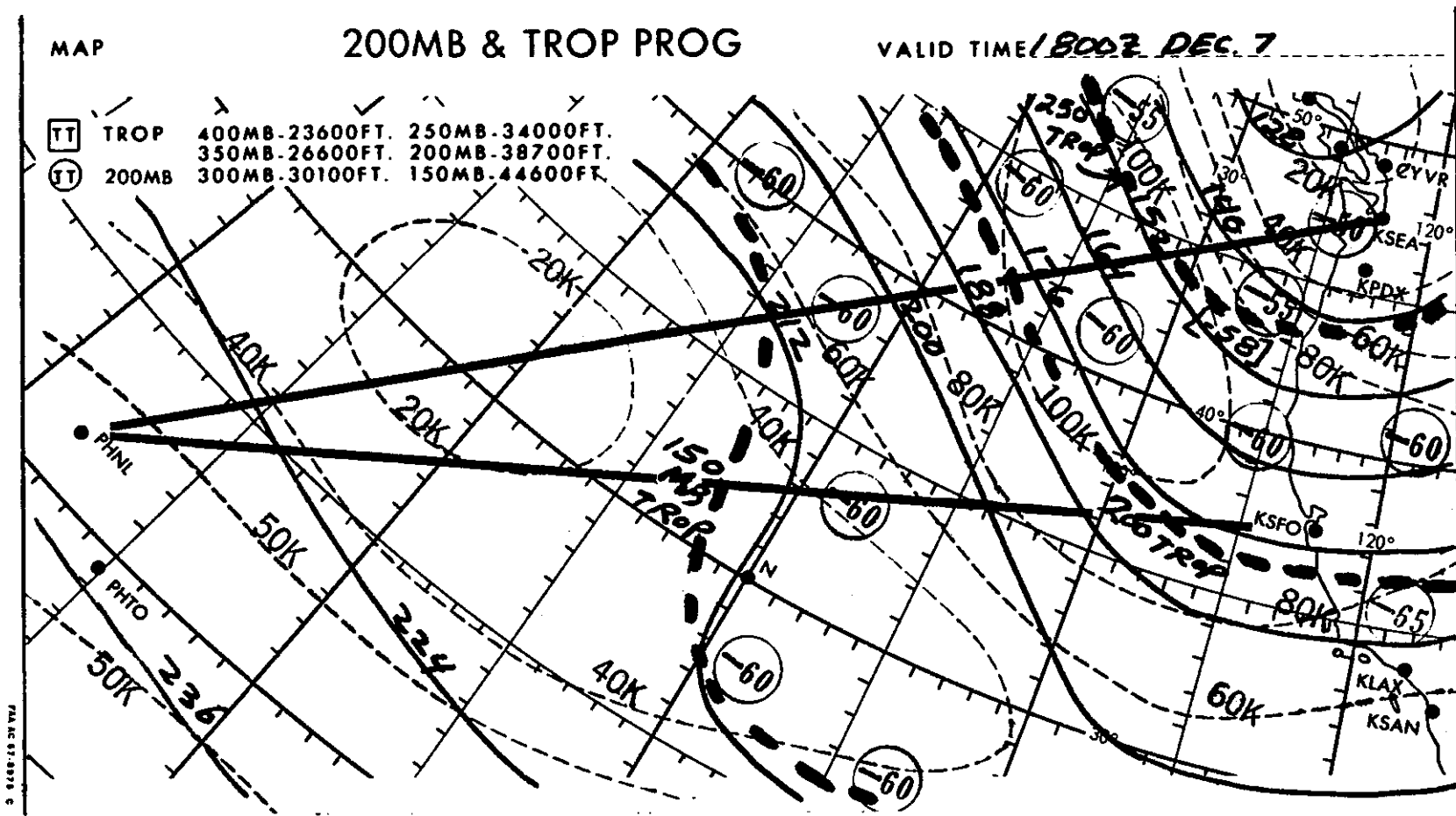


MAP

200MB & TROP PROG

VALID TIME 1800Z DEC. 7

TT TROP 400MB-23600FT. 250MB-34000FT.
350MB-26600FT. 200MB-38700FT.
TT 200MB 300MB-30100FT. 150MB-44600FT.



FMA AC 67-8278 C

GREENWICH A. M. 1969 MARCH 21 (FRIDAY)

GMT	SUN GHA Dec.	ARIES GHA T	VENUS-4.1 GHA Dec.	JUPITER-2.0 GHA Dec.	SATURN 0.7 GHA Dec.	MOON GHA Dec.	Lat.	Moon- rise	Diff.
h m	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	N	h m	m
00 00	178 09.0 N 0 04.8	178 20.1	156 22 N17 11	356 32 N 0 57	154 21 N 7 34	147 34 N15 40	°	03 58	*
10	180 39.0 05.0	180 50.5	158 52	359 03	156 51	149 59	72	04 40	*
20	183 09.0 05.1	183 20.9	161 22	1 33	159 21	152 25	70	05 08	-22
30	185 39.1 05.3	185 51.3	163 53	4 04	161 52	154 50	68	05 30	-12
40	188 09.1 05.5	188 21.7	166 23	6 34	164 22	157 15	66	05 48	-07
50	190 39.1 05.6	190 52.1	168 54	9 05	166 52	159 41	64	06 02	-03
01 00	193 09.2 N 0 05.8	193 22.5	171 24 N17 12	11 35 N 0 57	169 23 N 7 34	162 06 N15 53	62	06 15	00
10	195 39.2 06.0	195 52.9	173 55	14 06	171 53	164 32	60	06 25	+02
20	198 09.2 06.1	198 23.3	176 25	16 36	174 24	166 57	58	06 35	04
30	200 39.3 06.3	200 53.8	178 56	19 07	176 54	169 22	56	06 43	06
40	203 09.3 06.5	203 24.2	181 26	21 37	179 24	171 48	54	06 50	07
50	205 39.3 06.6	205 54.6	183 57	24 07	181 55	174 13	52	06 57	09
02 00	208 09.3 N 0 06.9	208 25.0	186 27 N17 12	26 38 N 0 57	184 25 N 7 34	176 39 N16 06	50	07 12	11
10	210 39.4 06.9	210 55.4	188 58	29 08	186 55	179 04	48	07 24	13
20	213 09.4 07.1	213 25.8	191 28	31 39	189 26	181 29	46	07 34	15
30	215 39.4 07.3	215 56.2	193 59	34 09	191 56	183 55	44	07 43	16
40	218 09.5 07.4	218 26.6	196 29	36 40	194 26	186 20	42	07 59	19
50	220 39.5 07.6	220 57.0	198 59	39 10	196 57	188 46	40	08 13	21
03 00	223 09.5 N 0 07.8	223 27.4	201 30 N17 12	41 41 N 0 57	199 27 N 7 35	191 11 N16 19	38	08 26	23
10	225 39.6 07.9	225 57.9	204 00	44 11	201 58	193 36	36	08 39	25
20	228 09.6 08.1	228 28.3	206 31	46 42	204 28	196 02	34	08 53	27
30	230 39.6 08.3	230 58.7	209 01	49 12	206 58	198 27	32	09 09	30
40	233 09.7 08.4	233 29.1	211 32	51 43	209 29	200 53	30	09 19	32
50	235 39.7 08.6	235 59.5	214 02	54 13	211 59	203 18	28	09 30	33
04 00	238 09.7 N 0 08.8	238 29.9	216 33 N17 12	56 43 N 0 57	214 29 N 7 35	205 43 N16 32	26	09 43	35
10	240 39.7 08.9	241 00.3	219 03	59 14	217 00	208 09	24	09 59	38
20	243 09.8 09.1	243 30.7	221 34	61 44	219 30	210 34	22	10 06	40
30	245 39.8 09.3	246 01.1	224 04	64 15	222 01	212 59	20	10 15	41
40	248 09.8 09.4	248 31.6	226 35	66 45	224 31	215 25	18	10 24	43
50	250 39.9 09.6	251 02.0	229 05	69 16	227 01	217 50	16	10 35	45
05 00	253 09.9 N 0 09.7	253 32.4	231 36 N17 12	71 46 N 0 57	229 32 N 7 35	220 16 N16 44	14	10 47	48
10	255 39.9 09.9	256 02.8	234 06	74 17	232 02	222 41	12		
20	258 10.0 10.1	258 33.2	236 37	76 47	234 32	225 06	10		
30	260 40.0 10.2	261 03.6	239 07	79 18	237 03	227 32	8		
40	263 10.0 10.4	263 34.0	241 37	81 48	239 33	229 57	6		
50	265 40.1 10.6	266 04.4	244 08	84 18	242 03	232 23	4		
06 00	268 10.1 N 0 10.7	268 34.8	246 38 N17 12	86 49 N 0 57	244 34 N 7 35	234 48 N16 57	2		
10	270 40.1 10.9	271 05.2	249 09	89 19	247 04	237 13	0		
20	273 10.2 11.1	273 35.7	251 39	91 50	249 34	239 39	0		
30	275 40.2 11.2	276 06.1	254 10	94 20	252 05	242 04	0		
40	278 10.2 11.4	278 36.5	256 40	96 51	254 35	244 29	0		
50	280 40.2 11.6	281 06.9	259 11	99 21	257 06	246 55	0		
07 00	283 10.3 N 0 11.7	283 37.3	261 41 N17 12	101 52 N 0 58	259 36 N 7 35	249 20 N17 09	0		
10	285 40.3 11.9	286 07.7	264 12	104 22	262 06	251 45	0		
20	288 10.3 12.1	288 38.1	266 42	106 53	264 37	254 11	0		
30	290 40.4 12.2	291 08.5	269 13	109 23	267 07	256 36	0		
40	293 10.4 12.4	293 38.9	271 43	111 54	269 37	259 02	0		
50	295 40.4 12.5	296 09.4	274 14	114 24	272 08	261 27	0		
08 00	298 10.5 N 0 12.7	298 39.8	276 44 N17 12	116 55 N 0 58	274 38 N 7 35	263 52 N17 22	0		
10	300 40.5 12.9	301 10.2	279 15	119 25	277 08	266 18	0		
20	303 10.5 13.0	303 40.6	281 45	121 55	279 39	268 43	0		
30	305 40.6 13.2	306 11.0	284 16	124 26	282 09	271 08	0		
40	308 10.6 13.4	308 41.4	286 46	126 56	284 40	273 34	0		
50	310 40.6 13.5	311 11.8	289 16	129 27	287 10	275 59	0		
09 00	313 10.6 N 0 13.7	313 42.2	291 47 N17 13	131 57 N 0 58	289 40 N 7 35	278 24 N17 34	0		
10	315 40.7 13.9	316 12.6	294 17	134 28	292 11	280 50	0		
20	318 10.7 14.0	318 43.1	296 48	136 58	294 41	283 15	0		
30	320 40.7 14.2	321 13.5	299 18	139 29	297 11	285 40	0		
40	323 10.8 14.4	323 43.9	301 49	141 59	299 42	288 06	0		
50	325 40.8 14.5	326 14.3	304 19	144 30	302 12	290 31	0		
10 00	328 10.8 N 0 14.7	328 44.7	306 50 N17 13	147 00 N 0 58	304 43 N 7 35	292 56 N17 47	0		
10	330 40.9 14.8	331 15.1	309 20	149 30	307 13	295 22	0		
20	333 10.9 15.0	333 45.5	311 51	152 01	309 43	297 47	0		
30	335 40.9 15.2	336 15.9	314 21	154 31	312 14	300 13	0		
40	338 11.0 15.3	338 46.3	316 52	157 02	314 44	302 38	0		
50	340 41.0 15.5	341 16.7	319 22	159 32	317 14	305 03	0		
11 00	343 11.0 N 0 15.7	343 47.2	321 53 N17 13	162 03 N 0 58	319 45 N 7 35	307 29 N17 59	0		
10	345 41.1 15.8	346 17.6	324 23	164 33	322 15	309 54	0		
20	348 11.1 16.0	348 48.0	326 54	167 04	324 45	312 19	0		
30	350 41.1 16.2	351 18.4	329 24	169 34	327 16	314 45	0		
40	353 11.1 16.3	353 48.8	331 54	172 05	329 46	317 10	0		
50	355 41.2 16.5	356 19.2	334 25	174 35	332 17	319 35	0		

Moon's P. in A.

All. Corr. +

All. Corr. +

0 6 56 55 31

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37 45 68 20

39 44 69 19

42 43 70 18

44 42 71 17

47 41 72 16

49 40 73 15

51 39 74 14

53 38 76 13

55 37 77 12

57 36 78 11

59 35 79 10

61 34 80

63 33

65 32

67 31

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95 17

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99 15

101 14

103 13

105 12

107 11

109 10

111 9

113 8

115 7

117 6

119 5

121 4

123 3

125 2

127 1

129 0

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SECTION 4. SEGMENT OF PLOTTING SHEET

