ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FOUR

INSTRUCTIONAL GUIDE

SECTION 3

EO C437.01 – SOLVE NAVIGATION PROBLEMS WITH A MANUAL FLIGHT COMPUTER

Total Time: 60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Prepare slides of the figures located at Attachment A.

Photocopy the Navigation Problems Worksheet located at Attachment B for each cadet.

Assistant instructors may be required for this lesson.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

A demonstration and performance was chosen for this lesson as it allows the instructor to explain and demonstrate solving navigation problems with a manual flight computer while providing an opportunity for the cadets to practice this skill under supervision.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall have solved navigation problems with a manual flight computer.

IMPORTANCE

It is important for cadets to be able to solve navigation problems with a manual flight computer as it is an important skill that is required for flight planning and en route navigation. Solving navigation problems provides skills for potential instructional duties and is part of the fundamentals that cadets pursuing future aviation training will require.

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For this lesson, it is recommended that the instruction take the following format:

(1) Explain and demonstrate the technique to use the manual flight computer while the cadets observe.

(2) Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.

(3) Monitor the cadets' performance as they practice using the manual flight computer to solve navigation problems.

Note: Assistant instructors may be used to monitor the cadets' performance.

Teaching point 1 **Demonstrate how to use a manual flight computer to convert units of measure and have the cadets practice converting units of measure.**

Time: 25 min Method: Demonstration and Performance

MANUAL FLIGHT COMPUTER

Navigation calculations are simplified by the use of a flight computer. Most manual flight computers consist of two sides: a circular slide rule and a wind side.

Show the slide of Figure A-1 to the cadets.

The instructions for using a manual flight computer are often printed directly on the flight computer.

Circular Slide Rule

The circular slide rule can be used to solve any problem of multiplication, division, or proportion. There are three scales printed on the circular slide rule. The outer scale is fixed to the computer. The two inner scales are printed together on a disc that may be rotated to any position opposite the outer scale.

Show the slide of Figure A-2 to the cadets.

The outer scale represents miles, gallons, true airspeed and corrected altitude. The inner scale represents time in minutes, calibrated airspeed, and calibrated altitude. The third scale represents time in hours and minutes.

The figures on the circular slide rule may represent any proportion or multiple of 10. For example, 10 on the outer scale may represent 1, 10, or 100; 45 may represent 4.5, 45, or 450.

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CONVERTING UNITS OF MEASURE

One of the most common types of calculations a pilot has to make is converting from one unit of measure to another. Fuel is sold by the litre, but fuel quantities and consumption are usually specified in the aircraft manual in gallons. Wind speeds are reported in knots, but the airspeed indicator (ASI) may be in statute miles per hour.

Using the circular slide rule for conversion calculations is a simple process. Rotate the inner scale to the correct position, locate the original quantity / measure on the outer scale, and read the converted quantity / measure from the inner scale, opposite to the appropriate marking.

Convert Between Nautical and Statute Miles

To convert between nautical and statute miles:

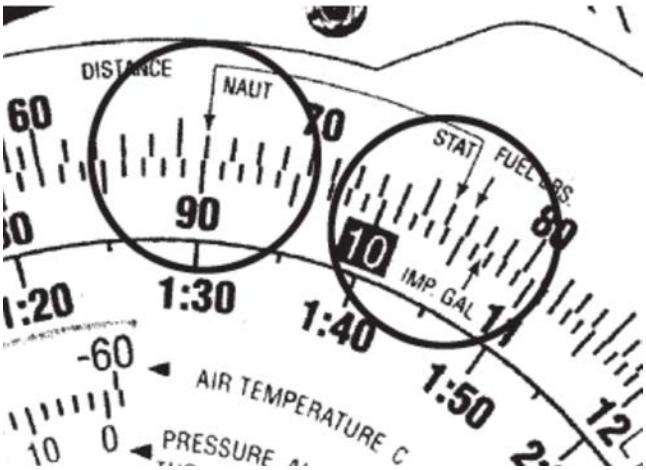
1. Rotate the inner scale until the known number of miles is under the appropriate index (NAUT or STAT).
2. Read the converted number of miles under the other index.



For example, to convert 90 nautical miles to statute miles:

(1) Rotate the inner scale until 90 is under the nautical miles index.

(2) Read the number of statue miles under the statue miles index (104 statute miles).



Note. From "Air Classics E6-B Flight Computer Instructions", Aviation Supplies and Academics, Inc. Retrieved November 26, 2008, from http://www.asa2fly.com/files/support/E6B_Manual.pdf

Figure 1 Nautical and Statute Mile Indexes

Convert Between Miles and Kilometres

To convert between miles and kilometres:

1. Rotate the inner scale until the known number is under the appropriate index (NAUT, STAT, or KM).
2. Read the converted number under the desired index.

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For example, to convert 115 statute miles to kilometres:

(1) Rotate the inner scale until 115 is under the statute miles index.

(2) Read the number of kilometres under the kilometres index (185 km).



Note. From "Air Classics E6-B Flight Computer Instructions", Aviation Supplies and Academics, Inc. Retrieved November 26, 2008, from http://www.asa2fly.com/files/support/E6B_Manual.pdf

Figure 2 Statute Mile and Kilometre Indexes

Convert Between Imperial and US Gallons

To convert between imperial and US gallons:

1. Rotate the inner scale until the imperial and US gallon indexes are aligned.

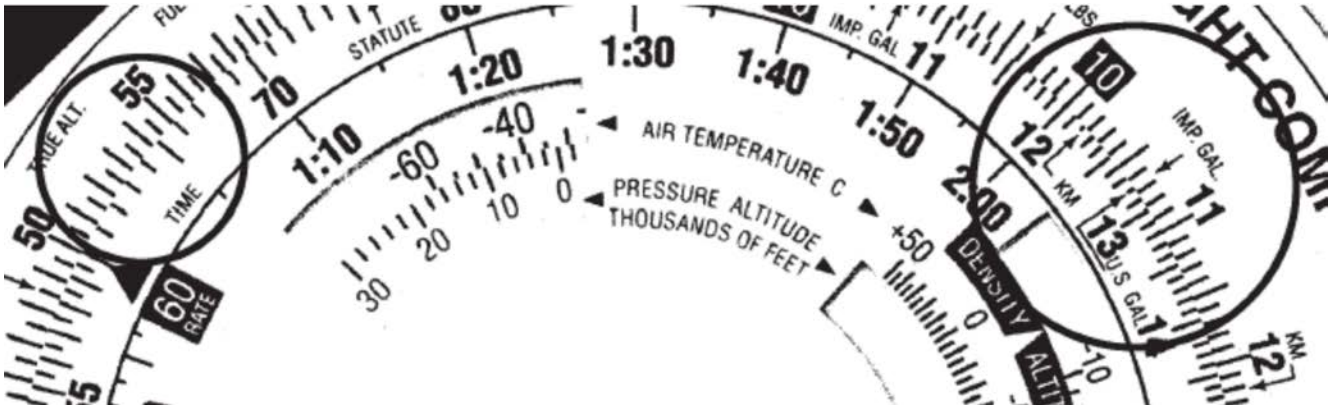
2. Locate the known quantity (outer scale for imperial gallons and inner scale for US gallons) and read the desired quantity on the opposite scale.

For example, to convert 55 imperial gallons to US gallons:

(1) Rotate the inner scale until the imperial and US gallon indexes are aligned.

(2) Locate 55 on the outer scale and read the quantity of US gallons on the inner scale (66 US gallons).

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Note. From "Air Classics E6-B Flight Computer Instructions", Aviation Supplies and Academics, Inc. Retrieved November 26, 2008, from http://www.asa2fly.com/files/support/E6B_Manual.pdf

Figure 3 US and Imperial Gallon Indexes

Convert Between Gallons and Litres

To convert between gallons and litres:

1. Rotate the inner scale until the litres index is aligned with the appropriate gallon index.
2. Locate the known quantity and read the desired quantity on the opposite scale.



For example, to convert 100 L to US gallons:

(1) Rotate the inner scale until the litres index is aligned with the US gallon index.

(2) Locate 100 on the outer scale and read the quantity of US gallons on the inner scale (26 US gallons).

Convert Between Pounds and Kilograms

To convert between pounds and kilograms:

1. Rotate the inner scale until the pounds index is aligned with the kilograms index.
2. Locate the known quantity and read the desired quantity on the opposite scale.



For example, to convert 100 pounds to kilograms:

(1) Rotate the inner scale until the pounds index is aligned with the kilograms index.

(2) Locate 100 on the outer scale and read the quantity of kilograms on the inner scale (45 kg).

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ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets practice converting units of measure using a manual flight computer.

RESOURCES

- Pen / pencil,
- Manual flight computer,
- Navigation Problems Worksheet located at Attachment B, and
- Navigation Problems Answer Key located at Attachment C.

ACTIVITY LAYOUT

Nil.

ACTIVITY INSTRUCTIONS

1. Distribute a manual flight computer and a Navigation Problems Worksheet to each cadet.
2. Have the cadets complete Part 1 of the worksheet using the manual flight computer.
3. Review the answers using the answer key located at Attachment C.

SAFETY

Nil.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching point 2 — **Demonstrate how to use a manual flight computer to calculate speed, distance, and time and have the cadets practice calculating speed, distance, and time.**

Time: 25 min — Method: Demonstration and Performance

SPEED, DISTANCE, AND TIME PROBLEMS

The rate arrow on the disk is always set to indicate a value per hour on the outer scale. There are three basic types of speed-time-distance problems. In two types of problems the speed is known, in the third, the speed is the unknown.

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When solving speed, distance, and time problems, the units have to agree. For example, if the speed is in knots, the distance has to be in nautical miles and the time in hours.

If the units do not agree, use the circular slide rule to perform the required conversions to make the units agree before attempting to solve the problem.

Calculating Time (Speed and Distance are Known)

To calculate time when speed and distance are known:

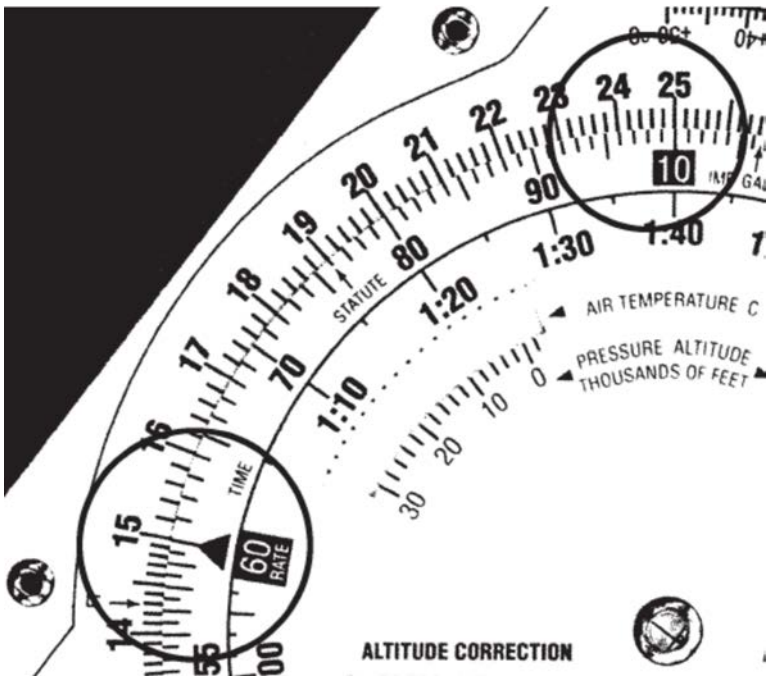
1. Rotate the inner scale until the rate arrow is opposite the speed.
2. Locate the distance on the outer scale.
3. Read the time from the inner scale, opposite the distance.

For example, to calculate the time en route if the speed is 150 knots and the distance is 245 nautical miles:

(1) Rotate the inner scale until the rate arrow is opposite 150.

(2) Locate 245 on the outer scale.

(3) Read the time en route from the inner scale, opposite 245 (1 hour and 38 minutes).



Note. From "Air Classics E6-B Flight Computer Instructions", Aviation Supplies and Academics, Inc. Retrieved November 26, 2008, from http://www.asa2fly.com/files/support/E6B_Manual.pdf

Figure 4 Rate Arrow, Speed, Distance, and Time

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For example, to calculate the time en route if the speed is 120 knots and the distance is 100 statute miles:

(1) Convert the distance to nautical miles (87).

(2) Rotate the inner scale until the rate arrow is opposite 120.

(3) Locate 87 on the outer scale.

(4) Read the time en route from the inner scale, opposite 87 (44 minutes).

When calculating time en route, use the aircraft's groundspeed, not the airspeed.

Calculating Distance (Speed and Time are Known)

To calculate distance when speed and time are known:

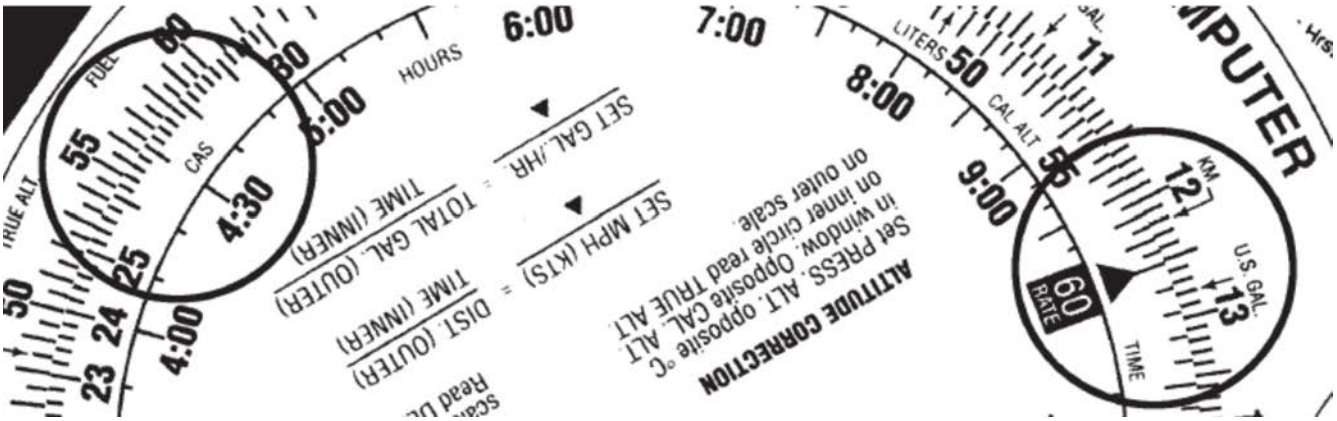
1. Rotate the inner scale until the rate arrow is opposite the speed.
2. Locate the time on the inner scale.
3. Read the distance from the outer scale, opposite the time.

For example, to calculate the distance if the speed is 125 knots and the time en route is 4.5 hours:

(1) Rotate the inner scale until the rate arrow is opposite 125.

(2) Locate 4:30 on the inner scale.

(3) Read the distance from the outer scale, opposite 4:30 (564 nautical miles).



Note. From "Air Classics E6-B Flight Computer Instructions", Aviation Supplies and Academics, Inc. Retrieved November 26, 2008, from http://www.asa2fly.com/files/support/E6B_Manual.pdf

Figure 5 Rate Arrow, Speed, Distance, and Time

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When calculating distance, use the aircraft's groundspeed, not the airspeed.

Calculating Speed (Distance and Time are Known)

To calculate speed when distance and time are known:

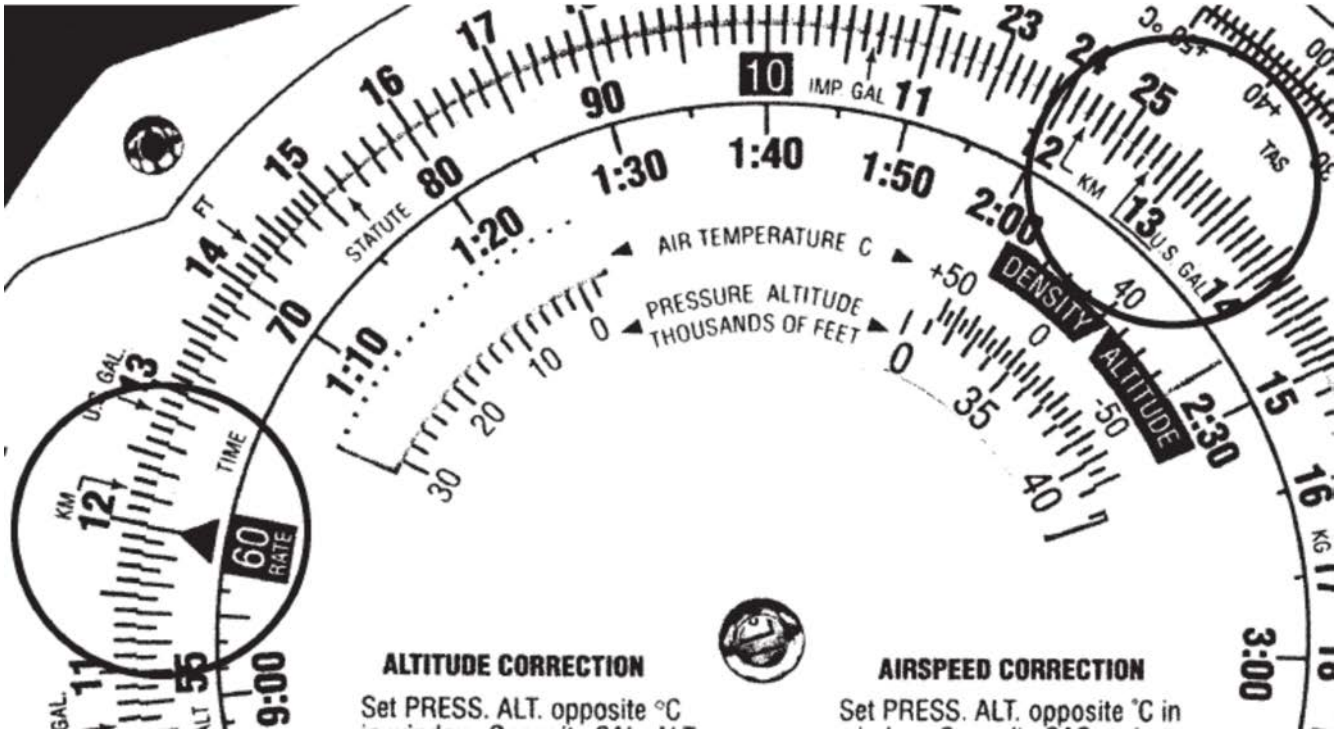
1. Rotate the inner scale until the distance is opposite the time.
2. Locate the rate arrow.
3. Read the speed from the outer scale, opposite the rate arrow.

For example, to calculate the speed if the distance is 26 nautical miles and the time en route is 13 minutes:

(1) Rotate the inner scale until 26 is opposite 13.

(2) Locate the rate arrow.

(3) Read the speed from the outer scale, opposite the rate arrow (120 knots).



Note. From "Air Classics E6-B Flight Computer Instructions", Aviation Supplies and Academics, Inc. Retrieved November 26, 2008, from http://www.asa2fly.com/files/support/E6B_Manual.pdf

Figure 6 Rate Arrow, Speed, Distance, and Time

When calculating speed from distance and time, it is the groundspeed that is being calculated, not the airspeed.

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ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is to have the cadets practice calculating speed, distance, and time using a manual flight computer.

RESOURCES

- Pen / pencil,
- Manual flight computer,
- Navigation Problems Worksheet located at Attachment B, and
- Navigation Problems Answer Key located at Attachment C.

ACTIVITY LAYOUT

Nil.

ACTIVITY INSTRUCTIONS

1. Have the cadets complete Part 2 of the worksheet using the manual flight computer.
2. Review the answers using the answer key located at Attachment C.

SAFETY

Nil.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' completion of the Navigation Problems Worksheet will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Additional time may be required for the cadets to complete the worksheet.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

Flight planning and navigation relies on being able to solve navigation problems. Being able to use a manual flight computer makes solving navigation problems faster and easier.

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INSTRUCTOR NOTES / REMARKS

Assistant instructors may be required for this lesson.

Cadets who are qualified Advanced Aviation may assist with this instruction.

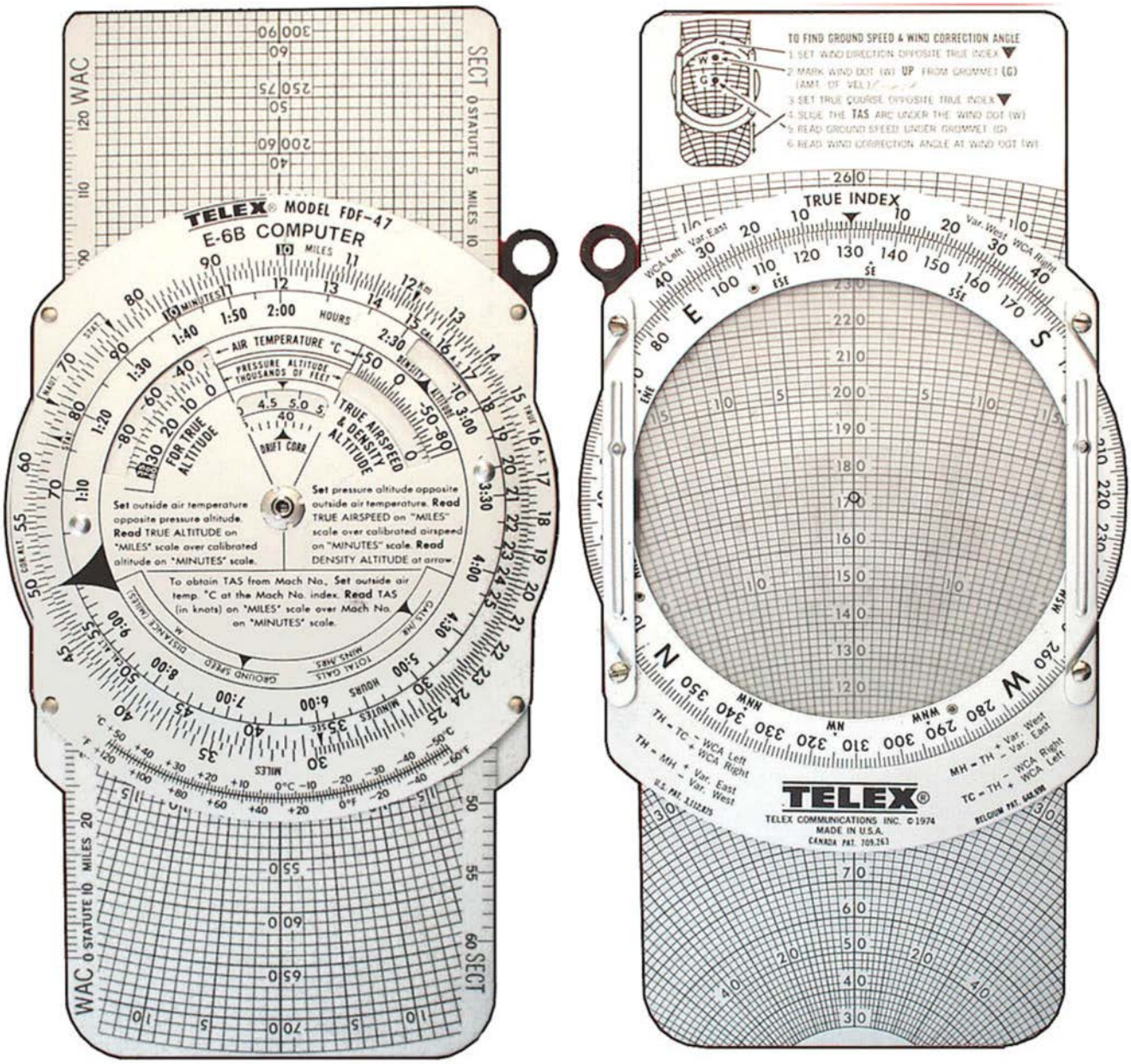
REFERENCES

C3-116 ISBN 0-9680390-5-7 MacDonald, A. F., & Peppler, I. L. (2000). *From the ground up: Millennium edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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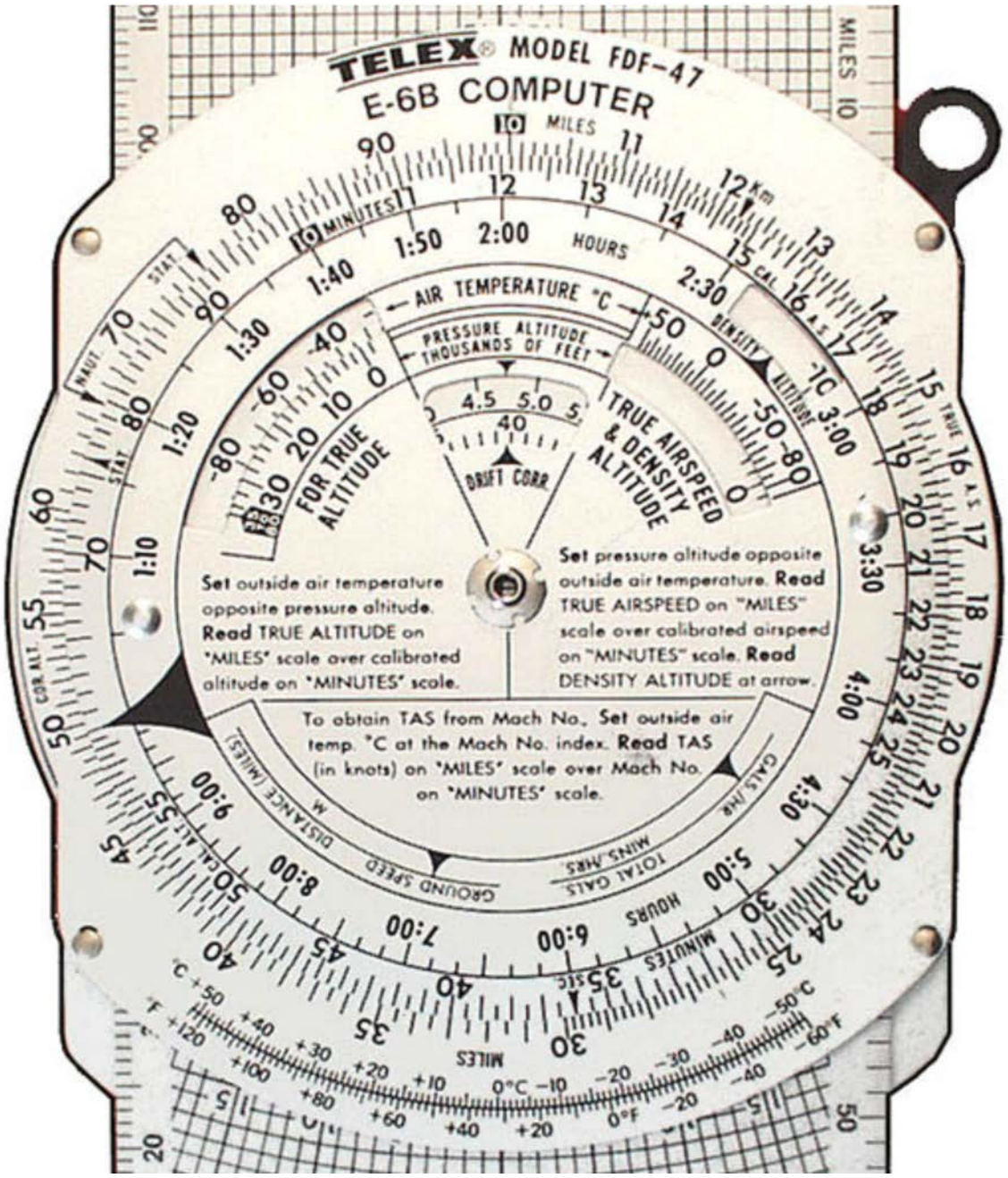
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Note. From "Slide Rule Catalog", Dutch Circle of Slide Rule Collectors. Retrieved November 26, 2008, from http://www.rekeninstrumenten.nl/pages%20and%20pictures/25261.jpg

Figure A-1 E6B Manual Flight Computer

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Figure A-2 E6B Circular Slide Rule

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NAVIGATION PROBLEMS WORKSHEET

Part 1

Convert		To		Convert		To	
123	nautical miles	_____	statute miles	23	nautical miles	_____	statute miles
99	statute miles	_____	nautical miles	1000	statute miles	_____	nautical miles
400	statute miles	_____	km	85	statute miles	_____	km
25	km	_____	statute miles	110	km	_____	statute miles
156	km	_____	nautical miles	93	km	_____	nautical miles
225	nautical miles	_____	km	48	nautical miles	_____	km
10	US gallons	_____	gallons	150	US gallons	_____	gallons
150	US gallons	_____	L	35	US gallons	_____	L
35	gallons	_____	US gallons	10	gallons	_____	US gallons
48	gallons	_____	L	225	gallons	_____	L
93	L	_____	gallons	156	L	_____	gallons
110	L	_____	US gallons	25	L	_____	US gallons
55	pounds	_____	kg	400	pounds	_____	kg
85	kg	_____	pounds	99	kg	_____	pounds
1000	feet	_____	m	123	feet	_____	m
23	m	_____	feet	55	m	_____	feet

Part 2

Calculate the missing values. Speed	Distance	Time
130 knots	100 nautical miles	_____
85 knots	_____	2.5 hours
_____	250 nautical miles	4 hours 15 minutes
_____	25 nautical miles	5 minutes
65 knots	200 statute miles	_____
78 miles per hour	55 nautical miles	_____
330 km/h	300 km	_____
95 km/h	45 nautical miles	_____
_____	1000 km	320 minutes
_____	55 nautical miles	2 minutes
122 miles per hour	_____	1.3 hours
101 knots	_____	45 minutes
150 knots	5525 m	_____

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NAVIGATION PROBLEMS ANSWER KEY

Part 1

Convert		To		Convert		To	
123	nautical miles	**142**	statute miles	23	nautical miles	**26**	statute miles
99	statute miles	**86**	nautical miles	1000	statute miles	**869**	nautical miles
400	statute miles	**644**	km	85	statute miles	**137**	km
25	km	**16**	statute miles	110	km	**68**	statute miles
156	km	**84**	nautical miles	93	km	**50**	nautical miles
225	nautical miles	**417**	km	48	nautical miles	**89**	km
10	US gallons	**8**	gallons	150	US gallons	**125**	gallons
150	US gallons	**568**	L	35	US gallons	**132**	L
35	gallons	**42**	US gallons	10	gallons	**12**	US gallons
48	gallons	**218**	L	225	gallons	**1023**	L
93	L	**20**	gallons	156	L	**34**	gallons
110	L	**29**	US gallons	25	L	**7**	US gallons
55	pounds	**25**	kg	400	pounds	**181**	kg
85	kg	**187**	pounds	99	kg	**218**	pounds
1000	feet	**305**	m	123	feet	**37**	m
23	m	**75**	feet	55	m	**180**	feet

Part 2

Calculate the missing values.		
Speed	**Distance**	**Time**
130 knots	100 nautical miles	**46 minutes**
85 knots	**213 nautical miles**	2.5 hours
59 knots	250 nautical miles	4 hours 15 minutes
300 knots	25 nautical miles	5 minutes
65 knots	200 statute miles	**2 hours 41 minutes**
78 miles per hour	55 nautical miles	**48 minutes**
330 km/h	300 km	**55 minutes**
95 km/h	45 nautical miles	**52 minutes**
188 km/h	1000 km	320 minutes
1650 knots	55 nautical miles	2 minutes
122 miles per hour	**159 statute miles**	1.3 hours
101 knots	**76 nautical miles**	45 minutes
150 knots	5525 m	**1 minute**

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