aero products research, inc.
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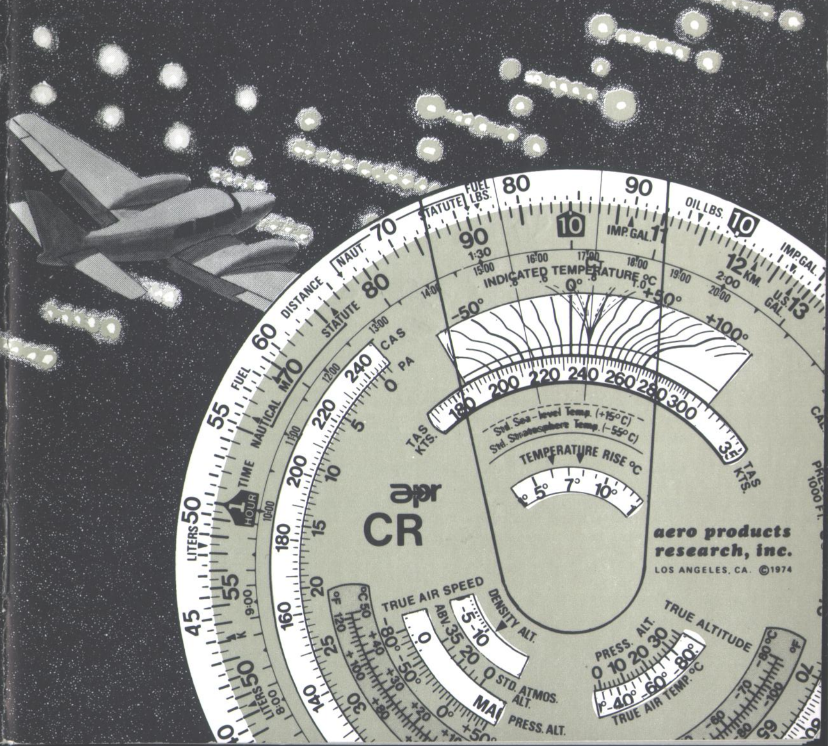
operations manual

apr CR COMPUTER



CONTENTS

INTRODUCTION

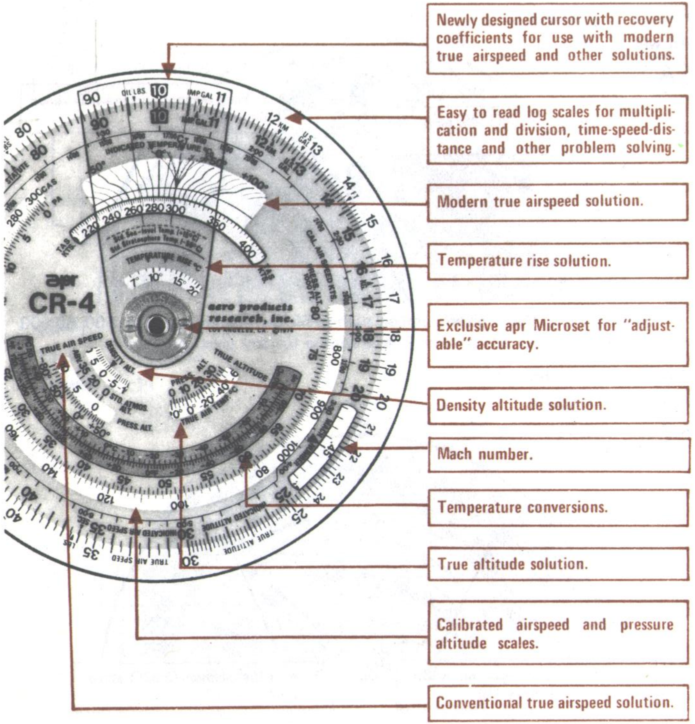
The CR computer has been a favorite of professional pilots, navigators, and flight engineers for approximately 20 years. If you began your flying career with the basic E6-B type computer you will find both similarities and important differences between the E6-B and the CR computers.

Once you become familiar with the CR computer it will more than likely be your favorite cockpit aid. Many of the scales on the calculator side are similar to those found on the E6-B. However, the CR has several new functions available on no other computer, making it the most useful instrument for modern piloting needs. The wind side of the CR uses a wind triangle that is somewhat different than the E6-B and it provides quick, simplified solutions to all course navigation problems.

Aero Products Research offers three models of the CR computer. The larger CR-6 provides maximum readability, while the smaller CR-3 and CR-4 models provide convenience. Only **apr's** computers have the exclusive **apr** Microset which allows the computers to be aligned for total accuracy before leaving the factory. Although they are precision instruments you will take pride in owning, the information they give you is only as good as the information you give them. For this reason, we recommend you take the time to study this manual carefully.

THE CALCULATOR

The calculator side of the CR computer is designed for quick, accurate computation with problem solving capabilities adapted to modern aviation needs. Some of the features of the CR calculator are illustrated below.*



** The Mach number index on the CR-6 is located above the Temperature Rise scale.*

Multiplication

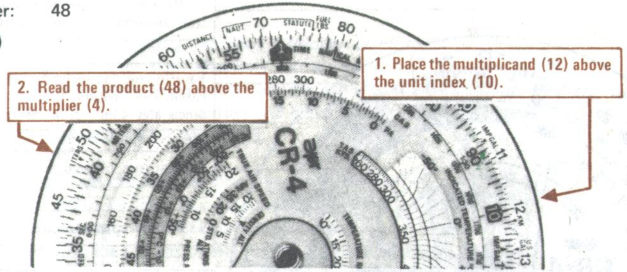
Multiplication is accomplished with the CR computer using conventional slide rule procedure: multiplicand above the unit index (10) displays the product above the multiplier.

Given: 4 x 12 = ?

Find: Product

Answer: 48

A

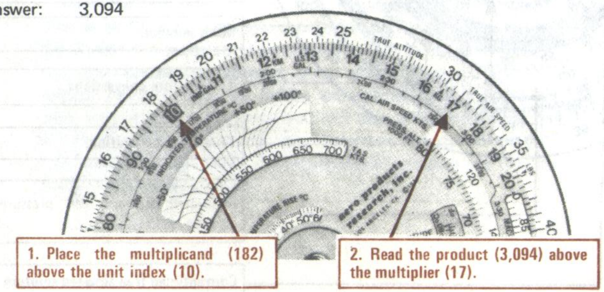


Keep in mind that a given number, such as 50, can also represent .5, 500, 50,000, etc. You must choose which value is appropriate for any given problem.

Given: 17 x 182 = ?

Find: Product

Answer: 3,094



Division

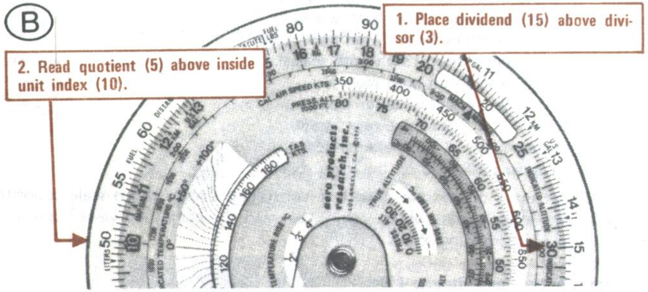
Division with the CR computer is accomplished with a procedure similar to multiplication: dividend above divisor displays the quotient above the unit index (10).

Given: 15 ÷ 3 = ?

Find: Quotient

Answer: 5

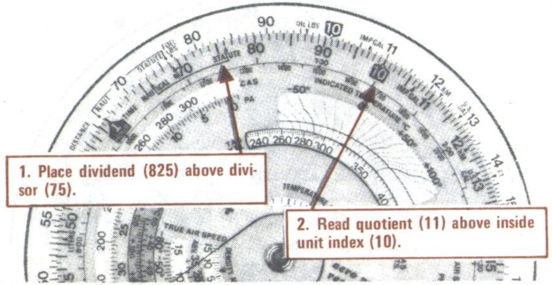
B



Given: 825 ÷ 75 = ?

Find: Quotient

Answer: 11



UNIT CONVERSIONS

Unit conversions are accomplished easily with the CR computer. For conversion purposes, the following items have labeled arrows on the inner and/or outer scales of the computer:

Nautical Miles (near 66 on both scales).
Statute Miles (near 76 on both scales).
Kilometers (near 12 on both scales).
Imperial Gallons (near 11 on both scales).
U.S. Gallons (near 13 on both scales).
Liters (near 48 on both scales).
Feet (near 14 on the outer scale).
Meters (near 44 on the inner scale).
Pounds (near 36 on the outer scale).
Kilograms (near 16 on the inner scale).

To convert units of measure, place the converting arrow for one scale opposite the appropriate arrow on the other scale. Then read the computed values opposite each other on corresponding scales.

Converting Nautical and Statute Miles

Given: 46 nautical miles
Find: Equivalent statute miles
Answer: 53 statute miles

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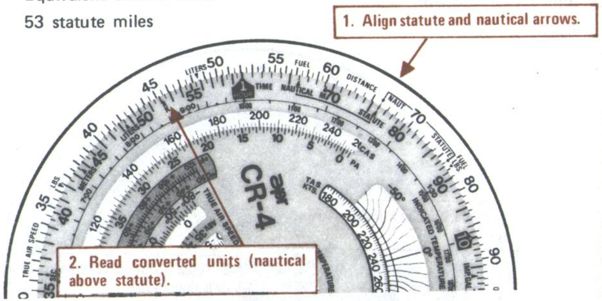

Note that by aligning nautical and statute mile indexes, any number of units may be converted progressively without resetting the computer.

Knots (nautical miles per hour) can be converted to miles per hour (statute) in two ways. As previously shown, aligning the nautical and statute arrows will give a progressive display of converted units.

An alternate procedure for converting knots to miles per hour uses the small arrow (K) near 52 on the inner scale for knots and the small arrow (M) near 69, also on the inner scale, for miles per hour.

Given: 80 knots
Find: Equivalent statute miles per hour
Answer: 92.1 mph

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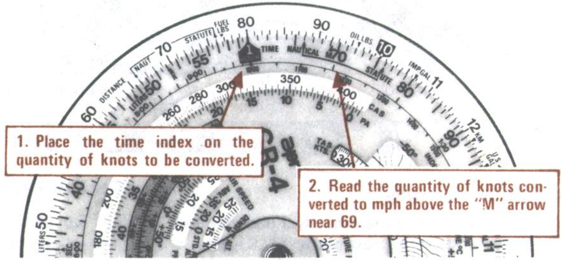

Given: 50 statute miles per hour
Find: Equivalent nautical miles per hour (knots)
Answer: 43.3 knots

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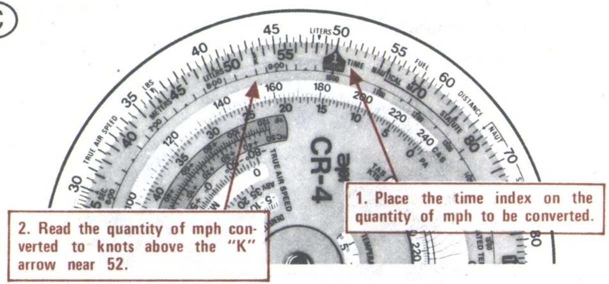

Converting U.S. Gallons to Imperial Gallons

Given: 21 U.S. gallons

Find: Equivalent imperial gallons

Answer: 17.5 imperial gallons

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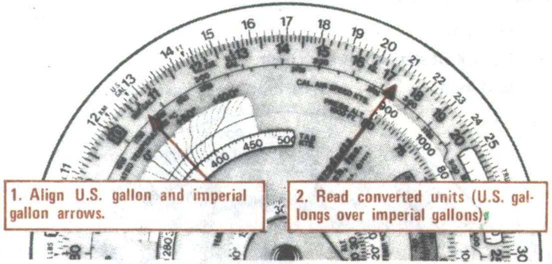

NOTE: Helpful "approximates"

1 kilogram = approximately 2 pounds
4 liters = approximately 1 U.S. gallon
1 kilometer = approximately .5 nautical mile
1 meter = approximately 3 feet

Converting Feet to Meters

Given: 2,800 feet

Find: Equivalent in meters

Answer: 851 meters

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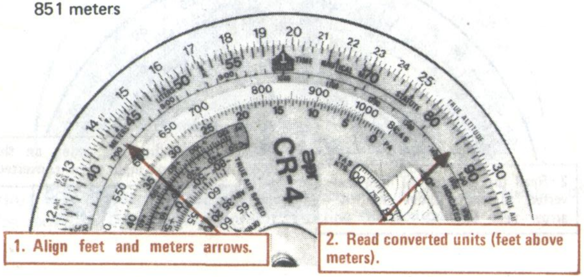

Temperature Conversion

Celsius and Fahrenheit conversions may be read directly from the temperature conversion scale.

Given: -10^{o}C.

Find: Equivalent in Fahrenheit

Answer: $+14^{o}$F.

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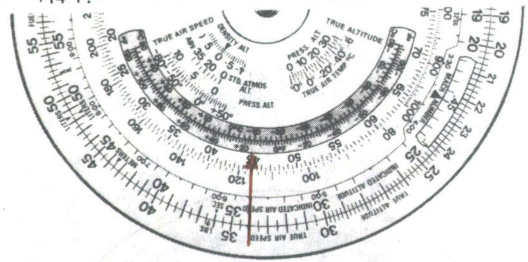

Weight of Fuel and Oil

A "fuel lbs" index is located near 77 on the outer scale. This index assumes a standard gasoline weight of 6 lbs per U.S. gallon and 7.2 lbs per imperial gallon. The "oil lbs" index is located near 96 on the outer scale and assumes a standard weight of 7.5 lbs per U.S. gallon and 9 lbs per imperial gallon.

NOTE: Check with your supplier for the specific weight of your fuel and oil.

To find the weight of a given amount of gasoline, align the U.S. (or imperial) gallon arrow with the "fuel lbs" arrow. Then read the weight of the fuel above the quantity as shown below.

Given: 26 U.S. gallons of gasoline

Find: Total weight

Answer: 156 lbs.

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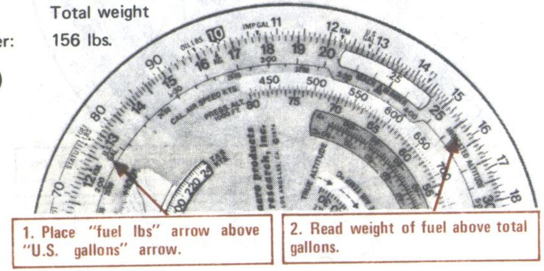


TIME, SPEED, DISTANCE

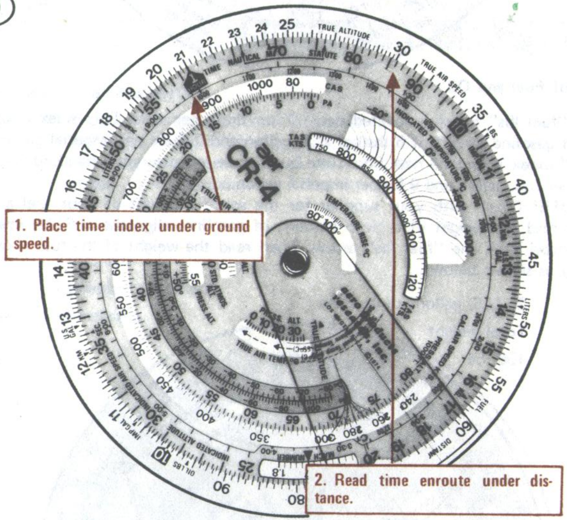
Time enroute, ground speed, and distance traveled may be easily computed using the inside (time) and outside (miles) scale of your CR computer. Such problems require the use of the "time index" located at 60 on the inside scale.

Remember that any given unit, such as 12, can also mean 1.2, 120, or 1,200, etc. You must decide which is the appropriate value for any given problem.

Finding Time Enroute

Given:	Ground speed	210 knots
	Distance traveled	300 miles
Find:	Elapsed time enroute	
Answer:	86 minutes	

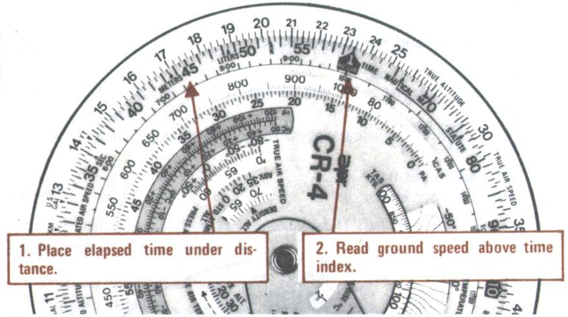
D



Finding Ground Speed

Given:	Distance traveled	175 miles
	Elapsed time	45 minutes
Find:	Ground speed	
Answer:	233 knots	

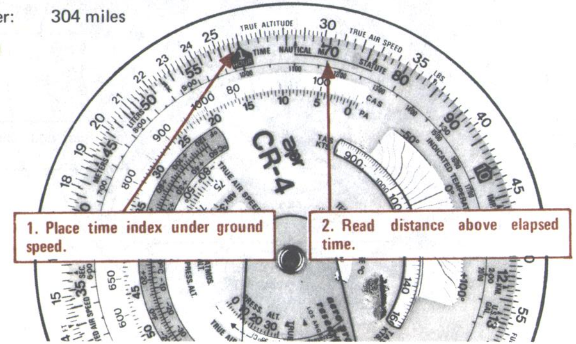
D



Finding Distance Traveled

Given:	Ground speed	260 knots
	Elapsed time	70 minutes (1:10)
Find:	Distance traveled	
Answer:	304 miles	

D



FUEL CONSUMPTION

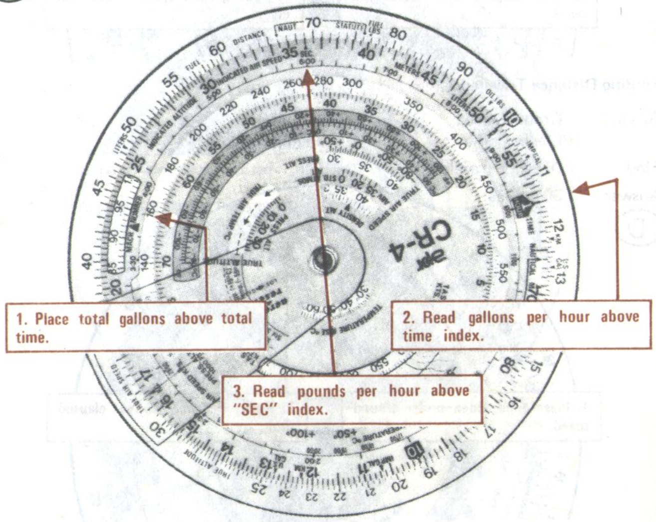
Fuel consumption problems are solved in the same manner as time—speed—distance problems except that gallons are found on the outer scale instead of miles.

If U.S. gallons of gasoline are being computed, pounds per hour may be determined simultaneously by reading the appropriate weight above the seconds ("SEC") index at 6:00 on the time scale.

Finding Gallons Per Hour and Pounds Per Hour

Given:	44 gallons consumed 3:50 flight time
Find:	Gallons per hour Pounds per hour
Answer:	11.5 gallons per hour 69 pounds per hour

E



ALTITUDE COMPUTATIONS

Altitude computations may be simplified by defining *applied* and appropriate terms:

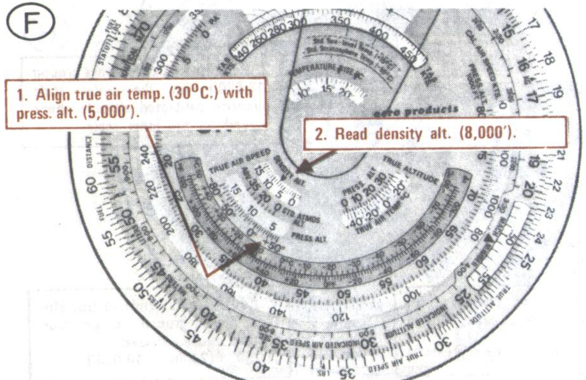
1. INDICATED ALTITUDE is the measurement appearing in an altimeter when it is set to the nearest station altimeter setting.
2. CALIBRATED ALTITUDE is indicated altitude corrected for instrument and position error.
3. PRESSURE ALTITUDE is the measurement appearing on the altimeter when it is set at 29.92.
4. DENSITY ALTITUDE is a measurement of pressure altitude corrected for non-standard temperature.
5. TRUE ALTITUDE is calibrated altitude corrected for temperature and pressure.

Density Altitude

The density altitude window is located just left of the center of the computer, above the temperature conversion scale.

Given:	True air temperature Pressure altitude	+30°C. 5,000′
Find:	Density altitude	
Answer:	8,000′	

F

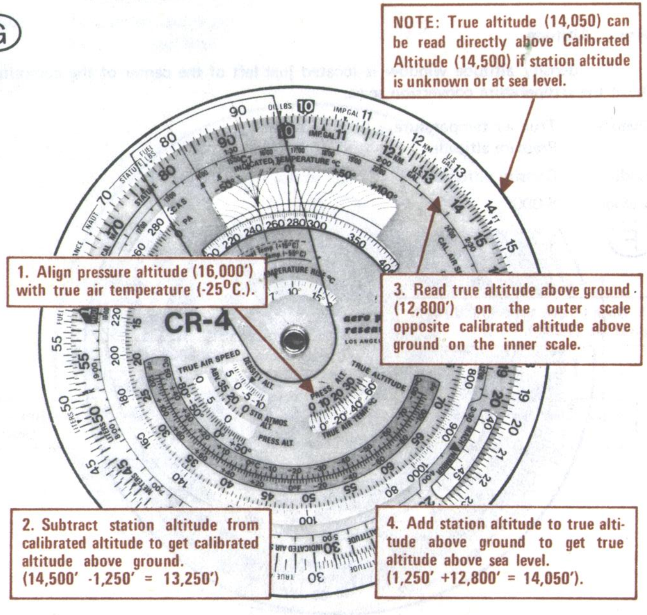


True Altitude

Finding true altitude requires the use of calibrated altitude (indicated altitude if calibrated is not available) and true air temperature. Greater accuracy can be obtained if you know the elevation of the ground station giving your altimeter setting.

Given:	Pressure altitude	16,000′
	Calibrated altitude	14,500′
	True air temperature	-25°C.
	Ground station altitude	1,250′
Find:	True altitude above ground	
	True altitude above sea level	
Answer:	12,800′ above ground	
	14,050′ above sea level	

G



TEMPERATURE RISE

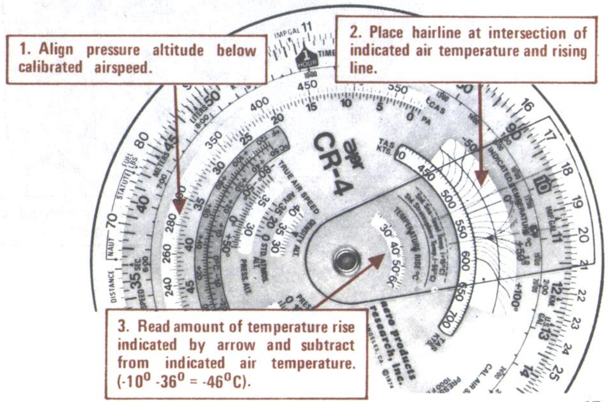
High speed aircraft travel through the atmosphere so fast that air cannot separate around them quickly enough and therefore builds up in the front. The air is heated from compression resulting in the aircraft's outside air temperature sensor feeling a greater temperature than actually exists in the surrounding free air of the atmosphere. In addition, friction from rapidly flowing air creates heat and causes a still higher reading. A compensation for this temperature rise is built into the CR computer with several temperature coefficients (which vary for individual aircraft), ranging from .6 to 1.0 imprinted on the cursor. The .8 coefficient (Ct) is the most common and is therefore separated for ease of use.

The broken lines on the cursor display apply to the standard sea level temperature of +15°C. The solid lines apply to the standard stratosphere temperature of -55°C. When flying between sea level and 35,000′ it is necessary to interpolate between the two lines.

True air temperature can be computed by subtracting temperature rise from the indicated air temperature.

Given:	Calibrated airspeed	280 knots
	Pressure altitude	38,000′
	Indicated air temperature	-10°C.
Find:	True air temperature	
Answer:	-46°C.	
NOTE:	This procedure also displays the Mach number and true airspeed.	

H



TRUE AIRSPEED

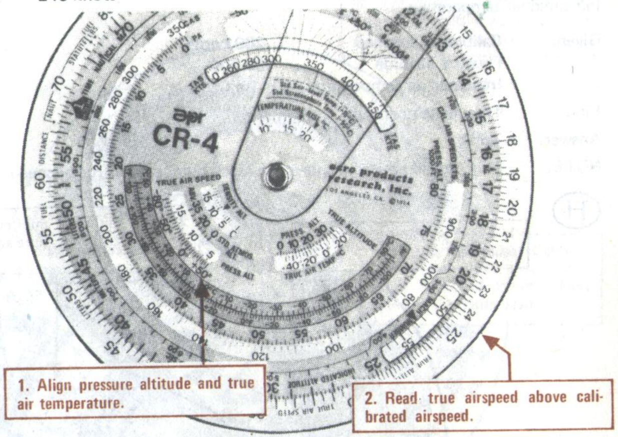
True Airspeed (Conventional Method)

The conventional method for finding true airspeed requires alignment of pressure altitude and true air temperature in the true airspeed solution window located just left of the center of the computer. True airspeed then appears on the outer scale above indicated airspeed on the inner scale.

This procedure is recommended for use when taking FAA written exams although it does not compensate for compression and temperature rise in high speed aircraft.

Given:	Calibrated airspeed	210 knots
	Pressure altitude	7,000′
	True air temperature	+20°C.
Find:	True airspeed	
Answer:	240 knots	

I



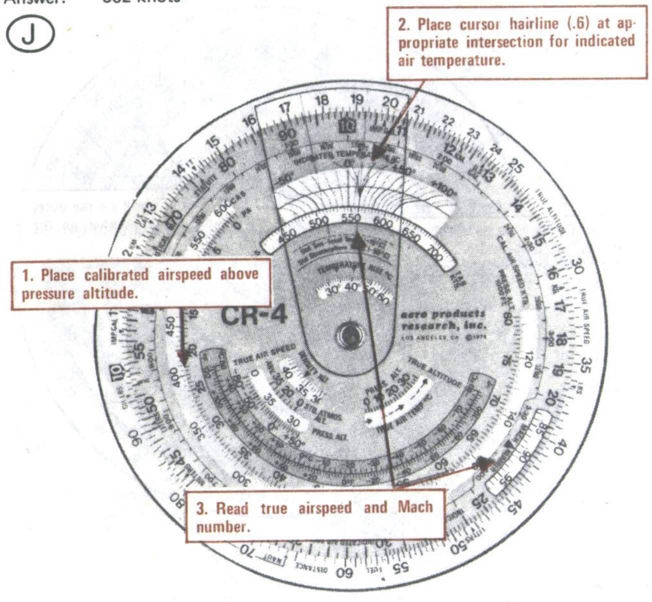
True Airspeed (Modern Method)

The procedure illustrated below is used to compute true airspeed with a process that compensates for compression and temperature rise.

True Airspeed From Calibrated Airspeed, Pressure Altitude, and Indicated Air Temperature.

Given:	Calibrated airspeed	400 knots
	Pressure altitude	23,000′
	Indicated air temperature	+10°C.
	Coefficient	.6
Find:	True airspeed	
Answer:	562 knots	

J

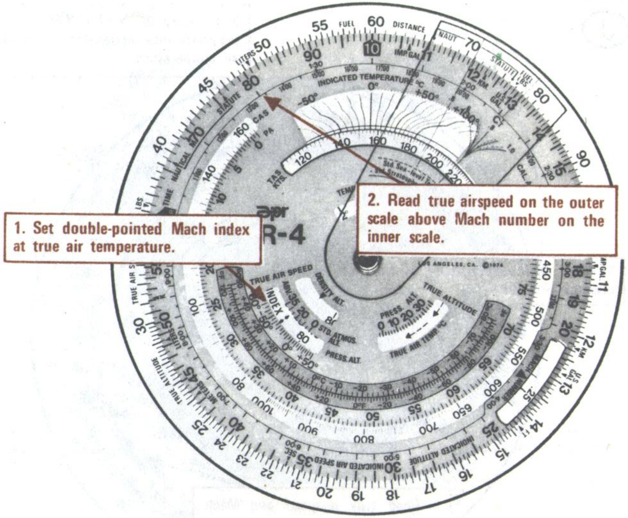


True Airspeed From Mach Number and True Air Temperature

If your aircraft is equipped with a Mach meter, and you know the true air temperature, you may compute your true airspeed as illustrated below. If your aircraft is equipped with a conventional airspeed indicator, the Mach number may be computed from calibrated airspeed and pressure altitude as shown on page 16.

Given:	Mach number	.80
	True air temperature	-35°C.
Find:	True airspeed	
Answer:	480 knots	

K

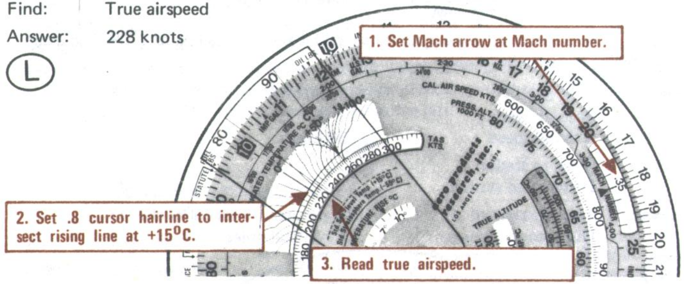


True Airspeed From Mach Number and Indicated Air Temperature

A Mach number is related to the speed of sound and is greatly affected by temperature. (Mach 1 is 669.6 mph at -50°C. and 806.9 mph at +50°C.) Since the speed of sound varies with air temperature it is possible to find true airspeed from air temperature and Mach number.

Given:	Mach number	.35
	Indicated air temperature	+15°C.
	Coefficient	.8
Find:	True airspeed	
Answer:	228 knots	

L

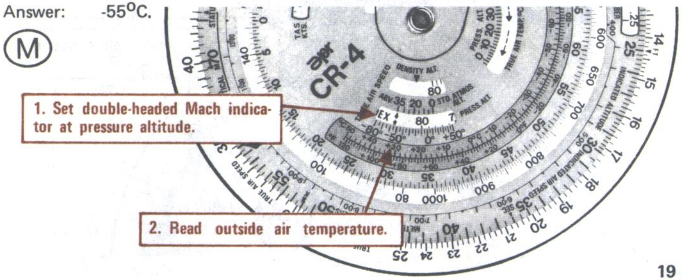


Air Temperature and Pressure Altitude in Standard Atmosphere

The double-pointed Mach index may be used to find the standard outside temperature for any given pressure altitude. The temperature of a "standard" atmosphere may be helpful in estimating actual outside air temperature.

Given:	Pressure altitude	35,000′
Find:	Estimated outside air temperature	
Answer:	-55°C.	

M



TIME AND DISTANCE TO STATION

Time and distance to station may be computed using two Omni or ADF bearings and the following formulas. The procedures assume a constant aircraft heading 90° perpendicular to the radials and uses the elapsed time between bearings as well as degrees of difference between first and second bearing.

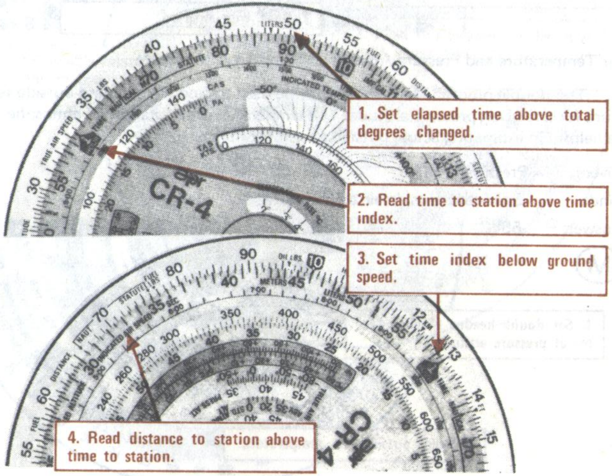
$$\frac{\text{Elapsed time (min)} \times 60}{\text{Degrees of change}} = \text{Time to station}$$

$$\frac{\text{Elapsed time (min)} \times \text{G/S}}{\text{Degrees of change}} = \text{Distance to station}$$

The example shown below assumes an initial aircraft heading of 170° with a constant heading between bearings.

Given:	First bearing	11:00/170°
	Second bearing	11:05/179°
	Ground speed	130 knots.
Find:	Time to station	
	Distance to station	
Answer:	Time to station	33 minutes, 15 seconds
	Distance to station	72 nautical miles

N



PRESSURE PATTERN

[Pressure pattern problems may be computed on the Navigator Model (CR-6) only.]

A direct route on a long over-water flight may be the shortest distance between destination and departure but, because of unfavorable winds, a direct route may not be the fastest route.

Winds tend to blow along the isobars. If the pattern of isobars (pressure pattern) at flight altitude is known, a pilot may select a route that might add miles to the route but increase ground speed to such an extent that his time enroute is considerably reduced.

apr's CR computer has D_1 and D_2 markings located between 30 and 35 on the outer scale of the computer face. D_1 and D_2 represent a first and second radio altimeter reading (minus pressure altimeter reading), taken at different times.

In the Northern Hemisphere, if D_2 is greater than D_1, wind direction is from the right, if D_2 is less than D_1, wind direction is from the left.

Given:	D_1	540′
	D_2	420′
	200 nautical miles between readings	
	Mid latitude 41°N.	
Find:	Crosswind component	
Answer:	19.6 knots left	

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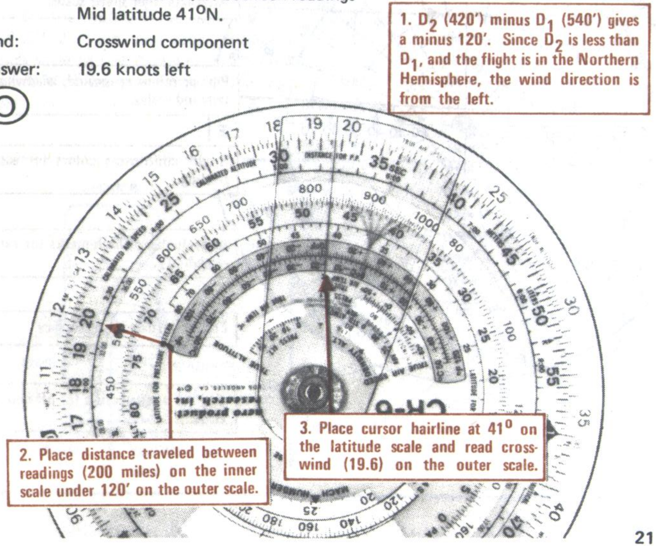
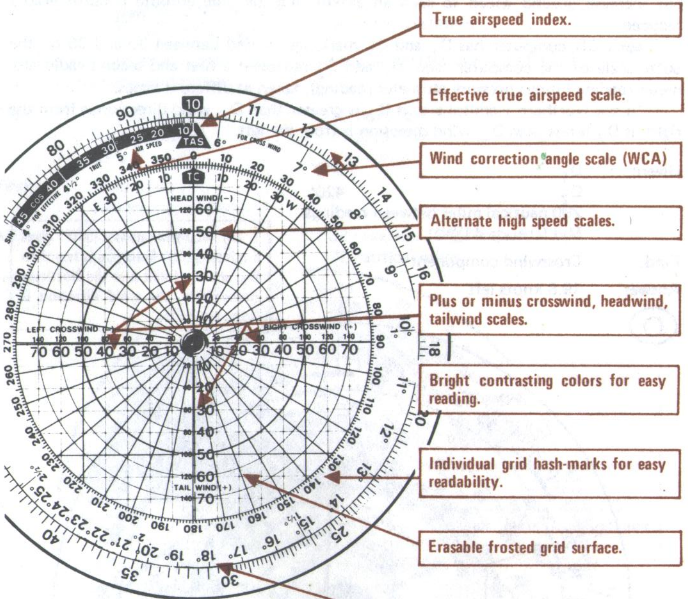


WIND COMPUTATION

The wind-computing side of your apr CR computer applies the latest "state-of-the-art" technology. With this new instrument your pre-flight and in-flight calculations are easier and more accurate. Some of the features on the windside on the CR flight computer are illustrated below.



The CR Wind Triangle

The CR computer uses a variation of the standard wind triangle to compute wind correction angle (WCA) and ground speed (G/S).

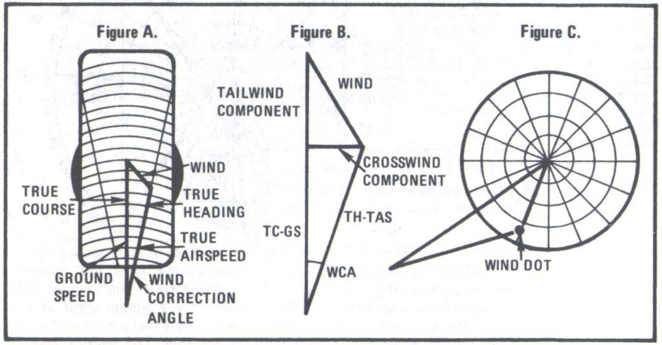
Figure A, below, shows a typical wind triangle as it would be applied to a slide-graphic flight computer. Figure B shows a second triangle formed by a line (representing a crosswind component) drawn perpendicular to the true course line. It is this triangle that is plotted on the CR computer.

Figure C shows how two sides of the triangle (true course and wind direction) are formed by existing lines on the computer. All that is needed to complete the CR wind triangle is a simple dot representing wind direction and velocity.

The CR wind triangle applies headwind, or tailwind, to the true airspeed line to compute accurate ground speed. However, as the wind correction angle (WCA) increases to 10° or more, the *effective true airspeed* scale (located left of the TAS index) must be used, rather than *true airspeed,* to find the accurate ground speed.

Two wind scales on the horizontal and vertical lines radiating from the center of the computer are for low speed (0-80) or high speed (0-160) computations. Only one scale may be used in each problem just as statute miles per hour and knots can not be used interchangeably for any one computation.

On the middle (TAS) disc there are two crosswind scales with small units of 1°, $1½^{\circ}$, 2°, $2½^{\circ}$ etc., and larger units of 10°, 11°, 12°, etc. Common sense will tell you which scale to use; however, you may assume that if the crosswind component is less than 10% of the true airspeed, the wind correction angle should be read on the lower scale.



PRE-FLIGHT PLANNING

Before computing a wind problem on your CR computer, note the high and low wind speed scales. The large numbered scale (0-80) should be used if the wind is less than 80 knots. The small scale should be used for winds of more than 80 knots. Be sure to use only one scale during each problem.

Given:	True airspeed	300 knots
	Magnetic course	130°
	Variation	15°W
	Wind velocity	40 knots from 60° true
Find:	Wind correction angle (WCA)	
	Magnetic heading (MH)	
	Ground speed (GS)	
Answer:	WCA	6° left
	MH	109°
	GS	277 knots

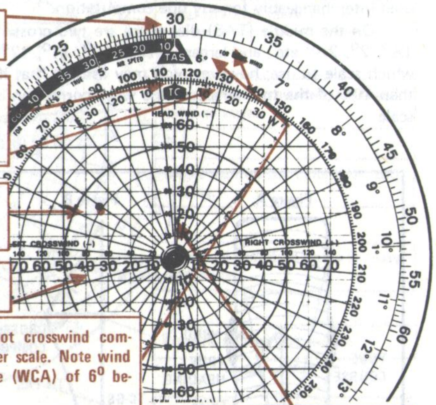
(P)

1. Set the true airspeed index on 30 (300 kts).

2. Set magnetic course (130°) above westerly variation (15°) and read true course (115°) above the TC index.

3. Place wind dot at intersection of wind direction radial (60°) and wind velocity circle (40 knots).

4. Read crosswind component (33 knots) on scale below dot.



5. Find 33 knot crosswind component on outer scale. Note wind correction angle (WCA) of 6° below.

6. Subtract left WCA (6°) from magnetic course (MC) of 130° giving a magnetic heading (MH) of 124°. (Note that a *left* WCA is *subtracted* from the MC while a *right* WCA is *added.*

7. Read 23 knot headwind to the right of the wind dot. Subtract headwind from true airspeed (300 knots) for a ground speed of 277 knots. (Note that a *headwind* is *subtracted* from TAS while a *tailwind* is *added.*

Planning the second leg of a flight can be easier than the first, especially if some of the data remains unchanged. In the illustration below, TAS and wind are the same as that of the first leg.

Given:	True airspeed	300 knots
	Magnetic course	182°
	Variation	11°W
	Wind velocity	40 knots from 60° true
Find:	Wind correction angle (WCA)	
	Magnetic heading (MH)	
	Ground speed (GS)	
Answer:	WCA	7°L
	MH	175°
	GS	314 knots

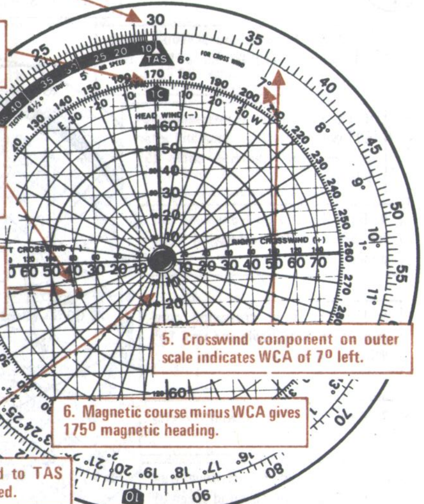
(P)

1. TAS remains on 300 (30) knots.

2. Set new magnetic course (182°) above new westerly variation (11°) and read TC of 171°.

3. Instead of marking a new wind dot note that old dot has automatically been computed to proper grid location.

4. Wind dot still represents 40 knots wind @ 60° but crosswind component is now 37 knots left.



5. Crosswind component on outer scale indicates WCA of 7° left.

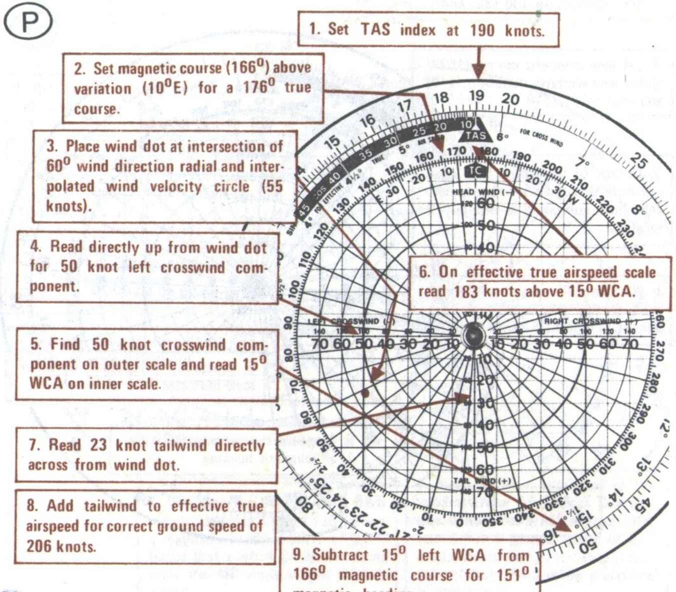
6. Magnetic course minus WCA gives 175° magnetic heading.

7. Add 14 knots tailwind to TAS for 314 knot ground speed.

Whenever the wind correction angle is greater than 10^{o}, a headwind, or tailwind, must be applied to an *effective true airspeed* instead of *true airspeed* in order to compute an accurate ground speed. The effective true airspeed (ETAS) scale is located to the left of the TAS index.

Given:	True airspeed	190 knots
	Magnetic course	166^{o}
	Variation	10^{o}E
	Wind velocity	55 knots from 60^{o} true
Find:	Wind correction angle (WCA)	
	Magnetic heading (MH)	
	Ground speed (GS)	
Answer:	WCA	
	MH	
	GS	

P

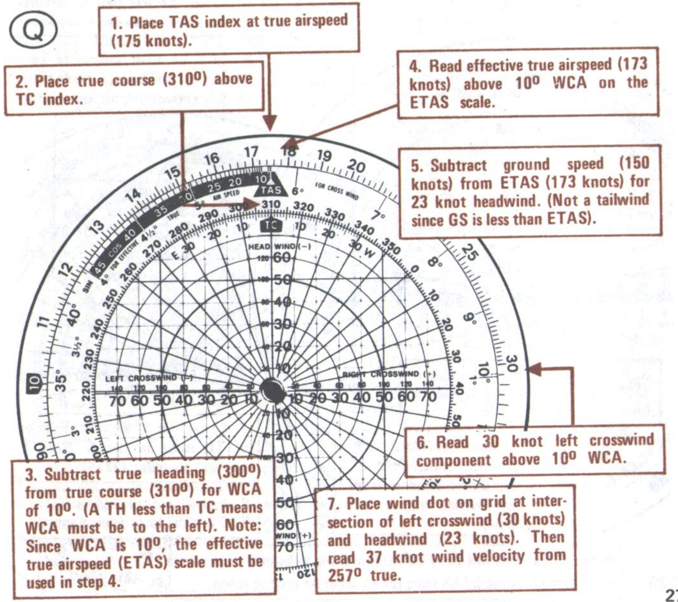


IN-FLIGHT PLANNING

Wind Direction and Velocity

When you have enough information available to determine your WCA, it is possible to compute existing wind velocity and direction.

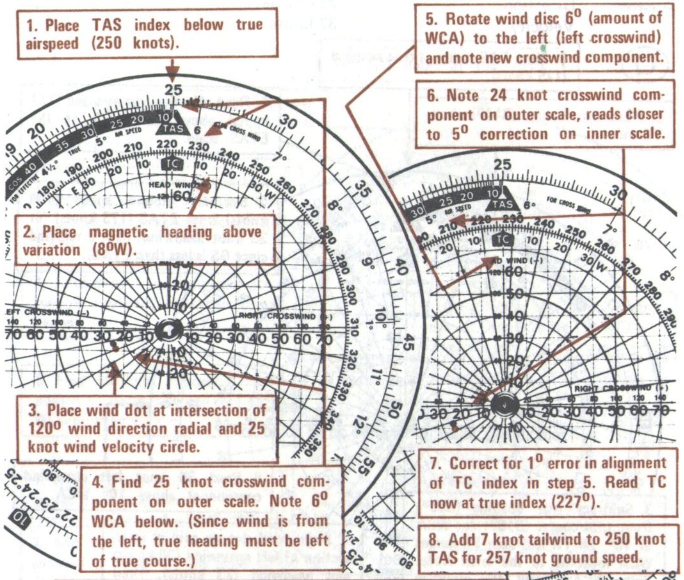
Given:	True airspeed	175 knots
	True course	310^{o}
	True heading	300^{o}
	Ground speed	150 knots
Find:	Wind direction	
	Wind velocity	
Answer:	Direction	257^{o} true
	Velocity	37 knots



TRUE COURSE AND GROUND SPEED

True course (track) and ground speed may be obtained from airspeed, heading, and wind information. Two illustrations are provided here because the wind disc must be realigned during solution of the problem.

Given:	True airspeed	250 knots
	Magnetic heading	230°
	Variation	8°W
	Wind velocity	25 knots from 120° true
Find:	True course	
	Ground speed	
Answer:	True course	227°
	Ground speed	257 knots



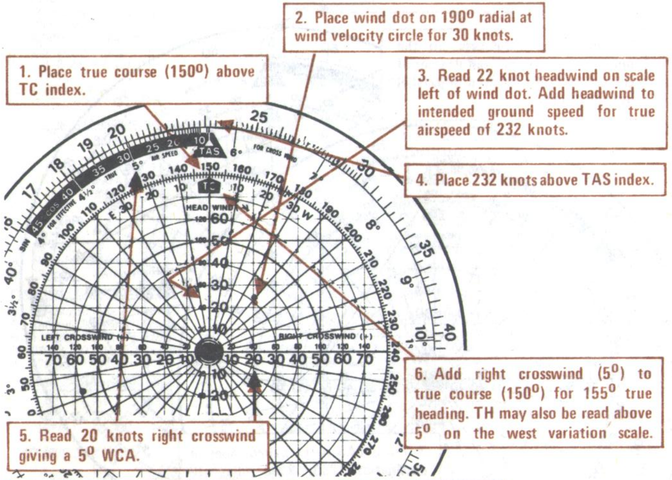
Note: If the WCA had been 10° or more, the tailwind would have to be applied to the ETAS scale for an accurate ground speed.

TRUE HEADING AND TRUE AIRSPEED

The wind side of the CR computer may be used to compute true airspeed and true heading from your true course, a desired ground speed, and wind information.

Given:	True course	150°
	Intended ground speed	210 knots
	Wind	30 knots from 190° true.
Find:	True airspeed (TAS)	
	True heading (TH)	
Answer:	TAS	232 knots
	TH	155°

(R)



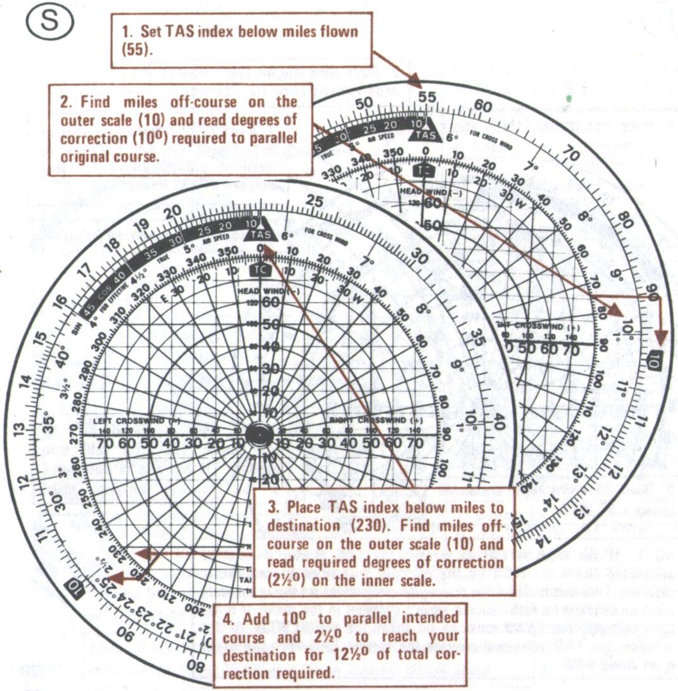
NOTE: If the WCA is 10° or greater, the TAS in step 4 must be positioned above the WCA on the *effective true airspeed* scale rather than the TAS index. Then the crosswind component on the outer scale must be checked to make sure it wasn't changed in the move. If it has been changed, the ETAS must be set above the correct WCA. In this solution, the TAS index will indicate the correct TAS when the ETAS is set above WCA.

OFF-COURSE CORRECTION

Two settings on the wind side of the CR computer will display a corrected heading which will take you directly to your destination provided you know total miles flown between checkpoints, miles off-course, and miles to your destination.

Given:	Miles flown	55
	Miles off-course	10
	Miles to destination	230
Find:	Amount of correction to heading	
Answer:	12½°	

S



PRACTICE ? PROBLEMS

A. Problems - multiplication

1. 13 x 7 = ?
2. 19 x 5 = ?
3. 137 x 7 = ?
4. 12.6 x 32 = ?
5. 111.4 x 17 = ?

B. Problems - division

6. 8 ÷ 4 = ?
7. 300 ÷ 15 = ?
8. 182 ÷ 14 = ?
9. 345 ÷ 15 = ?
10. 16,000 ÷ 80 = ?

C. Problems - conversion

11. 150 stat. mi. = ? km.
12. 120 naut. mi. = ? km.
13. 115 mph = ? kts.
14. 200 kts. = ? mph
15. 3.5 min. = ? sec.
16. 2.5 min. = ? sec.
17. 35 U.S. gal. = ? imp. gal.
18. 60 imp. gal. = ? U.S. gal.
19. 35 meters = ? ft.
20. 2,500 ft. = ? meters
21. 220 kgs. = ? lbs.
22. 110.8 lbs. = ? kgs.
23. -22°F. = ? C.
24. +30°C. = ? F.
25. -10°C. = ? F.

D. Problems - time/speed/distance

	Time	Speed	Distance
26.	?	120 kts.	200 naut. mi.
27.	?	250 kts.	160 naut. mi.
28.	?	280 kts.	540 naut. mi.
29.	?	350 kts.	70 naut. mi.
30.	?	120 kts.	15 naut. mi.
31.	40 min.	?	180 naut. mi.
32.	15 min.	?	47.5 naut. mi.
33.	19 min.	?	98 naut. mi.
34.	85 min.	210 kts.	?
35.	18 min.	190 kts.	?

E. Problems - fuel consumption

36. 60 gal./30 min. = ? gph
37. 450 gal./25 min. = ? gph
38. 172 gal./15 min. = ? gph
39. 60 gal./30 min. = ? lbs./ph
40. 172 gal./15 min. = ? lbs./ph

F. Problems - density altitude

	TAT	PA	DA
41.	+45°C.	32,000'	?
42.	50°F.	50,000'	?

G. Problems - true altitude

	PA	TAT	Cal. Alt.	Sta. Alt.	TA(ground)	TA(sea level)
43.	32,000'	-40°C.	31,000'	800'	?	?
44.	10,000'	+25°C.	11,400'	4,200'	?	?
45.	18,000'	-10°C.	16,500'	1,700'	?	?

H. Problems - true air temperature

	PA	IAT	CAS	Ct.	TAT
46.	35,000'	-15°C.	380 kts.	.7	?
47.	18,000'	-10°C.	250 kts.	.6	?

I. Problems - true airspeed

	PA	TAT	CAS	TAS
48.	5,000'	-10°C.	300 kts.	?
49.	8,000'	+10°C.	450 kts.	?

J. Problems - true airspeed

	PA	IAT	CAS	Ct.	TAS
50.	36,000'	-20°C.	400 kts.	.7	?
51.	29,000'	-15°C.	360 kts.	.8	?

K. Problems - true airspeed

	Mach	TAT	TAS
52.	.62	+10°C.	?
53.	.75	-5°C.	?
54.	1.11	-30°C.	?

L. Problems - true airspeed

	Mach	IAT	CT	TAS
55.	.55	+15°C.	.8	?
56.	.80	-10°C.	.8	?
57.	1.23	-55°C.	.8	?

M. Problems - air temperature

	PA	Std. Air Temp.
58.	20,000'	?
59.	15,000'	?

N. Problems - time and distance to station

	1st Br.	2nd Br.	GS	Time	Distance
60.	4:30/140°	4:38/145°	180 kts.	?	?
61.	19:00/270°	19:10/298°	290 kts.	?	?
62.	12:40/010°	13:10/358°	310 kts.	?	?

O. Problems - pressure pattern

	D_1	D_2	Distance	Latitude	Crosswind
63.	205'	360'	140 naut. mi.	44°N.	?
64.	150'	110'	105 naut. mi.	35°N	?
65.	375'	290'	210 naut. mi.	54°S.	?

P. Problems - wind correction angle

	TAS	MC	VAR	Wind	WCA	MH	GS
66.	175 kts.	110°	10°W.	30 kts. @ 220°	?	?	?
67.	410 kts.	180°	6°E.	45 kts. @ 020°	?	?	?
68.	280 kts.	240°	11°W.	30 kts. @ 210°	?	?	?

Q. Problems - wind direction and velocity

	TAS	TC	TH	GS	Wind
69.	350 kts.	110°	104°	320 kts.	? kts. @ ?
70.	480 kts.	275°	280°	505 kts.	? kts. @ ?

R. Problems - true course and true heading

	TC	GS	Wind	TAS	H	VAR
71.	?	?	25 kts. @ 240°	300 kts.	160°	7°W.
72.	315°	480 kts.	80 kts. @ 010°	?	?	N/A

S. Problems - off-course correction

	Mi. Flown	Mi. O/C	Mi. To Go	Correction
73.	55	8	95	?
74.	80	15	110	?
75.	210	40	1,280	?

ANSWERS

A.	1.	91		22.	50.3 kg.	G.	43.	31,200'/32,000'	N.	60.	96 min./288 naut. mi.
	2.	95		23.	-30°C.		44.	7,995'/12,195'		61.	21 min./103 naut. mi.
	3.	959		24.	+86°F		45.	15,400'/17,100'		62.	150 min./775 naut. mi.
	4.	403		25.	+14°F	H.	46.	-66°C	O.	63.	34 kts. R.
	5.	1,894	D.	26.	100 min.		47.	-24°C		64.	14 kts. L
B.	6.	2		27.	39 min.	I.	48.	315 kts.		65.	11 kts. R
	7.	20		28.	116 min.		49.	518 kts.	P.	66.	8°R./118°/190 kts.
	8.	13		29.	12 min.	J.	50.	650 kts.		67.	1½°L./178½°/454 kts.
	9.	23		30.	8 min.		51.	538 kts.		68.	2°L./238°/246 kts.
	10.	200		31.	270 kts.	K.	52.	405 kts.	Q.	69.	48 kts./060°
C.	11.	241 km.		32.	190 kts.		53.	476 kts.		70.	49 kts./035°
	12.	222 km.		33.	310 kts.		54.	672 kts.	R.	71.	299 kts./149°
	13.	100 kts.		34.	298 mi.	L.	55.	355 kts.		72.	523 kts./ 322°
	14.	230 mph		35.	57 mi.		56.	480 kts.	S.	73.	13°
	15.	210 sec.	E.	36.	120 gph		57.	635 kts.		74.	19°
	16.	150 sec.		37.	1,080 gph	M.	58.	-25°C.		75.	13°
	17.	29 imp. gal.		38.	688 gph		59.	-15°C.			
	18.	72 U.S. gal.		39.	720 lbs./ph						
	19.	115 ft.		40.	4,128 lbs./ph						
	20.	761 meters	F.	41.	40,000'						
	21.	485 lbs.		42.	50,500'						

GLOSSARY

CALIBRATED AIRSPEED (CAS). The indicated airspeed (IAS) corrected for instrument and position errors.

CALIBRATED ALTITUDE (CA). The indicated altitude (IA) corrected or installation errors.

DENSITY ALTITUDE (CA). Pressure altitude corrected for nonstandard temperature variations. This altitude is directly related to an aircraft's takeoff and climb performance.

GROUND SPEED (G/S). The speed of an aircraft relative to the ground.

INDICATED AIRSPEED (IAS). The speed of an aircraft as shown on the airspeed indicator.

MACH NUMBER (M). A number which relates the speed of the aircraft to the speed of sound. The speed of sound is represented as Mach 1.0.

MAGNETIC COURSE (MC). The direction of an aircraft measured with reference to magnetic north.

PRESSURE ALTITUDE (PA). The indicated altitude when the altimeter window (Kollsman) is set to 29.92 inches of mercury.

TRUE AIRSPEED (TAS). The speed of an aircraft relative to the air mass in which it is flying. True airspeed is equal to calibrated airspeed at sea level under standard atmospheric conditions.

TRUE ALTITUDE (TA). The absolute altitude above sea level, as can best be determined by aircraft instruments.

TRUE COURSE (TC). The direction of an aircraft measured with reference to true north.

TRUE HEADING (TH). The direction of the longitudinal axis of an aircraft measured with reference to true north.

WIND CORRECTION ANGLE (WCA). The angle created by the difference between aircraft heading and aircraft track.