ROTARY SLIDE RULE MANUAL

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You are now the proud owner of a Rotary Slide Rule. For best results, please read the instructions in this booklet carefully before using your Rotary Slide Rule. Please keep this manual handy for ready reference.

Vous voici l'heureux propriétaire d'une Règle à Calcul Rotative. Pour en obtenir de bonnes performances, veuillez, avant d'utiliser la Règle à Calcul Rotative, lire attentivement les explications de ce mode d'emploi que vous conserverez pour toute référence ultérieure.

Usted es ahora un honrado poseedor de la Regla de Cálculo Rotatoria. Para obtener de él los mejores resultados, lea las instrucciones del presente panfleto con cuidado antes del uso de su Regla de Cálculo Rotatoria. Guarde este manual para fácil referencia.

Sie sind nun stolzer Besitzer einer Drehbare Rechenschieber. Um die bestmögliche Nutzung Ihrer Drehbare Rechenschieber zu gewährleisten, lesen Sie bitte die Anleitungen in diesem Heftchen sorgfältig durch, bevor Sie den Drehbare Rechenschieber in Gebrauch nehmen. Verwahren Sie dieses Heftchen, um sich jederzeit wieder informieren zu können.

Siete ora in possesso di un Regolo Calcolatore a Rotazione. Per ottenere i migliori risultati dall'uso del Vostro orologio Vi consigliamo di leggere attentamente le istruzioni contenute in questo manuale prima di passare ad utilizzare il Regolo Calcolatore a Rotazione. Conservare poi il manuale per qualsiasi eventuale futuro riferimento.

Você pode sentir-se orgulhoso de possuir uma Régua de Cálculo Rotativa. Para obter os melhores resultados, leia atentamente as instruções contidas neste opúsculo antes de usar o seu Régua de Cálculo Rotativa. Conserve este manual para referências futuras.

閣下現在已經擁有一隻，旋環型計算尺。在使用您的旋環型計算尺以前，務請注意閱讀這本小册子中的各項說明。並請將手册妥加保管，以便隨時參考。

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ENGLISH

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ROTARY SLIDE RULE MANUAL

This watch is fitted with a rotary type slide rule for rapid calculations and conversion of various essential flight data required by pilots.
With this rotary slide rule, a wide variety of computations are possible, including ordinary multiplication, division, computation of flight speed, fuel consumption, and unit conversion.

1. SCALES

The rotary slide rule consists of (1) a ruler on the bezel (bezel ruler) and (2) a ruler on the dial (dial ruler).
The outer circumference of the bezel ruler is graduated at an interval of 3 deg. to form a utility bearing compass (Type I only), and the inner circumference is provided with a logarithmic scale graduated from 10 to 100.
The outer circumference of the dial ruler is marked with the same logarithmic scale (10 – 100) as the bezel ruler, and the inner circumference is graduated with a time scale (minute/hour scale ... 80 min./1:20, 120 min./ 2:00, 300 min. /5:00, etc.).
Depending on models, two types of rotary slide rules are available.

Type I:

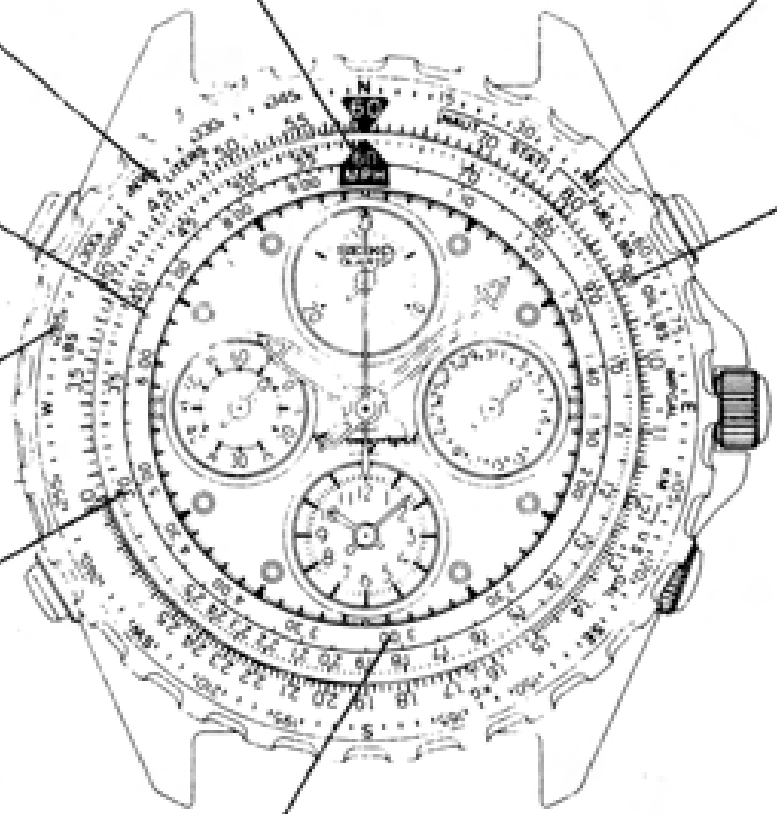
It has a rotating bezel ruler and a fixed dial ruler. Turn the bezel to bring the value on the bezel ruler in line with a desired value on the dial ruler.

Type II:

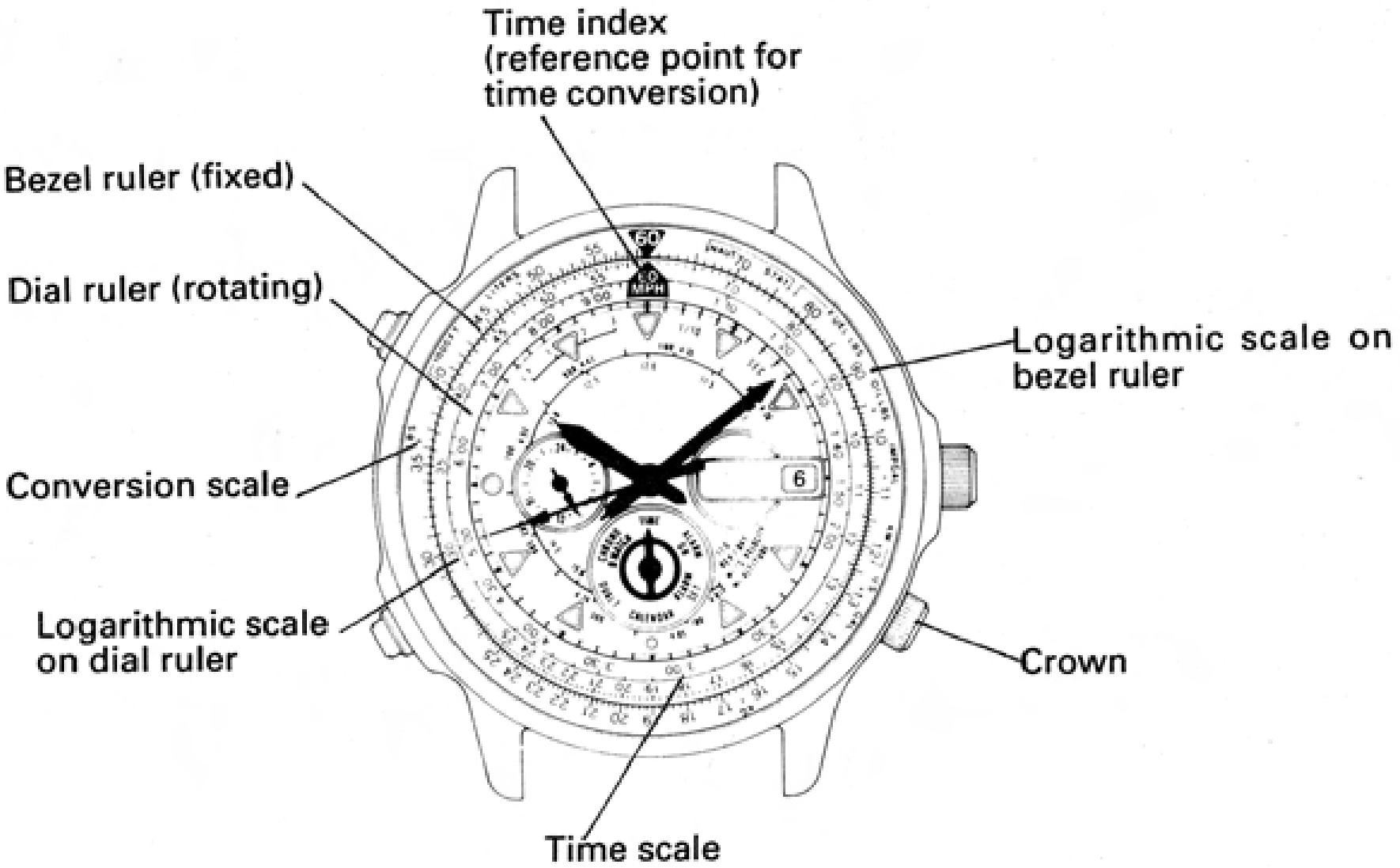
It has a rotating dial ruler and a fixed bezel ruler. Turn the crown at the 4 o'clock position to bring the value on the dial ruler in line with a desired value on the bezel ruler.

EXTERNAL VIEW OF ROTARY SLIDE RULE

[Type I]



[Type II]


Time index
(reference point for
time conversion)
Bezel ruler (fixed)
Dial ruler (rotating)
Logarithmic scale on
bezel ruler
Conversion scale
Logarithmic scale
on dial ruler
Crown
Time scale

Hint for calculation of the number of digits

Any value on the logarithmic scale is relative, for example, "90" assumes any values that are the n-th power of 10, multiplied by itself (9, 900, 9,000 ...). The calculation method to determine the correct number of digits (exponents) is as follows:

Any number can be expressed in terms of an exponential expression as follows:

Assume $A = a \times 10^x$, $B = b \times 10^y$, and $C = c \times 10^z \cdot (10 > a, b, c \geqq 1)$

Multiplication:

Thus, the product of A and B is represented by C ($= c \times 10^z$).

$z = x + y$ (if $c \geqq a, b$)

$z = x + y + 1$ (if $c < a, b$)

Division:

The quotient of A/B is represented by C ($= c \times 10^z$).

$z = x - y$ (if $a \geqq b$)

$z = x - y - 1$ (if $a < b$)

* If your calculation is to be expressed in hours, then minutes must be changed to hours. For example:

30 min. = 0.5 hours = 5×10^{-1}

2. ORDINARY COMPUTATION

2-1. Multiplication, division and the rule-of-three calculation

A. Multiplication

[Problem] 30 x 40 = ?

[Solution]

(1) Bring 30 on the bezel ruler and 10 on the dial ruler in line.

(2) Read the number on the bezel ruler scale corresponding to 40 on the dial ruler scale. The number is 12 (= 1.2×10^1).

(3) Calculate the number of digits following the formula in "Hint for calculation of the number of digits".

In this case:

$30 = 3 \times 10^1$, $40 = 4 \times 10^1$, and $12 = 1.2 \times 10^1$
$Z = 1 + 1 + 1$ $(1.2 < 3, 4)$
$Z = 3$
$c = 1.2$
$C = 1.2 \times 10^3 = 1200$

[Answer] 1200

B. Division

[Problem] $120 \div 40 = ?$

[Solution]

(1) Bring 12 on the bezel ruler and 40 on the dial ruler in line.

(2) Read the number on the bezel ruler scale corresponding to 10 on the dial ruler scale. The number is 30 ($= 3 \times 10^1$).

(3) Calculate the number of digits following the formula in "Hint for calculation of the number of digits".

In this case:

$120 = 1.2 \times 10^2$, $40 = 4 \times 10^1$, and $30 = 3 \times 10^1$
$Z = 2 - 1 - 1$ $(1.2 < 4)$
$Z = 0$
$c = 3$
Answer $= 3 \times 10^0 = 3$ $(10^0 = 1)$

[Answer] 3

C. Rule-of-three calculation

[Problem] 30/10 = ?/40

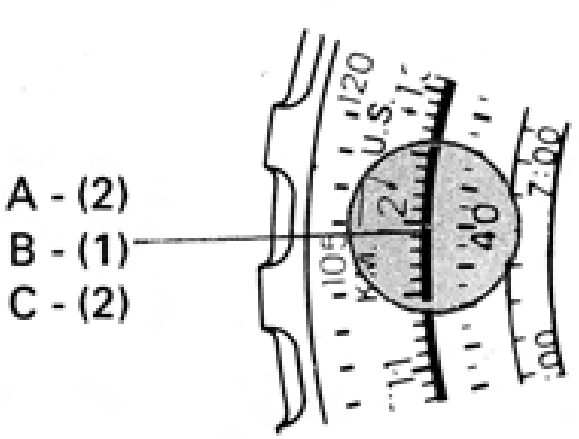
[Solution]

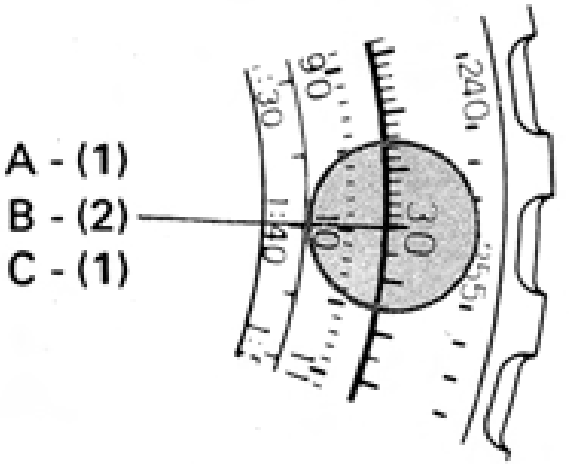
(1) Bring 30 on the bezel ruler and10 on the dial ruler in line.

(2) Read the number on the bezel ruler scale corresponding to 40 on the dial ruler scale. The number is 12 (= 1.2×10^1).

(3) Calculate the number of digits following the formula in "Hint for calculation of the number of digits".

[Answer] 120





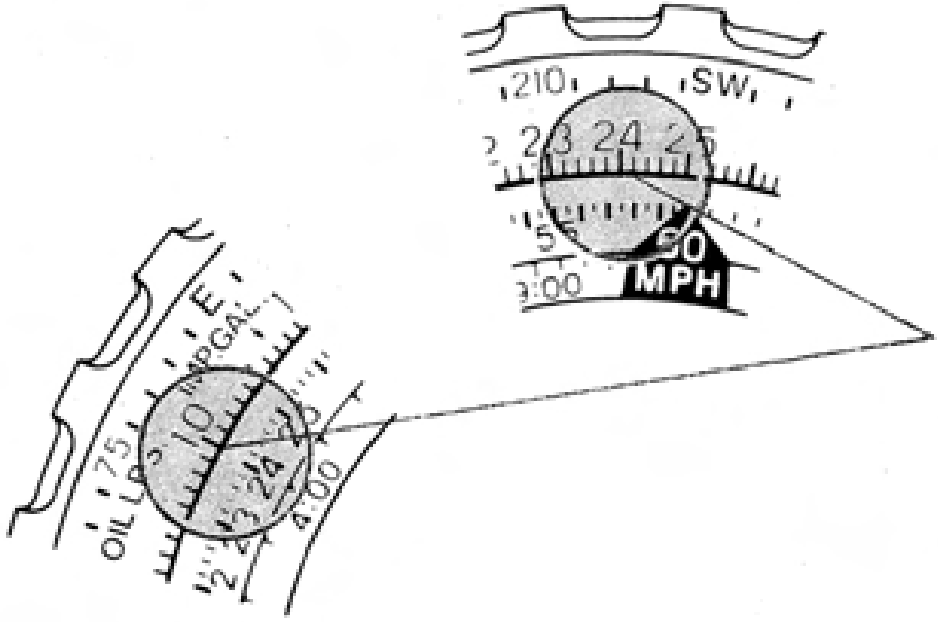
2-2. Calculation of square root

[Problem] Square root of 576 = ?

[Solution]

Locate 57.6 on the dial ruler scale, and 10 on the bezel ruler scale. Find the position where the value opposite 10 on the bezel ruler scale is the same as the value opposite 57.6 on the dial ruler scale.

[Answer] 24



Find the position where the value on the dial ruler scale corresponding to 10 on the bezel ruler scale is the same as the value on the bezel ruler scale corresponding to 57.6 on the dial ruler scale.

3. COMPUTATION FOR NAVIGATION

3-1. Calculation of time, speed and distance

A. Time calculation

[Problem]

Ground speed : 200 MPH
Distance to fly : 100 miles
Time to fly : ?

[Solution]

(1) Bring 20 on the bezel ruler and the time index (60 MPH) on the dial ruler in line.

(2) Read the dial ruler scale at a position corresponding to 10 on the bezel ruler scale. The number is 30.

(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the answer is 30.

[Answer] 30 (minutes)

B. Speed calculation

[Problem]

Ground speed : ?
Distance to fly : 100 miles
Time to fly : 30 minutes

[Solution]

(1) Bring 10 on the bezel ruler and 30 on the dial ruler in line.

(2) The value on the bezel ruler scale corresponding to the time index (60 MPH) on the dial ruler scale is 20.

(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the answer is 200.

[Answer] 200 MPH

C. Distance calculation

[Problem]

Ground speed : 200 MPH
Distance to fly : ?
Time to fly : 30 minutes

[Solution]

(1) Bring 20 on the bezel ruler and the time index (60 MPH) on the dial ruler in line.

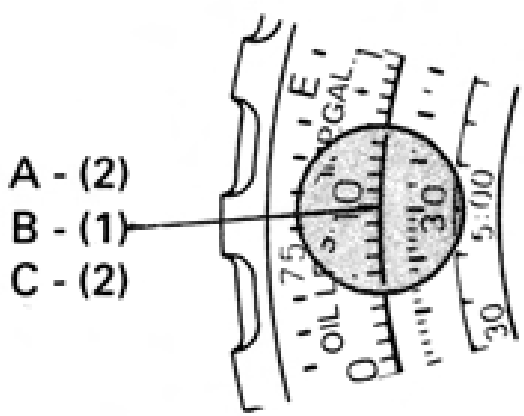
(2) The value on the bezel ruler scale that corresponds to 30 on the dial ruler scale is 10.

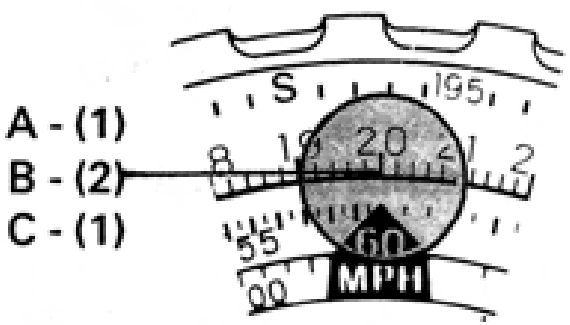
(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the answer is 100.

[Answer] 100 miles

All the examples here can be calculated according to the following formula:

SPEED = DISTANCE/TIME





3-2. Calculation of fuel consumption rate, fuel quantity required, and remaining cruising time

A. Calculation of fuel consumption rate (per hour)

[Problem]

Time to fly	:	300 minutes (5 hours)
Fuel consumption	:	175 gallons
Fuel consumption rate	:	?

[Solution]

(1) Bring 17.5 on the bezel ruler and 30 (5:00) on the dial ruler in line.

(2) The bezel ruler scale value corresponding to the time index (60 MPH) on the dial ruler scale is 35.

[Answer] 35 gallons/hour

B. Calculation of fuel quantity required

[Problem]

Time to fly	:	300 minutes (5 hours)
Fuel required	:	?
Fuel consumption rate	:	35 gallons/hour

[Solution]

(1) Bring 35 on the bezel ruler and the time index (60 MPH) on the dial ruler in line.
(2) Read the value on the bezel ruler scale which corresponds to the value 30 (5:00) on the dial ruler scale. The number is 17.5.
(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the correct value is 175.

[Answer] 175 gallons

C. Calculation of the time remaining for cruising

[Problem]

Time available for cruising	:	?
Fuel innage	:	175 gallons
Fuel consumption rate	:	35 gallons/hour

[Solution]

(1) Bring 35 on the bezel ruler and the time index (60 MPH) on the dial ruler in line.
(2) Read the value on the dial ruler scale that corresponds to 17.5 on the bezel ruler scale. The number is 30 (5:00).

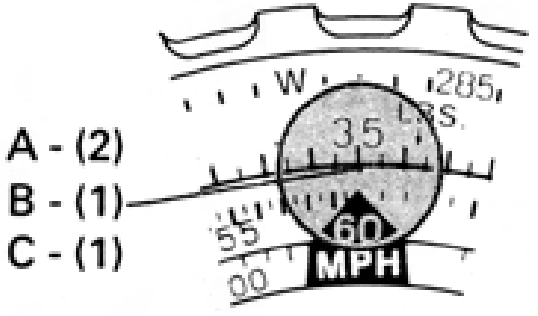
(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the answer is 300.

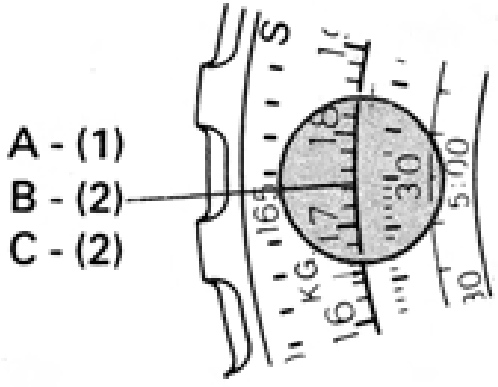
[Answer] 300 minutes (5 hours)

The following formula applies to all the calculation above.

FUEL CONSUMPTION RATE

= FUEL QUANTITY REQUIRED/ TIME TO FLY





3-3. Calculation of climbing altitude, climbing rate, and climbing time

A. Calculation of climbing altitude

[Problem]

Climbing rate : 430 FT/minute
Climbing time : 18.6 minutes
Altitude to reach : ?

[Solution]

(1) Bring 43 on the bezel ruler and 10 on the dial ruler in line.

(2) Find the value on the bezel ruler scale corresponding to 18.6 on the dial ruler scale. The number is 80.

(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the answer is 8000.

[Answer] 8000 FT

B. Calculation of climbing rate

[Problem]

Climbing rate : ?
Climbing time : 18.6 minutes
Altitude to reach : 8000 FT

[Solution]

(1) Bring 80 on the bezel ruler and 18.6 on the dial ruler in line.

(2) Find the value on the bezel ruler scale corresponding to 10 on the dial ruler scale. The number is 43.

(3) For the purpose of determining the correct number of digits, the same rule as for division (2-1(B)) applies. Thus, the answer is 430.

[Answer] 430 FT/minute

C. Calculation of climbing time

[Problem]

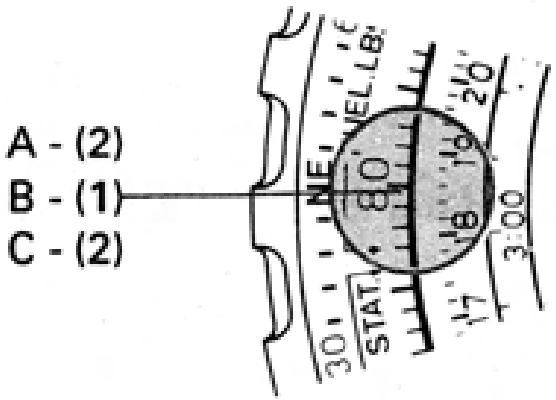
Climbing rate : 430 FT/minute
Climbing time : ?
Altitude to reach : 8000 FT

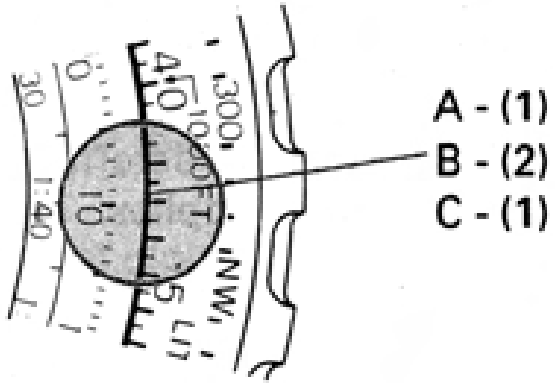
[Solution]

(1) Bring 43 on the bezel ruler and 10 on the dial ruler in line.

(2) Find the value on the dial ruler scale corresponding to 80 on the bezel ruler scale. The number is 18.6.

[Answer] 18.6 minutes





4. METHOD OF CONVERSION

For pilots, the conversion of distance, fuel quantity, weight and various other quantities used in navigational computation from one system of units to another is important. SEIKO Rotary Slide Rule is equipped with convenient conversion scales to facilitate this job. The following are typical examples of conversions often required by pilots.

(A) Distance conversion

(A) -1 : Nautical miles (NAUT) ↔ Statute miles (STAT) ↔ Kilometers (KM)

(A) -2 : Feet (FT) ↔ Kilometers (KM)

(B) Fuel volume conversion

(B) -1 : US gallons (US GAL) ↔ Imperial gallons (IMP GAL) ↔ Liters (LIT)

(C) Weight conversion

(C) -1 : Pounds (LBS) ↔ Kilograms (KG)

(D) Fuel volume-to-weight conversion

(D) -1 : Fuel pounds (FUEL LBS) ↔ US gallons (US GAL) ↔ Imperial gallons (IMP GAL)

(D) -2 : Oil pounds (OIL LBS) ↔ US gallons (US GAL) ↔ Imperial gallons (IMP GAL)

DESCRIPTION OF MARKINGS ON THE ROTARY SLIDE RULE

Classification	Marking	Explanation
Distance	NAUT	Abbreviation of nautical mile 1 NAUT = 1.852 km
	STAT	Abbreviation of statute mile 1 STAT = 1.609 km
	KM	Abbreviation of kilometer 1 KM = 3,280 feet
	FT	Abbreviation of feet
Fuel	LITERS	1 liter = 0.264 US gallons = 0.22 Imperial gallons
	US GAL	Abbreviation of US gallon 1 US GAL = 0.833 Imperial gallons = 3.78 liters
	IMP GAL	Abbreviation of Imperial gallon 1 IMP GAL = 1.2 US gallons = 4.545 liters

Classification	Marking	Explanation
Weight	KG	Abbreviation of Kilogram 1 KG = 2.22 pounds
	LBS	Abbreviation of pounds 1 pound = 0.45 kg
	FUEL LBS	Abbreviation of fuel pounds 1 fuel pound = 0.167 US gallons = 0.139 Imperial gallons
	OIL LBS	Abbreviation of oil pounds 1 oil pound = 0.133 US gallons = 0.111 Imperial gallons
Speed	MPH	Abbreviation of miles per hour 1 MPH = 1.609 km/h

Note: 1 knot = 1 NAUT/h = 1.852 km/h

4-1. Conversion between nautical miles, statute miles and kilometers

A. Nautical miles → Statute miles/Kilometers

[Problem]

35 nautical miles → ? statute miles
→ ? kilometers

[Solution]

(1) Bring the NAUT index on the bezel ruler and 35 on the dial ruler in line.

(2) Find the value on the dial ruler scale corresponding to the STAT index of the bezel ruler scale. The reading is 40.3.

(3) Find the value on the dial ruler scale corresponding to the KM index of the bezel ruler scale. The reading is 64.8.

[Answer] 40.3 statute miles
64.8 kilometers

B. Statute miles → Nautical miles/Kilometers

[Problem]

40.3 statute miles → ? nautical miles
→ ? kilometers

[Solution]

(1) Bring the STAT index of the bezel ruler and 40.3 on the dial ruler in line.

(2) Find the value on the dial ruler scale that corresponds to the NAUT index of the bezel ruler scale. The reading is 35.

(3) Find the value on the dial ruler scale that corresponds to the KM index of the bezel ruler scale. The reading is 64.8.

[Answer] 35 nautical miles
64.8 kilometers

C. Kilometers → Statute miles/Nautical miles

[Problem]

64.8 kilometers → ? statute miles
→ ? nautical miles

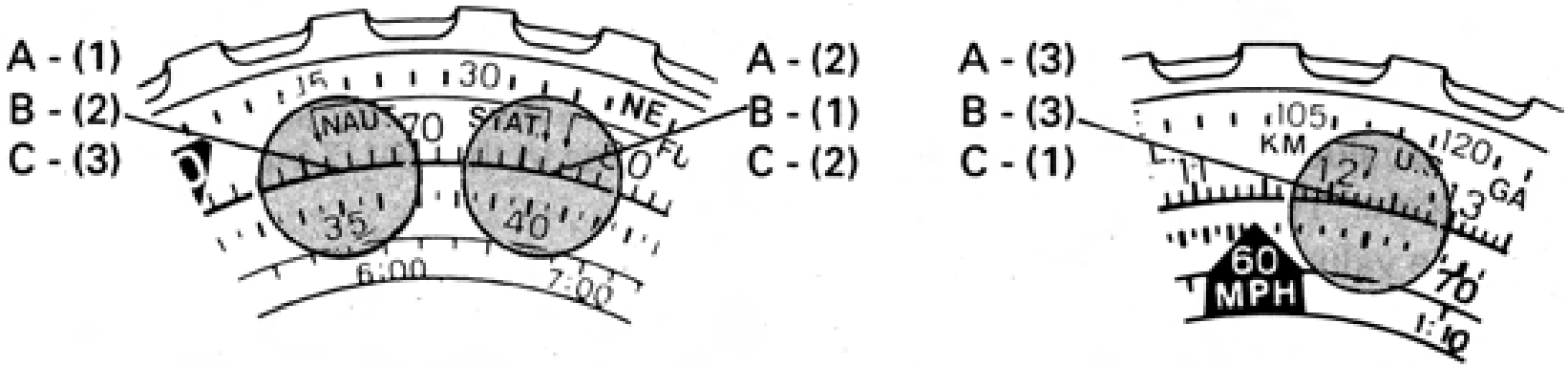
[Solution]

(1) Bring the KM index of the bezel ruler and 64.8 on the dial ruler in line.

(2) Find the value on the dial ruler scale that corresponds to the STAT index of the bezel ruler scale. The reading is 40.3.

(3) Find the value on the dial ruler scale that corresponds to the NAUT index of the bezel ruler scale. The reading is 35.

[Answer] 40.3 statute miles
35 nautical miles



4-2. Conversion between US gallons, Imperial gallons and liters

A. US gallons → Imperial gallons/Liters

[Problem]

42 US gallons → ? Imperial gallons
→ ? Liters

[Solution]

(1) Bring the US GAL index of the bezel ruler and 42 on the dial ruler in line.

(2) Find the value on the dial ruler scale corresponding to the IMP GAL index of the bezel ruler scale. The reading is 35.

(3) Find the value on the dial ruler scale corresponding to the LITERS index of the bezel ruler scale. The reading is 15.9.

(4) According to the rule for the division (2-1-(B)), the dial ruler scale value, 15.9, is interpreted as 159.

[Answer] 35 Imperial gallons
159 liters

B. Imperial gallons → US gallons/Liters

[Problem]

35 Imperial gallons → ? US gallons
→ ? Liters

[Solution]

(1) Bring the IMP GAL index of the bezel ruler and 35 on the dial ruler in line.

(2) Find the value on the dial ruler scale corresponding to US GAL index of the bezel ruler scale. The reading is 42.

(3) Find the value on the dial ruler scale corresponding to the LITERS index of the bezel ruler scale. The reading is 15.9.

(4) According to the rule for the division (2-1-(B)), the dial ruler scale value, 15.9, is interpreted as 159.

[Answer] 42 US gallons
159 liters

C. Liters → US gallons/Imperial gallons

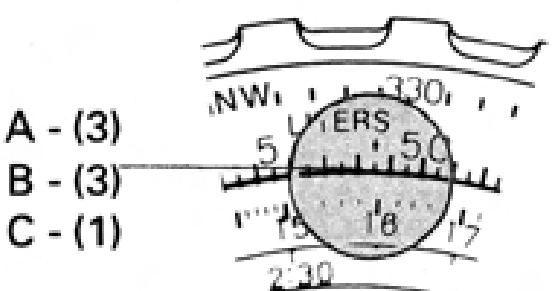
[Problem]

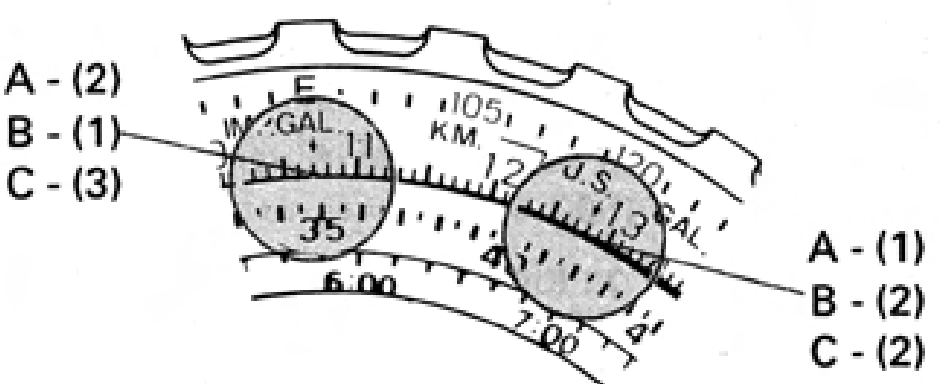
159 liters → ? US gallons
→ ? Imperial gallons

[Solution]

(1) Bring the LITERS index of the bezel ruler and 15.9 on the dial ruler in line.
(2) Find the value on the dial ruler scale corresponding to the US GAL index of the bezel ruler scale. The reading is 42.
(3) Find the value on the dial ruler scale corresponding to the IMP GAL index of the bezel ruler scale. The reading is 35.

[Answer] 42 US gallons
35 Imperial gallons





4-3. Conversion of fuel pounds and oil pounds to US gallons and Imperial gallons

A. Fuel pounds → US gallons/Imperial gallons

[Problem]

13.1 fuel pounds → ? US gallons
→ ? Imperial gallons

[Solution]

(1) Bring the FUEL LBS index of the bezel ruler and 13.1 on the dial ruler in line.

(2) Find the value on the dial ruler scale corresponding to the US GAL index of the bezel ruler scale. The reading is 21.8.

(3) According to the rule for the division (2-1-(B)), the dial ruler scale value, 21.8, is interpreted as 2.18.

(4) Find the value on the dial ruler scale corresponding to the IMP GAL index of the bezel ruler scale. The reading is 18.2.

(5) According to the rule for the division (2-1-(B)), the dial ruler scale value, 18.2, is interpreted as 1.82.

[Answer] 2.18 US gallons
1.82 Imperial gallons

B. Oil pounds → US gallons/Imperial gallons

[Problem]

16.4 oil pounds → ? US gallons
→ ? Imperial gallons

[Solution]

(1) Bring the OIL LBS index of the bezel ruler and 16.4 on the dial ruler in line.

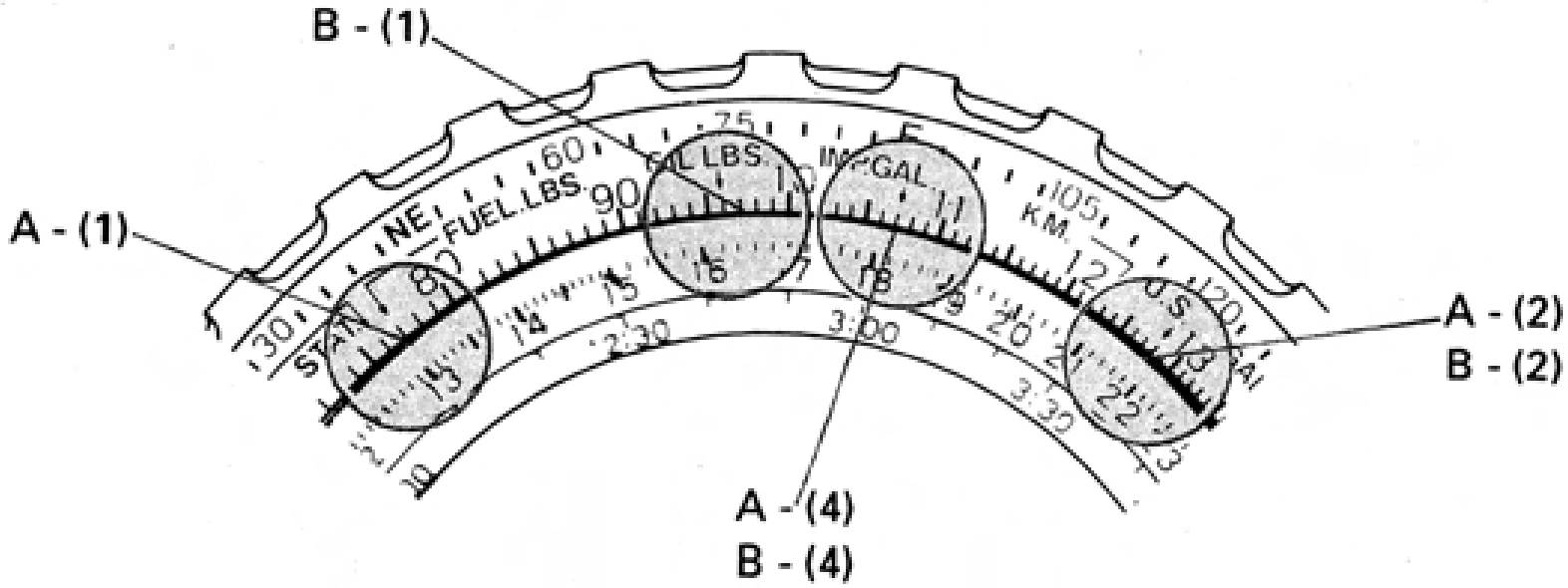
(2) Find the value on the dial ruler scale corresponding to the US GAL index of the bezel ruler scale. The reading is 21.8.

(3) According to the rule for the division (2-1-(B)), the dial ruler scale value, 21.8, is interpreted as 2.18.

(4) Find the value on the dial ruler scale corresponding to the IMP GAL index of the bezel ruler scale. The reading is 18.2.

(5) According to the rule for the division (2-1-(B)), the dial ruler scale value, 18.2, is interpreted as 1.82.

[Answer] 2.18 US gallons
1.82 Imperial gallons


B - (1)
A - (1)
A - (2)
B - (2)
A - (4)
B - (4)
FUEL LBS
GAL LBS
IMP GAL
KM
NE
STAN
60
75
90
105
120
130
2:30
3:00
3:30