

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

CONVERSION FACTORS  
AND  
MISCELLANEOUS TABLES

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Compiled by A. I. Johnson

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U.S. Geological Survey Open-File Report

Denver, Colorado  
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## CONVERSION FACTORS AND MISCELLANEOUS TABLES

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An Act of Congress in 1866 declared that "it shall be lawful throughout the United States of America to employ the weights and measures of the metric system." Only in scientific fields has the metric system received wide acceptance in the years since that date. However, the rapid increase in international trade and the scientific activities in recent years has placed more emphasis on the need for world-wide adoption of the metric system. In January 1964, the American Society for Testing and Materials took a long step forward in requiring that all future Standards established by the Society must report units in the metric as well as the English system.

With the English system, Americans now use 85 different weights and measures in their daily lives. Those Americans working in scientific fields or in frequent contact with foreign nationals also must use the metric weights and measures. Thus, there has been increasing use of the conversion factors between the English and metric systems.

To fill the above mentioned needs, some of the following tables and graphs were compiled by the writer in 1957 as part of a ground-water manual. Increasing use of the conversion factors, graphs, and tables in connection with the training of foreign participants in the field of hydrology emphasized the need for this information as a training aid in a readily available form. New information was added to the 1957 compilation and the present report is the result.

The information in this report was calculated directly or was compiled from a variety of sources, published and unpublished. The report has been printed in loose-leaf form and on colored paper so it may be used readily in a notebook-type manual. New information may be added as it becomes available. The writer will appreciate having any new conversion factors or useful tables brought to his attention.



## CONVERSION FACTORS

### Acres

x43,560	= square feet
x4047	= square meters
x1.562 X 10 <sup>-3</sup>	= square miles
x 4840	= square yards

### Acre-feet

x43,560	= cubic feet
x3.259 X 10 <sup>5</sup>	= gallons

### Atmospheres - atm

x76.0	= centimeters of mercury
x29.92	= inches of mercury
x33.9	= feet of water
x1.033	= kilograms per square centimeter
x14.70	= pounds per square inch
x1.058	= tons per square foot

### Bars

x0.9869	= atmospheres
x10 <sup>6</sup>	= dynes per square centimeter
x1.02 X 10 <sup>4</sup>	= kgs. per square meter
x2,089	= pounds per square foot
x14.5	= pounds per square inch

### Barrels, Liquid - bbl

x31.5	= gallons liquid
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### Barrels, Oil - bbl

x42	= gallons oil
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### British Thermal Units -Btu or B

x.252	= kilogram-calories
x777.5	= foot-pounds

## CONVERSION FACTORS

### British Thermal Units - Btu or B

$\times 3.927 \times 10^{-4}$	= horsepower-hours
$\times 107.5$	= kilogram meters
$\times 2.928 \times 10^{-4}$	= kilowatt-hours

### British Thermal Units Per Minute

$\times 12.96$	= foot-pounds per second
$\times 0.02356$	= horsepower
$\times 0.01757$	= kilowatts
$\times 17.57$	= watts

### Centares

$\times 1$	= square meters
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### Centigrams

$\times 0.01$	= grams
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### Centiliters

$\times 0.01$	= liters
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### Centimeters

$\times 0.3937$	= inches
$\times 0.01$	= meters
$\times 10$	= millimeters

### Centimeters of Mercury

$\times 0.01316$	= atmospheres
$\times 0.4461$	= feet of water
$\times 136$	= kilograms per square meter
$\times 27.85$	= pounds per square foot
$\times 0.1934$	= pounds per square inch

### Centimeters per second

$\times 1.969$	= feet per minute
$\times 0.03281$	= feet per second
$\times 0.036$	= kilometers per hour
$\times 0.6$	= meters per minute
$\times 0.02237$	= miles per hour

## CONVERSION FACTORS

### Centimeters per second

$\times 3.728 \times 10^{-4}$  = miles per minute

### Centimeters per second per second

$\times 0.03281$  = feet per second per second

### Cubic centimeters

$\times 3.531 \times 10^{-5}$  = cubic feet

$\times 6.102 \times 10^{-2}$  = cubic inches

$\times 10^{-6}$  = cubic meters

$\times 1.308 \times 10^{-6}$  = cubic yards

$\times 2.642 \times 10^{-4}$  = gallons

$\times 10^{-3}$  = liters

$\times 2.113 \times 10^{-3}$  = pints, liquid

$\times 1.057 \times 10^{-3}$  = quarts, liquid

### Cubic feet

$\times 2.832 \times 10^4$  = cubic centimeters

$\times 1728$  = cubic inches

$\times 0.02832$  = cubic meters

$\times 0.03704$  = cubic yards

$\times 7.48052$  = gallons

$\times 28.32$  = liters

$\times 59.84$  = pints, liquid

$\times 29.92$  = quarts, liquid

### Cubic feet of water

$\times 62.35$  = pounds

### Cubic feet per minute

$\times 472$  = cubic centimeters per second

$\times 0.1247$  = gallons per second

$\times 0.472$  = liters per second

$\times 62.4$  = pounds of water per minute

## CONVERSION FACTORS

### Cubic feet per second

x0.646317	= million gallons per day
x448.831	= gallons per minute
x26,928	= U. S. gallons per hour
x 60	= cubic feet per minute
x3,600	= cubic feet per hour
x86,400	= cubic feet per day
x0.9917	= acre-inch per hour
x1.9835	= acre-feet per day
x724	= acre-feet per year
x50	= miners inches in Idaho, Kansas Nebraska, New Mexico, North Dakota and South Dakota
x40	= miners inches in Arizona, California Montana and Oregon
x38.4	= statutory inches in Colorado

### Cubic inches

x16.39	= cubic centimeters
x5.787 X 10 <sup>-4</sup>	= cubic feet
x1.639 x 10 <sup>-5</sup>	= cubic meters
x2.143 x 10 <sup>-5</sup>	= cubic yards
x4.329 x 10 <sup>-3</sup>	= gallons
x1.639 x 10 <sup>-2</sup>	= liters
x0.03463	= pints, liquid
x0.01732	= quarts, liquid

### Cubic meters

x10 <sup>6</sup>	= cubic centimeters
x35.31	= cubic feet
x61,023	= cubic inches
x1.308	= cubic yards
x264.2	= gallons
x10 <sup>3</sup>	= liters



## CONVERSION FACTORS

### Cubic meters

x2115	= pints, liquid
x1057	= quarts, liquid

### Cubic yards

x7.646 x 10 <sup>5</sup>	= cubic centimeters
x27	= cubic feet
x46,656	= cubic inches
x0.7646	= cubic meters
x202	= gallons
x764.6	= liters
x1616	= pints, liquid
x807.9	= quarts, liquid

### Cubic yards per minute

x0.45	= cubic feet per second
x3.367	= gallons per second
x12.74	= liters per second

### Days

x24	= hours
x1440	= minutes
x86,400	= seconds

### Decigrams

x0.1	= grams
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### Deciliters

x0.1	= liters
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### Decimeters

x0.1	= meters
------	----------

### Degrees, Angular

x60	= minutes
x0.01745	= radians
X3600	= seconds

## CONVERSION FACTORS

### Degrees per second, angular

x0.01745	= radians per second
x0.1667	= revolutions per minute
x0.002778	= revolutions per second

### Dekagrams

x10	= grams
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### Dekaliters

x10	= liters
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### Dekameters

x10	= meters
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### Drams

x27.34375	= grains
x0.0625	= ounces
x1.771845	= grams

### Fathoms

x6	= feet
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### Feet

x30.48	= centimeters
x12	= inches
x0.3048	= meters
x.333	= yards

### Feet of water

x0.0295	= atmospheres
x0.8826	= inches of mercury
x0.03048	= kilograms per square centimeter
x62.43	= pounds per square foot
x0.4335	= pounds per square inch

### Feet per minute

x0.5080	= centimeters per second
x0.01667	= feet per second

## CONVERSION FACTORS

### Feet per minute

x0.01829	= kilometers per hour
x0.3048	= meters per minute
x0.01136	= miles per hour

### Feet per second

x30.48	= centimeters per second
x1.097	= kilometers per hour
x0.5921	= knots
x18.29	= meters per minute
x0.6818	= miles per hour
x0.01136	= miles per minute

### Feet per second per second

x30.48	= centimeters per second per second
x0.3048	= meters per second per second

### Foot-pounds

$x1.285 \times 10^{-3}$	= British thermal units
$x5.05 \times 10^{-7}$	= horsepower-hours
$x3.24 \times 10^{-4}$	= kilogram-calories
x0.1383	= kilogram-meters
$x3.766 \times 10^{-7}$	= kilowatt-hours

### Foot-pounds per minute

$x1.285 \times 10^{-3}$	= British thermal units per minute
x0.01667	= foot-pounds per second
$x3.03 \times 10^{-5}$	= horsepower
$x3.24 \times 10^{-4}$	= kilogram-calories per minute
$x2.260 \times 10^{-5}$	= kilowatts

### Foot-pounds per second

$x7.717 \times 10^{-2}$	= British thermal units per minute
$x1.818 \times 10^{-3}$	= horsepower
$x1.945 \times 10^{-2}$	= kilogram-calories per minute
$x1.356 \times 10^{-3}$	= kilowatts

# CONVERSION FACTORS

## Gallons

x3785	= cubic centimeters
x0.1337	= cubic feet
x231	= cubic inches
$x3.785 \times 10^{-3}$	= cubic meters
$x4.951 \times 10^{-3}$	= cubic yards
x3.785	= liters
x8	= pints, liquid
x4	= quarts, liquid

## Gallons, Imperial

x1.2009	= U. S. gallons
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## Gallons, U. S.

x0.83267	= Imperial gallons
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## Gallons, water

x8.3453	= pounds of water
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## Gallons per minute

$x2.228 \times 10^{-3}$	= cubic feet per second
x0.06308	= liters per second
x8.0208	= cubic feet per hour

## Grains, Troy

x1	= grains, avoirdupois
x0.06480	= grams
x0.04167	= pennyweights, troy
$x2.0833 \times 10^{-3}$	= ounces, troy

## Grains per U. S. Gallon

x17.118	= parts per million
x142.86	= pounds per million gallons

## Grains per Imperial gallon

x14.286	= parts per million
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## Grams

x980.7	= dynes
x15.43	= grains
$x10^{-3}$	= kilograms

## CONVERSION FACTORS

### Grams

$\times 10^3$  = milligrams

$\times 0.03527$  = ounces

$\times 0.03215$  = ounces, troy

$\times 2.205 \times 10^{-3}$  = pounds

### Grams per centimeter

$\times 5.6 \times 10^{-3}$  = pounds per inch

### Grams per cubic centimeter

$\times 62.43$  = pounds per cubic foot

$\times 0.03613$  = pounds per cubic inch

### Grams per liter

$\times 58.417$  = grains per gallon

$\times 8.345$  = pounds per 1000 gallons

$\times 0.062427$  = pounds per cubic foot

$\times 1000$  = parts per million

### Hectares

$\times 1.076 \times 10^5$  = square feet.

### Hectograms

$\times 100$  = grams

### Hectoliters

$\times 100$  = liters

### Hectometers

$\times 100$  = meters

### Hectowatts

$\times 100$  = watts

### Horsepower

$\times 42.44$  = British thermal units per minute

$\times 33,000$  = foot-pounds per minute

$\times 550$  = foot-pounds per second

$\times 1,014$  = horsepower, metric

$\times 10.7$  = kilogram-calories per minute

## CONVERSION FACTORS

### Horsepower

x0.7457 = kilowatts

x745.7 = watts

### Horsepower, boiler

x33,479 = British Thermal units per hour

x9.803 = kilowatts

### Horsepower-hours

x2547 = British thermal units

x1.98 x 10<sup>6</sup> = foot-pounds

x641.7 = kilogram-calories

x2.737 x 10<sup>5</sup> = kilogram-meters

x0.7457 = kilowatt-hours

### Hours

x60 = minutes

x3600 = seconds

### Inches

x2.540 = centimeters

### Inches of mercury

x0.03342 = atmospheres

x1.133° = feet of water

x0.03453 = kilograms per square centimeter

x70.73 = pounds per square foot

x0.4912 = pounds per square inch

### Inches of water

x0.002458 = atmospheres

x0.07355 = inches of mercury

x0.00254 = kilograms per square centimeter

x0.578 = ounces per square inch

x5.202 = pounds per square foot

x0.03613 = pounds per square inch

## CONVERSION FACTORS

### Kilograms

x980,665	= dynes
x2.205	= pounds
x1.102 x 10 <sup>-3</sup>	= tons, short
x10 <sup>3</sup>	= grams

### Kilograms per meter

x0.672	= pounds per foot
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### Kilograms per square centimeters

x0.9678	= atmospheres
x32.81	= feet of water
x28.96	= inches of mercury
x2048	= pounds per square foot
x14.22	= pounds per square inch

### Kilograms per square millimeter

x10 <sup>6</sup>	= kilograms per square meter
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### Kiloliters

x10 <sup>3</sup>	= liters
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### Kilometers

x10 <sup>5</sup>	= centimeters
x3281	= feet
x10 <sup>3</sup>	= meters
x0.6214	= miles
x1094	= yards

### Kilometers per hour

x27.78	= centimeters per second
x54.68	= feet per minute
x0.9113	= feet per second
x0.5396	= knots
x16.67	= meters per minute
x0.6214	= miles per hour

## CONVERSION FACTORS

### Kilometers per hour per second

x27.78	= centimeters per second per second
x0.9113	= feet per second per second
x0.2778	= meters per second per second

### Kilowatts

x56.92	= British thermal units per minute
x4.425 x 10 <sup>4</sup>	= foot-pounds per minute
x737.6	= foot-pounds per second
x1.341	= horsepower
x14.34	= kilogram-calories per minute
x10 <sup>3</sup>	= watts

### Kilowatthours

x3413	= British thermal units
x3.656 x 10 <sup>6</sup>	= foot-pounds
x1.341	= horsepower-hours
x860	= kilogram-calories
x3.671 x 10 <sup>5</sup>	= kilogram-meters

### Knots

x51.479	= centimeters per second
x6080	= feet per hour
x1.689	= feet per second
x1.853	= kilometers per hour
x0.915	= meters per second
x1	= miles (nautical) per hour
x1.152	= miles (statute) per hour

### Leagues (U. S. nautical)

x3,040	= fathoms
x18,241	= feet

### Links (engineer or Ramden's)

x12	= inches
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### Links (surveyor's or Gunter's)

x7.92	= inches
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## CONVERSION FACTORS

### Liters

$\times 10^3$	= cubic centimeters
$\times 0.0353$	= cubic feet
$\times 61.02$	= cubic inches
$\times 10^{-3}$	= cubic meters
$\times 1.308 \times 10^{-3}$	= cubic yards
$\times 0.2642$	= gallons
$\times 2.113$	= pints, liquid
$\times 1.057$	= quarts, liquid

### Liters per minute

$\times 5.886 \times 10^{-4}$	= cubic feet per second
$\times 4.403 \times 10^{-3}$	= gallons per second

### Meters

$\times 100$	= centimeters
$\times 3.281$	= feet
$\times 39.37$	= inches
$\times 10^{-3}$	= kilometers
$\times 10^3$	= millimeters
$\times 1.094$	= yards

### Meters per minute

$\times 1.667$	= centimeters per second
$\times 3.281$	= feet per minute
$\times 0.05468$	= feet per second
$\times 0.06$	= kilometers per hour
$\times 0.03728$	= miles per hour

### Meters per second

$\times 196.9$	= feet per minute
$\times 3.281$	= feet per second
$\times 3.6$	= kilometers per hour
$\times 0.06$	= kilometers per minute
$\times 2.237$	= miles per hour
$\times 0.03728$	= miles per minute

# CONVERSION FACTORS

## Microns

$\times 10^{-6}$  = meters

## Miles (nautical, International)

$\times 6,076.115$  = feet

$\times 1,852$  = meters

## Miles (statute, U.S.)

$\times 1.609 \times 10^5$  = centimeters

$\times 5280$  = feet

$\times 1.609$  = kilometers

$\times 1760$  = yards

## Miles per hour

$\times 44.7$  = centimeters per second

$\times 88$  = feet per minute

$\times 1.467$  = feet per second

$\times 1.609$  = kilometers per hour

$\times 0.8684$  = knots

$\times 26.82$  = meters per minute

## Miles per minute

$\times 2682$  = centimeters per second

$\times 88$  = feet per second

$\times 1.609$  = kilometers per minute

$\times 60$  = miles per hour

## Milligrams per liter

$\times 1$  = parts per million

## Millimeters

$\times 0.1$  = centimeters

$\times 0.03937$  = inches

## Miner's inches

$\times 1.5$  = cubic feet per minute (Ariz., Calif.,  
Mont., Oreg.)

## Minutes, angular

$\times 2.909 \times 10^{-4}$  = radians

## Ounces

$\times 16$  = drams

$\times 437.5$  = grains

## CONVERSION FACTORS

### Ounces

x0.0625	= pounds
x28.349527	= grams
x0.9115	= ounces, troy
x2.79 x 10 <sup>-5</sup>	= tons, long
x2.835 x 10 <sup>-5</sup>	= tons, metric

### Ounces, troy

x480	= grains
x20	= pennyweights, troy
x0.08333	= pounds, troy
x31.103481	= grams
x1.09714	= ounces, avoirdupois

### Ounces, fluid

x1.805	= cubic inches
x0.02957	= liters

### Ounces per square inch

x0.0625	= lbs per square inch
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### Parts per million

x0.0584	= grains per U. S. gallon
x0.07016	= grains per imperial gallon
x8.345	= pounds per million gallons

### Pennyweights, troy

x24	= grains
x1.55517	= grams
x0.05	= ounces, troy
x4.1667 x 10 <sup>-3</sup>	= pounds, troy

### Pounds

x 16	= ounces
x256	= drams
x7000	= grains
x0.0005	= tons, short

## CONVERSION FACTORS

### Pounds

x453.5924	= grams
x1.21528	= pounds, troy
x14.5833	= Ounces, troy

### Pounds, troy

x5760	= grains
x240	= pennyweights, troy
x12	= ounces, troy
x373.24177	= grams
x0.822857	= pounds, avoirdupois
x13.1657	= ounces, avoirdupois
$x3.6735 \times 10^{-4}$	= tons, long
$x4.114 \times 10^{-4}$	= tons, short
$x3.7324 \times 10^{-4}$	= tons, metric

### Pounds of water

x0.01602	= cubic feet
x27.68	= cubic inches
x0.1198	= gallons

### Pounds of water per minute

$x2.670 \times 10^{-4}$	= cubic feet per second
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### Pounds per cubic foot

x0.01602	= grams per cubic centimeter
x16.02	= kilograms per cubic meter
$x5.787 \times 10^{-4}$	= pounds per cubic inch

### Pounds per cubic inch

x27.68	= grams per cubic centimeter
$x2.768 \times 10^4$	= kilograms per cubic meter
x1728	= pounds per cubic foot

### Pounds per foot

x1.488	= kilograms per meter
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## CONVERSION FACTORS

### Pounds per square foot

x0.01602	= feet of water
x4.88 x 10 <sup>-4</sup>	= kilograms per square centimeter
x6.94 x 10 <sup>-3</sup>	= pounds per square inch

### Pounds per square inch

x0.06804	= atmospheres
x2.307	= feet of water
x2.036	= inches of mercury
x0.07031	= kilograms per square centimeter

### Quarts, Dry

x67.2	= cubic inches
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### Quarts, liquid

x57.75	= cubic inches
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### Rods

x16.5	= feet
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### Square Centimeters

x1.973 x 10 <sup>5</sup>	= circular mils
x1.076 x 10 <sup>-3</sup>	= square feet
x0.155	= square inches
x10 <sup>-4</sup>	= square meters
x100	= square millimeters

### Square feet

x 2.296 x 10 <sup>-5</sup>	= acres
x929	= square centimeters
x144	= square inches
x0.0929	= square meters
x3.587 x 10 <sup>-8</sup>	= square miles

### Square inches

x1.273 x 10 <sup>6</sup>	= circular mils
6.452	= square centimeters

# CONVERSION FACTORS

## Square inches

$\times 6.94 \times 10^{-3}$	= square feet.
$\times 10^6$	= square mils
$\times 645.2$	= square millimeters

## Square meters

$\times 2.471 \times 10^{-4}$	= acres.
$\times 10.76$	= square feet
$\times 3.861 \times 10^{-7}$	= square miles
$\times 1.196$	= square yards

## Square miles

$\times 640$	= acres
$\times 27.88 \times 10^6$	= square feet
$\times 2.59$	= square kilometers
$\times 3.098 \times 10^6$	= square yards

## Square millimeters

$\times 1.973 \times 10^3$	= circular mils
$\times 0.01$	= square centimeters
$\times 1.55 \times 10^{-3}$	= square inches

## Temperature

### Degrees Centigrade - C

+273	= absolute temperature
$+17.78 \times 1.8$	= degrees fahrenheit

### Degrees Fahrenheit

+460	= absolute temperature
$-32 \times .555$	= degrees centigrade

## Tons, Long

$\times 1016$	= kilograms
$\times 2240$	= pounds
$\times 1.12$	= tons, short

## Tons, metric

$\times 10^3$	= kilograms
$\times 2205$	= pounds

## CONVERSION FACTORS

### Tons, short

x2000	= pounds
x32000	= ounces
x907.18486	= kilograms
x2430.56	= pounds, troy
x0.8928	= tons, long
x29166.66	= ounces, troy
x0.90718	= tons, metric

### Tons of water per 24 hours

x83.333	= pounds water per hour
x0.16643	= gallons per minute
x1.3349	= cubic feet per hour

### Yards

x91.44	= centimeters
x3	= feet
x36	= inches

### Watts

x0.0569	= British thermal units per minute
x44.26	= foot-pounds per minute
x0.7376	= foot-pounds per second
$x1.341 \times 10^{-3}$	= horsepower
x0.0143	= kilogram-calories per minute
$x10^{-3}$	= kilowatts

### Watt-hours

x3.41	= British thermal units
x2656	= foot-pounds
$x1.341 \times 10^{-3}$	= horsepower-hours
x0.8605	= kilogram-calories
x367	= kilogram-meters
$x10^{-3}$	= kilowatt-hours

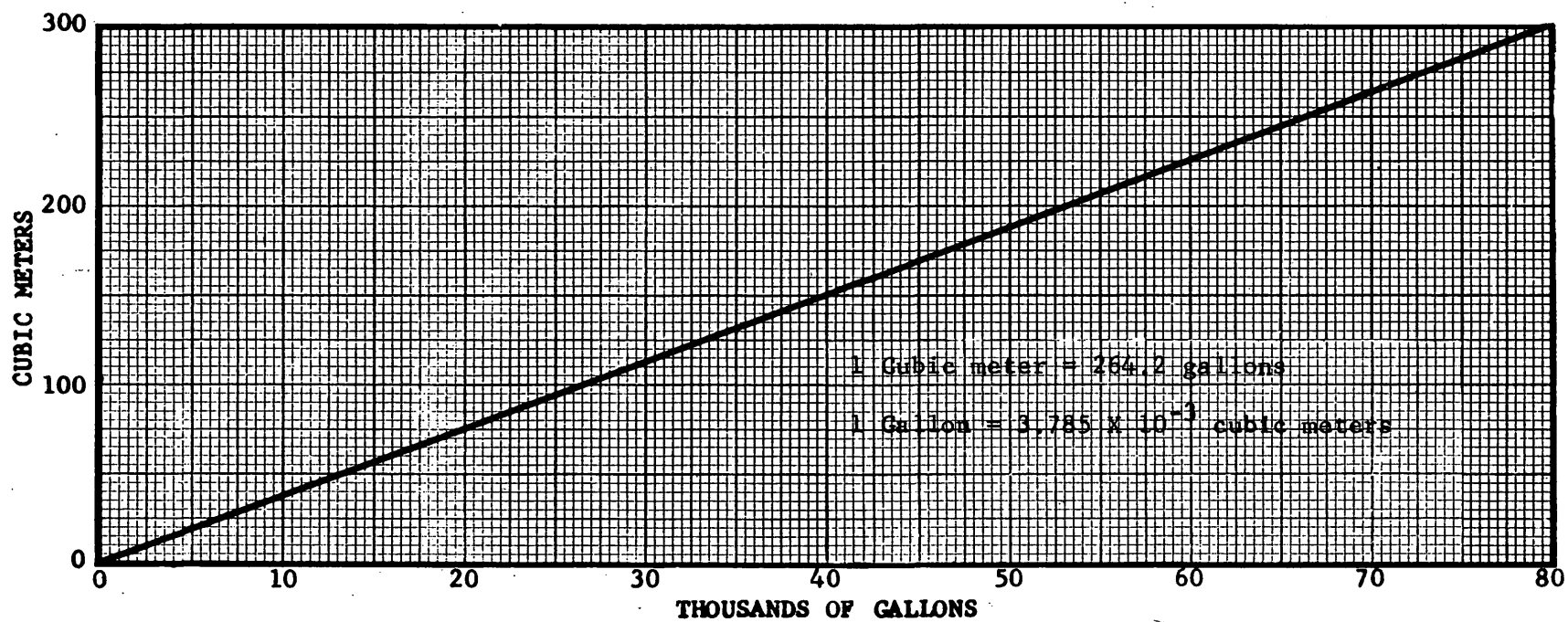
**CONVERSION TABLE FOR  
LITERS PER SECOND INTO GALLONS PER MINUTE**

L/S	0	1	2	3	4	5	6	7	8	9	Decimal	
0		15.852	31.7	47.6	63.4	79.3	95.1	111.0	126.8	142.7		
10	158.5	174.4	190.2	206.0	221.7	237.7	253.6	269.4	285.3	301.1	0.1	1.6
20	317.0	332.8	348.7	364.5	380.4	396.2	412.1	427.9	443.8	459.6	0.2	3.2
30	475.6	491.4	507.3	523.1	539.0	554.8	570.7	586.5	602.4	618.2	0.3	4.8
40	634.1	649.9	665.8	681.6	697.5	713.3	729.2	745.0	760.9	776.7	0.4	6.3
50	792.6	808.4	824.3	840.1	856.0	871.8	887.7	903.5	919.4	935.2	0.5	7.9
60	951.1	966.9	982.8	998.6	1014.5	1030	1046	1062	1078	1094	0.6	9.5
70	1109.6	1125	1141	1157	1173	1189	1205	1221	1236	1252	0.7	11.1
80	1268.2	1284	1300	1316	1332	1347	1363	1379	1395	1411	0.8	12.7
90	1426.6	1442	1458	1474	1490	1506	1522	1538	1553	1569	0.9	14.3
L/S	0	10	20	30	40	50	60	70	80	90	Decimal	
0		158.5	317.0	475.6	634.1	792.6	951.1	1110	1268	1427		
100	1585	1744	1902	2060	2219	2377	2536	2694	2853	3011	1	16
200	3170	3328	3487	3645	3804	3962	4121	4279	4438	4596	2	32
300	4756	4914	5073	5231	5390	5548	5707	5865	6024	6182	3	48
400	6341	6499	6658	6816	6975	7133	7292	7450	7609	7767	4	63
500	7926	8084	8243	8401	8560	8718	8877	9035	9194	9352	5	79
600	9511	9669	9828	9986	10145	10300	10460	10620	10780	10940	6	95
700	11100	11250	11410	11570	11730	11890	12050	12210	12360	12520	7	111
800	12680	12840	13000	13160	13320	13470	13630	13790	13950	14110	8	127
900	14270	14420	14580	14740	14900	15060	15220	15380	15530	15690	9	143

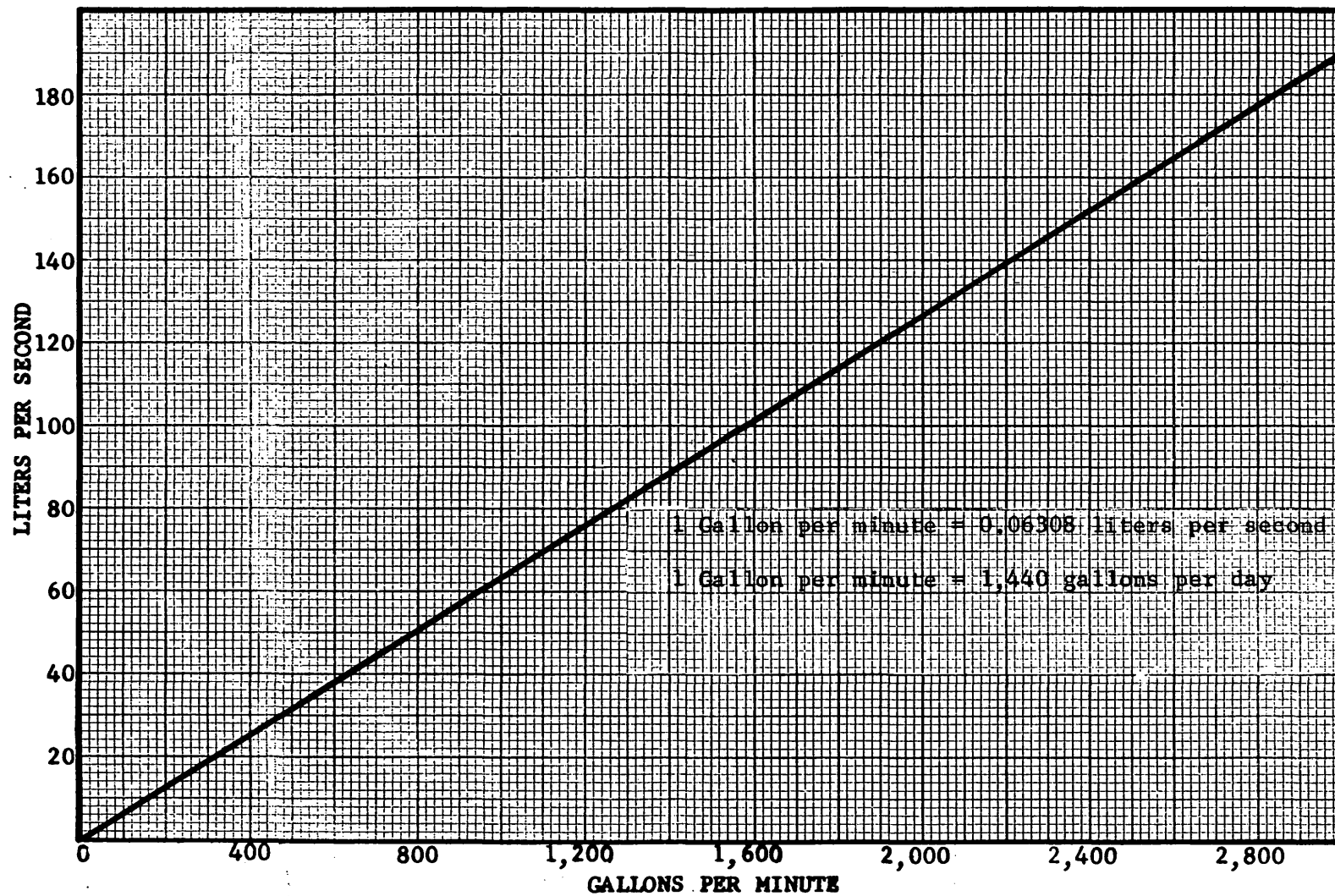


(or liters into gallons) (liters/min into gpm, etc.)

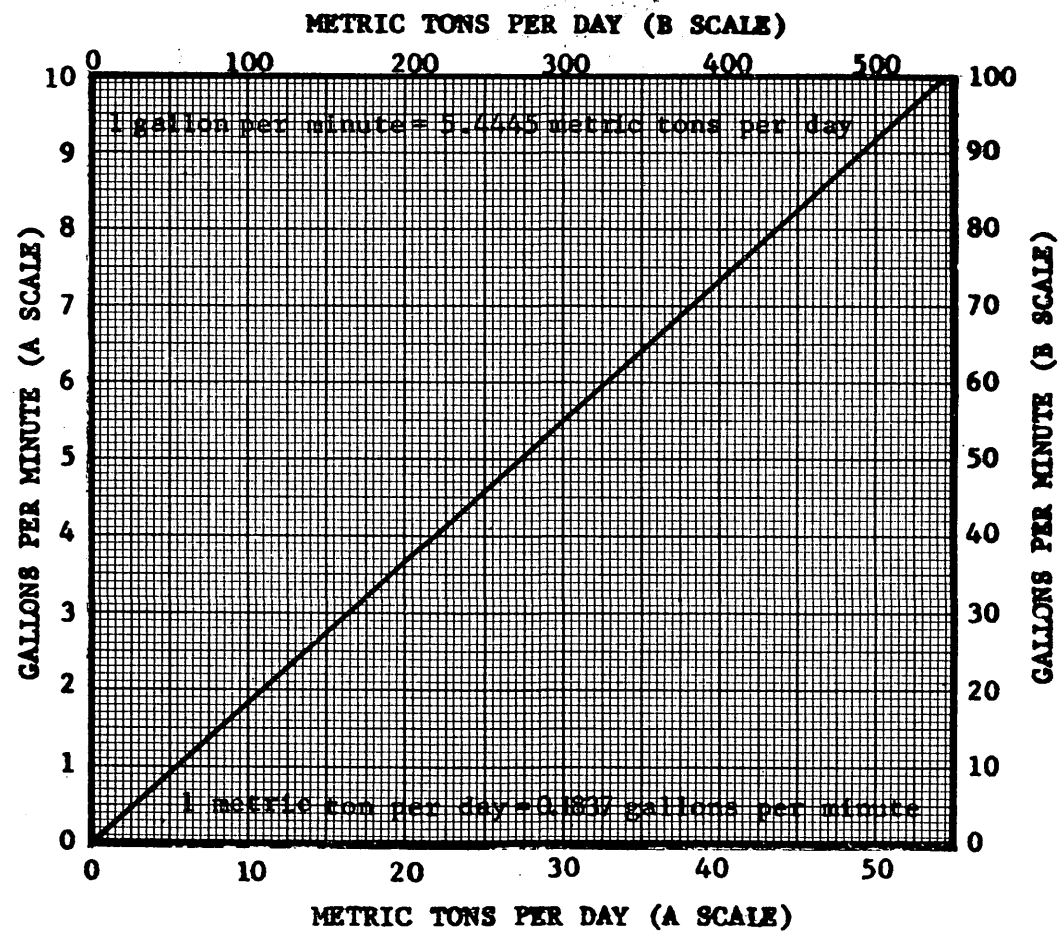
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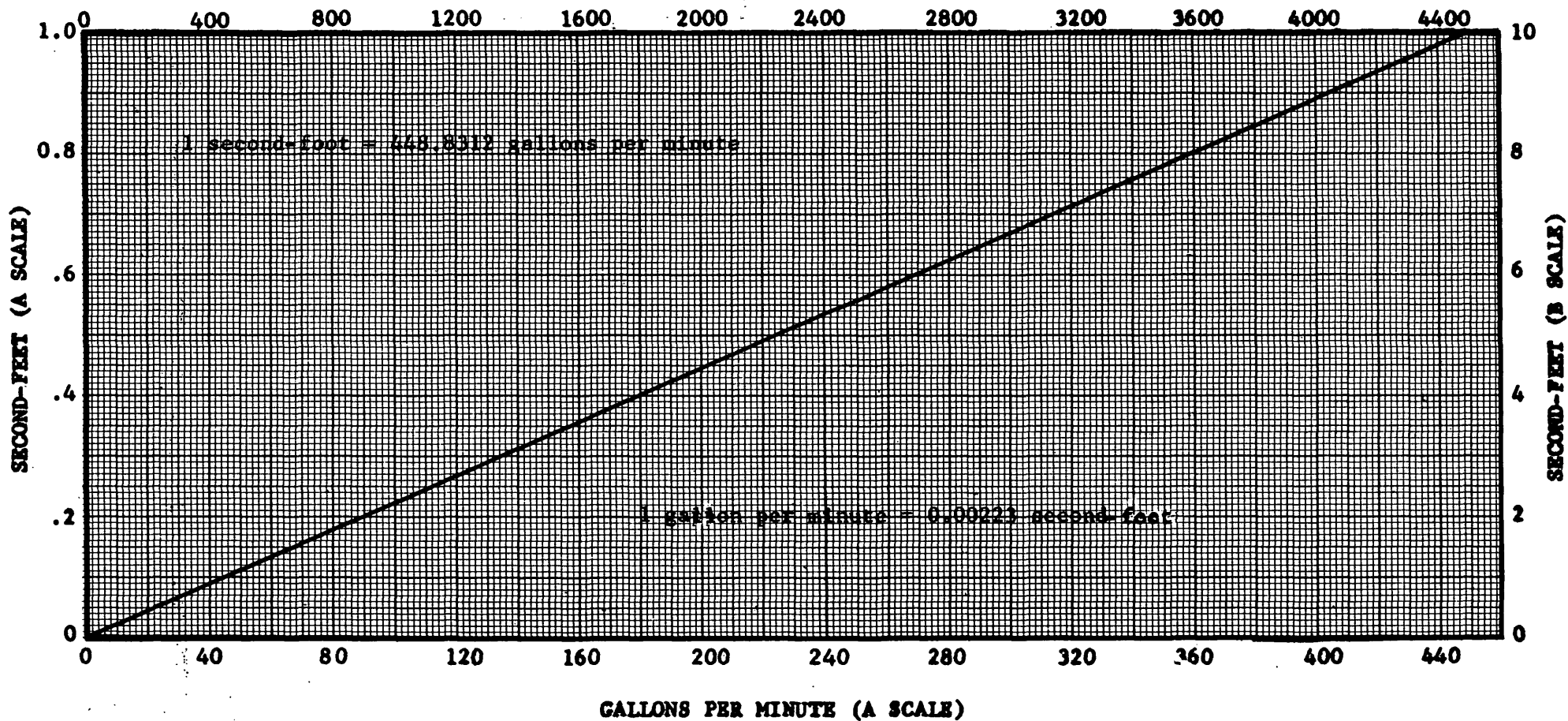
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June 1964

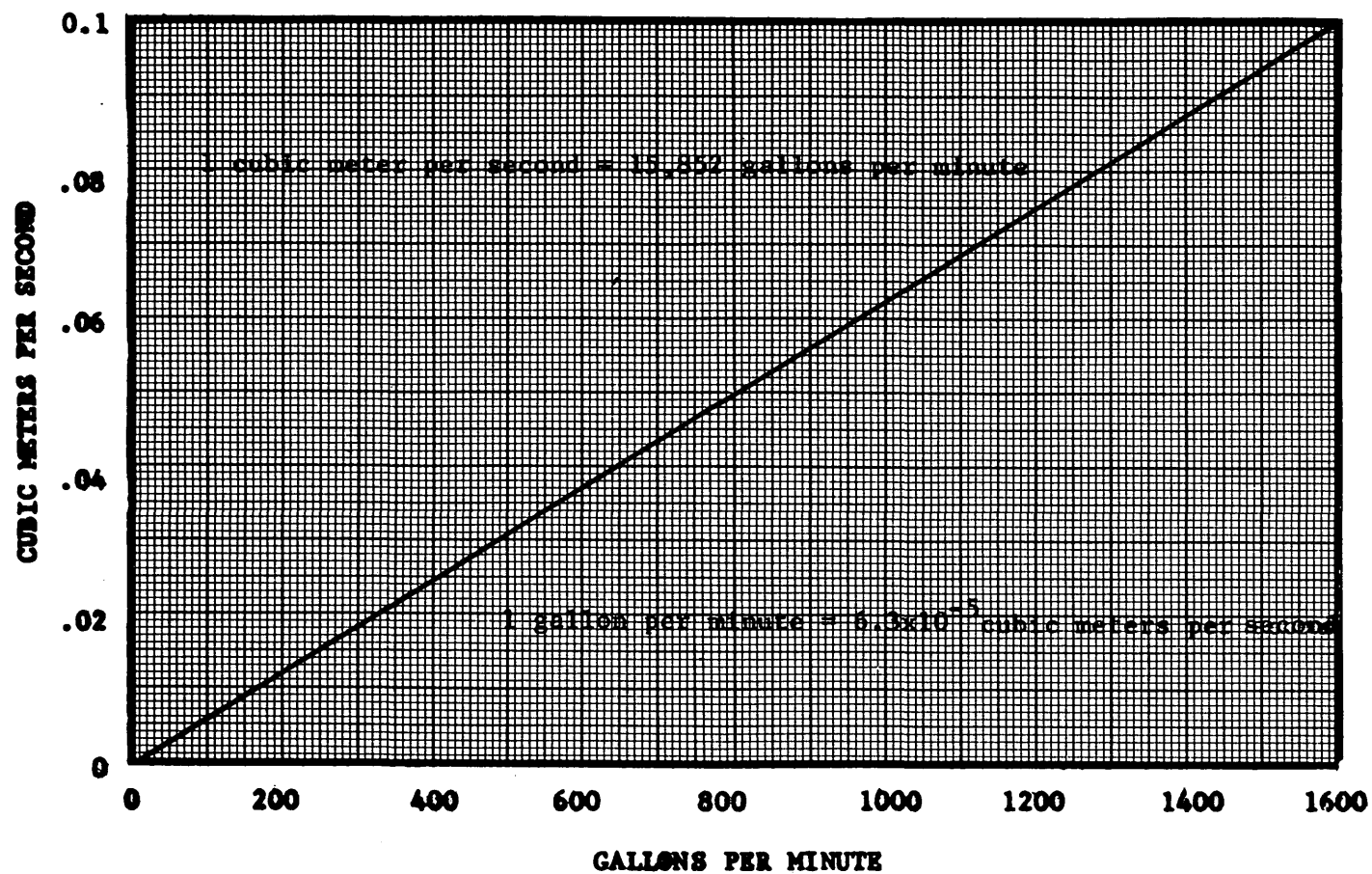


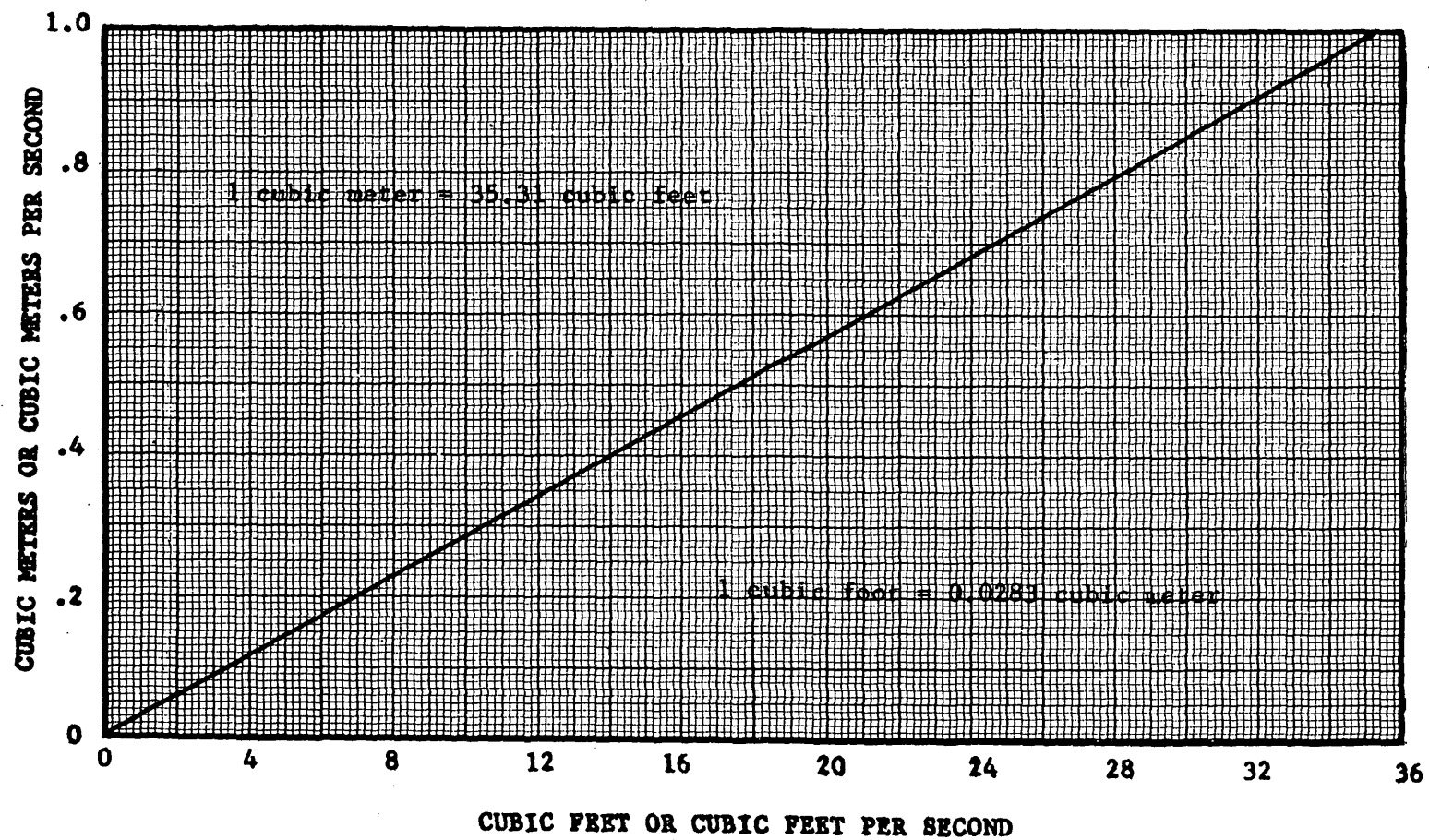
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GALLONS PER MINUTE (B SCALE)

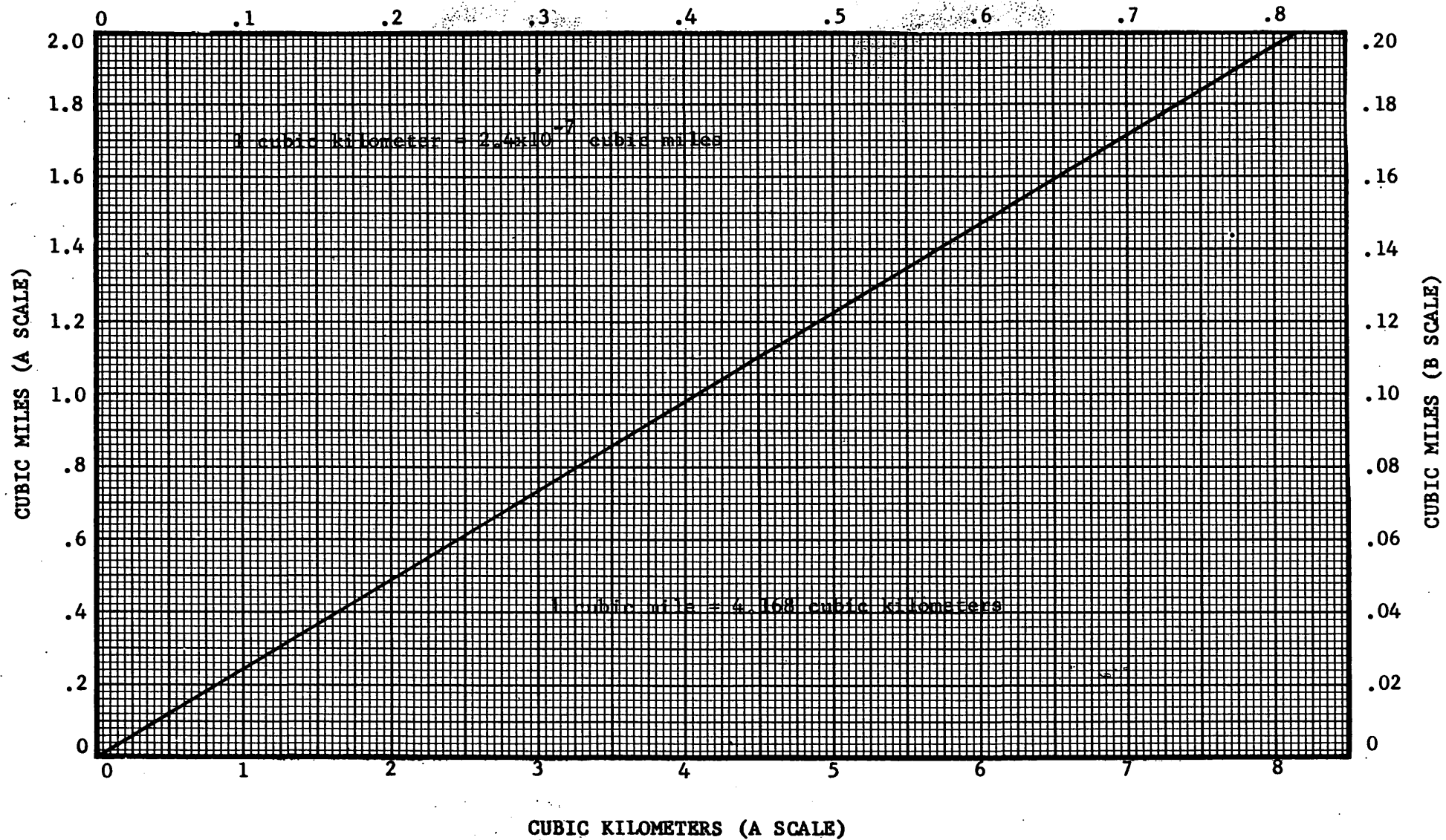






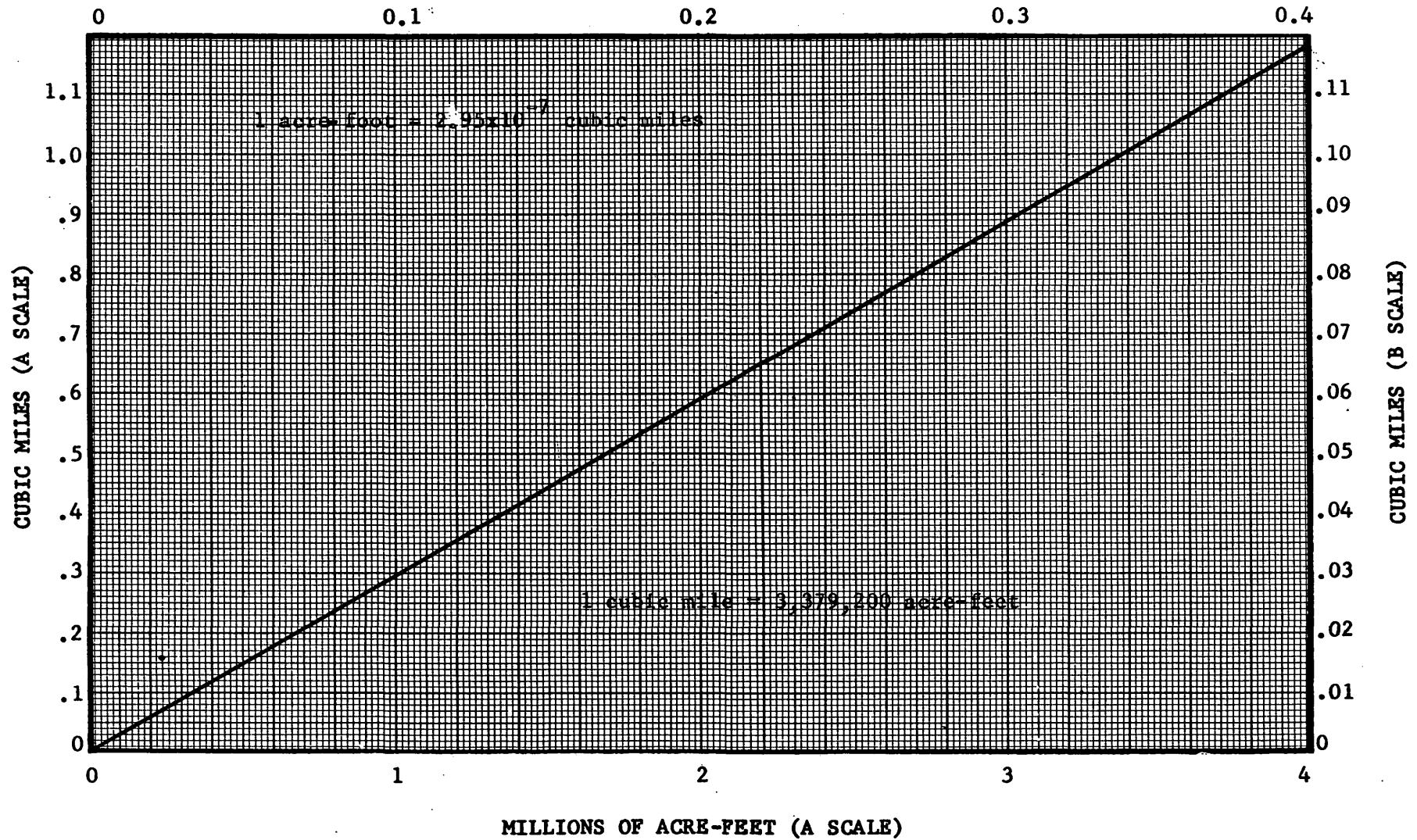


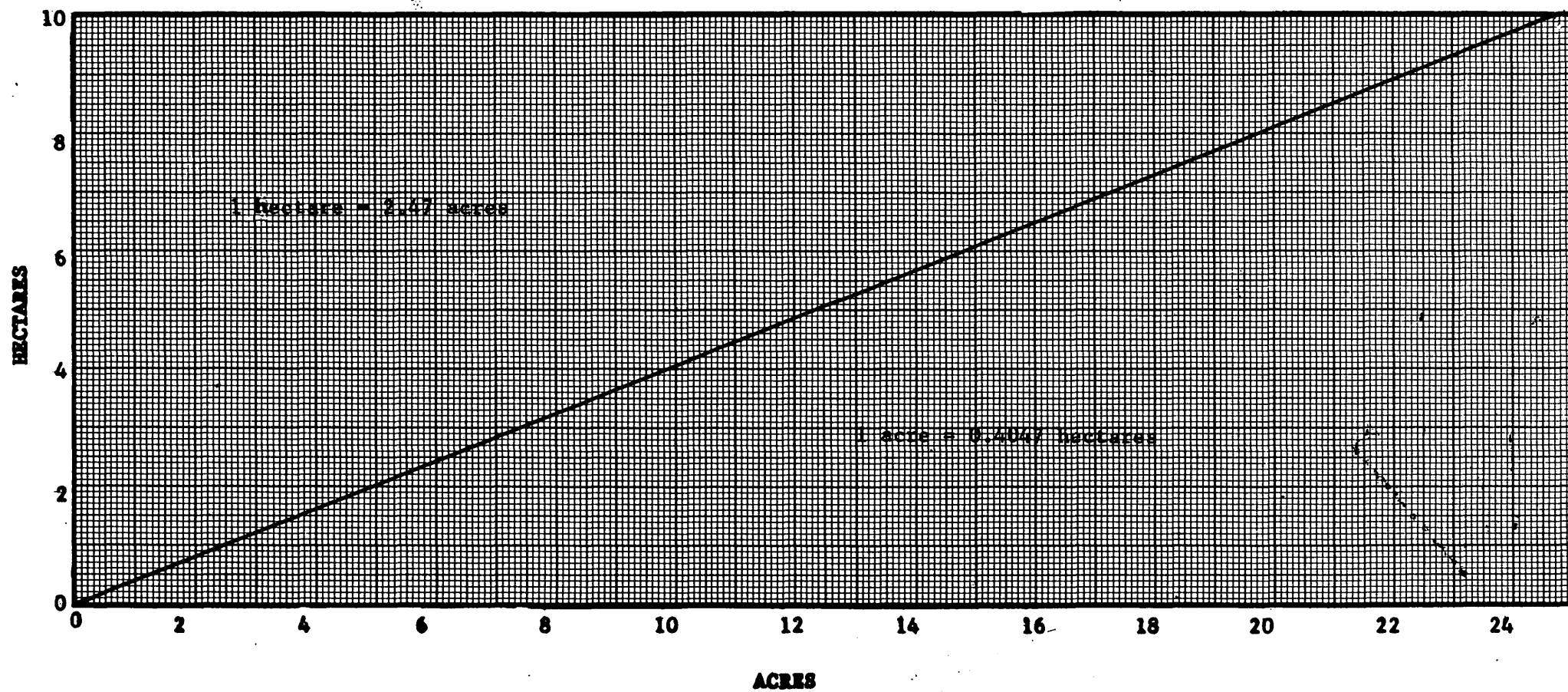
CUBIC KILOMETERS (B SCALE)

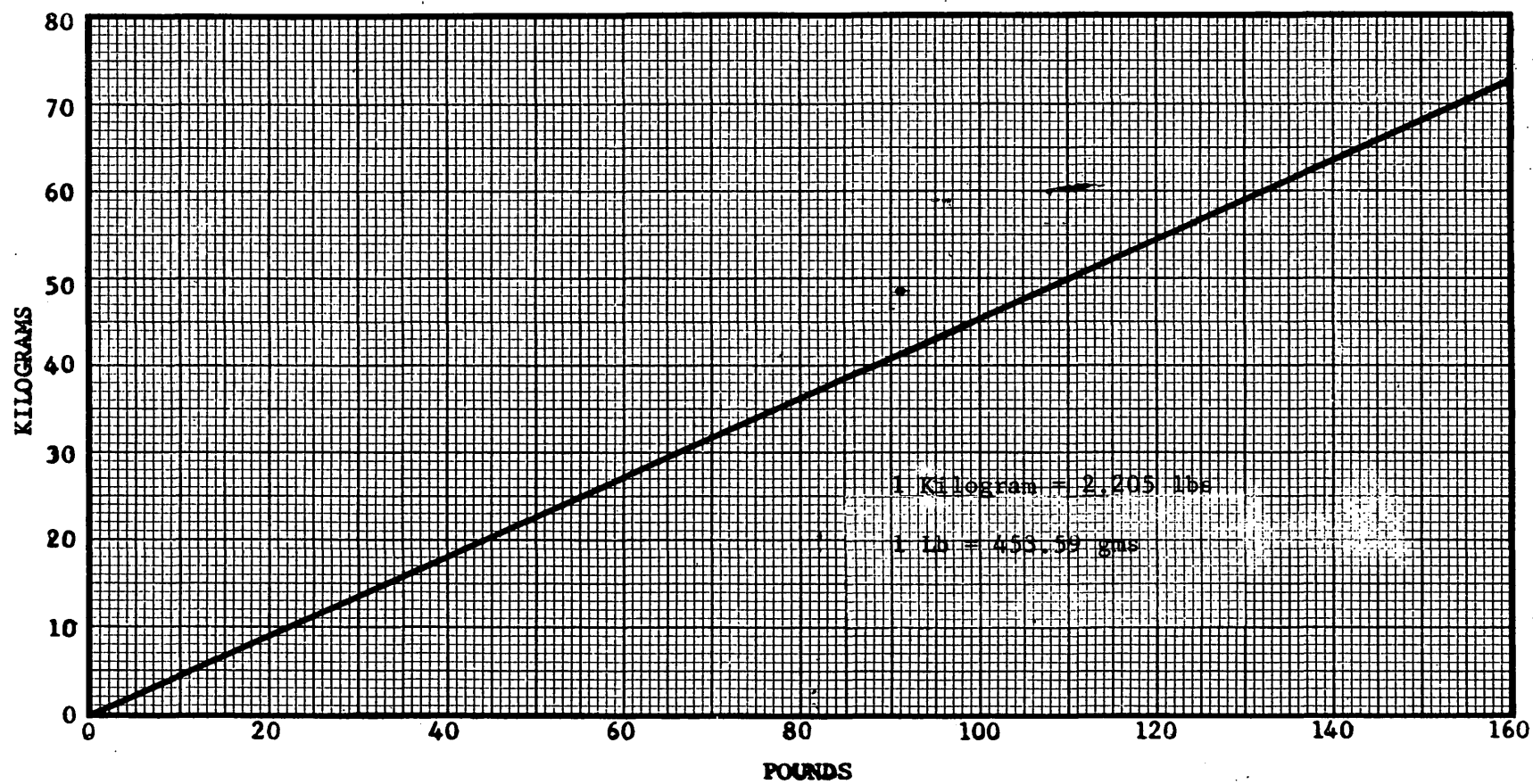




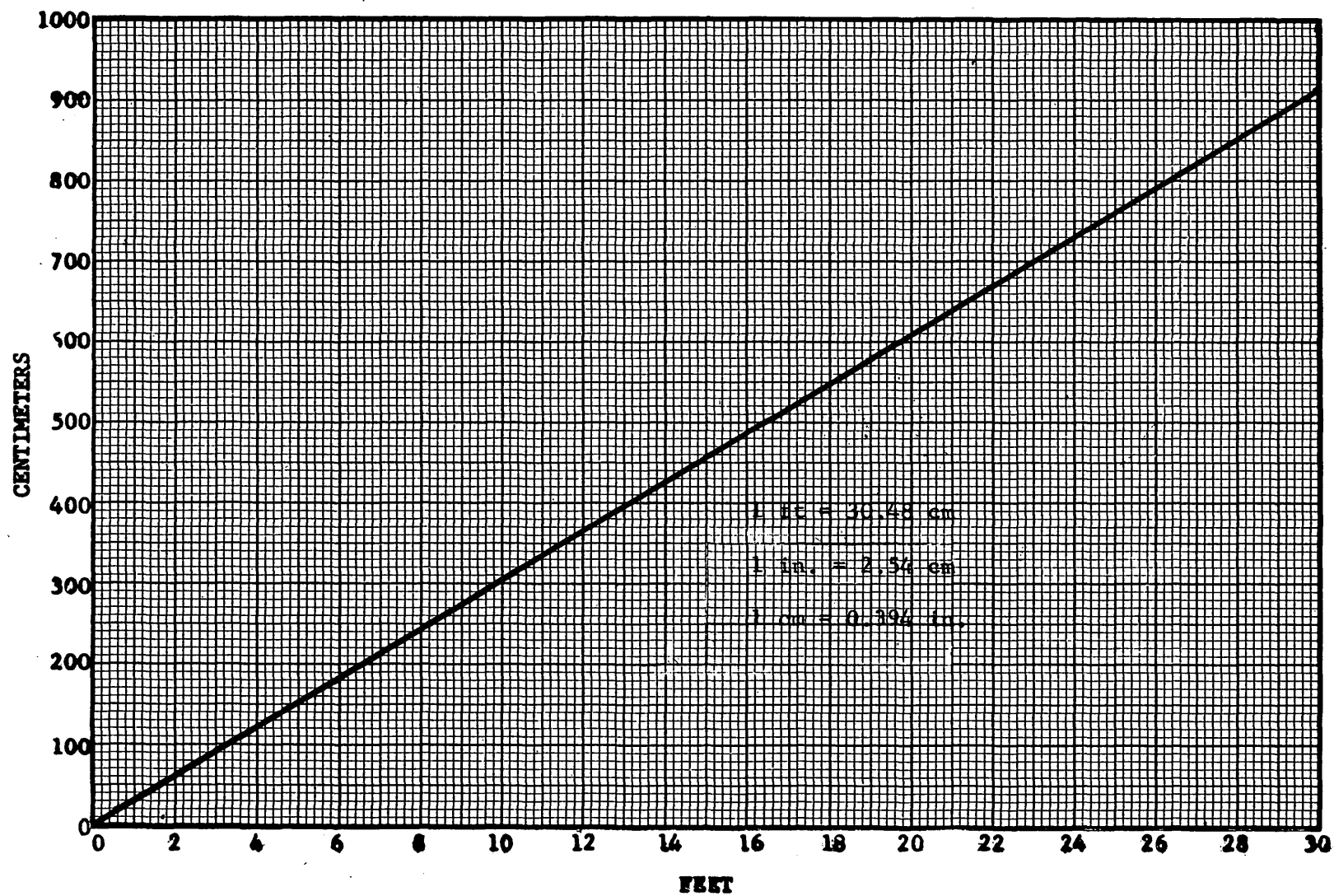
MILLIONS OF ACRE-FEET (B SCALE)







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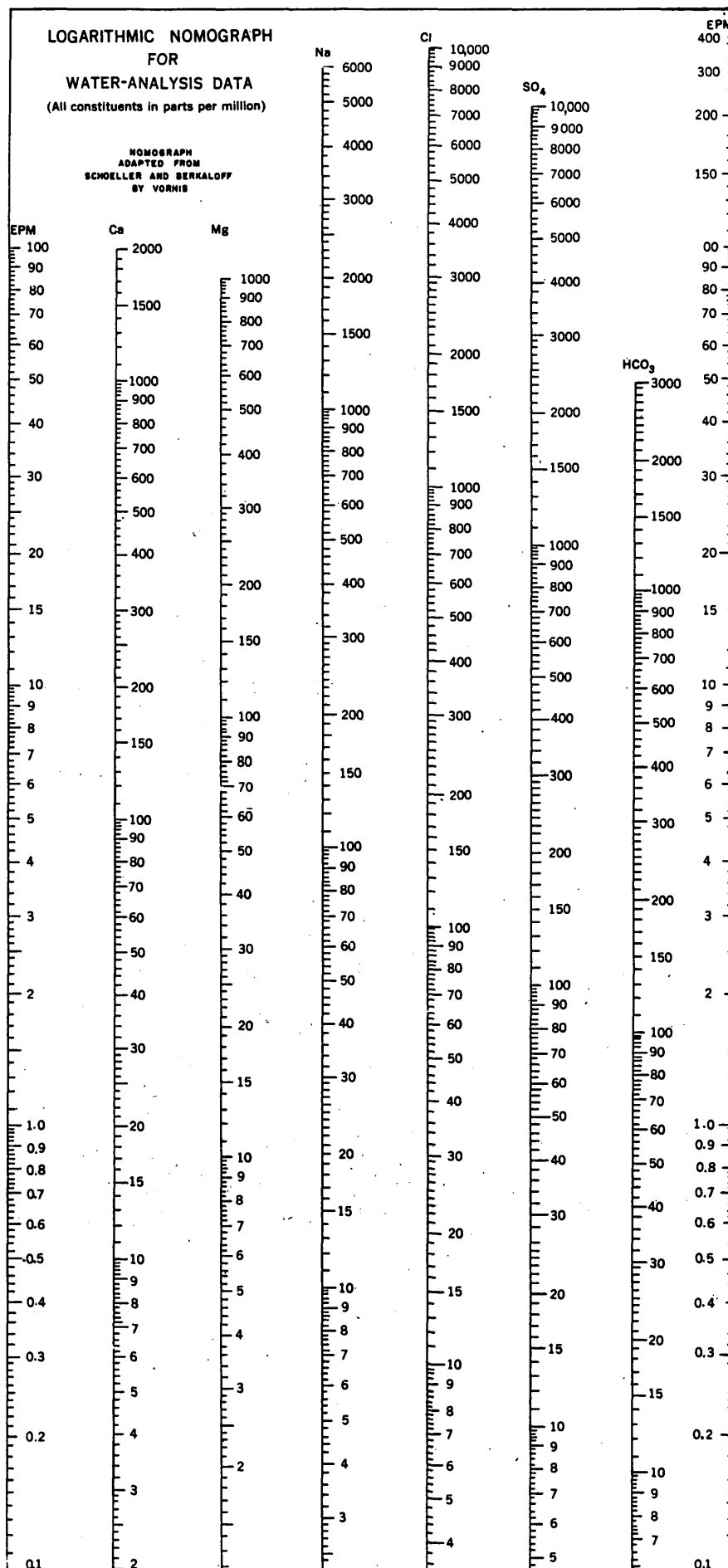
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Temperature corrections for laboratory permeabilities

Conversion factors for converting coefficients of permeability at water temperatures of 40°F - 90°F to coefficients of permeability at water temperature of 60°F.

$$k_{60} = k_T C_T$$

Water temperature (°F)	Conversion factor (C <sub>T</sub> )	Water temperature (°F)	Conversion factor (C <sub>T</sub> )
40	1.37	65	0.93
41	1.35	66	0.91
42	1.33	67	0.90
43	1.31	68	0.89
44	1.28	69	0.88
45	1.26	70	0.87
46	1.24	71	0.86
47	1.22	72	0.84
48	1.20	73	0.83
49	1.18	74	0.82
50	1.16	75	0.81
51	1.15	76	0.80
52	1.13	77	0.79
53	1.11	78	0.78
54	1.09	79	0.77
55	1.08	80	0.76
56	1.06	81	0.75
57	1.04	82	0.75
58	1.03	83	0.74
59	1.01	84	0.73
60	1.00	85	0.72
61	0.98	86	0.71
62	0.97	87	0.70
63	0.96	88	0.69
64	0.95	89	0.69
		90	0.68



From Vorhis, R. C., 1954, U.S. Geol. Survey Water Resources  
Bull., August 10, p. 53-57.

CONVERSION FACTORS: PARTS PER MILLION TO EQUIVALENTS PER MILLION

Ion	Multiply by	Ion	Multiply by
Aluminum ( $\text{Al}^{+++}$ )	0.11119	Iron ( $\text{Fe}^{++}$ )	0.03581
Barium ( $\text{Ba}^{++}$ )	.01456	Iron ( $\text{Fe}^{+++}$ )	.05372
Bicarbonate ( $\text{HCO}_3^-$ )	.01639	Lead ( $\text{Pb}^{++}$ )	.00965
Bromide ( $\text{Br}^-$ )	.01251	Magnesium ( $\text{Mg}^{++}$ )	.08224
Calcium ( $\text{Ca}^{++}$ )	.04990	Manganese ( $\text{Mn}^{++}$ )	.03640
Carbonate ( $\text{CO}_3^{--}$ )	.03333	Nitrate ( $\text{NO}_3^-$ )	.01613
Chloride ( $\text{Cl}^-$ )	.02820	Phosphate ( $\text{PO}_4^{--}$ )	.03159
Chromium ( $\text{Cr}^{6+}$ )	.11536	Potassium ( $\text{K}^+$ )	.02558
Copper ( $\text{Cu}^{++}$ )	.03148	Sodium ( $\text{Na}^+$ )	.04350
Fluoride ( $\text{F}^-$ )	.05263	Strontium ( $\text{Sr}^{++}$ )	.02282
Hydroxide ( $\text{OH}^-$ )	.05880	Sulfate ( $\text{SO}_4^{--}$ )	.02082
Iodide ( $\text{I}^-$ )	.00788	Zinc ( $\text{Zn}^{++}$ )	.03059

# CONVERSION FACTORS FOR QUALITY OF WATER DATA

To convert	To	Multiply by
Grains per gallon	Parts per million	17.12
Parts per million	Grains per gallon	0.05841
Parts per million	Tons per acre-foot	0.00136
Parts per million	Tons per day	Second-feet x 0.0027
Grams	Ounces (avoirdupois)	0.03527
Ounces (avoirdupois)	Grams	28.35
Liters	Quarts (U.S.)	1.057
Quarts (U.S.)	Liters	0.9463
Second-feet	Acre-feet	1.983471
Second-feet	Gallons per minute	448.8
Second-foot days	Gallons per day	646,317
Acre-feet	Gallons	325,851
Acre-feet	Cubic feet	43,560
Cubic feet	Gallons	7.481
Ca	CaCO <sub>3</sub>	2.497
CaCl <sub>2</sub>	CaCO <sub>3</sub>	0.9018
HCO <sub>3</sub>	CaCO <sub>3</sub>	0.8202
HCO <sub>3</sub>	CO <sub>3</sub>	0.49174
Mg	CaCO <sub>3</sub>	4.116
MgCl <sub>2</sub>	CaCO <sub>3</sub>	1.051
Na <sub>2</sub> CO <sub>3</sub>	CaCO <sub>3</sub>	0.9442
Fe <sup>+++</sup>	H <sub>2</sub> SO <sub>4</sub>	2.634



## WATER-QUALITY FACTORS

**Table 1. Taste threshold concentrations of panel of 53 adults for NaCl in distilled water**

PANEL RESPONSE	CONCENTRATIONS MG/L					
	Mean		Median		Range	
	NaCl	Cl	NaCl	Cl	NaCl	Cl
Difference from distilled water noted.....	160	97	100	61	70-600	42-364
Salt taste identified.....	870	530	650	395	200-2,500	120-1,215

Source: C. P. Richter and A. MacLean, "Salt taste threshold of humans. " *American Journal of Physiology*, 126: 1-6, 1939.

**Table 2. Dissolved solids in representative natural waters**

TYPE OF WATER	DISSOLVED SOLIDS
	<i>range, in mg/l</i>
Precipitation (rain and snow)	3-60
Mountain streams (uninhabited areas)	25-75
Lowland streams (humid and subhumid)	35-400
Lowland streams (western irrigated areas)	50-800
Freshwater lakes	20-1,000
Fresh groundwaters	25-1,000
Seawater	2,000-40,000
Mineralized groundwaters	1,000-325,000
"Fossil" groundwaters	50-350,000
Saline lakes	1,000-400,000

Source: Raymond L. Nace, "Waters of the Earth." *The Science Teacher* 30:6-13. April 1963.

**Table 3. Chemical composition of rainwater from several localities in the conterminous United States**

ENVIRONMENT, RAINFALL, AND CONSTITUENTS	LOCALITY			
	Cape Hatteras, N. C.	Brownsville, Tex.	Ely, Nev.	Columbia, Mo.
Distance from sea (miles)	0	1	410	650
Average annual rainfall (inches)	53.9	25.0	15.0	40.0
Sodium (Na) mg/l	4.49	22.30	.69	.33
Potassium (K) mg/l	.24	1.00	.14	.31
Calcium (Ca) mg/l	.44	6.50	3.79	2.18
Chloride (Cl) mg/l	6.50	21.96	.30	.15
Sulfate (SO <sub>4</sub> ) mg/l	.88	5.34	1.05	1.20
Nitrate (NO <sub>3</sub> ) mg/l	1.03	1.76	.81	3.81
Ammonia (as NH <sub>4</sub> ) mg/l	.11	.28	.35	.44

Source: Data after C. E. Junge and R. T. Werby. "The Concentration of Chloride, Sodium, Potassium, Calcium, and Sulfate in Rainwater over the United States." *Journal of Meteorology*, 15: 417-425. 1958.

**Table 4. Chemical composition of type waters in the Powder River basin. (Results in percent of sum of constituents)**

CONSTITUENT	WATER TYPE				
	Granite water	Limestone water	Gypsum water	Shale water	Mixed water
Silica (SiO <sub>2</sub> )	27.6	6.4	1.4	0.3	9.7
Calcium (Ca)	23.2	20.4	16.7	6.9	16.8
Magnesium (Mg)	2.2	10.8	5.5	3.8	5.7
Sodium and Potassium (Na+K)	1.2	1.2	7.6	20.3	7.7
Carbonate (CO <sub>3</sub> )	37.0	54.6	14.0	8.1	32.9
Sulfate (SO <sub>4</sub> )	7.4	3.6	52.8	60.0	25.8
Chloride and Nitrate (Cl+NO <sub>3</sub> )	1.4	3.0	2.0	.6	1.4
Total	100.0	100.0	100.0	100.0	100.0
Dissolved solids, mg/l	43	158	727	2020	155

**Most prevalent cations in sea and river water**

ELEMENT	MILLIGRAMS PER LITER	
	Seawater	River water
Sodium (Na).....	10,600	6.3
Magnesium (Mg)....	1,300	4.1
Calcium (Ca).....	400	15.0

Source: Herbert A. Swenson, "Minerals in Water," *The Science Teacher*, 32, January 1965.

## RECOMMENDED UNIT PREFIXES

As adopted by International Committee on Weights and Measures.  
Reprinted from NBS Technical News Bulletin, Feb. 1963, issued monthly,  
\$1.50 yr.\* Also see The Metric System of Measurement, NBS Misc.  
Publ. 232, 50c.\*

<i>Multiples and submultiples</i>	<i>Prefixes</i>	<i>Symbols</i>	<i>Pronunciation</i>
$10^{12}$	tera	T	tě'r' á
$10^9$	giga	G	jí' gá
$10^6$	mega	M	měg' á
$10^3$	kilo	k	kíl' ó
$10^2$	hecto	h	hěk' tó
10	deka	da	děk' á
$10^{-1}$	deci	d	děs' í
$10^{-2}$	centi	c	sě'n' tí
$10^{-3}$	milli	m	míl' í
$10^{-6}$	micro	$\mu$	mí' kró
$10^{-9}$	nano	n	nán' ó
$10^{-12}$	pico	p	pě' kó
$10^{-15}$	femto	f	fěm' tó
$10^{-18}$	atto	a	át' tó

## DEFINED VALUES AND CONVERSION FACTORS

Meter.....	1 650 763.73 wavelengths of the transition $2p_{10}$ — $5d_5$ in $^{86}\text{Kr}$
Kilogram.....	mass of the international kilogram
Second.....	1/31 556 925.974 7 of the tropical year 1900
Degree Kelvin.....	In the thermodynamic scale, $273.16\text{ }^\circ\text{K} =$ triple point of water (fp, $273.15\text{ }^\circ\text{K} = 0\text{ }^\circ\text{C}$ )
Unified atomic mass unit, $u$	1/12 the mass of an atom of the $^{12}\text{C}$ nuclide
Standard acceleration of free fall	$9.806\ 65\text{ m s}^{-2}$ , $980.665\text{ cm s}^{-2}$
Normal atmosphere.....	$101\ 325\text{ N m}^{-2}$ , $1\ 013\ 250\text{ dyn cm}^{-2}$
Thermochemical calorie .	$4.1840\text{ J}$ , $4.1840 \times 10^7\text{ erg}$
Int. Steam Table calorie .	$4.1868\text{ J}$ , $4.1868 \times 10^7\text{ erg}$
Liter.....	$0.001\ 000\ 028\text{ m}^3$ , $1\ 000.028\text{ cm}^3$ (recom- mended by CIPM, 1950)
Inch.....	$0.0254\text{ m}$ , $2.54\text{ cm}$
Pound (avdp.).....	$0.453\ 592\ 37\text{ kg}$ , $453.592\ 37\text{ g}$

\*For sale by the Superintendent of Documents, U.S. Government  
Printing Office, Washington, D.C., 20402

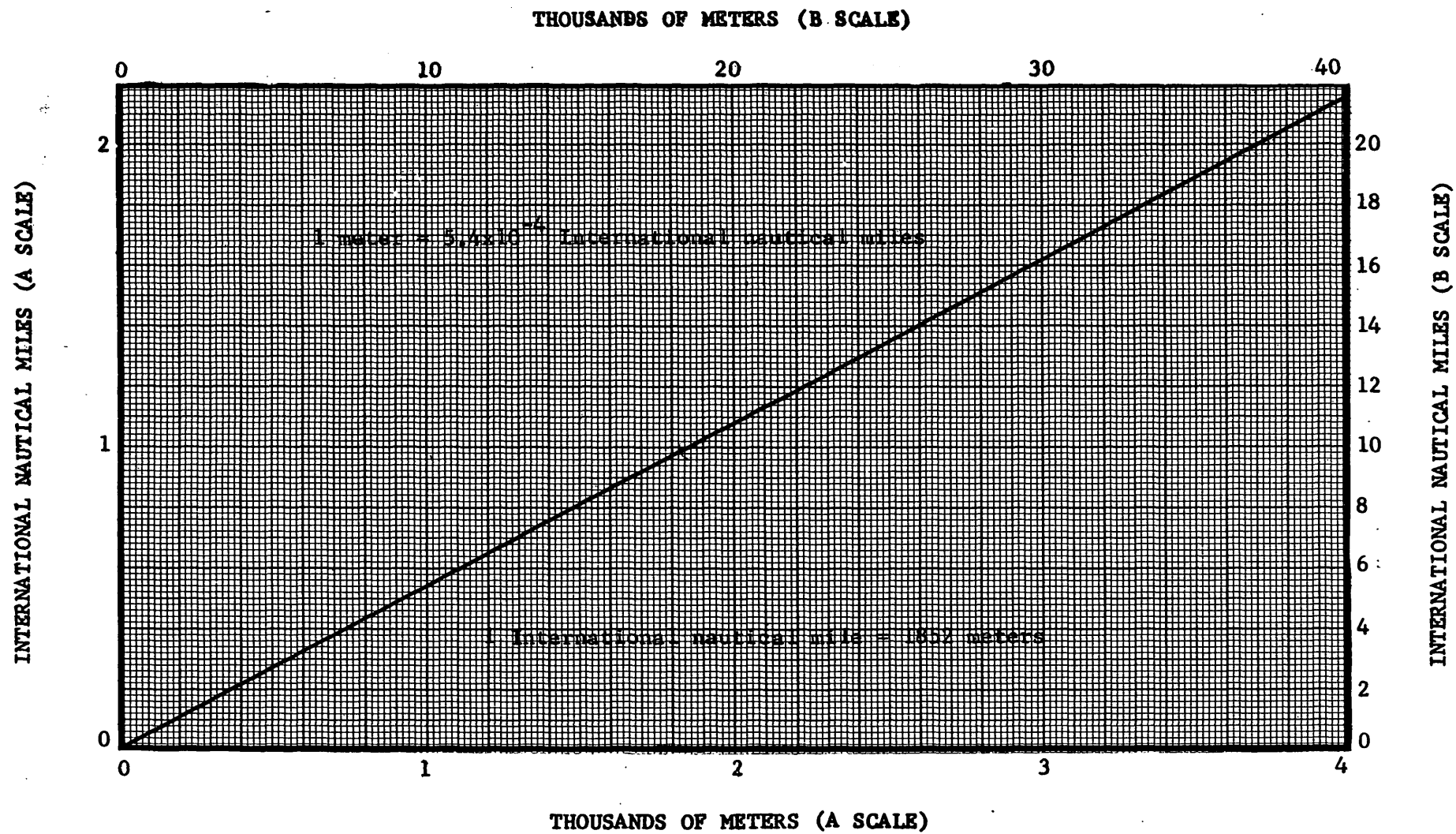
# GENERAL PHYSICAL CONSTANTS RECOMMENDED BY NAS-NRC

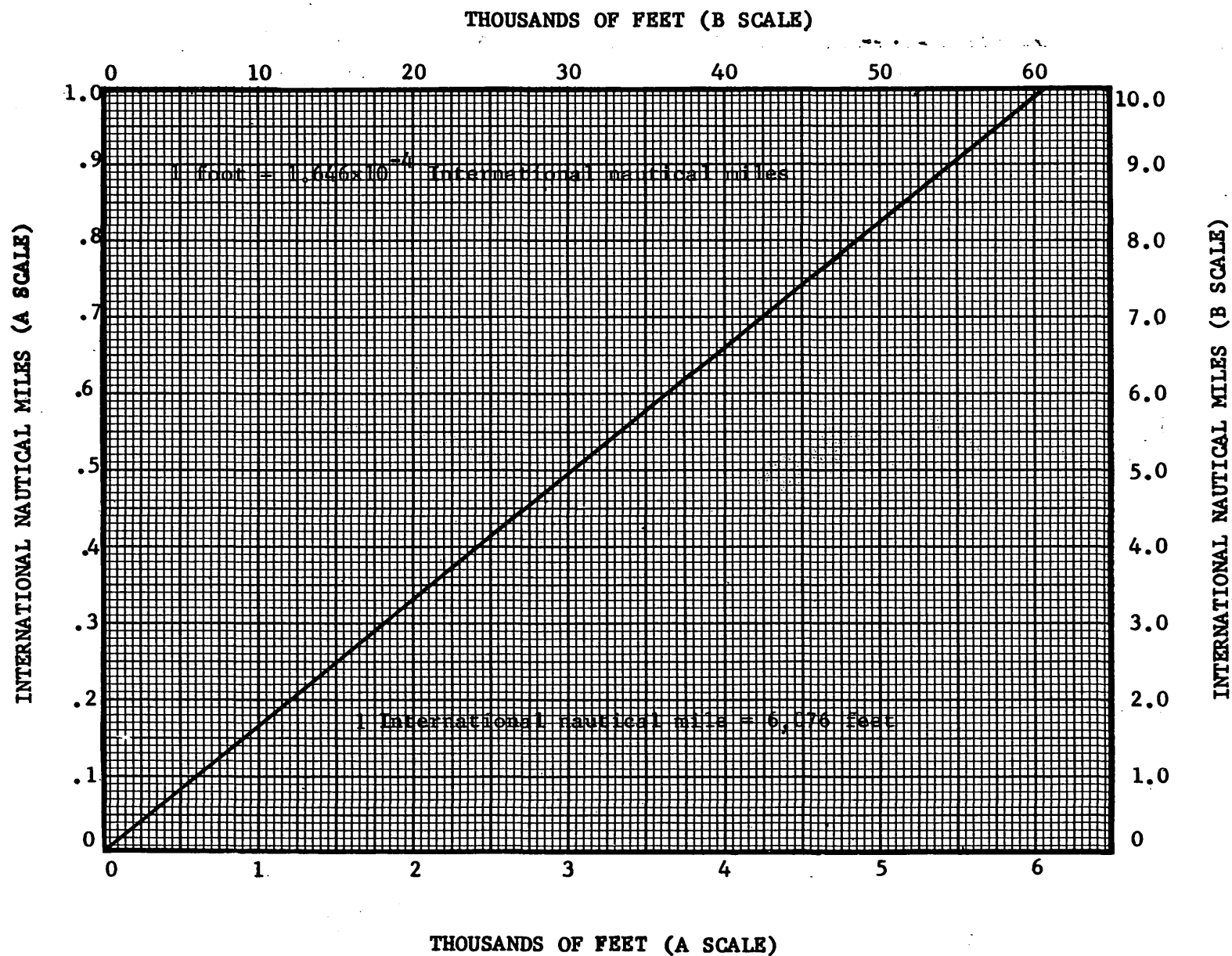
Adopted by NBS<sup>1</sup>

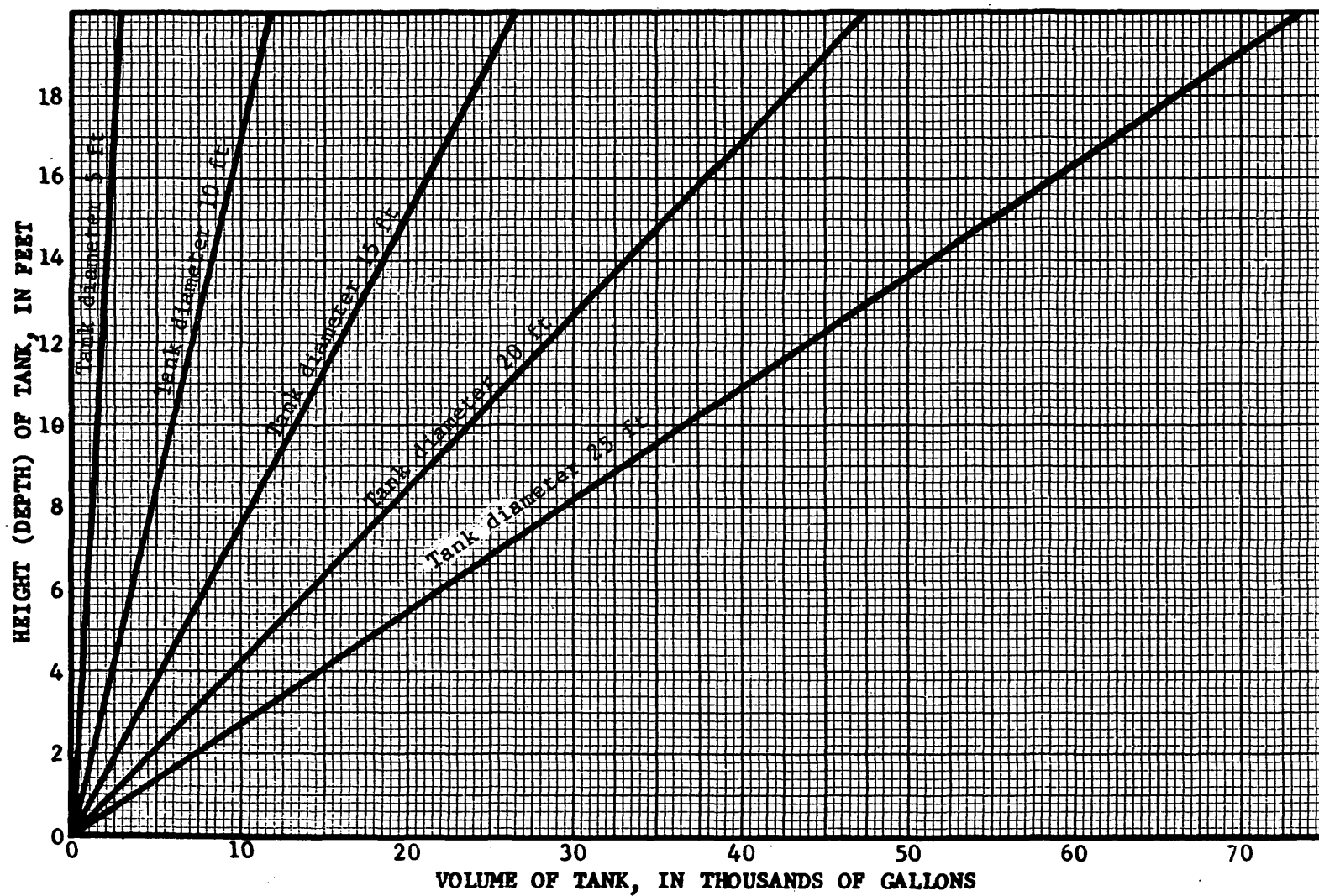
Constant	Sym- bol	Value	Est.* error limit	Unit			
				Système Intern. (MKSA)		Centimeter-gram- second (CGS)	
Speed of light in vacuum.....	<i>c</i>	2.997925	3	$\times 10^8$	m s <sup>-1</sup>	$\times 10^{10}$	cm s <sup>-1</sup>
Elementary charge.....	<i>e</i>	1.60210	7	$10^{-19}$	C	$10^{-20}$	cm <sup>1/2</sup> g <sup>1/2</sup> †
		4.80298	20	.....	.....	$10^{-10}$	cm <sup>3/2</sup> g <sup>1/2</sup> s <sup>-1</sup> ‡
Avogadro constant.....	<i>N<sub>A</sub></i>	6.02252	28	$10^{23}$	mol <sup>-1</sup>	$10^{23}$	mol <sup>-1</sup>
Electron rest mass.....	<i>m<sub>e</sub></i>	9.1091	4	$10^{-31}$	kg	$10^{-28}$	g
Proton rest mass.....	<i>m<sub>p</sub></i>	1.67252	8	$10^{-27}$	kg	$10^{-24}$	g
Faraday constant.....	<i>F</i>	9.64870	16	$10^4$	C mol <sup>-1</sup>	$10^3$	cm <sup>1/2</sup> g <sup>1/2</sup> mol <sup>-1</sup> †
Planck constant.....	<i>h</i>	6.6256	5	$10^{-34}$	J s	$10^{-27}$	erg s
Fine structure constant.....	$\alpha$	7.29720	10	$10^{-3}$	.....	$10^{-3}$	.....
Charge to mass ratio for electron.....	<i>e/m<sub>e</sub></i>	1.758796	19	$10^{11}$	C kg <sup>-1</sup>	$10^7$	cm <sup>1/2</sup> g <sup>-1/2</sup> †
		5.27274	6	.....	.....	$10^{17}$	cm <sup>3/2</sup> g <sup>-1/2</sup> s <sup>-1</sup> ‡
Rydberg constant.....	<i>R<sub>∞</sub></i>	1.0973731	3	$10^7$	m <sup>-1</sup>	$10^5$	cm <sup>-1</sup>
Gyromagnetic ratio of proton.....	$\gamma$	2.67519	2	$10^8$	rad s <sup>-1</sup> T <sup>-1</sup>	$10^4$	rad s <sup>-1</sup> G <sup>-1</sup> †
(Uncorrected for diamagnetism, H <sub>2</sub> O)...	$\gamma'$	2.67512	2	$10^8$	rad s <sup>-1</sup> T <sup>-1</sup>	$10^4$	rad s <sup>-1</sup> G <sup>-1</sup> †
Bohr magneton.....	$\mu_B$	9.2732	6	$10^{-24}$	J T <sup>-1</sup>	$10^{-21}$	erg G <sup>-1</sup> †
Gas constant.....	<i>R</i>	8.3143	12	$10^0$	J°K <sup>-1</sup> mol <sup>-1</sup>	$10^7$	erg°K <sup>-1</sup> mol <sup>-1</sup>
Boltzmann constant.....	<i>k</i>	1.38054	18	$10^{-23}$	J°K <sup>-1</sup>	$10^{-16}$	erg°K <sup>-1</sup>
First radiation constant (2 $\pi$ hc <sup>2</sup> ).....	<i>c<sub>1</sub></i>	3.7415	3	$10^{-16}$	W m <sup>2</sup>	$10^{-5}$	erg cm <sup>2</sup> s <sup>-1</sup>
Second radiation constant.....	<i>c<sub>2</sub></i>	1.43879	19	$10^{-2}$	m°K	$10^0$	cm°K
Stefan-Boltzmann constant.....	$\sigma$	5.6697	29	$10^{-8}$	W m <sup>-2</sup> °K <sup>-4</sup>	$10^{-5}$	erg cm <sup>-2</sup> s <sup>-1</sup> °K <sup>-4</sup>
Gravitational constant.....	<i>G</i>	6.670	15	$10^{-11}$	N m <sup>2</sup> kg <sup>-2</sup>	$10^{-8}$	dyn cm <sup>2</sup> g <sup>-2</sup>

\*Based on 3 std. dev., applies to last digits in preceding col. †Electromagnetic syst.

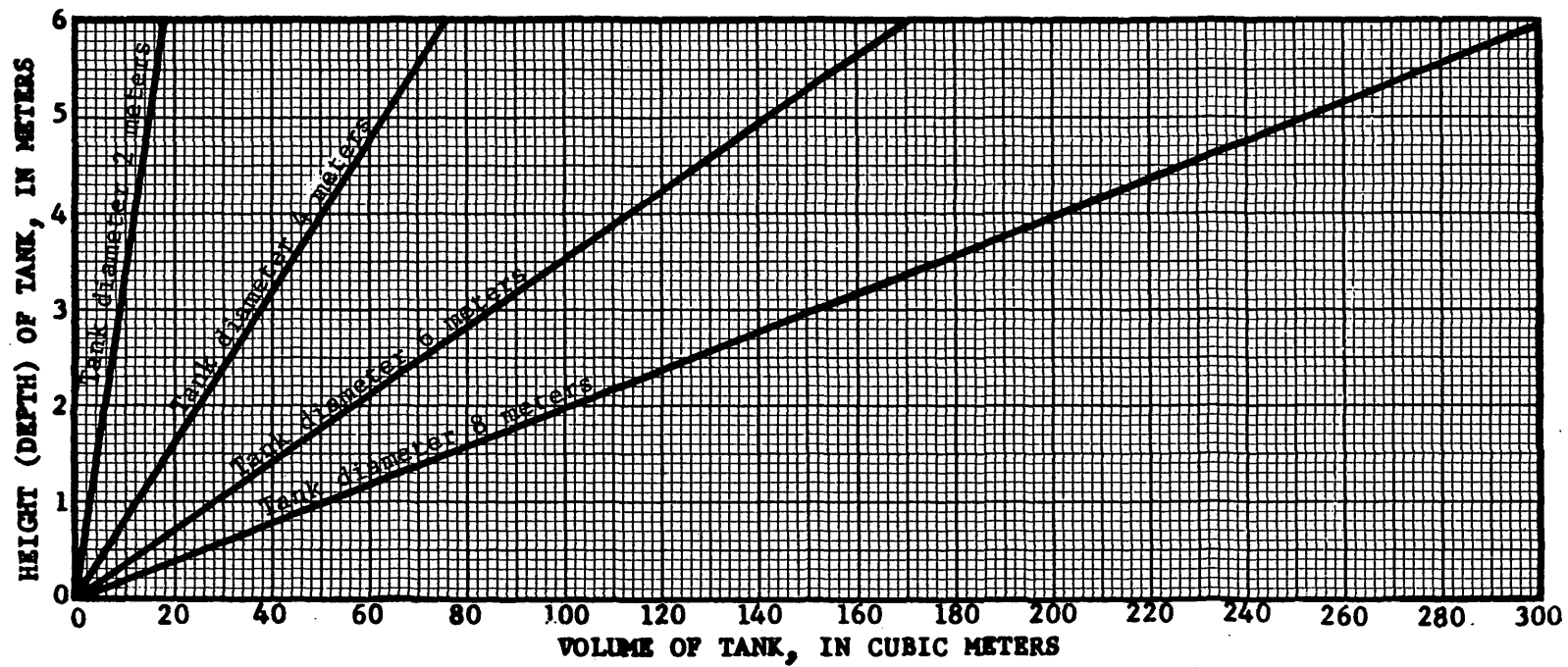
‡Electrostatic syst. <sup>1</sup>Reprinted from NBS Technical News Bulletin, Oct. 1963.





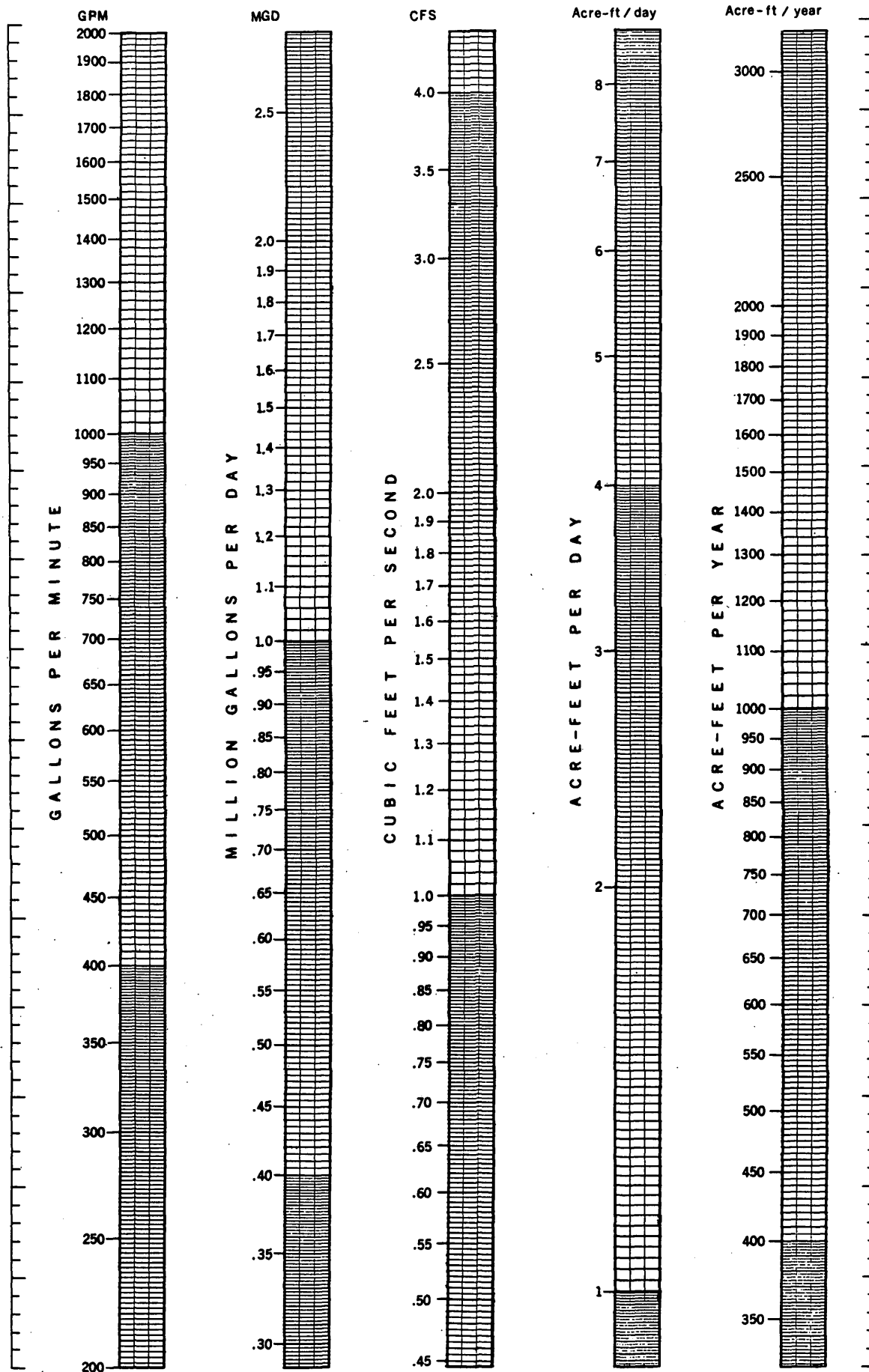


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June 1964



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June 1964





Nomograph for converting water-measurement units.

92596

# PIPE AND CASING

## Capacity of Standard Pipe

Nominal size (inches)	Diameters (inches)		Gallons per lin ft	Lin ft per gallon
	OD	ID		
4	4.500	4.026	.6613	1.5122
5	5.563	5.047	1.0391	.9624
6	6.625	6.065	1.5008	.6663
8	8.625	8.071	2.6577	.3763
8	8.625	7.981	2.5988	.3848
10	10.750	10.192	4.2382	.2359
10	10.750	10.136	4.1917	.2386
10	10.750	10.020	4.0963	.2441
12	12.750	12.090	5.9636	.1677
12	12.750	12.000	5.8752	.1702
14 OD	14.000	13.250	7.1629	.1396
15 OD	15.000	14.250	8.2849	.1207
16 OD	16.000	15.250	9.4885	.1054
17 OD	17.000	16.214	10.726	.0932
18 OD	18.000	17.182	12.045	.0830
20 OD	20.000	19.182	15.012	.0666

# WELL-SCREEN SLOT AND GAUZE DESIGNATION

Size of shutter-screen openings  
(Layne and Bowler, Inc.)

Slot number	Equivalent opening (inch)
1	0.205
2	.180
3	.155
4	.130
5	.105
6	.080
7	.055
8	.030

Size of screen openings  
(A. D. Cook, Inc.; E. E. Johnson, Inc.; and all other manufacturers)

Slot number	Equivalent opening (inch)	Gauze number
6	0.006	90
7	.007	80
8	.008	70
10	.010	60
12	.012	50
14	.014	
16	.016	
18	.018	40
20	.020	
25	.025	30
30	.030	
35	.035	20
40	.040	
50	.050	
60	.060	
70	.070	
80	.080	
100	.100	1/10 in.
125	.125	1/8 in.
187	.187	3/16 in.

# METRIC PREFIXES AND UNITS

PREFIXES	MEANING	FRACTION	DECIMAL
PICO-	= one-trillionth	$\frac{1}{1,000,000,000,000}$	.000000000001
NANO-	= one-billionth	$\frac{1}{1,000,000,000}$	.000000001
MICRO-	= one-millionth	$\frac{1}{1,000,000}$	.000001
MILLI-	= one-thousandth	$\frac{1}{1,000}$	.001
CENTI-	= one-hundredth	$\frac{1}{100}$	.01
DECI-	= one-tenth	$\frac{1}{10}$	.1
UNIT	= one	1	1
DEKA-	= ten	$\frac{10}{1}$	10
HECTO-	= one hundred	$\frac{100}{1}$	100
KILO-	= one thousand	$\frac{1,000}{1}$	1,000
MYRIA-	= ten thousand	$\frac{10,000}{1}$	10,000
MEGA-	= one million	$\frac{1,000,000}{1}$	1,000,000
GIGA-	= one billion	$\frac{1,000,000,000}{1}$	1,000,000,000
TERA-	= one trillion	$\frac{1,000,000,000,000}{1}$	1,000,000,000,000

Pressure Conversion Factors

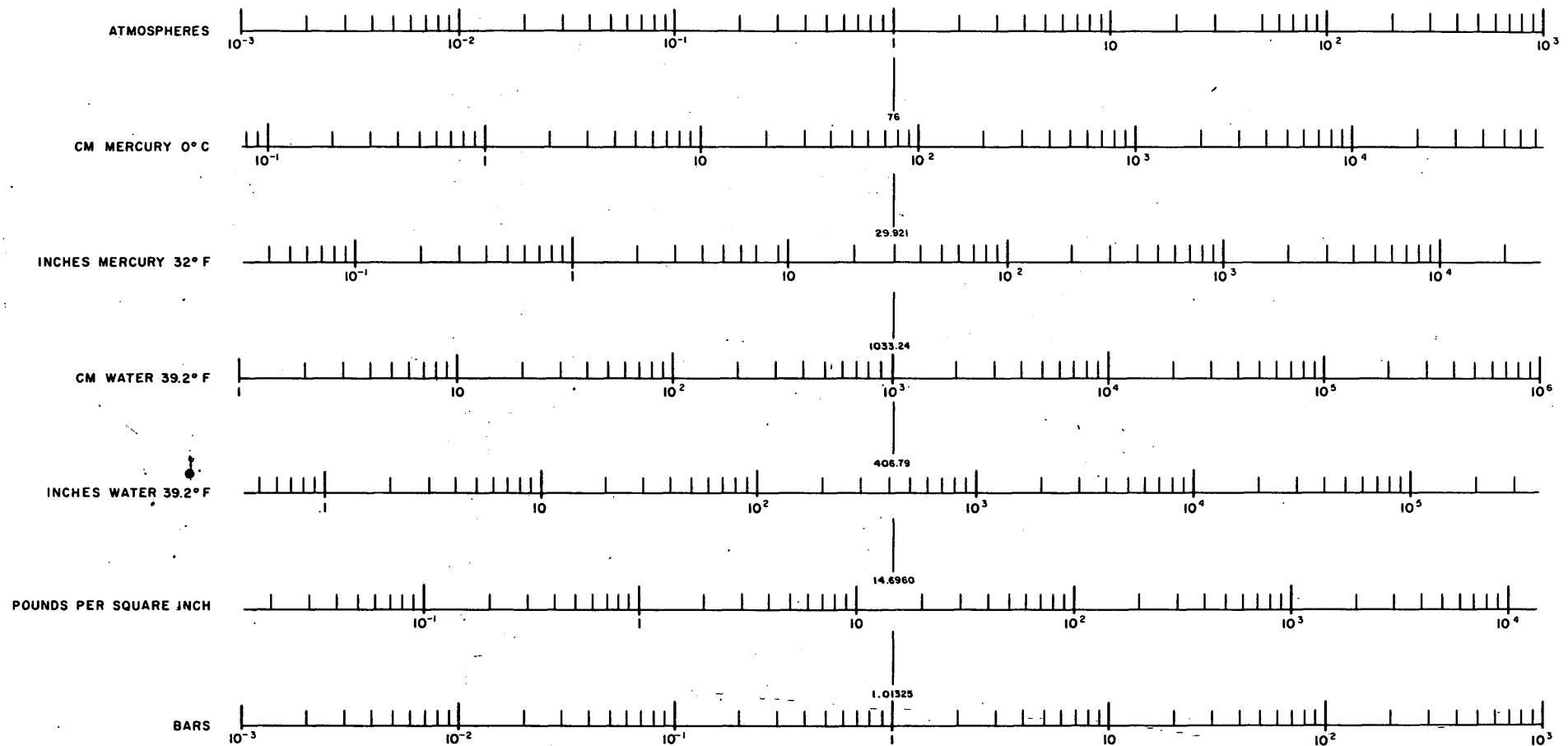
Taken or calculated (\*) from Zimmerman, O. T., and Lavine, Irvin, 1955, Conversion factors and tables: Industrial Research Service, Inc., Dover, N. H.

	atm	cm mercury	mm mercury	in. mercury	cm water	mm water	in. water	ft water	psi	bars
atm	1	76 (0°C)	760 (0°C)	29.921 (32°F)	1033.2487* (39.2°F)	10332.4867* (39.2°F)	406.79 (39.2°F)	33.899 (39.2°F)	14.6960	1.013250
cm mercury (0°C)	0.0131579	1	10* (0°C)	0.3937 (0°C)	13.5956* (39.2°F)	135.9563* (39.2°F)	5.3526* (39.2°F)	0.44605 (39.2°F)	0.193368	0.01333221
mm mercury (0°C)	0.001315789	0.1* (0°C)	1	0.03937 (0°C)	1.3596* (39.2°F)	13.5956* (39.2°F)	0.5353* (39.2°F)	0.044604 (39.2°F)	0.0193368	0.001333223
in. mercury (32°F)	0.0334211	2.54000508*	25.4000508 (0°C)	1	34.5376* (39.2°F)	345.3765* (39.2°F)	13.596* (39.2°F)	1.1330 (39.2°F)	0.491157	0.0338640
cm water (39.2°F)	0.00096779*	0.07355* (32°F)	0.73553* (32°F)	0.028958* (32°F)	1	10* (39.2°F)	0.3937* (39.2°F)	0.03281* (39.2°F)	0.014223*	0.000980616*
mm water (39.2°F)	0.00009678*	0.007355* (32°F)	0.07355* (32°F)	0.0028963* (32°F)	0.1* (39.2°F)	1	0.03937* (39.2°F)	0.003281* (39.2°F)	0.001422*	0.000098062*
in. water (39.2°F)	0.0024582	0.18683* (32°F)	1.86828* (32°F)	0.073554 (32°F)	2.54000508* (39.2°F)	25.4000508* (39.2°F)	1 (39.2°F)	0.0833333* (39.2°F)	0.0361265	0.00249077*
ft water (39.2°F)	0.0294990	2.24193 (0°C)	22.4193* (0°C)	0.882647 (32°F)	30.48006096* (39.2°F)	304.8006096* (39.2°F)	12* (39.2°F)	1 (39.2°F)	0.433518	0.0298899*
psi	0.0680457	5.17148 (0°C)	51.7148	2.03601 (32°F)	70.3099* (39.2°F)	703.0988* (39.2°F)	27.681 (39.2°F)	2.3067 (39.2°F)	1	0.0689473
bars	0.9869233	75.0062 (0°C)	750.062 (0°C)	29.530 (32°F)	1020.6858* (39.2°F)	10206.858* (39.2°F)	401.844* (39.2°F)	33.487 (60°F)	14.50385	1

Multiply unit at left by number in column to get unit at top of column.

(From Johnson, A. I., Morris, D. A., and Prill, R. C., 1961, Specific yield and related properties--An annotated bibliography: U.S. Geol. Survey open-file rept.)

NOMOGR.  
FOR COMPARISON OF  
PRESSURE VALUES



NOTE: TAKEN OR CALCULATED FROM: ZIMMERMAN, O.T. AND  
LAVINE, IRVIN, 1955, CONVERSION FACTORS AND TABLES: INDUSTRIAL  
RESEARCH SERVICE INC., DOVER, NEW HAMPSHIRE.

California Department of Water Resources  
Sacramento, Calif.