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Boating Tip #2: Nautical Formulas & Conversion Factors

Visibility

Distance to the horizon in nautical miles = 1.17 x (square root of your eye height)

Distance at which an object becomes visible = 1.17 x (square root of your eye height) + 1.17 x (square root of the height of the object)

Atmospheric Pressure

Atmospheric pressure at sea level = 14.7 psi

For each foot of water depth, pressure increases 0.445 psi

Pressure doubles every 33 feet

Example:

> Calculate pressure at a depth of 66'
> 66' x 0.445 psi / ft = 29.37 + 14.7 = 44.1 = 3 atmospheres

For each 1,000 feet in altitude, pressure decreases 1 foot of head or 0.433 psi, so at 2,000 feet above sea level, pressure would be 14.7 – 2 x 0.433 = 13.83

Barometric pressure

Average at sea level: 29.92 inches = 1013.2 millibars (range 950 mb – 1035 mb)
Inches of mercury x 33.86 = Millibars

Millibar ÷ 33.86 = Inches of mercury

Length

Statute mile = 5,280 feet

Nautical mile = 6,076 feet, 1 minute of latitude, 1/60 degree, 880 fathoms, 7.5 cables

League varies, but in U.S., Great Britain, France and Spain, 1 league = 6,075 yards, 18,225 feet, 5,555 meters, 3 nautical miles

Fathom = 6 feet, 1.83 meters

Meter = 3.281 feet, 0.547 fathoms

Cable = 120 fathoms, 720 feet

Speed conversion formulas

Nautical miles per hour (Knots) x 1.151 = Statute miles per hour
Statute miles per hour x 0.869 = Knots

Nautical miles per hour (Knots) x 1.852 = Kilometers per hour
Kilometers per hour x 0.540 = Nautical miles per hour (Knots)

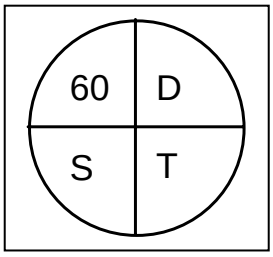
Statute miles per hour x 1.609 = Kilometers per hour
Kilometers per hour x 0.621 = Statute miles per hour

Nautical miles per hour (Knots) x 1.687 = Feet per second
Feet per second x 0.5925 = Nautical miles per hour (Knots)

Statute miles per hour x 1.467 = Feet per second
Feet per second x 0.682 = Statute miles per hour

Distance / Speed / Time Conversions

Distance = Speed x Time
Speed = Distance ÷ Time
Time = Distance ÷ Speed



60 D ST
Distance in knots
Speed in nautical miles per hour
Time in minutes

Speed = (60 x Distance) ÷ Time
Distance = (Speed x Time) ÷ 60
Time = (60 x Distance) ÷ Speed

Temperature Conversion

Fahrenheit to Celsius (F° - 32) ÷ 1.8 or F° - 32 x 5/9
Celsius to Fahrenheit (C° x 1.8) + 32 or C° x 9/5 + 32

Time

Day = 24 hours, 1,440 minutes, and 86,400 seconds

Time zones were standardized in 1883, with the prime meridian set at Greenwich, England. The earth was divided into 24 international time zones at each 15° of longitude. Each zone is one hour apart. Zones are sometimes altered due to geographic and political boundaries. Some states have modified their time zone boundaries, for example, Alaska, Texas, Michigan, Florida, and Indiana. Some countries, like China, have chosen to use only one time zone.

Time zones W of the prime meridian are "earlier" than Greenwich Mean Time (GMT). Greenwich Mean Time is also referred to as Universal Time (UTC). Times zones E of the prime meridian are "later" than GMT.

The International Date Line is an imaginary line directly opposite Greenwich at 180°. When traveling west, advance one day when you cross the International Date Line.

Daylight Savings Time is applied in many parts of the world to add an additional hour of daylight during parts of the year. Most countries observe Daylight Savings Time during their Summer months, but a few countries add an extra hour during their Winter months instead. In the U.S., Arizona, Hawaii and parts of Indiana do not observe Daylight Savings Time. In most of the United States, remember to:

Spring forward 1 hour the first Sunday in April
Fall back 1 hour the last Sunday in October

Longitude	Zone	Adjustment from UTC	Military / NATO	Cities / Countries
7° 30' W – 7° 30' E	Greenwich Mean Time Western European Time	0	Z Zulu	London
7° 30' W – 22° 30' W		-1	N November	Cape Verde
22° 30' W – 37° 30' W		-2	O Oscar	Azores
37° 30' W – 52° 30' W		-3	P Papa	Rio de Janeiro
52° 30' W	Newfoundland Standard Time	-3.5		St. Johns

52° 30’ W – 67° 30’ W	Atlantic Standard Time	-4	Q Quebec	Halifax
67° 30’ W – 82° 30’ W	Eastern Standard Time	-5	R Romeo	New York Havana
82° 30’ W – 97° 30’ W	Central Standard Time	-6	S Sierra	Chicago
97° 30’ W – 112 30’ W	Mountain Standard Time	-7	T Tango	Phoenix
112° 30’ W – 127’ 30’ W	Pacific Standard Time	-8	U Uniform	Los Angeles
127° 30’ W – 142° 30’ W	Alaska Standard Time	-9	V Victor	Anchorage
142° 30’ W – 157° 30’ W	Hawaii – Aleutian Standard Time	-10	W Whiskey	Honolulu
157° 30’ W – 172° 30’ W		-11	X X-ray	Midway
172° 30’ W – 180°	International Date Line	-12	Y Yankee	
172° 30’ E – 180°	International Date Line	+12	M Mike	Auckland
	Norfolk Island Time	+11.5		Norfolk Island
157° 30’ E – 172° 30’ E		+11	L Lima	
142° 30’ E – 157° 30’ E	Australian Eastern Standard Time	+10	K Kilo	Sydney
	Australian Central Standard Time	+9.5		Alice Springs
127° 30’ E – 142° 30’ E		+9	I India	Tokyo
112° 30’ E – 127° 30’ E	Australian Western Standard Time	+8	H Hotel	Perth China
97° 30’ E – 112° 30’ E	Christmas Island Time	+7	G Golf	Thailand
82° 30’ E – 97° 30’ E		+6	F Foxtrot	Bangladesh Rangoon
		+5.5		Delhi
67° 30’ E – 82° 30’ E		+5	E Echo	Karachi
52° 30’ E – 67° 30’ E		+4	D Delta	Oman
		+3.5		Teheran
37° 30’ E – 52° 30’ E		+3	C Charlie	Moscow Baghdad
22° 30’ E – 37° 30’ E	Eastern European Time	+2	B Bravo	Cairo, Helsinki Cape Town
7° 30’ E – 22° 30’ E	Central European Time	+1	A Alpha	Paris Rome

Note: There is no “J” or Juliet time zone. J is used to describe the current time for the observer.

Resistance to Capsizing Formula

Divide the boat’s gross tonnage in pounds by the constant 64, then take the cubed root of that number.

Divide the beam of the boat in feet and tenths of a foot by the number derived above. If the result is less than 2, the boat is relatively safe from capsize

Example:

Boat displaces 13 Gross Tons = 26,000 pounds
26,000 pounds ÷ 64 = 406.25
Cube root of 406.25 = 7.406
Beam = 12’ 11” = 12.916’
12.916’ ÷ 7.406 = 1.74
1.74 is < 2

Boat Displacement: Length Ratio Formula

Divide the LWL by 100, then cube the result

Divide the resulting number by the boat’s displacement in gross tons

Example:

34.9’ ÷ 100 = 0.349
$(0.349)^3$ = 0.0425
13 Gross Tons ÷ 0.0425 = 305.9

Number	Result
> 380	Very heavy displacement boat
320 – 380	Heavy displacement boat
250 – 320	Medium displacement boat
120 – 250	Light displacement boat
50 – 120	Very light displacement boat
< 50	Ultra light displacement boat

Maximum Hull Speed

1.34 x the square root of the LWL (waterline length)

Larger displacement sailboats can usually travel faster than smaller boats because hull speed depends on the length of the boat's waterline and the volume of water displaced. Resistance increases as speed increases. At optimum speed the bow and stern wakes combine to form a single wake or wave. Theoretically, a sailboat cannot travel faster than the wave created, and wave speed is 1.34 times the square root of the distance between wave crests. Wave length increases proportionally to wave height. So the higher the wave created, the greater the distance between crests, the faster the wave travels. As sailboat speed increases, a greater volume of water has to be displaced, the bow wave increases in height, the distance between crests increases, and boat speed increases. It is only possible to exceed hull speed, if the sailboat, because of its design (some fin keel and centerboard designs), is capable of planing along the water surface, or by sailing downwind and surfing down the front of a wave.

Beaufort Scale for Measuring Wind Speed

Beaufort Number	Description	Wind Speed
0	Calm	< 1 mph
1	Light air	1 - 3
2	Light breeze	4 -7
3	Gentle breeze	8 -12
4	Moderate breeze	13 - 18
5	Fresh breeze	19 - 24
6	Strong breeze	25 - 31
7	Moderate gale	32 - 38
8	Fresh gale	39 - 46
9	Strong gale	47 - 54
10	Whole gale	55 - 63
11	Storm	64 - 75
12	Hurricane	> 75 mph

Sea Watches

Time	Watch
1200 – 1600	Afternoon watch
1600 – 1800	First dog watch
1800 – 2000	Second dog watch
2000 – 2400	First night watch
0000 – 0400	Middle watch
0400 – 0800	Morning watch
0800 – 1200	Forenoon watch