

The Equivalent Time Algorithm

The Chester-le-Street ASC Time Converter, which is accessible online and within the Chester-le-Street ASC Online Membership System uses the British Swimming/SPORTSYSTEMS Equivalent Time Algorithm.

This document provides a high-level technical description of the operation of the the `clsasc/equivalent-time` package. It does not go into details of specific implementation of the algorithm. For that, visit the documentation on GitHub.

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1 How it works

1.1 In brief

Put simply, the converter converts the time to 50 metres, if it is not already and then converts it to the required course length. This is required to normalize the time.

2 Equations

These are the equations used behind the scenes in the time converter. They are shown as detailed in the specification, but we've formatted them using \LaTeX to make them look clearer.

If you wish, you can use these equations and data tables (next section) to convert times manually. Because there are a number of steps involved, it's usually best to just leave this to a computer program.

2.1 Conversion to 50m Time

$$longCourseTime = \frac{sourceTime + \sqrt{sourceTime^2 + 4 \times poolMeasure \times turnFactor \times numTurnFactor}}{2 \times poolMeasure}$$

Where $sourceTime \in \mathbb{R}$.

It follows that $longCourseTime \in \mathbb{R}$. The system provides methods for getting converted times as both real numbers and in a traditional time format (a string).

You may have noticed that the equation for converting a time to long course is of a similar form to the quadratic formula,

$$time = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

Except that there is no $-b$ and no negative square root in the equation. This is because you cannot have a negative time for an event.

2.2 Conversion to requested course length

$$distanceTime = longCourseTime \times poolMeasure$$

$$turnTime = turnValue \times \frac{imperialDistance}{100} + (turnsPerHundred - 1)$$

$$convertedTime = distanceTime \times turnTime + 0.05$$

$$result = \frac{\lfloor convertedTime \times 10 \rfloor}{10}$$

3 Required Data

This section describes the required data used by time converter. It explains variables and how to calculate them or contains lookup tables which contain the values required.

3.1 poolMeasure

The poolMeasure is a real number (\mathbb{R}) which is specified for each event. The number is not calculated but is specified in the algorithm. The Chester-le-Street-ASC/EquivalentTime package contains a PoolMeasure class which provides a static function, which when called with a valid pool course length and event string returns a poolMeasure value.

Pool Measures are as follows

Table 1: Pool measure lookup table.

Pool Course Length	Event	Pool Measure
20m	All Events	1
25m	All Events	1
33 $\frac{1}{3}$ m	All Events	1
50m	All Events	1
27 $\frac{1}{2}$ y	All Events	1.006041
36 $\frac{2}{3}$ y	All Events	1.006041
20y	50m Events	0.91147
25y	50m Events	0.91147
33 $\frac{1}{3}$ y	50m Events	0.91147
20y	100m Freestyle	0.91087
25y	100m Freestyle	0.91087
33 $\frac{1}{3}$ y	100m Freestyle	0.91087
20y	200m Freestyle	0.91157
25y	200m Freestyle	0.91157
33 $\frac{1}{3}$ y	200m Freestyle	0.91157
20y	400m Freestyle	0.91197
25y	400m Freestyle	0.91197
33 $\frac{1}{3}$ y	400m Freestyle	0.91197
20y	800m Freestyle	0.91217
25y	800m Freestyle	0.91217
33 $\frac{1}{3}$ y	800m Freestyle	0.91217
20y	1500m Freestyle	1.004155
25y	1500m Freestyle	1.004155
33 $\frac{1}{3}$ y	1500m Freestyle	1.004155
20y	100m Breaststroke	0.90895
25y	100m Breaststroke	0.90895
33 $\frac{1}{3}$ y	100m Breaststroke	0.90895
20y	200m Breaststroke, 100 Butterfly	0.91097
25y	200m Breaststroke, 100 Butterfly	0.91097
33 $\frac{1}{3}$ y	200m Breaststroke, 100 Butterfly	0.91097
20y	200m Butterfly	0.91177
25y	200m Butterfly	0.91177
33 $\frac{1}{3}$ y	200m Butterfly	0.91177
20y	100m Backstroke	0.91187
25y	100m Backstroke	0.91187
33 $\frac{1}{3}$ y	100m Backstroke	0.91187
20y	200m Backstroke	0.91247
25y	200m Backstroke	0.91247
33 $\frac{1}{3}$ y	200m Backstroke	0.91247
20y	200m Individual Medley	0.90443
25y	200m Individual Medley	0.90443
33 $\frac{1}{3}$ y	200m Individual Medley	0.90443
20y	400m Individual Medley	0.91046
25y	400m Individual Medley	0.91046
33 $\frac{1}{3}$ y	400m Individual Medley	0.91046

3.2 poolLengthFlag

The poolLengthFlag is used in some time conversions only. It is used to group certain types of pool course length together.

Table 2: Pool length flag lookup table.

Pool Course Length	Pool Length Flag
20m	1
25m	1
$33\frac{1}{3}$ m	1
50m	1
$36\frac{2}{3}$ y	2
$27\frac{1}{2}$ y	2
20y	3
25y	3
$33\frac{1}{3}$ y	3

3.3 turnFactor

The turnFactor is a real number (\mathbb{R}) that is specified in the algorithm for each event. The package contains a Turns class which provides a static function to get the turnFactor for an event.

Table 3: Turn Factor lookup table.

Event	Turn Factor
50 Free, 100 Free	42.245
200 Free	43.786
400 Free	44.233
800 Free	45.525
1500 Free	46.221
50 Breast, 100 Breast	63.616
200 Breast	66.598
50 Fly, 100 Fly	38.269
200 Fly	39.76
50 Back, 100 Back	40.5
200 Back	41.98
200 IM	49.7
400 IM	55.366

3.4 turnsPerHundred

The number of turns per hundred depends on the length of the pool. For example in a 50m pool, the number of turns per hundred is 1, in a $33\frac{1}{3}$ m pool it is 2 and in a 25m pool it is 3. It is possible to calculate turnsPerHundred, but as with poolMeasure and turnFactor, we just use a function to return the value given a pool course length string.

Table 4: Turns per hundred lookup table.

Pool Course Length	Turns per hundred
50m	1
33 $\frac{1}{3}$ m	2
36 $\frac{2}{3}$ y	2
33 $\frac{1}{3}$ y	2
20m	3
25m	3
27 $\frac{1}{2}$ y	2
20y	4
20m	4

3.5 numTurnFactor

The numTurnFactor is used as part of taking into consideration the number of turns per hundred.

$$numTurnFactor = \frac{distance}{100} \times \frac{imperialDistance}{100} \times (turnsPerHundred - 1)$$

3.6 turnValue

The turnValue is a value which relates turnFactor, distance and longCourseTime.

$$turnValue = \frac{turnFactor}{longCourseTime} \times \frac{distance}{100}$$

3.7 imperialDistance

The imperialDistance is a special case used when converting 1500 events in a pool measured in yards. Normally $imperialDistance = distance$ but in this special case $imperialDistance = 1650$.

The $imperialDistance = 1650$ when $distance = 1500$ and $poolLengthFlag = 3$.

4 Permitted Conversions

For most events, you can convert from all pool course lengths to all other pool course lengths. The main exceptions cover the Individual Medley (IM) and distance events, especially when pools measured in yards are considered.

Whether a conversion is allowed or not depends on the length of the pool that the time was swam in.

Table 5: Allowed for source pool lookup table.

Source Pool Course Length	Event	Allowed
50 Free	50m	Allowed
50 Free	25m	Allowed
50 Free	27 $\frac{1}{2}$ y	Allowed
50 Free	25y	Allowed
50 Free	20y	Forbidden

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Source Pool Course Length	Event	Allowed
50 Free	20m	Forbidden
50 Free	$33\frac{1}{3}$ y	Forbidden
50 Free	$36\frac{2}{3}$ y	Forbidden
50 Free	$33\frac{1}{3}$ m	Forbidden
100 Free	All pools	Allowed
200 Free	All pools	Allowed
400 Free	All pools	Allowed
800 Free	All pools	Allowed
1500 Free	All pools except $33\frac{1}{3}$ y and 20y	Allowed
50 Breast	50m	Allowed
50 Breast	25m	Allowed
50 Breast	$27\frac{1}{2}$ y	Allowed
50 Breast	25y	Allowed
50 Breast	20y	Forbidden
50 Breast	20m	Forbidden
50 Breast	$33\frac{1}{3}$ y	Forbidden
50 Breast	$36\frac{2}{3}$ y	Forbidden
50 Breast	$33\frac{1}{3}$ m	Forbidden
100 Breast	All pools	Allowed
200 Breast	All pools	Allowed
50 Fly	50m	Allowed
50 Fly	25m	Allowed
50 Fly	$27\frac{1}{2}$ y	Allowed
50 Fly	25y	Allowed
50 Fly	20y	Forbidden
50 Fly	20m	Forbidden
50 Fly	$33\frac{1}{3}$ y	Forbidden
50 Fly	$36\frac{2}{3}$ y	Forbidden
50 Fly	$33\frac{1}{3}$ m	Forbidden
100 Fly	All pools	Allowed
200 Fly	All pools	Allowed
50 Back	50m	Allowed
50 Back	25m	Allowed
50 Back	$27\frac{1}{2}$ y	Allowed
50 Back	25y	Allowed
50 Back	20y	Forbidden
50 Back	20m	Forbidden
50 Back	$33\frac{1}{3}$ y	Forbidden
50 Back	$36\frac{2}{3}$ y	Forbidden
50 Back	$33\frac{1}{3}$ m	Forbidden
100 Back	All pools	Allowed
200 Back	All pools	Allowed
200 IM	All pools	Allowed
400 IM	All pools	Allowed