MENTAL MATHEMATICS

FOR

MARITIME WARFARE OFFICERS, PILOTS & AVIATION WARFARE OFFICERS

This document is provided as a guide to assist potential Maritime Warfare, Pilot or Aviation Warfare Officers to prepare for the mental maths they will be required to utilise in their role within the Royal Australian Navy. Full training on all aspects of the job will be provided to applicants but this document enables candidates to gain insight into the role in order to assess whether they have an aptitude for the role.

Junior Warfare Officers on application courses will be expected to perform mental mathematics calculations in situations when there would appear to be very little time to spare. To those unpractised in the techniques contained in this guide, it seems as though their supervisor is simply trying to distract them from the task at hand. However, far from being a distraction, the rapid and accurate application of mental mathematics on the bridge of a warship or the cockpit of an aircraft significantly improves safety and amplifies the effectiveness of the Officer of the Watch (OOW), Aviation Warfare Officer or Pilot. It is intended that the following guidance should demonstrate the ease with which junior warfare officers at every stage of their careers can perform a host of calculations that will not only result in safer navigation and collision avoidance, but which will also make the task of navigating much easier.

The mental mathematics techniques in this guide require no more knowledge than the ability to conduct basic arithmetic and apply the sine and radian rules. It is, however, absolutely vital that potential Maritime Warfare, Pilot or Aviation Warfare Officers develop their arithmetic skills. The faster your arithmetic, the faster you will arrive at the correct solution and take action, and the more time you will have to perform other tasks and providing timely contact reports to the Commanding Officer (CO).

Mental mathematics also requires practice to improve speed. With practice, it will not be long before many of the answers jump into your head before you are even aware of how you performed the calculation. If you can master the following mental mathematics techniques you will be able to perform almost any of the basic navigation calculations required by Maritime Warfare, Pilot or Aviation Warfare Officers.

BASIC SPEED/TIME/DISTANCE CALCULATIONS

The most common and basic mental mathematics skill for navigation is the ability to perform speed/distance calculations. It is no coincidence that most Navigators conduct pilotage at certain speeds—as you will see; we do this to make our maths easier. 1 cable = 200 yards and 10 cables = 1 nautical mile (NM). For speed, navigators use knots (rather than km/hr). Knots is a measurement of NM/hr.

1.1 DISTANCE TRAVELLED IN A GIVEN TIME

The most basic speed/distance calculation is the one that determines how far you will travel at a certain speed in a given time. This is most commonly used to determine a Dead Reckoning (DR) or Estimated Position (EP) distance for periods of 6, 3 or 1 minute, and has given rise to the '6-3-1 minute' rule that states that you will travel:

- $^{1}/_{10}$ the distance in nautical miles of the speed in knots every 6 minutes
  eg. 1.8nm or 18 cables in 6 minutes at 18 knots

- The same distance in hundreds of yards as the speed in knots every 3 minutes
  eg. 1800 yards in 3 minutes at 18 knots

- The same distance in hundreds of feet as the speed in knots every minute
  eg. 1800 feet in 1 minute at 18 knots
  (or divide Sp 18 by 3 to get **6**000 yards in **1** minute)

For all other times it is necessary to conduct a quick calculation to determine what fraction of the hour your given time period represents. As 15 minutes is ¼ of an hour you will travel ¼ of the distance in nautical miles of the speed in knots in 15 minutes. The way you break this down for any given speed is up to you, but it is often simplest to choose a convenient time period and then multiply or divide it.

Example 1: How far will you travel in 15 minutes at 18 knots?

15 minutes is ¼ of an hour. Therefore you will travel 18 × ¼ = 4½nm

It may be easier for some people though to say that:

- In 30 minutes you will travel 18 ÷ 2 = 9nm
- In 15 minutes you will travel 9 ÷ 2 = 4½nm

1.2 TIME TAKEN (IN SECONDS) TO TRAVEL 1 CABLE AT A GIVEN SPEED

$$\text{TIME} = \frac{360}{\text{SPEED}}$$

The easiest way to use this equation is to divide 36 by the speed and add a zero at the end.

Example 2: 36 ÷ 8 = 4½ → 360 ÷ 8 = 45 → 1 cable takes 45 seconds at 8 knots

Example 3: 36 ÷ 18 = 2 → 360 ÷ 18 = 20 → 1 cable takes 20 seconds at 18 knots

Example 4: 36 ÷ 24 = 1½ → 360 ÷ 24 = 15 → 1 cable takes 15 seconds at 24 knots

By planning to conduct a pilotage at a speed that can be easily divided into 36 you can make your mental maths much easier. It can actually be easier to conduct pilotage at 18 knots than at 14 knots!

Note that at 12 knots it takes ½ minute to travel 1 cable. Therefore it is very simple to determine how long it takes to travel any number of cables at that speed—all you have to do is halve the number of cables! For 6 knots you don't even need to do that because it takes 1 minute per cable!

Example 5: 28 cables (2.8nm) at 12 knots

28 ÷ 2 = 14	→ 2.8 nm takes 14 minutes at 12 knots

Example 6: 13.5 cables (1.35nm) at 6 knots

13.5 ÷ 1 = 13.5	→ 1.35nm takes 13½ minutes at 6 knots

1.3 TIME TAKEN (IN MINUTES) TO TRAVEL 1 NM AT A GIVEN SPEED

$$\text{TIME} = \frac{60}{\text{SPEED}}$$

Example 7: 60 ÷ 10 = 6 → 1nm takes 6 minutes at 10 knots

Example 8: 60 ÷ 15 = 4 → 1nm takes 4 minutes at 15 knots

Example 9: 60 ÷ 20 = 3 → 1nm takes 3 minutes at 20 knots

A common method employed to make this calculation easier is to visualise an analogue clock face. Using example 8 we can see that 15 minutes (¼ of an hour) goes into the clock face 4 times. Therefore it takes 4 minutes to travel 1nm at 15 knots. For this reason, this rule is sometimes referred to as the 'Clockface Rule'.

This is also the technique used to determine that you travel $^{1}/_{10}$ of the speed in 6 minutes.

1.6 SPEED REQUIRED TO ACHIEVE AN ARRIVAL TIME

During pilotage it is important to achieve key timings in order to berth at the appointed time. Rather than guessing your required speed at any given point, it is possible to quickly calculate the speed increase or decrease that will achieve your planned ETA or wheelover time.

$$\%\ \text{SPEED ALTERATION} = \frac{\text{TIME DISCREPANCY}}{\text{PLANNED TIME REMAINING TO WAYPOINT}}$$

Example 1: You have planned to arrive at your next wheelover point at 0924. At 0914 you have 2.6nm to wheelover and your planned speed for this leg is 12 knots. What speed must you make good to get back on schedule?

At 12 knots it takes 13 minutes to travel 2.6nm. Therefore, at your planned speed you would arrive at wheelover at 0927. This is a time discrepancy of 3 minutes from your planned wheelover time of 0924 which is now only 10 minutes away.

3 ÷ 10 = 0.3 → Now, 0.1 x 12 = 1.2 and 1.2 x 3 = 3.6 knots.

Therefore, you must increase your speed by 3.6 knots (15.6 knots) to regain your timings by the next waypoint. As it takes time for the speed to actually come on, it would be probably be prudent to increase to 18 knots and continue to monitor your progress.

The easiest way to facilitate the use of this technique during pilotage is to note the planned time or the planned time remaining (as a 'T-minus' time) to each waypoint or to the start of the ship handling phase for a berthing/anchorage so that you can quickly determine the time discrepancy and the time remaining at your planned speed. All that is left to do is divide one by the other and apply the result to your planned speed.