Yr08 - Number

NAME		DATE	

A Lightening Rule of Thumb
Criterion D Assessment

Rules of thumb are rough estimates for calculating measurements. The phrase originates from carpenters who used their thumbs to approximately measure the width of pieces of wood they were working with.

Some examples of these are:

- Twice round the neck is once round the waist
- 72 divided by the current interest rate will tell you the number of years for an investment to double
- When serving food, two handfuls makes a portion

Rules of thumb are obtained by making comparisons.

Part 1
People often like to estimate how far away a storm is by counting how many seconds it is between when they see the lightning flash and when they hear the thunder. Not everyone estimates this in the same way.

Ada and Iris are together during a thunderstorm and decide to try and estimate how far away it is.

The lightning flashes and they count 20 seconds before they hear the thunder.

Ada says the storm is 10 kilometres away, but Iris disagrees as usual and says it is 5 kilometres away.

Write a rule of thumb for **both** Ada and Iris explaining how they calculated their estimates of the distance.

Use the information below to help.

1 kilometre is 1000 metres

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Part 2
It is generally accepted that the speed of sound is 343 metres per second in dry air at 20ºC.

Use this information to **write your own** rule of thumb for estimating the distance of a storm by counting the seconds between the lightning flash and the thunder, explaining any strategies you have used.

How far away do you think the storm was when Ada and Iris counted 20 seconds?

How accurate do you think your estimate is and does it make sense? Try and justify your reasoning.

Criterion D - Applying mathematics in real-life contexts

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1 - 2	The student is able to: **i.** **identify** some of the elements of the authentic real-life situation **ii.** **apply** mathematical strategies to find a solution to the authentic real-life situation, with limited success.
3 - 4	The student is able to: **i.** **identify** the relevant elements of the authentic real-life situation **ii.** **apply** mathematical strategies to reach a solution to the authentic real- life situation **iii.** **state**, but not always correctly, whether the solution makes sense in the context of the authentic real-life situation.
5 - 6	The student is able to: **i.** **identify** the relevant elements of the authentic real-life situation **ii.** **select** adequate mathematical strategies to model the authentic real-life situation **iii.** **apply** the selected mathematical strategies to reach a valid solution to the authentic real-life situation **iv.** **describe** the degree of accuracy of the solution **v.** **state** correctly whether the solution makes sense in the context of the authentic real-life situation.
7 - 8	The student is able to: **i.** **identify** the relevant elements of the authentic real-life situation **ii.** **select** adequate mathematical strategies to model the authentic real-life situation **iii.** **apply** the selected mathematical strategies to reach a correct solution to the authentic real-life situation **iv.** **explain** the degree of accuracy of the solution **v.** **describe** correctly whether the solution makes sense in the context of the authentic real-life situation.

A Solution

Part 1

The lightning flashes and they count 20 seconds before they hear the thunder.

Ada says the storm is 10 kilometres away, and Iris says it is 5 kilometres away.

Write a rule of thumb for **both** Ada and Iris explaining how they calculated their estimate of the distance.

Rule of thumb for Ada

$$\begin{aligned} speed &= \frac{distance}{time} \\ &= \frac{10km}{20s} \\ &= \frac{10000m}{20s} \\ &= 500m/s \end{aligned}$$

From this, I would suggest Ada's rule of thumb is that the speed of sound is 500m/s.

Rule of thumb for Iris

$$\begin{aligned} speed &= \frac{distance}{time} \\ &= \frac{5km}{20s} \\ &= \frac{5000m}{20s} \\ &= 250m/s \end{aligned}$$

From this, I would suggest Iris' rule of thumb is that the speed of sound is 250m/s.

For the girls to make their estimates I think they already knew from their physics teacher Mr McIntyre, and then used, the relationship between speed, distance and time. From my calculations, it would seem Ada and Iris then went and based their estimates on their own reckoning that the speed of sound was 500m/s and 250m/s respectively. I think the units for the speeds of sound they used are in m/s since these are easier to work with than km/s and also because they are the common convention for describing the speed of sound. I certainly did so in Part 2 because of these reasons.

Part 2

It is actually recognised that the speed of sound is 343 metres per second in dry air at 20ºc.

Use this further information to **write your own** rule of thumb for estimating the distance of a storm by counting the seconds between the lightning flash and the thunder, explaining any strategies you have used.

My rule of thumb

$$\text{If } speed = \frac{distance}{time}, \text{ then}$$

$$distance = speed \times time$$

$$distance = 350m/s \times time$$

where distance is measured in metres, time in seconds and speed m/s.

Before making my rule of thumb, I needed to rearrange the speed, distance time equation and then rounded the given value for the speed of sound up to the nearest 50m to make future estimates less complicated.

How far away do you think the storm was when Ada and Iris counted 20 seconds?

According to my rule of thumb, the storm would be 7000m (7km) away. My working for this is below.

$$\begin{aligned} distance &= speed \times time \\ distance &= 350m/s \times 20s \\ &= 7000m \end{aligned}$$

How accurate do you think your estimate is and does it make sense? Try and justify your reasoning.

I'm not entirely sure about the accuracy of my estimate and this is for a number of reasons. Firstly, I have rounded the given value of the speed of sound from the one given. Since I have rounded it up, the estimate will be higher than the one found using the exact value. Secondly, the value for the speed of sound given in the task is taken from a secondary data source and may therefore be unreliable. Finally, and perhaps most significantly, is that the the assumed speed of sound I have worked with is one which occurs in dry air at 20°c. The condition of dry air is certainly unlikely to be true in the advent of a storm. Alongside this, the assumption that Ada and Iris are in a location where the air temperature is 20°c is also one which could cause any estimates to be flawed, let alone mine.

Despite all this, based on the information given in this assessment, I would suggest my estimate for Part 2 does still make sense. This is because my own rule of thumb used a value for the speed of sound which lies between those used by Ada and Iris in Part 1 and went on to predict a distance of 7000m in Part 2, which itself lies between Ada and Iris' own estimates.