STUDENT WORKSHEETS

In Parts 1 and 2, you will investigate the information in *Grandpa’s Story* and construct tables of information that will be used later in the problem.

**Part 1**
Work with a group of five to form a bucket brigade.

You will need:
- a stopwatch
- a bucket
- a water source
- a large container to receive the buckets of water, and
- some way of measuring distance or estimating it accurately.

- Your task will be to find out how long – on average – it takes to pass a fairly full bucket of water along the length of the brigade and to empty it into a container at the other end. (Imagine that this container represents the fire.)

Write the results on the first line of this table.

<table>
<thead>
<tr>
<th>Number of people in the brigade</th>
<th>Length of the brigade (metres)</th>
<th>How long it took (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- After experimenting as a brigade of five members, join up with another group to make ten members. Now find the average time it takes to move a bucket of water along the longer brigade. Record your results in the above table.
- Now make a brigade of 15 members and find the average time it takes to move a bucket of water along this brigade. Record your results in the above table.
• In the space below, work out the average speed a bucket takes to travel along a bucket brigade. Give this rate using a unit such as metres per second or seconds per 10 metres, and round off your answer sensibly.

What do you notice?

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How full should the bucket be to cut spillage?
How long before people slowed down because they got tired?
Part 2

In this part you will investigate ‘Mack’s Rule’ given the two pieces of data from Grandpa’s Story.

You should try to do this on your own.

- **Fill in the missing values in this table. The extra 20 minutes (between 10 minutes and 30 minutes) needs an extra 100 buckets.**

<table>
<thead>
<tr>
<th>Time in minutes from the siren to the first bucket hitting the fire</th>
<th>$T$</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of buckets needed to put out the fire</td>
<td>$B$</td>
<td>75</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **In the box below use algebra to write Mack’s Rule for how many buckets are needed. Remember that it has to work for every value of $B$ and $T$ – not just one or two!**
What I did

How many buckets would be needed to put out a fire that had been burning for 23 minutes? .................
Part 3

Before you can make sense of the table below you need to work out exactly how long the fire has been burning before the first bucket is thrown.

There are two things to consider here:

• the distance in metres from the water source to the fire. We’ll call this $d$.
• the time it takes for the first bucket to be passed from the water source along the brigade and be thrown on the fire. We’ll call this $t(i)$.

• Use your results from Part 1 to invent a formula for finding $t(i)$ in seconds if you know $d$ in metres. Write it in this box.

$t(i) = \quad$

• Now use this formula to fill in the missing values in this table.

<table>
<thead>
<tr>
<th>Distance in metres from the water source to the fire ($d$)</th>
<th>10</th>
<th>25</th>
<th>48</th>
<th>87</th>
<th>123</th>
<th>156</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time in seconds for the first bucket to be passed along and thrown on the fire: $t(i)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The fire also burns between the time the siren is blown and when the truck arrives at the fire.

<table>
<thead>
<tr>
<th>Distance in kilometres from the post office to the fire</th>
<th>$D$</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time taken to reach the fire</td>
<td>$T\ (ii)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Write the formula for finding $t\ (ii)$ if you knew the value of $D$.**

$t\ (ii) =$
Part 5
Now you have to put together all of the rules and algebra you have done so far in order to predict the number of buckets it would take to put out some other fires.

- Work out the values of $D$, $d$, $t\,(i)$ and $t\,(ii)$ from the description of each fire, using your formulas where you need to.
- Write these into the table below.
- Work out the total time taken from the sounding of the siren until the first bucket is thrown on the fire. Call it $T$.
- Then use your formula for Mack’s Rule to find $B$, the number of buckets the brigade would need to use in order to put out the fire.
- Show how you worked these out in the box underneath the table.

Fire 1: a house on the edge of town, 3 km away. Water source was a backyard tap, 10 metres away.

Fire 2: a barn on a farm, 33 km from the post office. Water source was a rainwater tank, 120 metres down the hill.

Fire 3: the golf course clubhouse, 8 km from the post office. Water source was a dam near the 18th green, 15 metres away.

Fire 4: The school shelter shed, 2 km from the post office. Water source was the tap for the oval sprinklers, 220 metres away.

<table>
<thead>
<tr>
<th></th>
<th>$D$ – From the post office to the fire</th>
<th>$(d)$ – From the water source to the fire</th>
<th>$T = t,(i) + t,(ii)$ Total time in minutes from the siren to the first bucket being thrown</th>
<th>$B$ – Number of buckets needed to put out the fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 km</td>
<td>10 metres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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</tbody>
</table>