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Certificate III in Asset Management

Pest Management Technical

Booklet VP2: Ratio in Mixing Chemicals

DEADLY MATHS VET

Certificate III in Asset Management

PEST MANAGEMENT TECHNICAL

Mathematics for Unit 6

BOOKLET 2: RATIO IN MIXING CHEMICALS

VP2

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YuMi Deadly Maths
Past Project Resource

Acknowledgement

We acknowledge the traditional owners and custodians of the lands in which the mathematics ideas for this resource were developed, refined and presented in professional development sessions.

YuMi Deadly Centre

The YuMi Deadly Centre is a Research Centre within the Faculty of Education at Queensland University of Technology which aims to improve the mathematics learning, employment and life chances of Aboriginal and Torres Strait Islander and low socio-economic status students at early childhood, primary and secondary levels, in vocational education and training courses, and through a focus on community within schools and neighbourhoods. It grew out of a group that, at the time of this booklet, was called "Deadly Maths".

"YuMi" is a Torres Strait Islander word meaning "you and me" but is used here with permission from the Torres Strait Islanders' Regional Education Council to mean working together as a community for the betterment of education for all. "Deadly" is an Aboriginal word used widely across Australia to mean smart in terms of being the best one can be in learning and life.

YuMi Deadly Centre's motif was developed by Blacklines to depict learning, empowerment, and growth within country/community. The three key elements are the individual (represented by the inner seed), the community (represented by the leaf), and the journey/pathway of learning (represented by the curved line which winds around and up through the leaf). As such, the motif illustrates the YuMi Deadly Centre's vision: *Growing community through education*.

More information about the YuMi Deadly Centre can be found at http://ydc.qut.edu.au and staff can be contacted at ydc@qut.edu.au.

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Queensland University of Technology

DEADLY MATHS VET

Certificate III in Asset Management

PEST MANAGEMENT TECHNICAL

MATHEMATICS FOR UNIT 6

BOOKLET VP2

MATHEMATICS BEHIND MIXING CHEMICALS FOR SPRAYING

DRAFT 1: 16/4/08

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BACKGROUND

This booklet (Booklet VP2) was the second booklet produced as material to trial with pesticide students completing Unit 6 as part of the Open Learning Institute of TAFE course Certificate III in Asset Management (Pest Management – Technical).

This trial was part of the ARC Linkage project LP0455667: *Numeracy for Access to Traineeships, Apprenticeships and Vocational Studies and Empowerment and Low Achieving Post Year 10 Students*. This project studied better ways to teach mathematics to VET students at: Bundamba State Secondary College, Gold Coast Institute of TAFE, Metropolitan South Institute of TAFE, Open Learning Institute of TAFE, and Tropical North Queensland Institute of TAFE (Thursday Island Campus).

This booklet focuses on using ratio and proportion to correctly mix chemicals for pesticide spraying as required for Unit 6. It follows on from Booklet VP1 which looks at area and volume formulae for the same unit.

The chief investigators of this project were Dr Annette Baturo and Professor Tom Cooper. The research assistants for the development of this booklet were Kaitlin Moore and Elizabeth Duus. The project manager was Gillian Farrington.

CONTENTS

PREAMBLE

The Certificate III in Asset Maintenance (Pest Management – Technical) is a new course to train pesticide sprayers. It contains two units, 6 and 10, which focus on using proportion to mix the required chemicals for a spraying job.

This mixing is based on the mathematics of ratio and proportion. Ratio is a mathematical idea which describes mixing in terms of the two ingredients, for example, sand to cement at 5:2 or chemical to water at 40 mL to 3 L. Nearly all the time, the mixing ratio does not give the exact amount needed, so the amount of ingredients has to be changed so that the mixture is the same strength. For example, for sand to cement at 5:2, if need 6 shovels full of cement, then need 15 shovel fulls of sand because 15:6 is the same strength mixture as 5:2. This 15:6 being the same as 5:2 is called proportion.

Unit 6 provides formulae and a method called "easy grid" to work out mixtures for real jobs using the information on the labels of pesticide chemicals. These work quite well and enable all amounts to be calculated.

However to support the Unit 6 material, this booklet provides a different model for working out mixtures and focuses on activities aimed at building an understanding of what ratio and proportion are.

This booklet may, therefore, be of use to you in the course for two reasons. First, if you are finding the "easy grid" difficult to use, then this booklet will provide an alternative way to do the work. Second, it will provide understanding that lies behind the "easy grid" method. This is a useful thing to have because when a rule or process is simply learnt by rote, it can be easily forgotten and difficult to apply. Remembering the method and transferring your knowledge to new labels are easier when you understand how and why things are done as they are.

The focus of this booklet is, therefore, to look at pesticide applications of proportion with understanding. This is done through focusing on:

1. providing an overview of the mathematics behind the pesticide applications;
2. understanding what ratio and proportion are;
3. looking at how numbers in proportion are the same multiples of each other in 2 ways, e.g. 2:3=8:12 because 2x1.5=3 & 8x1.5=12, and 2x4=8 and 3x4=12;
4. using this multiple approach to solve pesticide mixing chemicals problems;
5. extending this to a number line method for using multiples for solving complex problems; and
6. extending this number line method to the most complex pesticide problems.

1. OVERVIEW

Unit 6 of the Certificate III in Asset Maintenance (Pest Management – Technical) spends section 8.2 looking at label calculations. In this section examples such as "a sprayer is required to mix chemical to spray 8.5 m² of wall with a label which states 150 mL of pesticide has to be diluted with 5 L of water to cover 100 m²" are considered.

In the course, the spraying students are given an "easy grid" as below. The students are told that QA is question-answer, where the answers appear; Label is for the information on the label; m² is area, L is water; and mL is chemical.

	m²	L	mL
QA			
Label			

Information from the label and the situation is entered on the grid as below. In the example below, the label says that for 100 m², you use 5 L of water with 150 mL of chemical and the situation you face is having to spray 85 m² of wall.

	m²	L	mL
QA	85		
Label	100	5	150

Your task is, therefore, to find A and B in the QA row.

	m²	L	mL
QA	85	A	B
Label	100	5	150

Then a process is given that to get the QA numbers that are not known:

(1) find a column with two numbers,

(2) divide the top number by the bottom number for this column, and

(3) multiply this division by the bottom number in the column that has the QA numbers you want.

Thus, for the example, A is found by dividing 85 by 100 and then multiplying this by 5 (this makes A = 4.25 L), while B is found by multiplying 85/100 by 150 (this makes B=127.5 mL).

x85/100 ↑

	m²	L	mL
QA	85	4.25	127.5
Label	100	5	150

Therefore, the sprayer has to mix 127.5 mL of chemical with 4.25 L of water and use this across the whole 85 m².

The understanding behind this is that, since everything has to be in proportion, the changes from Label row up to QA row have to follow the same multiple, that is,

x85/100 x85/100 x85/100

100 → 85; 5 → 4.25 150 → 127.5

This booklet will, therefore, focus on developing understanding of proportion as multiples and build from this to some methods for solving pesticide mixing problems.

The sequence followed in this book is as follows:

1. Section 2: Meaning of ratio – shows how ratio is a multiplicative comparison which usually relates the same attribute (e.g. volume or mass), but can be used with different attributes.

2. Section 3: Proportion and multiple patterns – shows that proportion is when ratios use the same strength and shows how ratios in proportion are related to each other with multiplication (in 2 ways).

3. Section 4: Using multiples to mix chemicals – shows how the multiples from Section 3 can be used to understand how to mix chemicals.

4. Section 5: Using double number lines to mix chemicals – introduces a simple-to-follow picture to help see how mixing and proportion relate.

5. Section 6: Using triple number line to prepare spray – this extends Section 5 to take account of area as well as strength of mixture – it includes complicated mixing and spraying problems where there can be two different proportions – this section shows how the triple number line handles this.

2. MEANING OF RATIO

2.1 Meaning

When there are two numbers, e.g., 6 and 24, or measures, e.g., 6 g and 18 g, there are 3 types of comparison:

(1) numerical – 24 is a larger number than 6, and 18 g is larger than 6 g;

(2) additive – 24 is 18 more than 6, and 18 g is 12 g more than 6 g; and

(3) multiplicative – 24 is 4 times 6, and 18 g is 3 times 6 g.

Ratio is a special form of multiplicative comparison. It looks at the comparison not as a multiple, e.g. 4 times, but in terms of two numbers. To see this, let us look at the two measures, e.g., 6 kg of cement and 15 kg of sand. Obviously 15 is larger than 6 (numerical) and 15 is 9 more than 6 (additive). And, in terms of multiplication, we could say that 15 is 2½ times bigger than 6. But another way is to say that the 6 kg and 15 kg are 6 to 15 or 6:15.

This method of showing comparison is what we call ratio. It is based upon the word "to" and the symbol ":". That is, in ratio terms, the relationship between 6 kg cement and 15 kg sand is stated/written as:

cement to sand is 6 to 15 or cement : sand = 6:15

It should be noted that, since 6 = 2x3 and 15 = 5x3, that the ratio 6:15 is the same as the ration 2:5. This is important because ratios are often given in the simplest terms. For example, a bag of cement will say that to make concrete, the cement should be mixed with sand in the ratio 2:5. This means that:

2 kg of cement should be mixed with 5 kg of sand,
2 kg of cement should be mixed with 5 kg of sand, and
2 kg of cement should be mixed with 5 kg of sand, thus
6 kg of cement should be mixed with 15 kg of sand.

This means that 2:5 will give 6:15.

It should also be noted (see Section 2.2) that ratio is between the same attribute (e.g., length) and normally between the same unit (e.g., metre). However, in chemical mixing where a small amount of concentrated chemical is mixed with a lot of water, different units can be used. For example, 10 mL of chemical with 2 L of water can be thought of as 10:2000 as 2 L is 2000 mL, but it can also be 10:2 as long as the units are remembered. One way, of course to do this is to put the units in the ratio, e.g., 10 mL:2 L.

Activity 2.1

Circle the representation which is the ratio.

Write the ratio in the simplest form

The first is done for you.

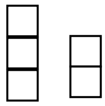
	SITUATION	CIRCLE RATIO REPRESENTATION	WRITE SIMPLEST RATIO
(1)	12 kg sand to 8 kg cement	1.5x 4 kg more (12:8)	3:2
(2)	200 mL chemical to 3 L water	15 times 200mL:3L 15x	________
(3)	300 g butter to 500 g flour	3:5 $1^2/_3$x 200 g more	________
(4)	5 bottles cola to each bottle of lemonade	5x 5:1 4 bottles more	________
(5)	15 mL chemical to 5 L water	3x 4.985 L more 15mL:5L	________
(6)	200 g raisins to 400 g dates	double 2 times 4:2	________
(7)	2 parts cordial to 7 parts water	2:7 3.5 times 5 more	________
(8)	4 L water to 25 mL chemical	16x 3.975 L more 4L:25mL	________
(9)	3 parts red to 9 parts green	3x 3:9 6 more	________

2.2 Models for ratio

The crucial thing in getting to know an idea like ratio is to develop a visual model of it. There are two useful ways to do this.

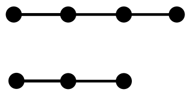
The first is by <u>area</u> (or by squares):

e.g. 3 kg sand to 2 kg cement or 3:2

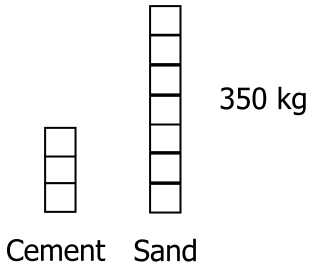


The second is by <u>length</u>:

e.g. 3 kg sand to 2 kg cement or 3:2



The idea is that when you think of ratio, you think of one of these pictures to help you work out what to do. For example*, if a paving mortar is a cement to sand mix of 3 to 7, how much cement for 350 kg of sand?*, we need to use the 3:7 mixture ratio to calculate the amount of cement. This we can do with the area model:



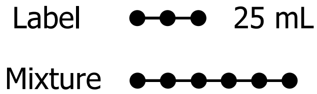
Step 1 – in the mind, picture the squares/area model for 3 to 7

Step 2 – in the mind, put the amount of sand beside the squares for sand

Step 3 – work out the value of one square [350 kg ÷ 7 squares = 50 kg per square]

Step 4 – apply this value to the cement squares [3 squares x 50 kg/square = 150 kg], giving the amount of cement required as 150 kg.

Let us look at another example and use the number line, *the label said 25 mL chemical mixed with 2 L, how much chemical for 5 L?*



Step 1 – in the mind, picture the length model for 2 to 5

Step 2 – in the mind, put the amount of chemical [25 mL] on the label beside the length for the label.

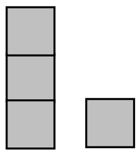
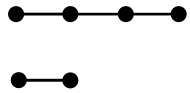
Step 3 – work out the value of one step [25 mL ÷ 2 steps = 12.5 mL per step]

Step 4 – apply this value to the mixture steps [5 steps x 12.5 mL/step = 62.5 mL], giving the amount of chemical required for 5 L as 62.5 mL.

Activity 2.2

Fill in all the spaces below.

The first one is done for you.

	RATIO SITUATION	AREA MODEL	LENGTH MODEL
(1)	6 kg sand to 2 kg cement or 3:1		
(2)	200 g butter to 300 g flour or 2:3		
(3)	400 mL chemical to 1 L water or 400:1000 or 2:5		
(4)	3 cups of cordial to 10 cups of water or 3:10		
(5)	35 mL chemical to 20 L water or 35:20 or 7:4		

2.3 Ratio situations

The other common way of stating multiplicative comparison is by rate. Rate divides the first number by the second. So if 20 L of fuel costs $28, the rate is 28÷20=1.4 or $1.40/L. Note: if this was a ratio, it would be 28:20 = 7:5 as 28x5/7=20 & 7x5/7=7, and 7x4=28 and 5x4=20.

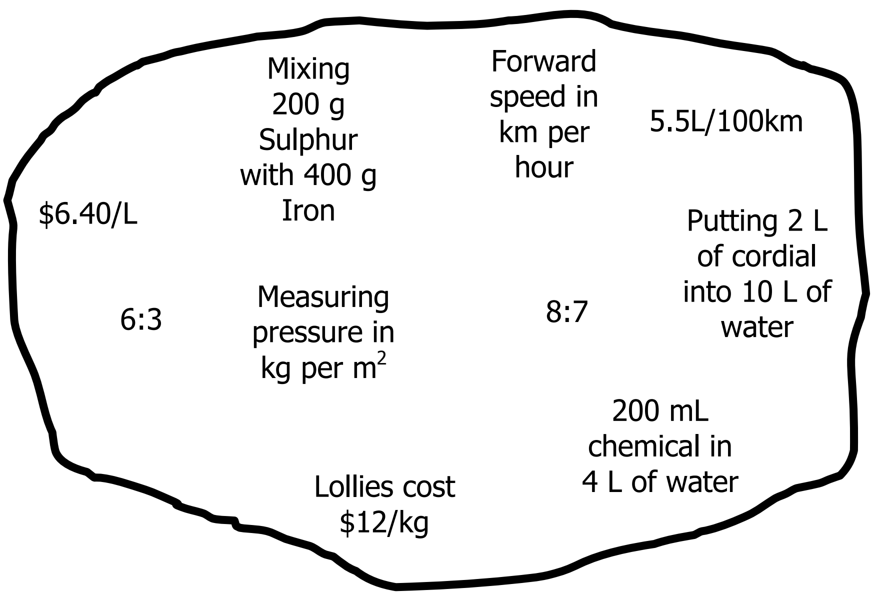
Rate and ratio have come from two different sources in our history. Ratio was used mainly in mixing (chemistry) that is, two chemicals or ingredients in a cake. Therefore, it is mostly used when the measure is the same e.g., kg to kg or L to L. However, rate came out of physics and is to do with how two different measures relate to each other, e.g. speed km/hour or cost $/L. This can be illustrated in the following diagram.

Measures							
		Length	Area	Volume	Mass	Time	Money
Measures	Length						
	Area						
	Volume						
	Mass						
	Time						
	Money						

Therefore, normally, the shaded areas are ratio and the rest are rate. However, it is possible to talk about two different measures using ratio symbolism, e.g., painting uses 2 L of paint for 5 m^2 of wall. In these situations, which do occur in mixing chemicals, we will use the ratio symbol with the measures, e.g., 2L:5m^2.

Activity 2.3

Circle the situations that are ratio. Cross out the situations that are rate.

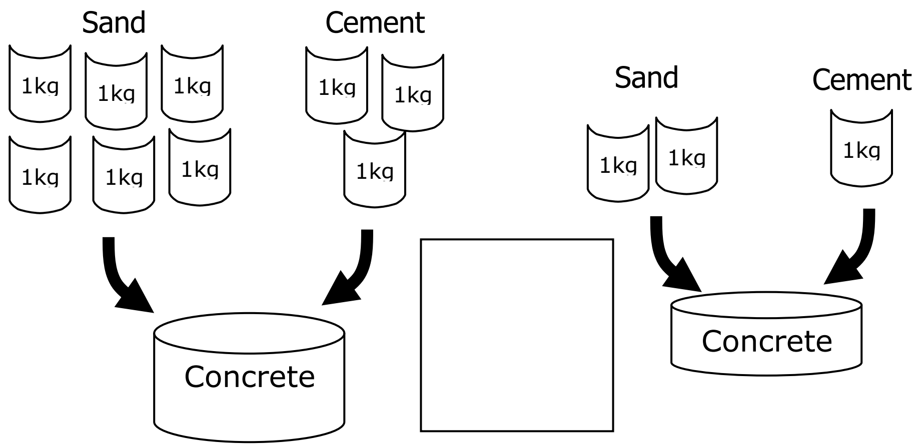


3. PROPORTION AND MULTIPLE PATTERNS

3.1 Defining proportion

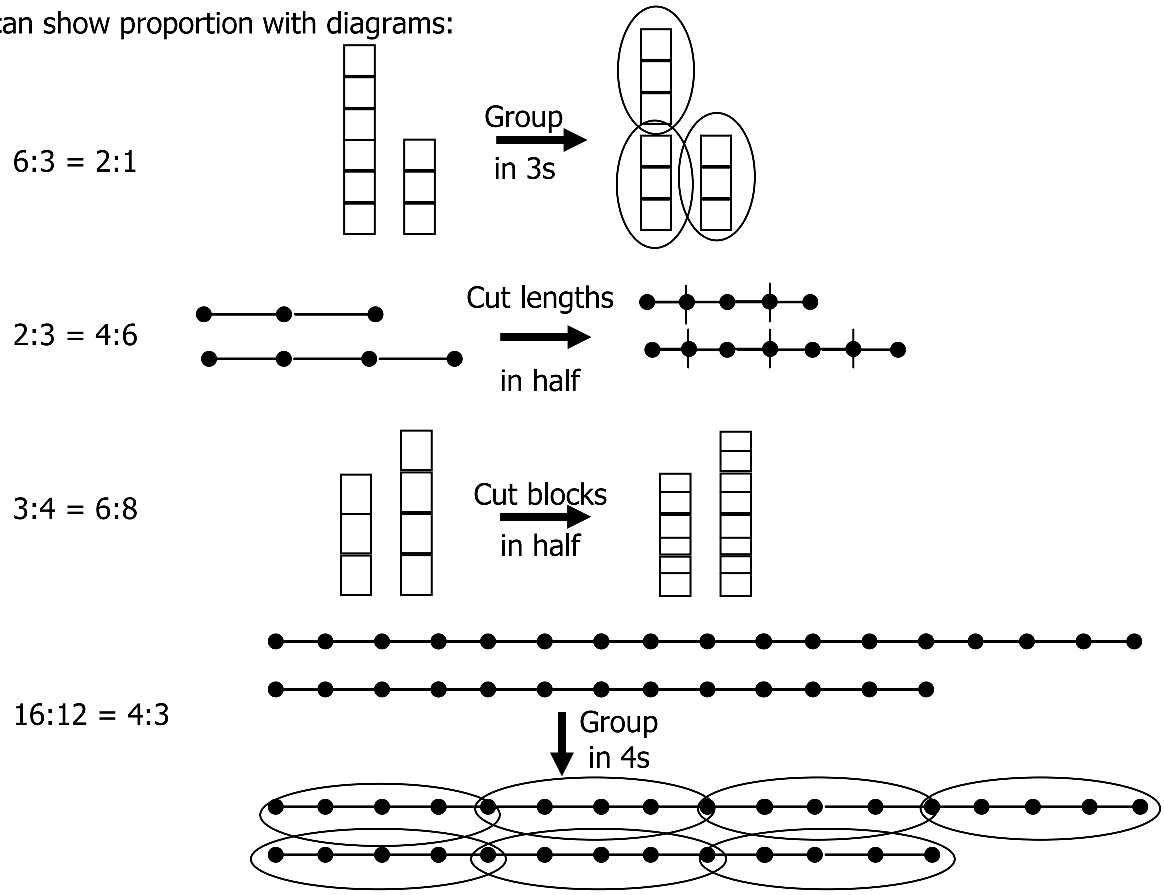
Let us look at two ratios 6:3 and 2:1. In the first, 6 measures of something are mixed with 3 measures of something else (e.g., 6 kg of sand with 3 kg of cement).

In the second ratio, 2 is mixed with 1 (e.g., 2 kg of sand with 1 kg of cement). This is illustrated below:



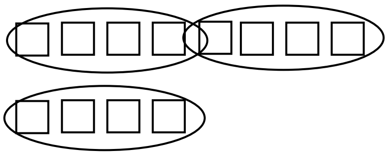
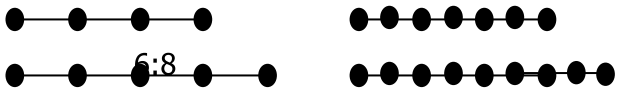
Obviously we end up with 9 kg of concrete mix in the first ratio and 3 kg of concrete mix in the second, but the mixture is the same strength in both. It is 2 parts of sand with 1 part of cement. This means 6:3 is the same as 2:1 or 6:3 = 2:1. This is called equivalence of ratios or equivalent ratios and has a special name "proportion". That is, 6:3 is the same proportion as 2:1 or 6:3 and 2:1 are "in proportion".

We can show proportion with diagrams:



Activity 3.1

Use squares or length models to check if the two ratios are in proportion. The first two have been done for you.

Two ratios	Model			In proportion
(1) 2:1; 8:4	8:4		2:1	Yes, 8:4 = 2:1
(2) 3:4; 6:7	3:4			No, 3:4 ≠ 6:7
(3) 2:3; 8:10				
(4) 4:2; 12:6				
(5) 12:4; 3:1				
(6) 2:5; 6:12				
(7) 8:2 = 3:1				
(8) 6:5; 18:15				

3.2 Multiples patterns in proportion

Make up pattern sticks. These are columns of wood (popsicle sticks, bundling sticks or tongue depressors) or paper where the first one shows the multiples of 1, the second the multiples of 2, and so on up to the tenth which shows the multiples of 10 (see below):

1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100

Make up a set of sticks. There is a paper set attached you can cut up. Show ratios with the sticks as follows:

(i) put out the two sticks side by side that make up the ratio, e.g., for 5:2 this is the 5 stick and the 2 stick side by side as on right;

(ii) look down the two sticks, see the sequence of ratios 5:2, 10:4, 15:6 , 20:8, and so on;

(iii) note that these form equivalent ratios or proportion; and

(iv) check that proportion holds for other pairs, e.g., 1:3 or 7:8.

5	2
10	4
15	6
20	8
25	10
30	12
35	14
40	16
45	18
50	20

These proportional ratios that are revealed when 2 sticks are put side by side can be used to find a multiples pattern that relates ratios that are in proportion. To do this, use the sticks as follows:

(i) put out 2 sticks side by side, e.g., 4:3 as on right, and look down the list of ratios, e.g., 4:3, 8:6, 12:9, and so on, for a pattern that goes across the two sticks (i.e., do not focus on the 4 stick increasing by 4 and the 3 stick increasing by 3 – look for similarities in the way 4 relates to 3, 8 relates to 6, and so on); and

(ii) divide 3 stick number by 4 stick number and see that always get 0.75 or ¾. (i.e., 3÷4=0.75, 6÷8=0.75; 9÷12=0.75; 12÷16=0.75;and so on).

4	3
8	6
12	9
16	12
20	15
24	18
28	21
32	24
36	27
40	30

Thus we can see that two ratios are equivalent or in proportion if they have the same multiples. There are 2 ways for this.

Way 1: The normal way for ratio is first to second. For example:

x1.5 x1.5

2:3=14:21 because 2 : 3 and 14 : 21 (they are on the 2 & 3 sticks)

x0.4 x0.4

10:4=5:2 because 10 : 4 and 5 : 2 (they are on the 5 & 2 sticks)

x7/3 x7/3

15:35=12:28 because 15 : 35 and 12 : 28 (they are on the 3 & 7 sticks)

Similarly, ratios are not in proportion because multiples are different. For example:

x1.5 x2.25

2:3≠4:9 because 2 : 3 and 4 : 9 and 1.5 ≠ 2.25.

x2/7 x4/21

21:6 ≠42:8 because 21 : 6 and 42 : 8 and 2/7 = 6/21 ≠ 4/21.

<u>Note</u>: The multiple does not have to go first to second, it can be second to first; thus, ratios are also equivalent or in proportion if they have the same multiple in the other direction. For example:

x2/3 x2/3

2:3=14:21 because 2 : 3 and 14 : 21 (again they are both on the 2 & 3 sticks)

Way 2: As well, there is also a common multiple between corresponding numbers in the ratio when two ratios are in proportion,. For example:

x7

when 2:3=14:21, then 2 : 3 and 14 : 21;

x7

This way, enables understanding of how ratios equivalent to 2:3 can be found. Each number in the ratio is multiplied by 2, then 3, 4, 5 and so on:

2:3 = 4:6 = 6:9 = 8:12 = 10:15 = 12:18 and so on.

x2 x3 x4 x5 x6

Activity 3:2

(1) The 2 & 5 sticks on the right show that 2:5 = 8:20 is true.

(a) Use 3 & 7 sticks to show whether 3:7=18:44 is true or false. *Tick if true.*

(b) Use 4 & 1 sticks to show whether 4:1=28:5 is true or false. *Tick if true*.

(c) Use 5 & 3 sticks to show whether 5:3=40:24 is true or false. *Tick if true*.

(d) Use 6 & 5 sticks to show whether 6:5=30:24 is true or false. *Tick if true*

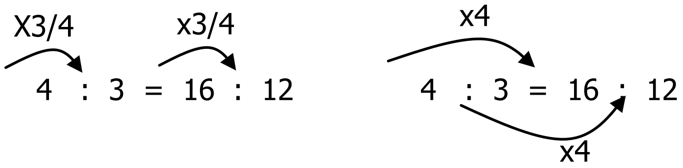
2	5
4	10
6	15
8	20
10	25
12	30
14	35
16	40
18	45
20	50

(2) The 2 & 5 sticks on the right show that 10:25 = 16:40, as both ratios are on the same pair of sticks. Check the following are in proportion by choosing a pair of sticks with the first ratio on them. *Tick the pairs that are in proportion*.

(a) 12:28; 27:63 (b) 36:30; 12:9 (c) 14:16; 21:24

2	5
4	10
6	15
8	20
10	25
12	30
14	35
16	40
18	45
20	50

(3) 4:3 = 16:12 because the multiples are the same:



Check these are in proportion by seeing if their multiples are the same. *Tick those that are in proportion.*

(a) 18 : 42 = 3 : 7 (b) 5 : 6 = 40 : 42 (c) 18 : 42 = 27 : 63

(d) 3 : 7 = 15 : 35 (e) 18 : 4 = 27 : 10 (f) 48 : 30 = 16 : 10

(4) Use multiples to create sequences of ratios that are in proportion as has been done for you for 11:2. *Use a calculator*.

x2 x3 x4 x5
11:2 = 22:4 = 33:6 = 44:8 = 55:10 and so on

(a) 12:5 =

(b) 3:14 =

(c) 13:8 =

(d) 29:23 =

4. USING MULTIPLES TO MIX CHEMICALS

4.1 Finding proportional ratios

The label on the chemical container states: "mix 420 mL of chemical in 10 L of water". We need only 4 L of mixture for our spraying job so we have to work out how much chemical we need for this amount of mixture. Because the amount of chemical is small, we assume that 10 L of water gives 10 L of mixture (and, similarly, 4 L of water with chemical will give us 4 L of mixture). This means that the water ratio is 10mL:4L (note the differences in measure – we could make them both mL but as long as we remember the units, we can leave as this). To ensure our 4 L of mixture is the same strength as the Label requires, the chemical ratio has to be in proportion to this; thus 10 : 4 = 420 : ? where ? is the yet to be calculated amount of chemical to be mixed with the 4 L of water. To work out how to find ?, we first look at how multiples can find unknowns in proportion and then how we use this in mixing.

Example: Let us look at an example: The label says that cement and sand should be mixed 3 parts cement with 7 parts sand for the concrete. The questions are: (a) How much sand do we need for 9 tonnes of cement? and (b) How much cement do we need for 28 tonnes of sand?

(a) The cement ratio is 3:9 and the sand ratio has to be in proportion. This means 3:9 = 7:? (where ? is the unknown amount of sand). To solve this, we remember that proportional ratios have a common multiple. That is, the multiple for the cement ratio is the same as the multiple for the sand ratio. As the cement is x3, this means

$$\overset{\times 3}{\frown}\quad 3 : 9 = \overset{\times 3}{\frown}\quad 7 : ?,$$ thus ? (sand) = 3x7 = 21 tonnes.

(b) The sand ratio is 7:28 and the cement ratio has to be in proportion. This means 7:28 = 3:? (where ? is the unknown amount of cement). To solve this, we remember that proportional ratios have a common multiple. That is, the multiple for the sand ratio is the same as the multiple for the cement ratio. As the sand is x4, this means:

$$\overset{\times 4}{\frown}\quad 7 : 28 = \overset{\times 4}{\frown}\quad 3 : ?,$$ thus ? (sand) = 3x4 = 12 tonnes.

Second example: Butter and milk are mixed 2 parts butter to 3 parts milk. (a) How many mL of milk for 500 g of butter? and (b) How many grams of butter for 210 mL of milk?

(a) The butter ratio is 2:500, a multiple of 250, so the milk ratio has to be the same:

$$\overset{\times 250}{\frown}\quad 2 : 500 = \overset{\times 250}{\frown}\quad 3 : ?,$$ thus ? (milk) = 3x250 = 750 mL.

(b) The milk ratio is 3:210, a multiple of 70, so the butter has to be the same:

$$\overset{\times 70}{\frown}\quad 3 : 210 = \overset{\times 70}{\frown}\quad 2 : ?,$$ thus ? (butter) = 2x70 = 140 g.

Activity 4.1

Calculate the answers to the following problems:

(1) Coke and lemonade we sold in ratio 7 bottles to 2 bottles. How many slabs of lemonade are needed if buy 28 slabs of coke?

x4 x4

7 : 28 = 2 : ?, thus ? = ______________________.

Coke ratio *Lemonade ratio*

(2) Lead and Zinc are mixed in ratio 5 tonnes to 4 tonnes. How much lead if 24 tonnes of zinc?

x6 x6

4 : 24 = 5 : ?, thus ? = ______________________.

Zinc ratio *Lead ratio*

(3) Chemical is mixed with liquid detergent in ratio 3L to 8L. How much chemical for 20 L of detergent?

x2.5 x2.5

8 : 20 = 3 : ?, thus ? = ______________________.

Detergent ratio *Chemical ratio*

(4) Cordial is mixed by 2 parts of syrup to 11 parts of water. How much water for 2.5 L of syrup?

x1.25 x1.25

2 : 2.5 = 11 : ?, thus ? = ______________________.

Syrup ratio *Water ratio*

(5) Chemical is mixed with water 30 mL to 2 L. How much chemical for 15 L of water?

x7.5 x7.5

2 : 15 = 30 : ?, thus ? = ______________________.

Water ratio *Chemical ratio*

(6) Chemical is mixed with water 45 mL to 5 L. How much water for 250 mL of chemical?

x50/9 x50/9

45 : 250 = 5 : ?, thus ? = ______________________.

Chemical ratio *Water ratio*

4.2 Mixing Chemicals

Obviously the techniques of 4.1 can be applied to mixing chemicals. In the problem: "The label says 420 mL with 10 L of water. How much chemicals for 4 L?" Set up the proportional ratios and determine the multiple:

$$\underbrace{10 \overset{\times 0.4}{\curvearrowright} : 4}_{\textit{Water ratio}} = \underbrace{420 \overset{\times 0.4}{\curvearrowright} : ?}_{\textit{Chemical ratio}}, \quad \text{thus } ? = 420 \times 0.4 = 168 \text{ mL.}$$

Some other examples are:

(a) 150 mL chemical with 5 L water, how much chemical for 12 L water?

$$\underbrace{5 \overset{\times 2.4}{\curvearrowright} : 12}_{\textit{Water ratio}} = \underbrace{150 \overset{\times 2.4}{\curvearrowright} : ?}_{\textit{Chemical ratio}}, \quad \text{thus } ? = 150 \times 2.4 = 360 \text{ mL.}$$

(b) 150 mL chemical with 5 L water, how much water for 250 mL of chemical?

$$\underbrace{150 \overset{\times 5/3}{\curvearrowright} : 250}_{\textit{Chemical ratio}} = \underbrace{5 \overset{\times 5/3}{\curvearrowright} : ?}_{\textit{Water ratio}}, \quad \text{thus } ? = 5 \times 5/3 = 8.333 \text{ L.}$$

Note: Example (b) above is common in real life because numbers in real life don't work out easily. There may be no simplifications at all. Consider the following example: "35 mL chemical with 8 L water, how much water for 127 mL of chemical?". In this example, the chemical ratio is 35:127 and the multiple has no reduction – it is x127/35. This means that the relationship is:

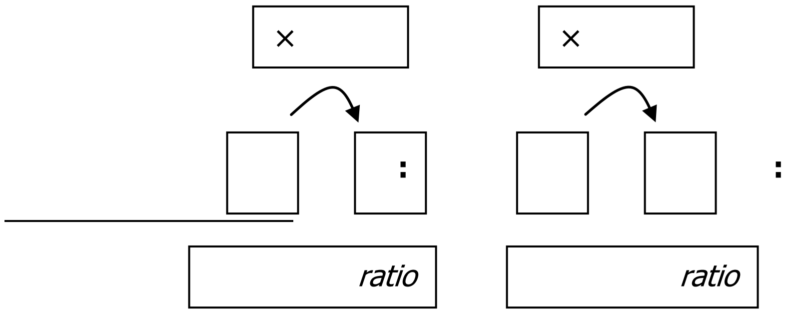
$$\underbrace{35 \overset{\times 127/35}{\curvearrowright} : 127}_{\textit{Chemical ratio}} = \underbrace{8 \overset{\times 127/35}{\curvearrowright} : ?}_{\textit{Water ratio}}, \quad .$$

This means that the water is 8 x 127/35 = 1016/35 = 29.029 L.

Activity 4.2

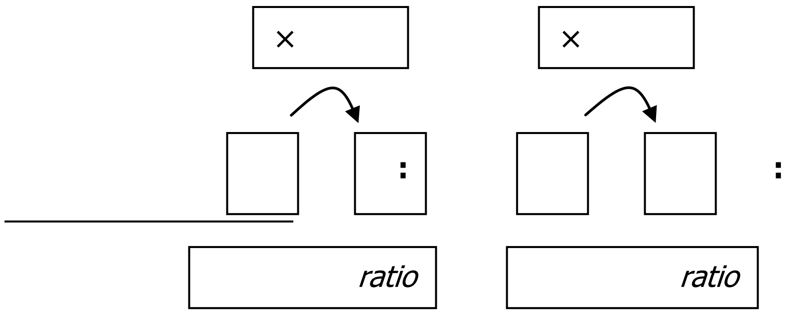
Find the values in these problems

(1) 30 mL of chemical in 2 L of water. How much chemical for 25 L of water?



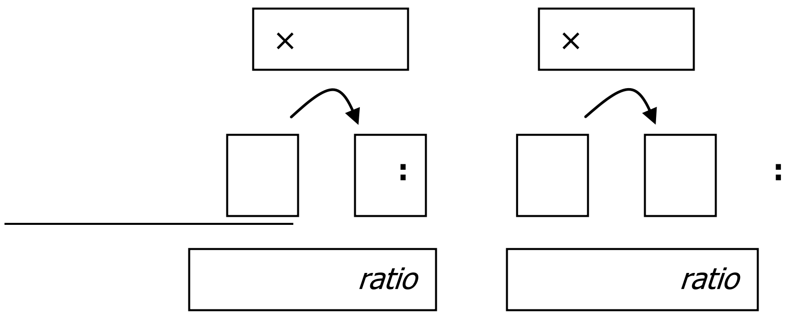
thus ? =

(2) 150 mL of chemical in 5 L of water. How much chemical for 18 L of water?



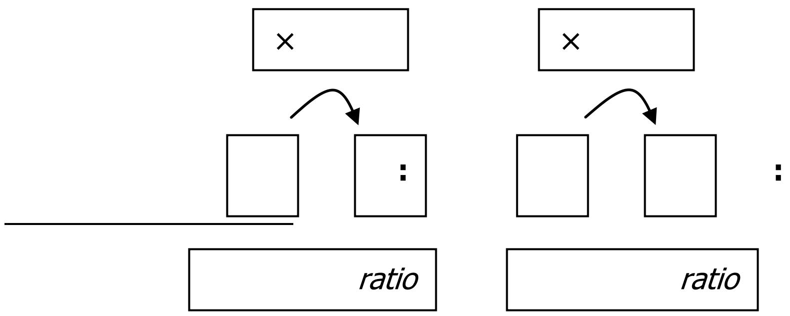
thus ? =

(3) 75 mL of chemical in 5 L of water. How much water for 250 mL of chemical?



thus ? =

(4) 160 mL of chemical in 4 L of water. How much water for 500 mL of chemical?



thus ? =

4.3 Getting a feel for proportion

What do you do when you get the strength wrong?

Example: Suppose you make it too strong, that is, you have mixed 400 mL of chemical with 10 L of water and you notice that the label says 150 mL with 5 L. You do the multiples

$$\overset{\times 2}{5 : 10} = \overset{\times 8/3}{150 : 400}$$

Water ratio *Chemical ratio*

As 8/3 = 2.667, the water has increased less than the chemical (and the chemical more than the water). They are no longer in proportion. So let us see what it should have been if the chemical had increased the same as the water:

$$\overset{\times 2}{5 : 10} = \overset{\times 2}{150 : ?} \quad \text{, thus ? = 150 x 2 = 300 mL}$$

Water ratio *Chemical ratio*

Thus, your mixture is too strong – you have put in 100 mL too much chemical. What do you do? Add water or chemical? The answer of course is to make it weaker by diluting it with some more water. How much water can be determined by looking at the original chemical ratio:

$$\overset{\times 8/3}{5 : ?} = \overset{\times 8/3}{150 : 400} \quad \text{, thus ? = 5 x 8/3 = 13.333 L}$$

Water ratio *Chemical ratio*

So the water should be 13.333 L not 10 L and so we need to add 3.333 L of water.

Another example: Suppose your mixture has too little chemical, what do you do? For example, you mixed 250 mL with 8 L of water when label says 75 mL in 2 L:

$$\overset{\times 4}{2 : 8} = \overset{\text{X}10/3}{75 : 250}$$

Water ratio *Chemical ratio*

As 10/3 = 3.333, the water has increased more than the chemical (and the chemical less than the water). They are no longer in proportion. So let us see what it should have been if the chemical had increased the same as the water:

$$\overset{\times 4}{2 : 8} = \overset{\times 4}{75 : ?} \quad \text{, thus ? = 75 x 4 = 300mL}$$

Water ratio *Chemical ratio*

Thus, you have put in an extra 50 mL of chemical.

Therefore, the ability to know whether the mixture is too weak or too strong and whether extra chemical or water must be added to return it to the right strength is very important.

<u>Activity 4.3</u>

Complete activities in the Deadly Maths Mixing Chemicals Program. It is attached as a CD on the last page of this booklet.

As you mix, get a feel for how much water or chemical to add. Remember, making chemicals too strong has particular problems for sprayers.

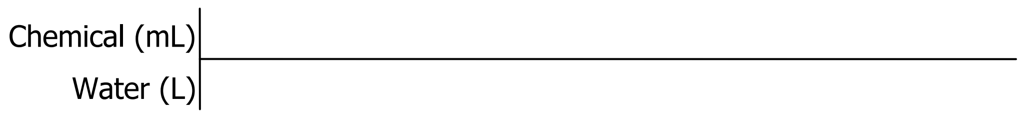
5. USING DOUBLE NUMBER LINES TO PREPARE SPRAYS

A powerful way to expand the multiples method is to use the length model to set up spraying problems.

This is done by using a double number line. This is a number line with one part of the proportion above the line and the other part below the line.

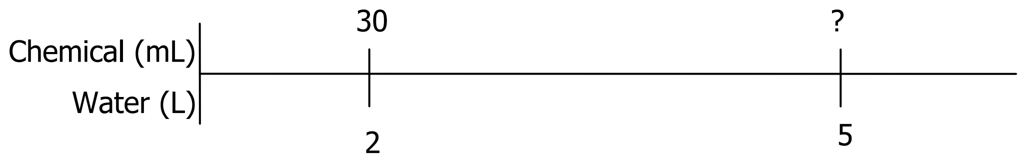
Consider the problem "Chemical is mixed 30 mL to 2 L of water, how much chemical for 5 L?" We have chemical above and water below the line as follows.

Step 1



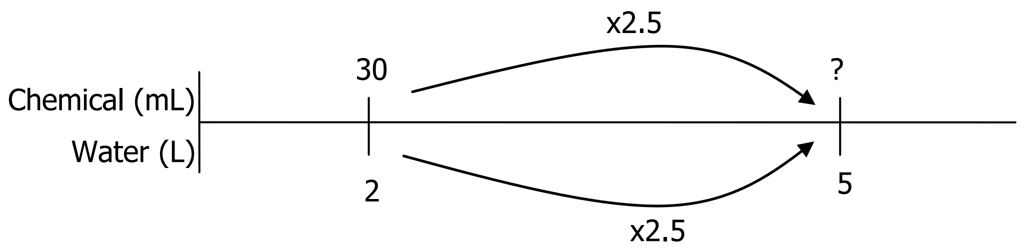
Step 2

The two related amounts (the 30 mL and the 2 L) are placed either side of the same cross line and an unknown amount of chemical is put on the same cross line as the 5 L. The drawing does not have to be accurate but it helps if the 2 and the 5 are roughly in relation to each other on the line



Step 3

Then the multiples are used. As before the two measures 2 L and 5 L are used to determine the multiple (which is 5 ÷ 2 or 2.5). The arrows showing the multiples are put above and below the line.



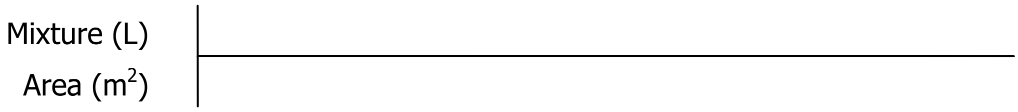
Step 4

The chemical is changed the same as the water, so the answer is: 75 mL

? = 30 x 2.5 = 75 mL of chemical

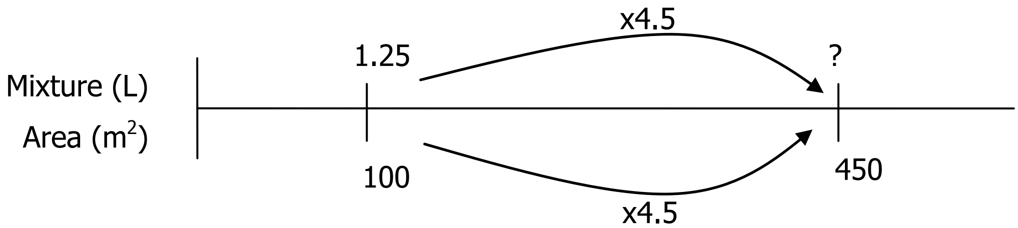
This method can also work for the number of litres of mixture for an area. For example "The mixture should be applied for 1.25 L per 100 m², how much mixture for 450 m²?"

Step 1



Step 2

Step 3



Step 4

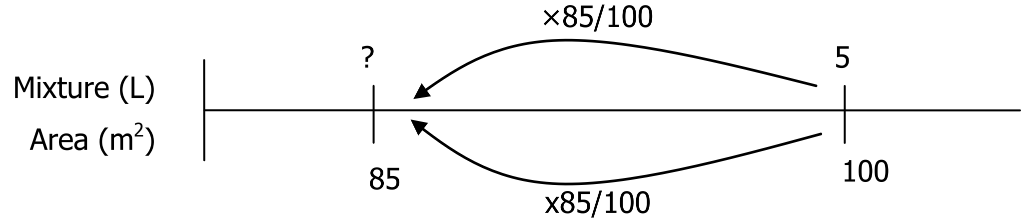
? = 1.25 x 4.5 = 5.625 L of mixture

NOTE: The arrows can go the other direction if the ? is on left of the known measures.

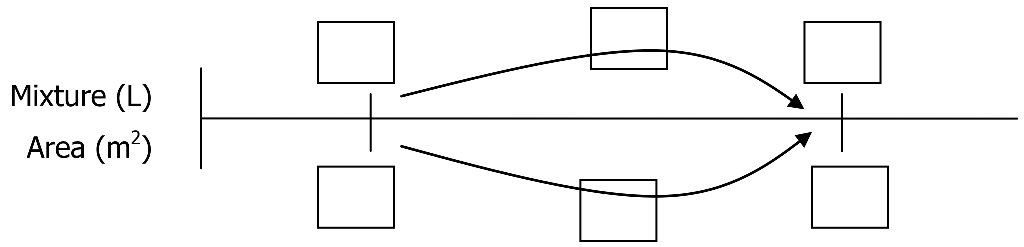
Activity 5

Complete the following:

1. The mixture is sprayed 5 L for 100 m². How much mixture for 85 m²?



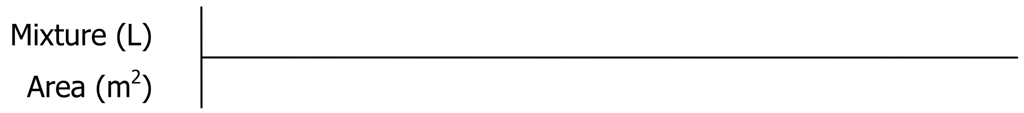
2. The mixture is sprayed 5 L for 100 m². How much for 250 m²?

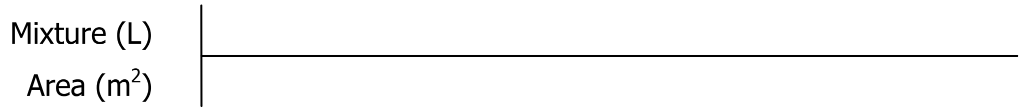


3. The mixture is sprayed 1.25 L for 100 m².

   (a) How much mixture for 375 m²?

   (b) How much area for 3 L?





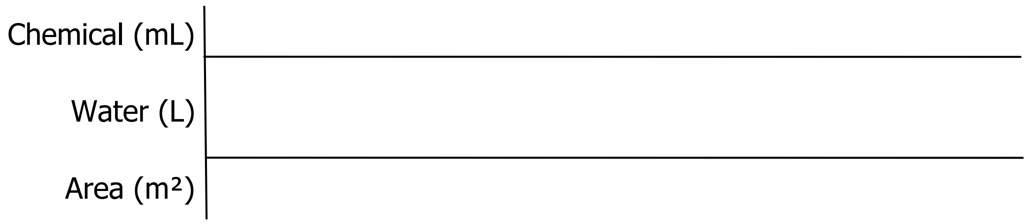
6. USING TRIPLE NUMBER LINE TO PREPARE SPRAYS

6.1 Setting up the triple number line

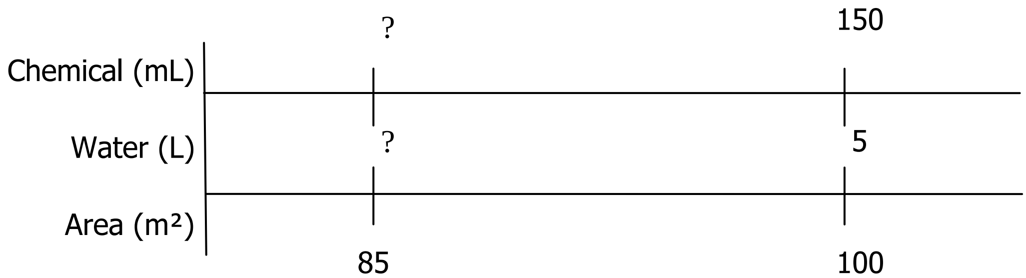
Most labels require the spray to be prepared in relation to both (1) a chemical to water ratio and (2) a mixture to area ratio. So this means both of these have to happen together. This means combining 2 double number lines into a "triple line" as follows.

Let us consider the problem, "How much chemical has to be mixed with how much water to spray 85 m² of wall if the label says 150 mL of pesticide has to be diluted with 5 mL of water to cover 100 m²? Solving this is 4 steps as follows:

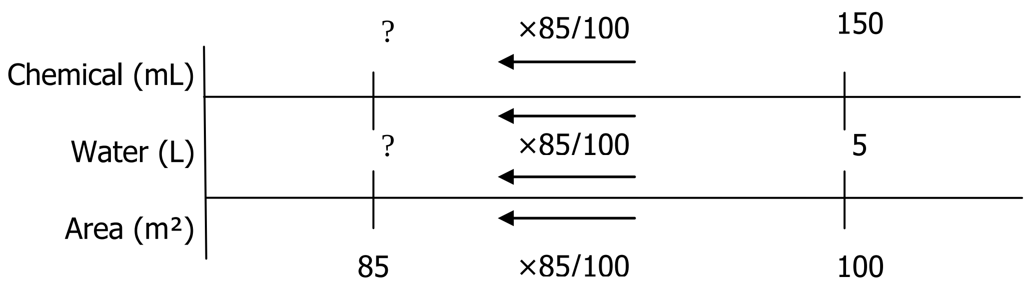
Step 1: Set up 2 lines and 3 side labels and place the different components as follows:



Step 2: Place any relationships between the 3 components on cross lines as for the double number lines as follows (NOTE: In this example, the relationships are in one line):



Step 3: Write in the multiples using the known measures to work out what the commonalities are. In this example the multiples are straightforward with all 3 things changing in the same way. We use the simplest way to determine multiples – multiplying by second number divided by first number (x85/100). (NOTE: We also use straight arrows for multiples to save space.)



Step 4: Use the common-fraction multiple 85/100 to work out the L of water and mL of chemical: Water = 5 x 85/100 = 425/100 = 4.25 L; Chemical = 150 x 85/100 = 1.5 x 85 = 127.5 mL.

Activity 6.1

Complete the following problems using triple number lines

1. For Label A below, how much mL of concentrate in how many litres of mix for 125 m² of wall?

Label A

Situations	Pests	Stat	Treatment Rate	Critical comments
Domestic, commercial, industrial and public buildings	Cockroaches, fleas, spiders, ants, and silverfish	All	Initial treatment 150 mL	On non-porous surfaces dilute with 5 L of water and apply as a coarse spray at a rate of 5 L per 100 m² not exceeding the point of run-off

2. For Label A above, how many litres of mix can be produced and what area will it cover for 250 mL of chemical?

3. For Label B below, how much mL of concentrate in how many litres of mix for 64 m²?

Label B

Situations	Pests	Stat	Treatment Rate	Critical comments
Domestic, commercial, industrial and public buildings	Cockroaches, fleas, spiders, ants, and silverfish	All	Initial treatment 150 mL	On non-porous surfaces dilute with 5 L of water and apply as a coarse spray at a rate of 5 L per 100 m² not exceeding the point of run-off

4. For Label C below, answer the following:

   (a) For initial treatment, how much chemical and mixture for 175 m²?

   (b) For maintenance, how much chemical and mixture for 425 m²?

Label C

Situations	Pests	Stat	Treatment Rate	Critical comments
Domestic, commercial, industrial and public buildings	Cockroaches, fleas, spiders, ants, and silverfish	All	Initial treatment 150 mL Maintenance treatment 75 mL	On non porous surfaces dilute with 5 L of water and apply as a coarse spray at a rate of 5 L per 100 m² not exceeding the point of run-off
	Carpet beetles, clothes moths, bird mites, and bed bugs	All		On porous surfaces or use through power equipment, dilute with 10 L of water and apply per 100 m² of surface, not exceeding point of run off
	House flies	All	75 mL	

6.2 Complicated mixes

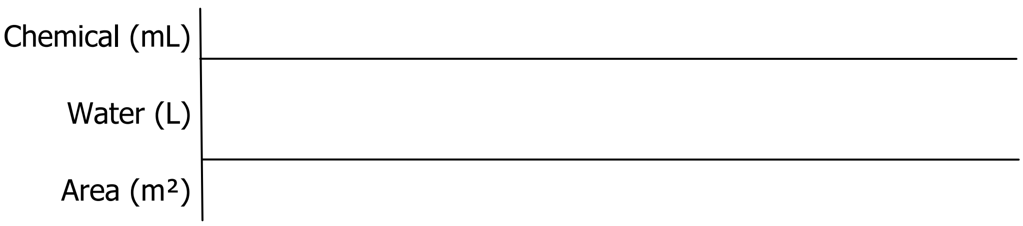
In the following label, the L of water in mix does not directly relate to the L of mix in area. For example:

Pests	Treatment Rate	Critical comments
Fleas	420 mL in 10 L water	Litres of mix per 100m² The entire carpet should be treated. Application to most surfaces should be as light as possible, approx 1.25 L per 100 m²

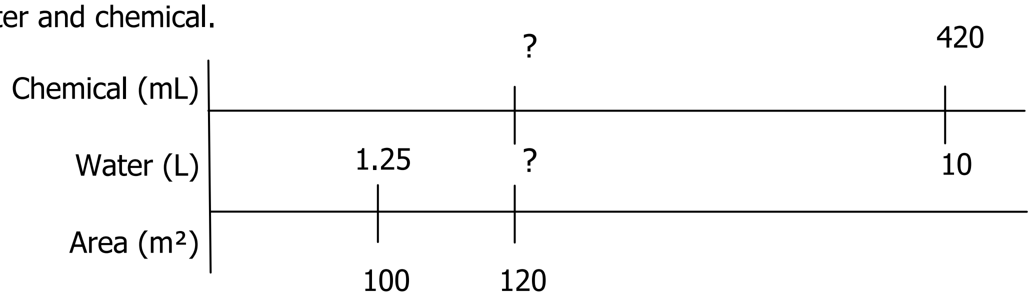
The question is "How much chemical and mix for 120 m² of carpet?"

Once again we go through steps – however, this time there are 6 steps.

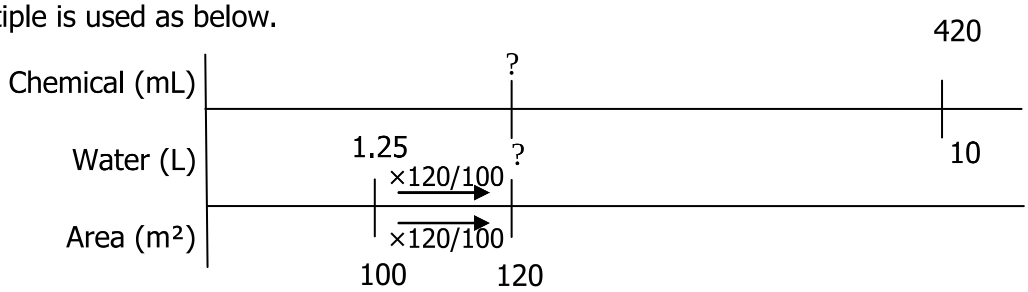
Step 1: Draw the triple number line and note that there are 3 components, chemical, water and area as below.



Step 2: Place any relationships as cross lines. However, we have to be aware that, for this example, there are two different relationships – not three things in a line like the example in 6.1. Thus, there needs to be a line between 420 mL and 10 L and a different line between 1.25 L and 100 m², as below. The answer has to be found for 120 m² in terms of both water and chemical.

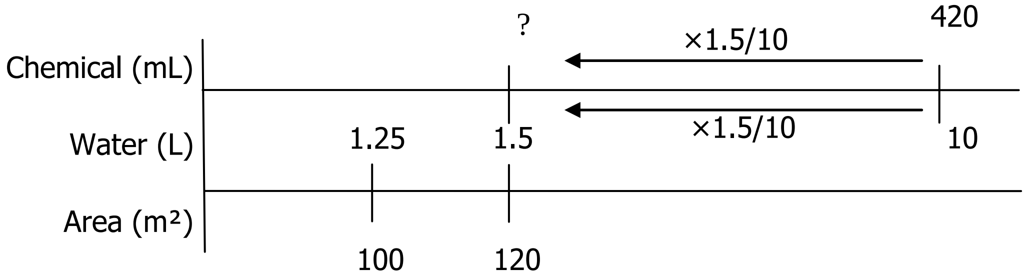


Step 3: Write the first multiple on the diagram. There are two different multiples in this example – one for finding the water and then one for finding the chemical. The water multiple is used as below.



Step 4: Calculate the amount of water: ? = 1.25 x 120/100 = 1.25 x 1.2 = 1.5 L.

Step 5: Write the second multiple on the diagram as below. Now, we can do the chemical multiple as below.



Step 6: Finally, the amount of chemical can be calculated: ? = 420 x 1.5/10 = 42 x 1.5 = 63 mL.

Activity 6.2

Complete the following problems for Label D using triple number lines

Label D

Situations	Pests	Stat	Treatment Rate	Critical comments
Domestic, commercial, industrial and public buildings	Cockroaches, fleas, spiders, ants, and silverfish	All	Initial treatment 150 - 200 mL Maintenance treatments 100 mL/10 L	Apply as a coarse low pressure surface spray to areas where pests hide frequently. Spray to the point of runoff using around 5 L of spray mixture for 100 m² and ensuring thorough coverage of the treated area. Where indicated, use the higher rate in situations pest presence is severe, and where rapid knockdown and for maximum residual protection is desired. Pay particular attention to protected dark areas such as cracks and crevices, behind and under sinks, stoves, refrigerators, furniture, pictures and other known hiding places.

1. How much concentrate to mix for 180 m² of carpet for initial treatment?
2. You prepare 18 L of mix.
    (a) How much concentrate?
    (b) How much area for initial treatment?
    (c) How much area for maintenance treatment?
3. You have 180 mL of chemical.
    (a) How much area can you cover for initial treatment?
    (b) How much can you cover for maintenance treatment?