



YUMI DEADLY CENTRE
School of Curriculum

Enquiries: +61 7 3138 0035
Email: ydc@qut.edu.au

<http://ydc.qut.edu.au>

Numeracy for Transition to Work

Year 11 Prevocational Mathematics

Booklet 11.4: "Exchange Student"

Operations, discounts, tables, metric conversion and best buys

The image shows the front cover of a booklet. At the top left is the Bundamba State Secondary College logo, and at the top right is the QUT logo. Below these logos, the text reads: 'Bundamba State Secondary College', 'Queensland University of Technology', and 'DEADLY MATHS CONSORTIUM'. In the center, it says 'TEACHER RESOURCE BOOKS', 'NUMERACY FOR TRANSITION TO WORK', and 'YEAR 11: SEMESTER 2'. A large, semi-transparent '11.4' watermark is overlaid on the cover. Below the watermark, the text reads: 'PREVOCATIONAL MATHEMATICS', 'Booklet 11.4: "Exchange Student"', and 'VERSION 1, 2008'. At the bottom, the authors are listed: 'Bevan Penrose', 'Bundamba State Secondary College', 'Tom J Cooper', 'Annette R Baturo', 'with Kaitlin Moore', 'Elizabeth Duus', 'Deadly Maths Consortium', and 'Faculty of Education, QUT'. At the very bottom, in small text, it says: 'Funded by ARC Linkage Grant LP0455667- Numeracy for Access to Traineeships, Apprenticeships and Vocational Studies and Empowerment and Low Achieving Post Year 10 Students'.

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.

Restricted waiver of copyright

This work is subject to a restricted waiver of copyright to allow copies to be made for educational purposes only, subject to the following conditions:

1. All copies shall be made without alteration or abridgement and must retain acknowledgement of the copyright.
2. The work must not be copied for the purposes of sale or hire or otherwise be used to derive revenue.
3. The restricted waiver of copyright is not transferable and may be withdrawn if any of these conditions are breached.

© QUT YuMi Deadly Centre 2008
Electronic edition 2013

School of Curriculum
QUT Faculty of Education
S Block, Room S404, Victoria Park Road
Kelvin Grove Qld 4059
Phone: +61 7 3138 0035
Fax: + 61 7 3138 3985
Email: ydc@qut.edu.au
Website: <http://ydc.qut.edu.au>

CRICOS No. 00213J

This booklet was developed as part of a project which ran from 2005–2008 and was funded by an Australian Research Council Linkage grant, LP0455667: *Numeracy for access to traineeships, apprenticeships, and vocational studies and empowerment and post Year 10 students*.

Bundamba State Secondary College &
Queensland University of Technology

TEACHER RESOURCE BOOKLETS
NUMERACY FOR TRANSITION TO WORK

YEAR 11 PREVOCATIONAL MATHEMATICS
BOOKLET 11.4: "Exchange Student"
VERSION 1: 2008

Research Team:

Bevan Penrose

Tom J Cooper

Annette R Baturu

with

Kaitlin Moore

Elizabeth Duus

Deadly Maths VET

School of Mathematics, Science and Technology Education,
Faculty of Education, QUT

DEADLY MATHEMATICS VET

Deadly Maths VET was the name given to the materials produced to support the teaching of numeracy to vocational education and training students, particularly those from Indigenous backgrounds. These booklets were produced by the *Deadly Maths Consortium* at Queensland University of Technology (QUT) but also involving a researcher from Nathan Campus of Griffith University.

At the time of the production of this booklet, Deadly Maths VET was producing materials as part of an ARC-funded Linkage grant LP0455667 (12 booklets on Years 11 and 12 Prevocational Mathematics course and 2 booklets on pesticide training) and ASISTM-funded 2008 grant (3 booklets on construction; 3 booklets on engineering; 3 booklets on marine; 1 booklet on retail; and 2 booklets and a series of virtual materials on basic mathematics).

CONTENTS

	Page
THE PREVOCATIONAL MATHEMATICS BOOKLETS	iv
OVERVIEW.....	1
1. Theoretical position	1
2. Mathematics for this booklet	1
3. Pedagogy	2
4. How to use this booklet	3
PRELIMINARY ACTIVITIES.....	4
1. Identifying operations.....	4
1.1. Addition and subtraction	4
1.2. Multiplication and division	4
1.3. Operations activities	5
2. Determining discounts	6
2.1. Percent	6
2.2. Discounts	8
2.3. Discount activities.....	10
3. Using tables.....	11
3.1. Lists to tables.....	11
3.2. Calculating with tables	12
3.3. Table activities	14
4. Metric conversion	14
4.1. Place-value relationships	14
4.2. Converting metric units.....	15
4.3. Metric conversion activities.....	17
5. Best buys.....	17
5.1. Metric conversion activities.....	17
5.2. Calculating best buys	18
5.3. Best buy activities.....	20
6. "Exhaustion" and "Parts" strategies	20
6.1. Using the exhaustion and parts strategies	21
6.2. Calculating using parts/exhaustion.....	21
6.3. Strategy activities	22
CULMINATING TASK.....	23
ASSESSMENT RUBRIC	25

THE PREVOCATIONAL MATHEMATICS BOOKLETS

In 2005 to 2008 researchers Annette Baturo and Tom Cooper from the Deadly Maths Consortium received an ARC Linkage grant (LP0455667) to study mathematics learning of Year 11 and 12 and adult students undertaking vocational education and training (VET) courses who had low achievement in mathematics. The title of this ARC Linkage project was *Numeracy for Access to traineeships, apprenticeships, and vocational studies and empowerment and post year ten students*. The project studied better ways to teach mathematics to VET students at Bundamba State Secondary College, Metropolitan Institute of TAFE (Moreton Campus), Gold Coast Institute of TAFE (Ridgeway Campus), Tagai College (Thursday Island Campus), and the Open Learning Institute of TAFE.

As part of the study, the Deadly Maths research team developed booklets and other resources to be trialled by VET students and teachers. The project's activity with Bundamba State Secondary College focused on the Year 11 and 12 Prevocational Mathematics subjects taught at that college to less able mathematics students. The project used a series of intervention case studies to research learning. As part of this, the following 12 Prevocational Mathematics resource booklets were produced (6 for Year 11 and 6 for Year 12). The booklets are numbered 11.1 to 11.6 and 12.1 to 12.6.

- 11.1 – “Using Numbers of Numbers” – Yr 11 prevocational maths booklet: Number, decimals, fractions and problem solving.
- 11.2 – “The Big Day Out” – Yr 11 prevocational maths booklet: Number, tables, budgeting, algebra and problem solving.
- 11.3 – “Rating our World” – Yr 11 prevocational maths booklet: Rate, area and volume activities and problems.
- 11.4 – “Exchange Student” – Yr 11 prevocational maths booklet: Operations, discounts, tables, metric conversion and best buys.
- 11.5 – “Planning a Roster” – Yr 11 prevocational maths booklet: Tables, 24-hour time, percentages and computation strategies.
- 11.6 – “The Man from Hungary” – Yr 11 prevocational maths booklet: Time relationships, time calculations, timetables and efficient scheduling.
- 12.1 – “Beating the Drought” – Yr 12 prevocational maths booklet: Fractions, probability, graphing and data.
- 12.2 – “Monopoly” – Yr 12 prevocational maths booklet: Fractions, probability, game strategies, property finance, graphs and tables.
- 12.3 – “How tall is the Criminal?” – Yr 12 prevocational maths booklet: Multiplicative structure, ratio and proportion, problem solving.
- 12.4 – “Design a Kitchen” – Yr 12 prevocational maths booklet: Visual imagery, percent, rate, ratio, perimeter, area and volume.
- 12.5 – “Healthy Eating” – Yr 12 prevocational maths booklet: Data collection and analysis, tables and graphing (line and histograms).
- 12.6 – “Rocking around the World” – Yr 12 prevocational maths booklet: Time and angle, time operations and problem-solving strategies.

OVERVIEW

1. Theoretical position

The Bundamba Prevocational Mathematics booklets are based on the notion of Renzulli (1977) that mathematics ideas should be developed through three stages.

Stage 1: Motivate the students – pick an idea that will interest the students and will assist them to engage with mathematics.

Stage 2: Provide prerequisite skills – list and then teach all necessary mathematics ideas that need to be used to undertake the motivating idea.

Stage 3: Culminating task – end the teaching sequence by setting students an open-ended investigation to explore.

These booklets use Stage 3 as an assessment item and so we have added an assessment rubric whereby the culminating task can be used to check the knowledge held by the student.

The booklets combine two approaches to teaching:

- (1) Structural activities that lead to the discovery of mathematical concepts, processes, strategies and procedures; and
- (2) Rich-style tasks which allow students an opportunity to solve problems and build their own personal solution.

2. Mathematics for this booklet

The motivating idea behind this booklet is that of setting up and budgeting for a 26-week stay in a flat by two exchange students. This task should have resonance with the students in that it is something they may have to do for themselves in their future. It is not a simple task, with many things to consider, so it is not only a relevant thing to do, it has many options. The culminating task is thus motivating and open.

The prerequisite skills are not so obvious. However, for this booklet, they will be deemed to consist of the following:

- (1) *Identifying operations* – calculators or spreadsheets can be used to calculate totals; therefore, all that is required is to be able to identify which operators and which numbers are needed to determine the total cost.
- (2) *Determining discounts* – as it is necessary to keep the costs to a minimum, it is important to find the best discounts; therefore, calculating the effect of discounts is a part of calculation.
- (3) *Using tables* – the best way to set up the budget is with a table (as the culminating task directs); therefore, how to use tables is part of the prerequisite skills.
- (4) *Metric conversions* – to find the cheapest items, different sizes and masses will have to be considered; therefore, it is important to be able to convert between units (e.g. between L and mL).

- (5) *Best buys* – again, because costs should be kept down, the groceries to be bought should be determined by whichever size/brand is the best buy; therefore, various methods of determining this should be considered.
- (6) *The exhaustion and parts strategies* – determining what is needed in a flat requires a process to ensure that all requirements are covered and this is best done through a series of steps; therefore, the strategies of “exhausting all possibilities” and “breaking the problem into parts” are considered.

3. Pedagogy

The pedagogy for the culminating task is to (a) interest the students in the situations so they are engaged in the task, (b) provide them with all they need mathematically to gather information and compute totals, and (c) let them develop their solution as they see fit.

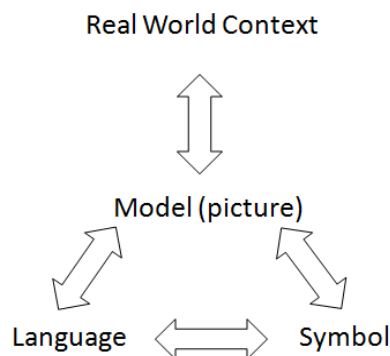
The pedagogy for the prerequisite skills is to develop mental models (pictures in the mind) and connect all representations for the mathematics concepts, processes, strategies and procedures that are needed to tackle the culminating task. For example, to work out whether 300g at \$.68c is better than 500g at \$1.18 requires connections between:

- (1) real-life situations;
- (2) models of the situations (pictures), for example, the double number line for the proportion method of calculating “best buy”:



- (3) language, for example, cost per cent, greater, smaller, etc.; and
- (4) symbols, for example, $300g \div 68c = 4.41g/c$.

Thus instruction is based on the so-called Rathmell Triangle (Payne & Rathmell, 1978):



The prerequisite pedagogy also involves three major generic strategies:

- (1) Flexibility – trying to ensure students understand things in a variety of ways (e.g. discount, reduction, etc.; %, part per 100, decimal hundredths, fraction out of 100, and so on.)

- (2) Reversing – trying to teach in all directions (e.g. real-world situation to best buy; best buy to real-world situation).
- (3) Generalising – trying to teach things in the most general way (going beyond the needs of a task).

Particular strategies for tackling some of the preliminary activities will be provided at the start of the activities.

4. How to use this booklet

The major focus of the unit is the culminating task. The preliminary activities are only suggestions for prior work if you think your students require this work before they begin the culminating task. Therefore:

- (1) use the culminating task as the focus of the unit – to motivate engagement;
- (2) look through the preliminary activities and pick and choose things that you believe will be useful for your students – it is not necessary to do everything and to do it in the order that it appears in this booklet (although there is a logic to the order);
- (3) do these activities as a lead in to the culminating activity; and
- (4) try to organise things so that the students can do the culminating activity as an assessment of their abilities to do mathematics.

The preliminary activities are in six sections and there are real activities at the end of each section. The earlier parts of each section simply explain the ideas/models/pictures in the mind that are being attempted. Although how they are presented gives some hints on pedagogy, you will have to determine your own way to teach these.

PRELIMINARY ACTIVITIES

1. Identifying operations

In many situations, you can use a calculator to work out the answer to a computation, but you need to know the numbers and the operations – the calculator will not tell you what those are.

1.1. Addition and subtraction

Addition and subtraction were invented by mathematicians as ways to describe, and solve problems with respect to, joining and separating situations. However, it is not as simple as joining being addition and separation (e.g. take-away) being subtraction. Consider the following problem: *I went to the bank and took out \$55. This left \$212 in the bank. How much did I have to start with?* Although the action in the problem is take-away, the question requires the two numbers to be added.

Thus, the part-part-total approach is the best way to think about addition and subtraction:

- (a) addition – knowing the parts and wanting the total, and
- (b) subtraction – knowing the total and one part and wanting the other part.

Then, when the problem above is analysed, it can be seen that the \$55 and the \$212 are parts and the unknown is the total. This makes the problem addition regardless of the words and actions in the description.

Addition and subtraction can also describe comparison situations. Once again, determining the operation is not straightforward. For example, the problem, *John has \$36, Frank has \$15 more than John, how much does Frank have?*, is solved by addition; while the problem, *Frank has \$15 more than John, Frank has \$62, how much does John have?*, is solved by subtraction. However, the part-part-total approach still applies here if a little creativity is used.

1.2. Multiplication and division

Multiplication and division were invented by mathematicians as ways to describe, and solve problems with respect to, combining equal groups and partitioning into equal groups situations. Once again, things are not as simple as combining being multiplication and partitioning being division. For example, the following problem is solved by multiplication but is a partitioning action: *The money was shared between 11 people, each person got \$156, how much was there to be shared?*

As before, there is an approach that enables the problems to be correctly interpreted – it is called factor-factor-product:

- (a) multiplication – the two factors are known (the number of groups and the number in each group) and the product is wanted, and
- (b) division – one factor and the product is known and the other factor is wanted.

Multiplication and division can also describe comparison situations. Once again, determining the operation is not straightforward. For example: the problem, *Mary has 4 times the money*

Jane has, Jane has \$26, how much does Mary have?, is solved by multiplication; while the problem, Mary has 4 times the money Jane has, Mary has \$184, how much does Jane have?, is solved by division. However, similar to addition-subtraction, the factor-factor-product approach still applies if used with a little creativity.

1.3. Operations activities

(1) Circle which operation has to be used:

- (a) There are 8 times as many apples as oranges, there are 56 apples, how many oranges? + - × ÷
- (b) There were 24 more cattle sent to market from Jensen Station than there were from Tropica Station. Jensen sent 328 cattle, how many cattle did Tropica send to market? + - × ÷
- (c) There were 88 crates of cans, there were 11 cans in each crate, how many cans? + - × ÷
- (d) There were 16 fewer people after lunch, this made 84 people, how many started the day? + - × ÷
- (e) The men and women were loading sheep into 8 trucks, there were 124 sheep in each truck, how many sheep? + - × ÷

(2) Tick the operation needed to complete the table:

Item	Number of items	Cost/item	Total cost	Operation?
Can of beans	6	?	\$12.54	+ - × ÷
Bottle of juice	3	\$3.45	?	+ - × ÷
Packet of pasta	?	\$2.56	\$12.80	+ - × ÷
SUBTOTAL			?	+ - × ÷
Reduction			?	+ - × ÷
TOTAL			\$31.85	

(3) Construct an everyday money/shopping problem for each situation:

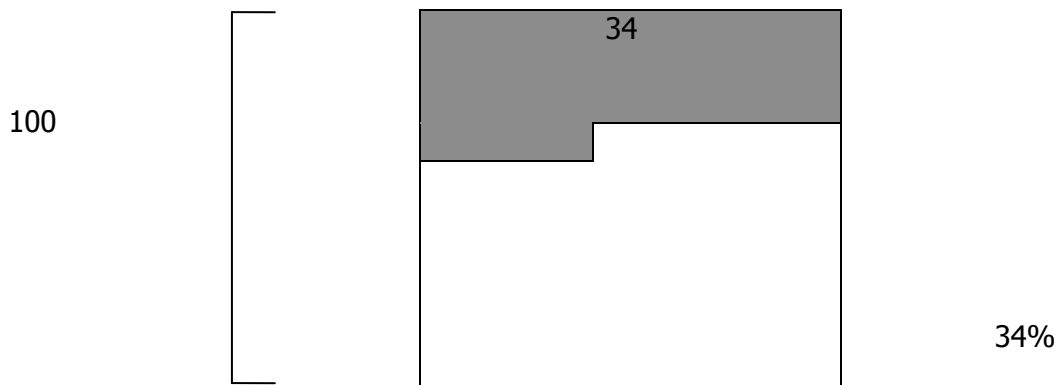
- (a) $\$28 \div 7$ Jack spends 7 times as much as Jill.
- (b) $\$48.27 + \63.21 Sue loses some money.
- (c) $\$128 - \56.54 Bill buys two shirts, one of which costs \$56.54.
- (d) $\$34.68 \times 8$ Fred packs the windcheaters into bags of 8.

2. Determining discounts

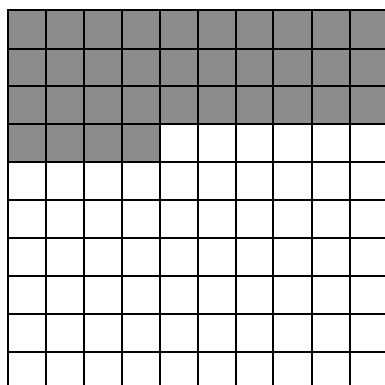
Discounts are a particular use of percent. Therefore we will look at percent in general first.

2.1. Percent

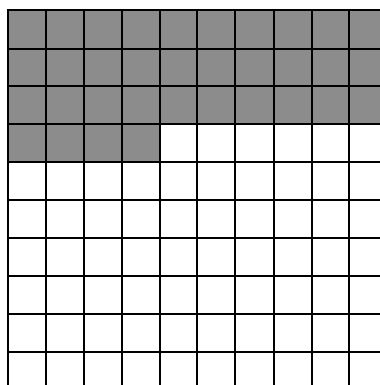
Percent is parts per hundred. The easiest way to think of this is to consider, for example, 34% as a whole square cut into 100 parts of which 34 are shaded.



Different ways of looking at this diagram give rise to different representations. For example, the 34% can be seen as 3 rows and 4 small squares. As each row is a tenth and each square is a hundredth, this means that 34% is 0.34. Similarly, the 34 shaded squares can be considered as 34 small squares out of 100 equal-sized squares that make up one whole, and the diagram represents the fraction 34/100.

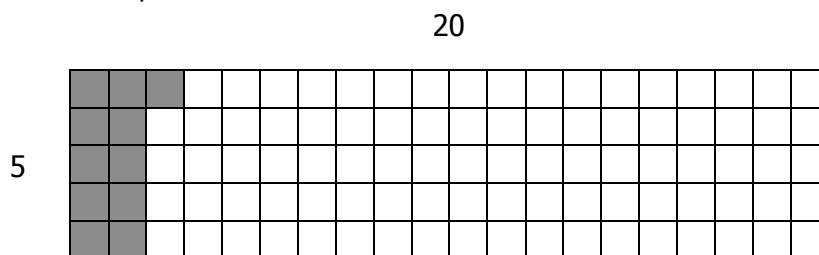


0.34



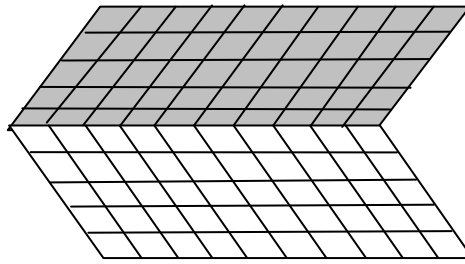
34/100

It is not necessary to think of only a square; any collection of 100 things can be made into a percent. For example, the diagram could be a rectangle which, if we shade 11 squares, represents 11%, 0.11 or 11/100.



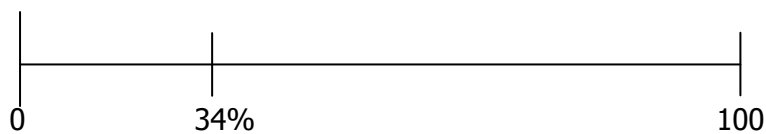
11%, 0.11 or 11/100

The diagram could also be a chevron which if we shade 50 rhombi, represents 50%, 0.5 or 50/100 or 1/2.



50%. 0.5, 50/100, or 1/2

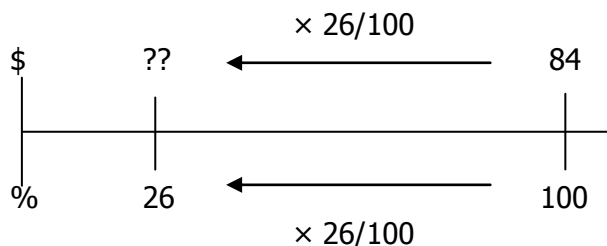
There are other ways to think of percent. One good way is using a double number line. For example, 34% can be represented on a double number line as below. This method is particularly useful for problems.



There are three types of percent problems. Each can be solved using the double number line.

Problem 1 – Finding a percentage:

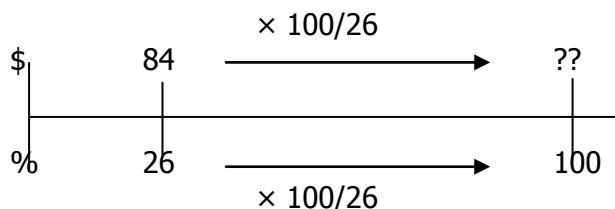
For example, *Find 26% of \$84:*



The change from 100% to 26% is equivalent to multiplying by 26/100, so this is done to the \$84 to find what is equivalent to the 26%. Thus, the answer = 26/100 × \$84 OR 0.26 × \$84.

Problem 2 – Finding the original amount:

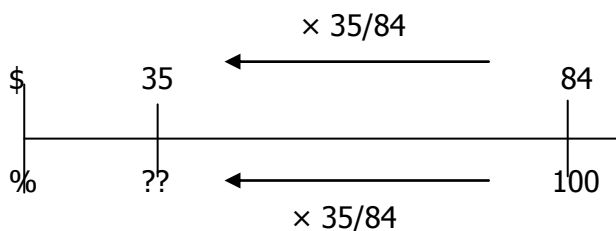
For example, *Find the total cost when \$84 is 26% of that cost:*



The change from 26% to 100% is achieved by multiplying by 100/26, so this is done to \$84 to find the original cost. Thus, the answer = 100/26 × \$84 = \$84/0.26.

Problem 3 – Finding percent:

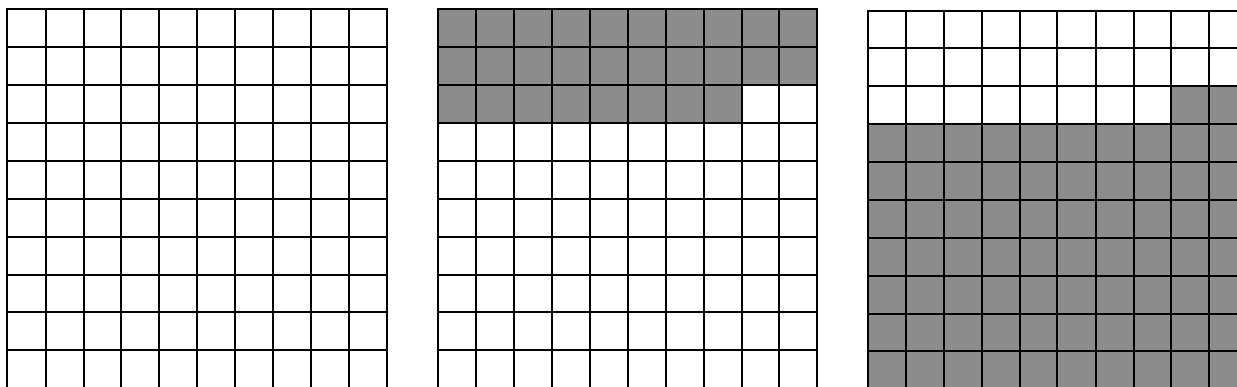
For example, *\$35 is what percent of \$84?*



The change from \$84 to \$35 is achieved by multiplying by $35/84$, so this is done to 100% to find the percentage that 35 is of 84. Thus, the answer = $35/84 \times 100\%$.

2.2. Discounts

Discounts are a special use of percent where the amount or cost is reduced to a lower cost. For example, a 28% discount can be represented on a 10×10 square as follows. The reduction of the 100 squares by 28 squares leaves 72 squares behind. Thus, a 28% discount is equivalent to 72% of the total.



100%

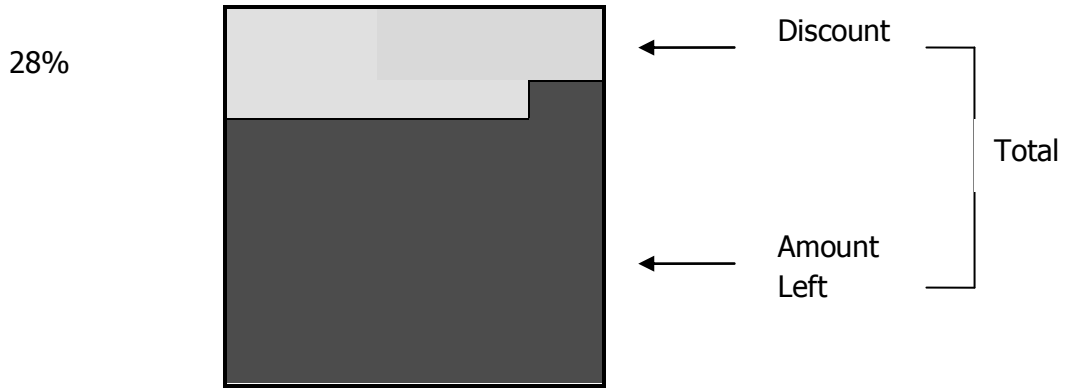
28% discount

72% left

Discounts can also be represented on a number line. We shall choose a representation that has the discount as a reduction from the 100% as follows. The example is for a discount of 28%.

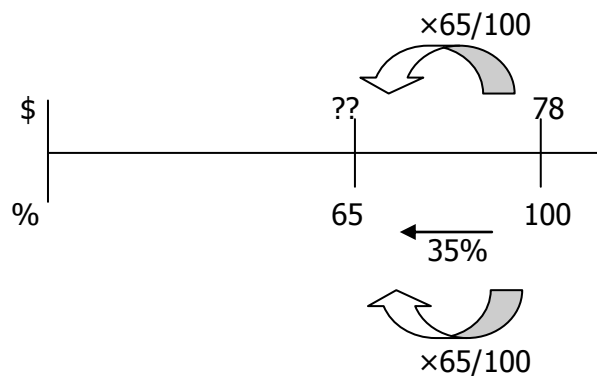


Discounts therefore have three parts (see diagram next page).



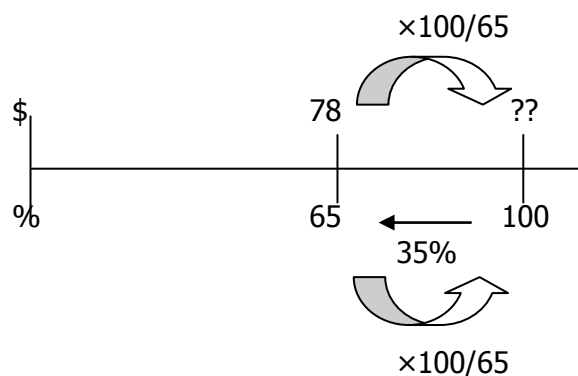
As with anything that has three parts, discounts therefore have three types of problem as follows. These three types of problem can be solved using a double number line.

- (1) Discount price unknown: The \$78 dress was discounted 35%, what was the discount price?



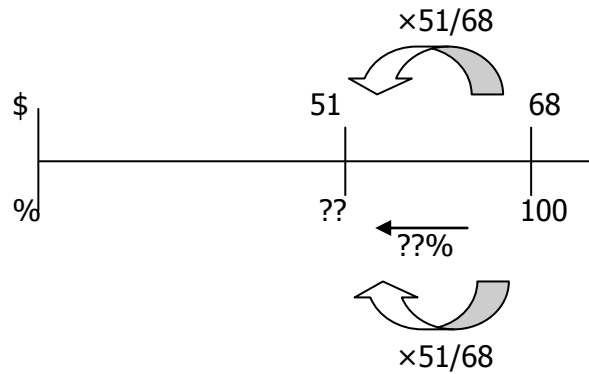
The change from 100% to 65% is achieved through $\times 65/100$; therefore, \$78 has to be changed similarly. Thus, the discount price = $\$78 \times 65/100$.

- (2) Original price unknown: The dress was discounted 35% to \$78, how much did it originally cost?



The change from 65% to 100% is achieved through $\times 100/65$; therefore, \$78 has to be changed similarly. Thus, the original price = $\$78 \times 100/65$.

(3) Discount unknown: The dress was reduced from \$68 to \$51, what was the discount?



The change from \$68 to \$51 is achieved through $\times 51/68$; therefore, 100% has to be changed similarly. Thus, the percent the dress is reduced to $= 100 \times 51/68 = 75\%$. Thus, the discount is $100 - 75 = 25\%$.

2.3. Discount activities

(1) Solve the following.

- (a) The toaster was \$58.60, there was a 15% discount, how much did it cost after the discount?
- (b) The microwave was on sale at \$139, there was a 25% discount, what was its original price?
- (c) The saucepan set was reduced from \$150 to \$105, what was the discount?

(2) Fill in the gaps in the tables.

Item	Amount	Cost	Discount	Total
Pizza	3	\$4.25 each	20%	?
Steak	4kg	\$12.60/kg	?	\$37.80
Mince	3kg	?	30%	\$11.97

(3) Construct a discount problem from the following.

- (a) 25% of $\$7.48 = \1.87 . Finding the cost after a 25% discount for something needed in a flat.
- (b) 35% of $\$36.80 = \12.88 . Finding the original cost when there is a 35% discount for something needed in a flat.
- (c) 20% of $\$145.90 = \29.18 . Finding the discount when something needed for a flat is reduced in cost.

3. Using tables

In tasks like setting up a flat, it is important to ensure that everything that is needed (in the flat) has been taken into account. An effective way to do this is to use tables based on lists of requirements.

3.1. Lists to tables

To ensure that the cost of setting up a flat is accurate, complete and exhaustive, lists have to be developed of what is needed in the flat and then turned into a form that will facilitate computation. The best form for this is to turn the lists into tables. It is also good if the table can contain all the information required in a form that allows it to use technology (e.g. Excel spreadsheets). This section looks at how to turn lists into tables; the next section will look at how to set up the table for computation.

To show how lists can become tables, we will look at a simpler example than setting up a flat, for example, *What would be the cost of clothing a man for a 4-day trip?* There are four steps as follows.

Step 1 – Develop a list: One way to do this is to consider the clothing needed in terms of parts of the body and then different activities; for example, a list could be:

- Shoes
- Socks
- Underwear
- Pants
- Shirts
- Coat/jumper
- Hat
- Pyjamas

Step 2 – Consider all needed for table: One way to do this is to think of one item and what is needed to work out cost (e.g. the number of items, where to buy it, the cost and so on). Because of the nature of the task of setting up a flat, there is also a need to consider any discounts.

- Item
- Place to buy it (shop)
- Number of items
- Cost of each item
- Any reductions
- Totals

Step 3 – Translate to a table: An effective way to do this is to put the needs (Step 2) across the top and the list of all items (Step 1) down the left-hand side of the table.

Shop	Item	Number	Cost/item	Item reduction	Totals
Athlete's Foot	Shoes				
Target	Socks				
Target	Underwear				

Jeans West	Pants				
Chaps Menswear	Shirts				
Chaps Menswear	Coat/jumper				
Target	Hat				
Target	Pyjamas				
OVERALL TOTAL					

Step 4 – Determine numbers/costs: The next step is to complete the table by filling in the gaps – determining the number of items, the shop, and the cost/item (plus any reductions).

Shop	Item	Number	Cost/item	Item reduction	Totals
Athlete's Foot	Shoes	1			
Target	Socks	4			
Target	Underwear	4			
Jeans West	Pants	2			
Chaps Menswear	Shirts	4			
Chaps Menswear	Coat/jumper	1			
Target	Hat	1			
Target	Pyjamas	1			
OVERALL TOTAL					

From the resulting table, totals can be calculated. How this is done is left to the next section.

3.2. Calculating with tables

Once the table has been set up, then operations can be used to determine totals (budgets) as follows.

Step 1 – Select appropriate operations: Selecting the right operations within a table is easier than in real-life situations, but still needs to be accurate. In general, the rules are:

- (1) addition for totals and overall totals;

- (2) subtraction for any reductions (discounts); and
- (3) multiplication of number \times cost or number \times reduced cost for total in each row.

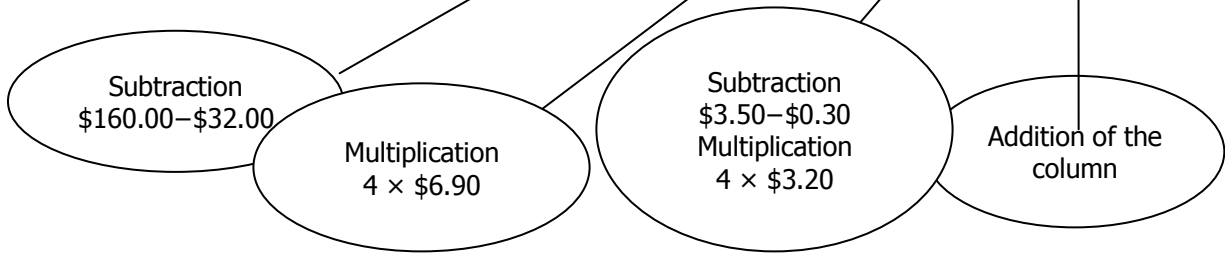
Of course, if we have to work backwards (e.g. find the cost per item when we know cost of 4 items), the operations can invert (e.g. from multiplication to division).

Step 2 – Determine form of totalling: In a table, you can find the overall total at the end or you can total cumulatively – keep a running total that advances at each row.

Step 3 – Complete the operations: Here are examples for overall total and cumulative total based on the cost of clothing for a 4-day trip for a man.

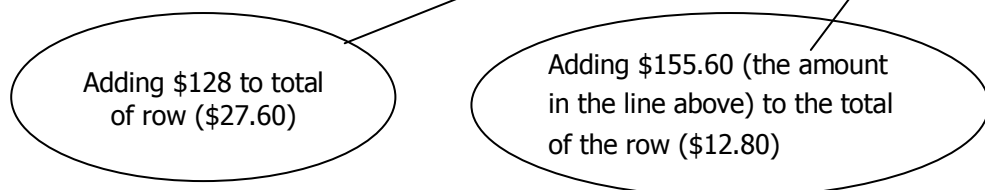
Overall total:

Shop	Item	Number	Cost/Item	Any reduction	Total
Athlete’s foot	Shoes	1 pair	\$160.00	\$32.00	\$128.00
Target	Socks	4 pairs	\$6.90		\$27.60
Target	Underwear	4	\$3.50	\$0.30	\$12.80
OVERALL TOTAL					\$168.40



Cumulative total:

Shop	Item	Number	Cost/ item	Any reduction	Cumulative total
Athlete’s food	Shoes	1 pair	\$160.00	\$32.00	\$128.00
Target	Socks	4 pairs	\$6.90		\$155.60
Target	Underwear	4	\$3.50	\$0.30	\$168.40



3.3. Table activities

- (1) Develop a list of items for the following situations:
 - (a) things other than clothing that you need to take on a holiday; and
 - (b) things that you might need to put in a new car to make it more liveable/drivable.
- (2) Translate the two lists from (1) into tables as follows:
 - (a) a table that determines the cost for these other items / or a holiday for two weeks; and
 - (b) a table that determines the cost of these items so set up for 6 months.
- (3) Use the internet to find values of items and work out the budget for each of the two situations from (1).

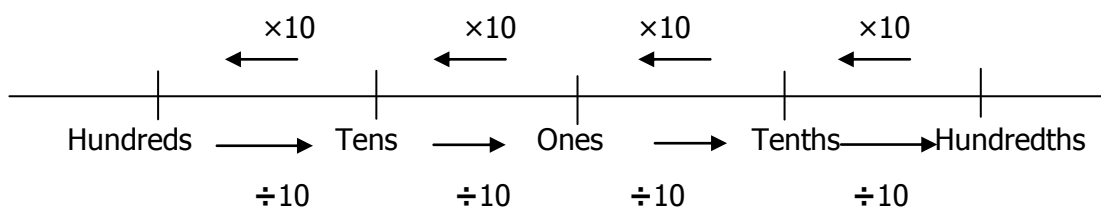
4. Metric conversion

When working out the cheapest way to buy things, the two items to be compared often use different units. For example, one sauce bottle could be 500 mL but its larger version could be 1.5 L. The methods for working out best buys in a supermarket (see section 5) require that units can be converted to the same unit for both items. This requires an understanding of place value.

4.1. Place-value relationships

Place value is built around two relationships/patterns:

- (1) The multiplicative relationship between adjacent place-value positions (moving one position left is equivalent to multiplying by 10 and one to right dividing by 10);



The pattern of threes in the place-value positions (hundreds-tens-ones).

MILLIONS			THOUSANDS			ONES			THOUSANDTHS		
H	T	O	H	T	O	H	T	O	H	T	O

These two relationships/patterns can be taught or discovered as follows.

- (2) Saying numbers:
 - (a) get students to look at numbers and to break into threes (e.g. /356/487);
 - (b) say each group of three as if it were the only number (e.g. 356 is “three-hundred and fifty-six” and 487 is “four-hundred and eighty-seven”);

- (c) look at each group of three as a group of places noticing again the symmetry around the ones and add this to the words for each group of three (i.e. first HTO is ones, HTO to the left of the ones is thousands, HTO to the right of the ones is thousandths, HTO to the left of thousands is millions, and so on); and
- (d) put these two together (e.g. 356 487 is “three-hundred and fifty-six thousand(s), four-hundred and eighty-seven (ones)” – Note: the “ones” is not said.

(3) Using place-value charts:

- (a) set out place-value charts (using paper, computer, posters on a wall, etc.) – note the placement of the decimal point;

MILLIONS			THOUSANDS			ONES			THOUSANDTHS		
H	T	O	H	T	O	H	T	O	H	T	O

- (b) move numbers along the place values left and right;

MILLIONS			THOUSANDS			ONES			THOUSANDTHS		
H	T	O	H	T	O	H	T	O	H	T	O

- (c) use calculators to see that movements to the left are the same as multiplying by 10 and movements to the right are the same as dividing by 10;
- (d) do the reverse activity – pick a number (e.g. 20), use calculators to multiply by 10 and divide by 10 and watch how the digits move along the place values; and
- (e) encourage students to see the pattern – move left is multiply by 10, move right is divide by 10.

(4) Use a place-value slide rule as below (cut where edge is perforated):

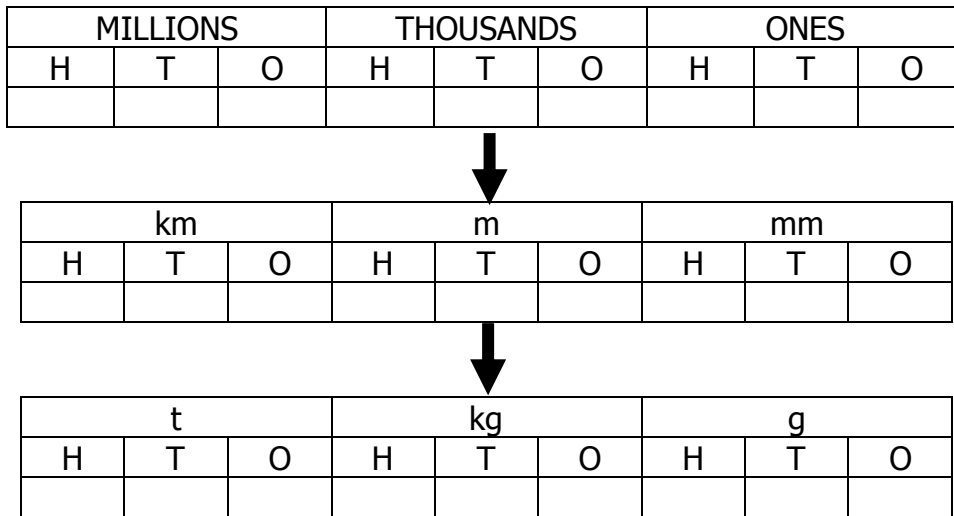
MILLIONS			THOUSANDS			ONES			THOUSANDTHS		
H	T	O	H	T	O	H	T	O	H	T	O
6											
2 7											

Slides should be 2–3 times the length of the board and slide through cuts (dotted lines) on the left and right of the board. The slides should be moved in partnership with a calculator so students can see that moving the slide to the left is the same as $\times 10$ and moving the slide to the right is the same as $\div 10$.

4.2. Converting metric units

Metric conversions can be built on place-value understandings in two ways where the idea is to replace the place-value chart with metrics as follows.

(1) Replacing the number chart with metrics:



The decimal point can be put anywhere depending on what is the focus, for example, 3 m and 23 mm can be placed on a chart as follows and the decimal point put at the m. Then, 3 m and 23 mm can be seen to be 3.023 m:

m			mm		
H	T	O	H	T	O
		3		2	3

●

Or the decimal point can be placed at the mm; and then 3 m and 23 mm can be seen to be 3023 mm.

m			mm		
H	T	O	H	T	O
		3		2	3

●

Of course, money is based on hundredths, so it uses a smaller chart based on individual place values.

\$			c	
H	T	O	T	O

Thus, 4 dollars and 23 cents is \$4.23 or 423c depending on where the decimal point is placed.

\$			c	
H	T	O	T	O
		4	2	3

● ●

(2) Using special slides on the original place-value chart:

MILLIONS			THOUSANDS			ONES			THOUSANDTHS			MILLIONTHS		
H	T	O	H	T	O	H	T	O	h	t	o	h	t	o

					km			m		cm	mm			
		t			kg			g						

The slides can be moved so that, for length, the km, m, cm, or mm is in the ones position. Then the position of other units can be seen, for example, km in millions and mm in ones; km in thousands and mm in thousandths; or km in ones and mm in millionths.

4.3. Metric conversion activities

(1) Complete the conversions:

- (a) \$3.64 = c
- (b) 4.3 L = mL
- (c) 320 g = kg
- (d) 4370 mL = L
- (e) 4 kg and 37 g = kg = g

(2) Do the following:

- (a) 10 cans of 150 g tuna = kg
- (b) 100 bottles of 600 mL milk = L
- (c) 10 cans of beans is 4.25 kg. Therefore 1 can = g

5. Best buys

Once the tables are set up, the job is to find the best price for each item. This, in many cases such as a shirt, is based on price. But on other items, for example, sauce bottles, it is based on the relationships between mass, size, length and price – that is, Proportion.

5.1. Metric conversion activities

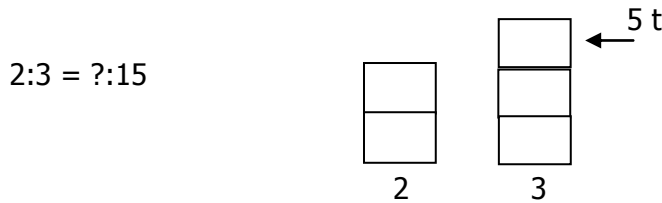
There are a variety of proportions that have to be taken into account for best buys:

- (1) mass and price – *two different cans of beans are 300 g @ 68c and 500 g @ \$1.18 – the best buy is the one with most grams for each cent;*
- (2) volume and price – *two different bottles of sauce are 500 mL @ \$1.45 and 750 mL @ \$2.10 – the best buy is the one with most mL for each cent; and*

- (3) time and price – *two different light globes are globe A which lasts 6 months @ \$1.50 and globe B which lasts 3 years @ \$8.50* – the best buy is the one with most months for each cent.

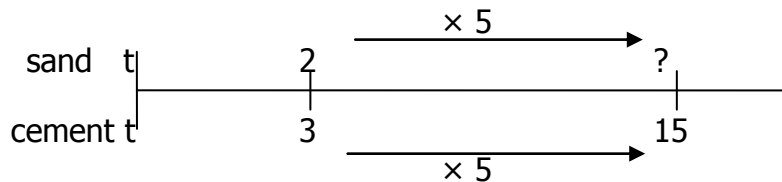
As is evident, proportion involves relationships between two attributes. Therefore, it has to be modelled by relating those two attributes. This can be done in three ways, as can be seen for the example: *sand to cement is 2:3, how much sand for 15 tonne of cement?*

- (1) By area/rectangles:



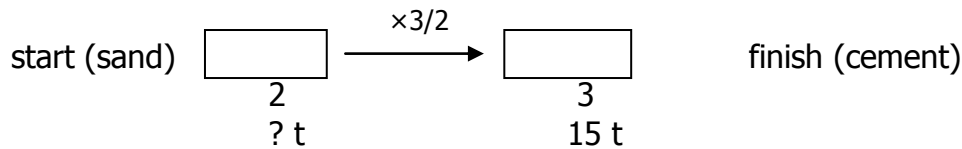
Ratio 2:3 is represented by 2 rectangles and 3 rectangles; thus, 15 t for 3 rectangles means 5 t per rectangle. Therefore, the 2 side is 10 t, the amount of sand needed.

- (2) By double number line:



Changing 3 to 15 is achieved by $\times 5$; therefore, the amount of sand = $2 \times 5 = 10$ t.

- (3) By a change diagram:

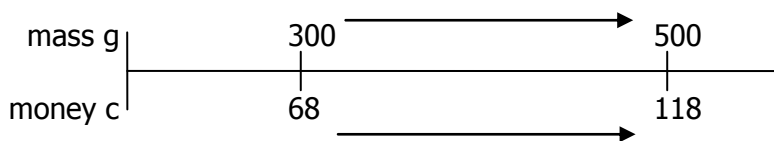


The ? is found by dividing 15 by $3/2 = 15 \times 2/3 = 10$ t.

Although all these three ways are good, we will use the double number line in what follows.

5.2. Calculating best buys

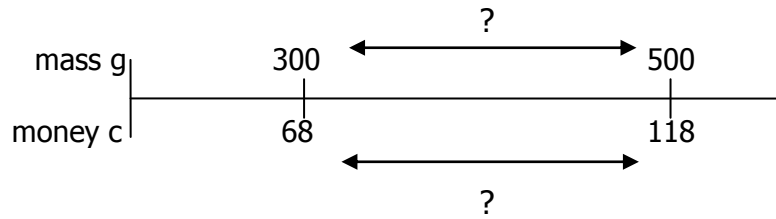
Once you have the problem like, *Which is the cheapest way to buy beans, 300 g @ 68c or 500 g @ \$1.18?*, the idea is to place it on the number line (use the same attribute, \$ or c, for both numbers).



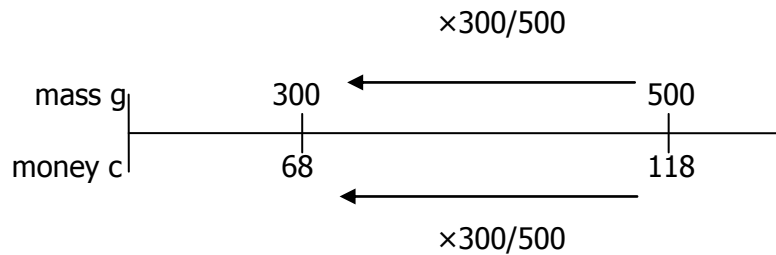
Then there are a variety of ways to check which is best; we will look at two ways.

Way 1 – Comparison of one item:

- (1) Pick one of the items (e.g. the 300 g can) and change the other one to see what it would cost if it was the same size.



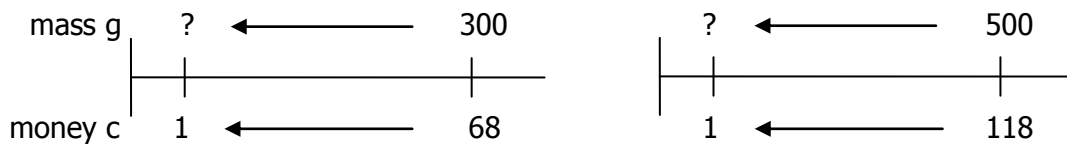
- (2) The secret is that the change on top and bottom of the line is the same, so find the change at the top and do it for the bottom.



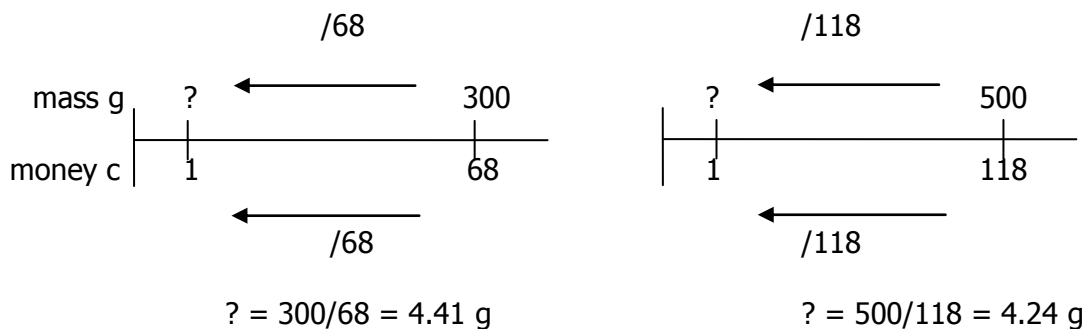
- (3) Use a calculator to calculate the cost – $118 \times 300/500 = 70.8c$.
- (4) Compare the two costs – the lower the better (in this case the larger can 500 g is more expensive).

Way 2: Unitary method

- (1) Put each item on a separate double number line.

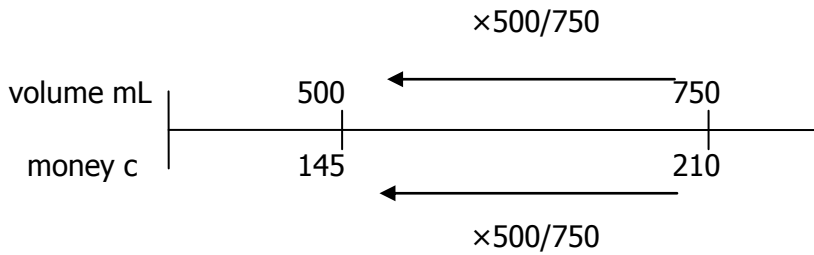


- (2) Calculate the number of grams in one cent.

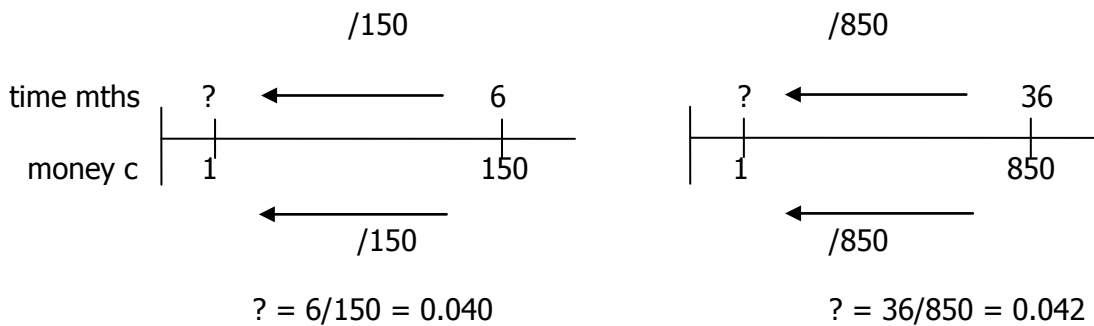


- (3) Compare the gram/cent – the higher the better (again the smaller can is cheaper).

- (4) The best buy between sauce 500 mL @ \$1.45 and 750 mL @ \$2.10 using comparison on one item:



- (5) At the 750 mL rate, the 500 mL would cost $210 \times 500/750 = 140c$. Thus the 750mL is the cheaper buy.
- (6) The best buy between globe A which lasts 6 months @ \$1.50 and globe B which lasts 3 years @ \$8.50 by the unitary method (per month):



- (7) The 3-year globe B is the better buy as it gives more time per cent (however, if you only want the globe for 6 months, globe A is better).

5.3. Best buy activities

- (1) Use your preferred method to solve the following.
- (a) Best buy for juice: 2.4 L @ \$3.84 and 3.4 L @ \$5.60.
 - (b) Best buy for pasta: 750 g @ \$4.85 and 2 kg @ \$11.95.
 - (c) Best buy for detergent: detergent A 750 mL @ \$6.72 and detergent B 1.2 L @ \$11.05.
- (2) Obtain a price list from a supermarket. Ask the students to select 10 major household necessities (food, cleaning etc.) and work out best buys for each of these from among options.

6. "Exhaustion" and "Parts" strategies

Solving the "setting up a flat" problem means ensuring all requirements of flat living are met. This means covering all necessities needed for life in the flat. In mathematics, this is the strategy of "exhaustion" – ensuring all possibilities are exhausted. However, the only way, often, to ensure this exhaustion is complete is to break the problem into parts. For example, food, cleaning, utilities, etc. This is also an important strategy.

It should be noted that the advent of computers has increased the mathematical importance of both these strategies. The speed of computers means that checking all possibilities (exhaustion) is a useful and effective strategy. This, in turn, has meant that problems now can handle much larger data sets, which has increased the need to be able to break things into parts to make them manageable.

6.1. Using the exhaustion and parts strategies

The idea of this strategy is to make sure that everything is covered. To do this, it is parts first, and then exhaustion. Suppose we were to prepare for a trip say for 2 weeks, what would we take?

- (1) Make a list of types of things to be taken:
 - (a) clothing to wear during the day;
 - (b) things for night time;
 - (c) bathroom/toiletries/personal hygiene goods;
 - (d) entertainment goods; and
 - (e) other necessities (e.g. money).
- (2) Make sub-lists for each of these:
 - (a) clothing – shoes, socks, underwear, shirts, pants, dresses, skirts, jumpers and coats, hats, belts;
 - (b) night – pyjamas, alarm clock, book;
 - (c) bathroom – soap, shampoo, toothbrush and toothpaste, deodorant, perfume, makeup, brush, comb, etc.;
 - (d) entertainment – iPod, camera, charger, mobile phone, computer, cards, board games; and
 - (e) other – scissors, tape, working material, medicines, wallet, passport, maps, information booklets.
- (3) Try to exhaust all possibilities, imagine what you will be doing and what you need to have as you are doing it, and ask others to check your list.

6.2. Calculating using parts/exhaustion

If there is a need to exhaust possibilities, the task is complicated and requires tables and spreadsheets. It will also require more than one operation. For example, preparing for a party requires multiple amounts of each item. If there is a budget, it requires continually looking to see how much money is left and what this money should be spent on.

An example may suffice. Suppose we are having a drink at \$5.50 a bottle with 10% off if a crate of 12 is bought. We have \$200 but we must retain \$70 for the pizzas. How many bottles can we buy?

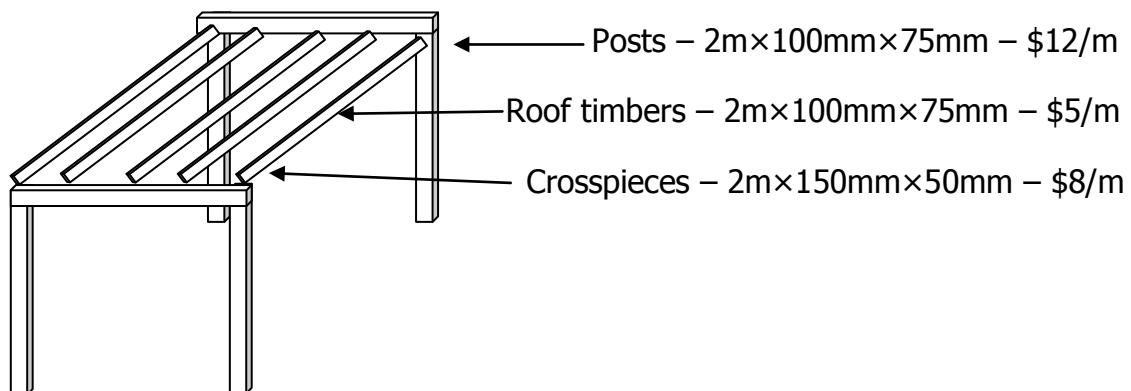
- (1) First there is subtraction:
 $\$200 - \$70 = \$130$ for the drinks.

- (2) Then there is division:
 $\$130 \div \$5.50 = 23.64$ – so we could buy 23 bottles at \$5.50 each.
- (3) Then we must deal with the dozens and the 10% discount that occurs then. Multiplication and subtraction are needed:
 The first 12 bottles cost \$66; 10% discount is \$6.60 (multiplication by 0.1). So they really cost \$59.40 (subtraction \$66 minus \$6.60).
- (4) This leaves \$70.60 still to spend (subtraction \$59.40 from the \$130 that we had left to spend).
- (5) This allows more to be bought as we can buy another dozen for \$59.40 from the \$70.60 leaving \$11.20 (subtraction) which enables two more bottles to be bought (adding \$5.50 to \$5.50 to give \$11). Thus, the total number of bottles we can buy is 26 (adding 12 + 12 + 2).

6.3. Strategy activities

- (1) Build a pergola:

Consider the problem, *How much change would you receive from \$200 when buying wood for a pergola as below?*



- (a) In order, list the operations needed to solve the following problem (it is not necessary to solve the problem – just list the operations you would use).
- (b) Construct a table from the list and set up a spreadsheet to do the calculations.
- (c) Do the calculations and work out the cost.
- (d) Calculate how much each month for three months to pay this cost interest free.
- (2) Plan a Party:
- (a) Design a party for 20 people – what will you do; where will you have it; what will you have?
- (b) Use parts and exhaustion to list everything needed for the party.
- (c) Place your list on a table or spreadsheet and use the internet to find the costs of each item and then calculate to find the total cost of the party.

CULMINATING TASK

EXCHANGE STUDENT

Directions: You have been asked to organise accommodation for two exchange students from the United States. They are staying in a flat near the Ipswich University campus. There is a common lounge room for television and associated activities. Therefore no arrangements are needed for the living room.

The two students will require equipment for the bedroom, kitchen and bathroom. They will need a weekly food supply. All bathroom and other needs will need to be purchased on a regular basis. **Note:** Each student budgets for two exchange students.

The students are here for 26 weeks (a full semester plus holidays).

Task One:

You are to budget for the **total** cost of accommodating the two exchange students for the 26-week period. A set of brochures from a variety of retail outlets is supplied for classroom use. The internet is also available. And you may use your own brochures if you wish.

Your solution should contain a fully planned set of information in table form which includes **something** like the following for **each** room.

Table One: Cost of setting up the kitchen.					
Shop/Outlet	Item	Cost	Discount Cost	Saving	Cumulative Total
Myer	Toaster	\$32.50	\$28.75	\$3.75	\$28.75
Myer	Cutlery set	\$54.50	\$54.50	\$0.00	\$83.25

In your costing you should look for the **best discounts** you can in the brochures.

A **grocery planner** for each week is also required. All the items should be costed. If items do not need to be bought every week, this should be indicated.

Items required on a **less regular** basis, such as soap, will need to be recorded as many times as necessary in the 26-week period. A **separate** table for **non-kitchen** items is required.

Your work should have a total of 5 tables of information.

Task Two:

Now use the information in *Task One* to complete *Task Two*. Be sure to read all the information below to make sure the calculations are done correctly.

- (1) Calculate the total cost for the twenty-six (26) week period.
- (2) Calculate the total amount saved from the discounts.
- (3) Calculate the weekly charge for each of the exchange students.

The exchange students need to be charged enough to cover all costs, with the following exceptions.

- (1) Any items that **stay** in the flat after the exchange students leave will be charged to the exchange students at 20% of the original cost of the item.

- (2) All perishable items are charged at full cost.
- (3) A 10% surcharge on top of the total is to be added to cover incidental costs.

Task Three:

You are to present a **short** (5 minute) presentation to the class.

The presentation is to be done as if you were explaining to the exchange students how you costed their weekly charge.

ASSESSMENT RUBRIC

Assessment Form:

General Objectives	Specifics	Assignment Grade (A-E)
Knowing	Use currency symbols correctly. Round correctly where required. Use a calculator to perform mathematical operations correctly. Know what is meant by a percentage. Find a percent of a fixed amount. Know how to budget to meet a need.	
Applying	Select the correct arithmetic operations in context. Correctly calculate costs involved in preparing a budget. Calculate sub-totals and totals. Use a calculator to solve common percent problems. Organise data. Create a budget for a specific purpose. Find the best buys and discounts.	
Explaining	Explain the steps to teachers and peers on how maths problems are solved. Present solutions in writing involving tables and calculations.	
Overall Grade		

Assessment Criteria:

GRADE	KNOWLEDGE	APPLICATION	EXPLAINING
A	Effectively uses given rules to carry out tasks.	Applies rules across all contexts effectively.	Presents detailed solutions logically and clearly.
B	Uses given rules to carry out tasks.	Applies rules across most contexts effectively.	Presents solutions logically and clearly.
C	Uses given rules adequately to carry out tasks.	Applies rules adequately across most contexts.	Presents readable solutions.
D	Uses given rules to carry out parts of tasks.	Applies rules in some contexts adequately.	Presents partial solutions.
E	Did not meet standard D.	Did not meet standard D.	Did not meet standard D.