TI-30XB MultiView™ Cabinets & Flat Packs

This Unit includes:

- Teacher Notes & Lesson Overview — T
- Teacher PowerPoint — PPT
- Worksheets 1 & 2 — W
- Student Assessment Task — AT
- Solutions to Student Worksheets — WS

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Curriculum Links
TI-30XB MultiView™: Cabinets & Flat Packs

C

Year 7 Algebra, Function and Pattern – Working Mathematically

Statement of Learning Opportunities

Algebra, Function and Pattern

- Define variable and interpret mathematical expressions
- Use whole numbers to construct tables for functions
- Specify rules of linear functions and use this function to predict other values

Working Mathematically

- choose and use sets of things, lists, tables, diagrams and graphs to represent, interpret and analyse data, relations and functions
- present and discuss a problem, its formulation, possible solution strategies, and processes and results obtained, with the assistance of technology as applicable

Key Ideas

- The concept of representing a number by a variable
- Using the calculator as a learning tool
- Use of diagrams and tables to document progress
- Multiplication of decimal factors can be changed to equivalent whole number problems to simplify the solution process

Key Vocabulary

'exactly' fit, flat packs, multiples, equations involving parameters and variables.

Lesson Overview

i) Extension of prior pattern
ii) Formation of table of values and the calculation of the first difference
iii) Equation of the pattern
iv) Use the rule to predict values
v) Use of the rule in forming a table of values and formation of graph
vi) Comparison of results using manual substitution with the values formed by the table in the calculator
vii) Using the 'ask function' in a calculator to think – guess – check to determine the input number for a given output
viii) Formation of a line of regression

Lesson Overview

TI-30XB Mulitview™ calculator, match sticks, copies of worksheets, graph paper

Curriculum Links
TI-30XB MultiView™: Cabinets & Flat Packs

C

Indicators of Success

- Extending and describing a pattern
- Drawing a scaled diagram
- The difference between the combination of flat packs and the arrangements of the flat packs
- Expressing ideas of generality in a report
- Forming a table of values with all the appropriate combinations
- Use a rule to predict the number of spaces and the threshold value for the flat packs

Teachers Explanatory Notes
TI-30XB MultiView™: Cabinets & Flat Packs

T

This unit has students engaged in working with two or three different sized prepacked cabinets (bought as flat packs) to explore different possible combinations along a fixed length of wall. The cabinets are for the Do It Yourself (DIY) handyman and come in precut sizes. The arrangement of multiple fixed length flat packs can cover a variety of wall lengths. Students are asked to design a wall of cabinets for a fixed length using the appropriate combination of flat packs.

- What is the minimum length of wall for which there will always be an appropriate combination?
- Which lengths of wall have more than one solution?
- Which lengths of wall do not have any 'exact' solution, and how many walls are there that cannot be covered using a two specified sizes of flat packs?

1. Show the associated PowerPoint to familiarise the students with the concept of a 'Flat Pack'. Display the advertisement for the Lumina Supreme Kitchens. As a whole class discuss the intent of the advertisement, and the mathematics of the advertisement. Why did the company call their flat packs by the 'size 7 flat pack' and 'size 5 flat pack'? What does 'modules that exactly fit a wall' mean? Measure a wall length in the class room. Discuss whether the company means a wall 6550 mm can be fitted exactly. Has the company rounded wall lengths to a particular value? In real life, how would a cabinet maker fill in the missing pieces if cabinets do not exactly fit?

PPT

2. Hand out and have students' complete worksheet 1 and review answers with the whole class before going onto worksheet 2.

W1

W2

3. Handout worksheet 2. In task 1, encourage the students to work in pairs or groups. Have the groups display their diagrams and tables. Discuss as a group the effectiveness of the representations. While repeated guesses may be used to decide which combinations of flat packs can fill a wall length, the flat pack numbers represent factors. As factors, we know that for 'non trivial common' factors, the HCF is usually one, and that one factor is not a multiple of the other factor.

   For example, 4 and 5 are non trivial common factors as they have a HCF of 1. This allows ease of calculation for the LCM which is the product of the values . Hence for 4 and 5, the LCM is 20.

   When using the addition of multiples of two values to form a number, two mathematical expressions exist which allow you to determine the largest number which cannot be formed using these two numbers.

This expression is **x.y – (x + y)**

For example when x = 4 and y = 5, the value of **x.y – (x + y)** = 20 – 9 = 11. This implies that every number after 11 can be written as a combination of the values 4 and 5. For cabinet makers this means that any wall longer than 1.1m can be filled using a combination of 0.4m and 0.5m module units. (assuming the wall lengths are truncated to the nearest tenth of a metre).

Another expression **0.5(x - 1)(y - 1)** allows the cabinent maker to determine how many wall lengths there are below the value **x.y – (x + y)** where wall can definitely be fitted. For example when x = 4 and 5, there are 0.5(4 – 1) (5 – 1) = 6 lengths of wall below 1.1 metres that cannot be fitted using any combination of 0.4 metre and 0.5 metre modules. These lengths are 0.1m, 0.2m, 0.3m, 0.6m, 0.7m and 1.1m.

This discussion about common factors and LCM would be advisable before we begin.

Questions such as 'Is it possible to determine...'
'How do we know if...'

Are questions Mathematicians ask about a problem when they are 'working mathematically'.

4. Students can benefit from using the table function on their TI-30XB MultiView™ .
On the TI-30XB MultiView™ calculator you are able to enter RULE for linear patterns.

   To enter a RULE:

   a) Press table
   b) If a previous RULE has been used, clear this by pressing clear
   c) Enter the RULE y = 2x+3. Use the key x^{yzt}_{abc} to enter 'x'. Then press enter
   d) Use the down arrow on the NAVIGATION button to highlight Ask-x.
      a. Then move to highlight OK and press enter
   e) Enter a desired x value to find the y value using the entered equation.

5. A research assessment task has been included. Stress the need for communication with an audience for the report to be compiled by answering questions in the worksheet. Encourage the documentation of representative calculations in mathematics and reflection on these results in the explanation.

AT

6. Extension Activity:
   The cabinets unit involves different pathways and multiples… the Wipe Out activity below does exactly the same. It deals with odd and even numbers and pathways which fit into patterns, in much the same way as the rules allow the tables to be fitted into pathways… the difference this time is can you find how long a chain will be, not whether a set combination is cheaper or if the length of the wall exists.

PPT

Wipe Out is a challenge for a team of 4 people.
The task is to form the longest chain of numbers until you hit the WIPE OUT number, which is 1.

How to play
Each team is randomly assigned 3 digits. These digits are arranged to form 4 different starting numbers. A chain of numbers are formed according to the following rules:

The chain is formed by following these three rules:

Rule 1: When the number is EVEN, the next number is formed by dividing by 2
Rule 2: When the number is ODD, the next number is formed by multiplying by 3 then add 1
Rule 3: The chain stops when you get to 1

The length of the chain you create secures points. **You score:**

- 1 point for chains less than 10 numbers
- 2 points for chains from 10 to 20 numbers
- 4 points for chains from 21 to 30 numbers
- 8 points for chains from 30 to 40 numbers
- 16 points for chains over 40 numbers

The competition begins with each team **generating 3 RANDOM digits from 0 to 9.**
The random digits are arranged to **make your starting number.**
(e.g. If you have a 3, 5, 1 means you can start with 351 or 135 or 531)
A number formed by another team cannot be reused. You will need to select again:

Example: If you start with 15 which is odd, so 15 x 3 + 1 = 46
46 is even, so 46 ÷ 2 = 23,
23 is odd, so …
Keep going until WIPE OUT (get to 1)

15 → 46 → 23 → 70 → 35 → 116 → 58 → 29 → 88 → 44 → 22 → 11 → 34 → 17 → 52 → 26 → 13 → 40 → 20 → 10 → 5 → 16 → 8 → 4 → 2 → 1 [chain length is 26 which gives 4 points]

Wipe Out extension questions
Look at the patterns for wipe outs in the class.

- Did everyone finally WIPE OUT?
- Does a pattern of numbers occur which will mean a WIPE OUT is definitely coming?
- What is the average chain length?
- Is this the same average for odd and even starting numbers?
- Does starting with an odd or an even number give longer chain lengths?
- What is the shortest chain that comes from starting with a 3 digit starting number?
- Do prime numbers give longer chains than the average number for the class?
- Do chains ending in ZERO give longer chains than chains ending in FIVE?
  Explain the result.
- Use a whole class diagram to show the chains that were formed using the different start numbers?
- IS THE GAME FAIR?

Some items to consider when teaching this unit:

MOVE FROM THE VISUAL to the NUMERICAL
- to cost a project
- to determine a combination that may fit, and looking at the constraints
- Using different combinations of two flat packs between the restraints

CHANGING a parameter (length of wall)
- Asking new questions?
- Does the doubling of the wall length mean more than twice as many solutions?
- Is the threshold for always having a match using the two flat pack sizes reached?
- Formation of the table of values

ANOTHER PATTERN ➔ ANOTHER MODEL
- Looking again for the axial intercepts and first order constant difference
- Find the first order finite difference and the initial value using the statistical features of the TI-30XB MultiView™ calculator

Remember some important question in mathematics are:

- What am I trying to show and how will I know if I am successful?
- How can I get more information to assist me in solving my question?
- Can I do this another way?
- Is this a valid solution?
- How many solutions are there?
- How do I know if I have found all the solutions?
- What happens if I change one of the parameters (flat pack size)?
- Is there a general pattern that allows me to shorten the investigation and find the result of the investigation without copious calculations?
- Can I think of another situation in which I may apply this mathematical technique or knowledge (e.g. packing a container with other rectangular boxes – a 2D situation)?

Worksheet Solutions 1
TI-30XB MultiView™: Cabinets & Flat Packs

WS1

Task 1

a) $1149.20

b) No, would cover only 2.9 metres of the 3.3 metres.

c) 6 size 5 flat packs would cover only 3 metres.

d) 4 size 7 flat packs would cover only 3 metres.

	0	**0.7**	**1.4**	**2.1**	**2.8**
0	0	.7	1.4	2.1	2.8
0.5	.5	1.2	1.9	2.6	3.3
1.0	1.0	1.7	2.4	3.1	
1.5	1.5	2.2	2.9		
2.0	2.0	2.7			
2.5	2.5	3.2			
3.0	3.0				

Task 2

a) Five size 5 flat packs and one size 7 flat packs

b) $1231.60

Task 3

a) Six size 7 flat packs
or
seven size 5 flat packs and one size 7 flat packs

	0	0.7	1.4	2.1	2.8	3.5	4.2
0	0	.7	1.4	2.1	2.8	3.5	4.2
0.5	.5	1.2	1.9	2.6	3.3	4.0	
1.0	1.0	1.7	2.4	3.1	3.8		
1.5	1.5	2.2	2.9	3.6			
2.0	2.0	2.7	3.4	4.1			
2.5	2.5	3.2	3.9				
3.0	3.0	3.7					
3.5	3.5	4.2					

Six size 7 flat packs costing $1425.60

Task 4

a) No arrangement makes 1.8 metre, the closest is two size 5 flat packs and one size 7 flat packs that cover 1.7 metres

b) Not all sizes will be covered using 7 flat packs and 5 flat packs

Think Spot

a)
7 7 7 7 7 5
7 7 7 7 5 7
7 7 7 5 7 7
7 7 5 7 7 7
7 5 7 7 7 7
5 7 7 7 7 7

b)
7 7 7 7 5 5
7 7 7 5 5 7
7 7 5 5 7 7
7 5 5 7 7 7
5 5 7 7 7 7

7 7 7 5 7 5
7 7 5 7 5 7
7 5 7 5 7 7
5 7 5 7 7 7

7 7 5 7 7 5
7 5 7 7 5 7
5 7 7 7 5 7

7 5 7 7 7 5
5 7 7 7 5 7

5 7 7 7 7 5

Worksheet Solutions 2
TI-30XB MultiView™: Cabinets & Flat Packs

WS2

Task 1

Sizes to fit using size 4 and 7 flat packs

	0	**0.7**	**1.4**	**2.1**	**2.8**	**3.5**	**4.2**
0	.0	.7	1.4	2.1	2.8	3.5	4.2
0.4	.4	1.1	1.8	2.5	3.2	3.9	
0.8	.8	1.5	2.2	2.9	3.6	4.3	
1.2	1.2	1.9	2.6	3.3	4.0		
1.6	1.6	2.3	3.0	3.7	4.4		
2.0	2.0	2.7	3.4	4.1			
2.4	2.4	3.1	3.8	4.5			
2.8	2.8	3.5	4.2				
3.2	3.2	3.9					
3.6	3.6	4.3					
4.0	4.0						
4.4	4.4						

Cost for 4 and 7 flat packs

	0	**0.7**	**1.4**	**2.1**	**2.8**	**3.5**	**4.2**
0	0	237.6	475.2	712.8	950.4	1188	1425.6
0.4	176.5	414.1	651.7	889.3	1126.9	1364.5	
0.8	353	590.6	828.2	1065.8	1303.4	1541	
1.2	529.5	767.1	1004.7	1242.3	1479.9		
1.6	706	943.6	1181.2	1418.8	1656.4		
2.0	882.5	1120.1	1357.7	1595.3			
2.4	1059	1296.6	1534.2	1771.8			
2.8	1235.5	1473.1	1710.7				
3.2	1412	1649.6					
3.6	1588.5	1826.1					
4.0	1765						
4.4	1941.5						

Worksheet Solutions 2
TI-30XB MultiView™: Cabinets & Flat Packs

WS2

Sizes to fit using size 5 and 7 flat packs

	0	0.7	1.4	2.1	2.8	3.5	4.2
0	0	.7	1.4	2.1	2.8	3.5	4.2
0.5	.5	1.2	1.9	2.6	3.3	4.0	
1.0	1.0	1.7	2.4	3.1	3.8	4.5	
1.5	1.5	2.2	2.9	3.6	4.3		
2.0	2.0	2.7	3.4	4.1			
2.5	2.5	3.2	3.9				
3.0	3.0	3.7	4.4				
3.5	3.5	4.2					
4.0	4.0						

Cost of cabinets using size 5 and 7 flat packs

	0	0.7	1.4	2.1	2.8	3.5	4.2
0	0	237.6	475.2	712.8	950.4	1188	1425.6
.5	198.8	436.4	674	911.6	1149.2	1386.8	
1.0	397.6	635.2	872.8	1110.4	1348	1585.6	
1.5	596.4	834	1071.6	1309.2	1546.8		
2.0	795.2	1032.8	1270.4	1508			
2.5	994	1231.6	1469.2				
3.0	1192.8	1430.4	1668				
3.5	1391.6	1629.2					
4.0	1590.4						

Worksheet Solutions 2
TI-30XB MultiView™: Cabinets & Flat Packs

WS2

Sizes to fit using size 4 and 5 flat packs

	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
0	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
0.4	.4	.9	1.4	1.9	2.4	2.9	3.4	3.9	4.4	
0.8	.8	1.3	1.8	2.3	2.8	3.3	3.8	4.3		
1.2	1.2	1.7	2.2	2.7	3.2	3.7	4.2			
1.6	1.6	2.1	2.6	3.1	3.6	4.1				
2.0	2.0	2.5	3.0	3.5	4.0	4.5				
2.4	2.4	2.9	3.4	3.9	4.4					
2.8	2.8	3.3	3.8	4.3						
3.2	3.2	3.7	4.2							
3.6	3.6	4.1								
4.0	4.0	4.5								
4.4	4.4									

Costs of cabinets using size 4 and 5 flat packs

	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
0	0	198.8	397.6	596.4	795.2	994	1192.8	1391.6	1590.4	1789.2
0.4	176.5	375.3	574.1	772.9	971.7	1170.5	1369.3	1568.1	1766.9	
0.8	353	551.8	750.6	949.4	1148.2	1347	1545.8	1744.6		
1.2	529.5	728.3	927.1	1125.9	1324.7	1523.5	1722.3			
1.6	706	904.8	1103.6	1302.4	1501.2	1700				
2.0	882.5	1081.3	1280.1	1478.9	1677.7	1876.5				
2.4	1059	1257.8	1456.6	1655.4	1854.2					
2.8	1235.5	1434.3	1633.1	1831.9						
3.2	1412	1610.8	1809.6							
3.6	1588.5	1787.3								
4.0	1765	1963.8								
4.4	1941.5									

a) Compare your two situations. Are there any lengths that one combination of flat packs will fill but the other combination will not fill? Yes

b) Which lengths of wall cannot be exactly fitted by either flat pack combinations?
0.1 0.2 0.3 0.6

c) Which lengths of wall are filled using only one size of flat packs?
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
0.4 0.8 1.2 1.6 2.4 2.8 3.2 3.6 4.4
0.7 1.4 2.1 4.2

Task 2

When looking for the cost of the cabinets to be fitted along a wall length, there is usually more than one way to fill the length of wall. Only the unshaded lengths are uniquely fitted if you compare walls fitted using the 4 and 7 flat packs with those fitted using the 4 and 5 flat packs.

Lengths fitted by combinations of 0.4 m and 0.7 m

	0	**0.7**	**1.4**	**2.1**	**2.8**	**3.5**	**4.2**
0	.0	.7	1.4	2.1	2.8	3.5	4.2
0.4	.4	1.1	1.8	2.5	3.2	3.9	
0.8	.8	1.5	2.2	2.9	3.6	4.3	
1.2	1.2	1.9	2.6	3.3	4.0		
1.6	1.6	2.3	3.0	3.7	4.4		
2.0	2.0	2.7	3.4	4.1			
2.4	2.4	3.1	3.8	4.5			
2.8	2.8	3.5	4.2				
3.2	3.2	3.9					
3.6	3.6	4.3					
4.0	4.0						
4.4	4.4						

Worksheet Solutions 2
TI-30XB MultiView™: Cabinets & Flat Packs

WS2

Lengths fitted by combinations of 0.5 m and 0.4 m

	0	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
0	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
0.4	.4	.9	1.4	1.9	2.4	2.9	3.4	3.9	4.4	
0.8	.8	1.3	1.8	2.3	2.8	3.3	3.8	4.3		
1.2	1.2	1.7	2.2	2.7	3.2	3.7	4.2			
1.6	1.6	2.1	2.6	3.1	3.6	4.1				
2.0	2.0	2.5	3.0	3.5	4.0	4.5				
2.4	2.4	2.9	3.4	3.9	4.4					
2.8	2.8	3.3	3.8	4.3						
3.2	3.2	3.7	4.2							
3.6	3.6	4.1								
4.0	4.0	4.5								
4.4	4.4									

The majority of wall lengths can be filled in many different ways

For example: cost of filling 4.4 metres using different combinations

11 units of 0.4 metres = cost $1941.50
6 units of 0.4 metres and 4 units of 0.5 metres = cost $1854.20
1 unit of 0.4 metres and 8 units of 0.5 metres = cost $1766.90
4 units of 0.4 metres and 4 units of 0.7 metres = cost $1656.40

Using 7 and 5
Longest wall that cannot be fitted is 2.3 metres
The number of walls that cannot be fitted is 12

Using 7 and 4
Longest wall that cannot be fitted is 1.7 metres
The number of walls that cannot be fitted is 9

Using 5 and 4
Longest wall that cannot be fitted is 1.1 metres
The number of walls that cannot be fitted is 6