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Burpengary State School, Burpengary
Chancellor State College, Sippy Downs
Coolum State School, Coolum Beach
Coopers Plains State School, Coopers Plains
Crestmead State School, Crestmead
Currumbin State School, Currumbin
Dakabin State School, Dakabin
Elanora State School, Elanora
Greenbank State School, Greenbank
Harristown State School, Toowoomba
Ipswich North State School, North Ipswich
Marsden State School, Marsden
Marymount Primary School, Burleigh Waters
McDowall State School, McDowall
Morayfield East State School, Morayfield
Mountain Creek State School, Mountain Creek
Narangba State School, Narangba
Rangeville State School, Toowoomba
Samford State School, Samford
Scarborough State School, Scarborough
Shailer Park State School, Shailer Park
St Columba's Primary School, Wilston
St Eugene School, Burpengary
St Rita's Primary School, Victoria Point
Sunnybank Hills State School, Sunnybank Hills
Toowoomba East State School, Toowoomba
Tullawong State School, Caboolture
Undurba State School, Murrumba Downs
Warrigal Road State School, Eight Mile Plains
Waterford West State School, Waterford West
Wilsonton State School, Toowoomba
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</table>
Working with Multiples and Factors

Mathematical Background
A knowledge of multiples and factors helps students when they multiply and divide large numbers mentally. For example, $288 \div 18$ might be solved by factoring 18 into 2 and 9 and reasoning that $288 \div 9$ is 32 and then $32 \div 2$ is 16. Of course, knowledge of divisibility rules also helps establish the fact that 288 can be factored into 2 or 9 (or 3, 4, 6 or even 8). Analysing the patterns and searching for properties involving multiples and factors is the heart of thinking, reasoning and working mathematically. Other reasons for exploring multiples and factors relate to the emerging applications of mathematics for security systems used on the Internet. These recent innovations are all based on the ability to factor, or more appropriately the inability to factor, large numbers.

Lessons
5.1 Investigating Patterns Made by Multiples
5.2 Extending Patterns Made by Multiples
5.3 Working with Factors
5.4 Using Logical Reasoning: Solving Number Puzzles
5.5 Constructing Factor Trees

Links to Other Core Learning Outcomes
PA 4.1 Students identify and create representations of patterns and functions and apply backtracking to solve simple equations that involve combinations of the four operations.
Criteria
On completion of this unit, the students should be able to

A. use patterns to identify multiples of 3, 4 and 9
B. identify factors of a given two-digit number
C. use factors and multiples as clues to solve number puzzles
D. create a factor tree for a given two-digit number
E. use a factor tree to help list all factors of a two-digit number

Techniques
The following tools can be used to assess the relevant criteria.

1. Investigation
   See opposite page.

2. Written Diagnostic Task
   Allow time for the students to complete the diagnostic task for Unit 5 on page 5 of the GO Check assessment book. You may want to administer the task one or two weeks after completion of the unit.

3. Student Journal Page
   Refer to GO Maths student journal page 23.
Investigation

**What is the most common number of factors for all counting numbers less than 100?**

**Ask**
- What is a factor of a number?
- Do all counting numbers have factors? (Yes, the number itself and 1.)
- How do you know that you have all the factors of any number being considered?
- What is the least number of factors for a number less than 100?
- What are some numbers that you think would have a large number of factors? Why?
- How could a calculator be useful to help solve this task? (By using division and interpreting any divisor that results in a decimal answer as not being a factor.)

**Observe**
Was the student able to
- identify all the whole number factors for one- and two-digit numbers less than 100?
- use division to find whole number factors of numbers from 1–100?
- interpret the calculator display to identify whole number factors of numbers?

**Reflect**
Discuss what it means for a number to have an odd number of factors. (Numbers with an odd number of factors must be square numbers; for example, 25 has three factors: $1 \times 25$ and $5 \times 5$.) Discuss what would be special about numbers with just two factors. (These must be prime numbers.) List the factors of several numbers and discuss any patterns that can be seen, such as the doubling and halving of factors (e.g. factors of 24: $1 \times 24$, $2 \times 12$, $3 \times 8$, $4 \times 6$).

**Recording**
- Indicate successful achievement of assessment criteria \( \text{A B C D E} \) by shading the box for Unit 5 (Level 4A) in N.4.3 of each student’s Student Progress Record in the GO Check assessment book.

For students who need extra assistance, revisit the relevant parts of the unit.
Investigating Patterns Made by Multiples

In this lesson, students explore patterns formed by the digits in the ones place for all multiples of 2 to 9.

Daily Number Sense

Draw the number line below on the board.

Say: Divide the line segment from 1 to 2 into 10 equal parts. Where should we draw the marks? Invite volunteers to describe the thinking they use to work out the position of the marks. After the marks have been drawn, point to a mark greater than 1 and ask: What numbers should we write here? How do you know? How far away is the next whole number on this side? (Note: The set of whole numbers includes zero.) Encourage the students to write a common fraction above the number line and a decimal fraction below it and describe how they can find the difference. Repeat the discussion for other marks selected at random.

Activity

1. Display one grid from Blackline Master 5 on the projector and ask: How many squares are in each row? If we count in steps of 5, where do we write the multiples of 5? Invite volunteers to write the numbers and then describe how the numbers are arranged. (They lie on the diagonals.)

2. Use the same grid to repeat the discussion for counting in steps of 2. It is not necessary to write the numbers. Bring out the fact that all multiples of 2 are in the second, fourth and sixth columns.

3. Now display the second grid and ask: If we count the squares, what numbers should we write in the last column? Invite individuals to begin counting in steps of six and write 6, 12, 18 etc. down the last column.

4. Ask: What pattern(s) do you see? Invite students to make general comments, such as all of the numbers are even. Bring out the fact that the digits in the ones place repeat in the pattern ’6, 2, 8, 4, 0, 6, 2, 8, 4, 0’. Then discuss questions such as: What do you think the next five digits in the ones place will be? Do you think the number 99 is a number that could be a multiple of 6?

5. Have the students work independently to complete page 20 of the GO Maths student journal.

Reflection

Discuss the students’ answers to page 20 of the GO Maths student journal. Have the students give a variety of observations. Promote the continual search for patterns.

Materials

- GO Maths student journal, page 20
- Blackline Master 5 copied onto an overhead transparency
- Overhead projector

Optional

- 1 copy of Blackline Master 5 for each pair of students

Teaching Note

Numbers arranged in rows of 6 are useful when prime numbers are investigated. After the first row, all prime numbers are in the first or fifth columns.

Daily Computation Practice

Write multiplication sentences with three one-digit factors on the board. Two of the factors should be 2, 4 or 5 (e.g. 2 × 4 × 5 or 6 × 4 × 5 = 120). Ask the students to copy and complete the sentences or simply write the answers.

Consolidation

Ask the students to work in pairs to write the multiples of 2 and 3 on the same grid from Blackline Master 5. They should then circle the numbers that are both multiples of 2 and 3. (These will be the multiples of 6.)
Extending Patterns Made by Multiples

This lesson extends the investigation of patterns to numbers beyond 100.

**Daily Number Sense**

Draw the number line below on the board.

![Number Line]

Ask: Where would we draw the marks to divide the line from 0 to 2 into 8 equal parts? Follow the steps described in the Daily Number Sense discussion from the previous lesson to write four fractions. Then erase the fractions and repeat the discussion to divide the line into five equal parts.

**Activity**

1. Display the overhead transparency and ask: Pretend we count by ones. What is the greatest number on this grid? Write the number 100 in the last (lower right-hand) space.

2. Now say: Pretend that we start at 2 and count in steps of 2. What is the last number we will say on this grid? How do you know? Invite individuals to describe a variety of strategies, such as: ‘The numbers we would say have a 0, 2, 4, 6 or 8 in the ones place so the number must be 100’ or ‘The numbers we say are in the second, fourth, sixth, eighth and tenth columns so it must be 100’. Make a small mark in the space for 100 to indicate it is a multiple of 2.

3. Repeat the discussion to identify the last number on the chart that is a multiple of 3.

4. Have the students work in pairs using a method of their choice to identify the last number that is a multiple of 4, 5, 6, 7, 8 and then 9. Encourage them to avoid counting in steps from the beginning of the chart.

5. Invite individuals to describe their thinking, such as: ‘We started at 80, a number we knew was a multiple of 8. Two more eights is 96 so that is the last multiple of 8 on the chart.’

6. Have the students work independently to complete page 21 of the GO Maths student journal.

**Reflection**

1. Discuss the students’ answers to page 21 of the GO Maths student journal. Challenge confident individuals to describe number patterns. Invite students to describe number patterns they might have observed for the multiples of 3 or 9, such as: ‘The digits of the multiples of 3 when added together also make a multiple of 3’.

2. For the multiples of four, ask: When you count by fours, what do you say? What numbers greater than 100 are multiples of four? What do you notice? Bring out the fact that the tens and ones are the same (e.g. 4 and 104, 8 and 108, 12 and 112 and so on).

**Materials**

- GO Maths student journal, page 21
- Overhead transparency of a blank 10-by-10 grid (use Blackline Master 11 from Unit 11)
- Overhead projector

**Daily Computation Practice**

Repeat the previous Daily Computation Practice activity.
Working with Factors

In this lesson, students use the patterns related to each set of multiples to help find factors of two-digit numbers.

Daily Number Sense

Draw the number line below on the board.

Ask: Where would we draw an arrow to show the number 1.35? How do you know? How far is this number from the whole numbers on either side? Encourage students to locate the number using thinking such as: ‘The number is a little less than halfway between 1 and 2 or close to $1\frac{1}{3}$’. Say: Pretend the number line shows metres. What are some ways you could read this length? Encourage students to use metres, centimetres or millimetres. Repeat for another arrow if necessary.

Activity

1. Draw the following diagram on the board:

   ![Diagram](image)

   Ask: What numbers could we write in the boxes so the relationship ‘is a multiple of’ is true? Invite individuals to suggest pairs of numbers and bring out the fact that there may be more than one number that can be written in the second box.

2. Now draw the second arrow as shown below and ask: What do you think we should write for this arrow? How do we read the arrow moving left to right? What should we say when we move right to left? Invite a volunteer to write two numbers in the boxes such as 21 and 3 and then describe how 3 relates to 21. Move your hand from left to right saying: 21 is a multiple of 3 so … (move your hand from right to left) … 3 is a factor of 21.

   ![Diagram](image)

   Erase the numbers and invite individuals to write new numbers in the boxes. Ask: How do you know when a number is a factor of another? Reinforce the idea that a factor must divide the other number exactly.

3. Have the students work independently to complete page 22 of the GO Maths student journal.

Reflection

Discuss the students’ answers to page 22. Ask questions such as: If 2 is a factor of 60, what other factor did you find for 60? Reinforce the idea that one factor of a number can be used to find another factor.

Materials

- GO Maths student journal, page 22
- GO Figure computation practice book, page 9

Optional

- 3 wooden cubes for each group of students, with the following on the faces:
  - Cube 1: 1, 1, 2, 3, 4, 5
  - Cube 2: 1, 1, 4, 5, 6, 7
  - Cube 3: 1, 1, 6, 7, 8, 9

Daily Computation Practice

Have the students complete page 9 of the GO Figure computation practice book.

Did You Know

The origin of the word ‘factor’ is the Latin factus, which means ‘maker’. In this sense, two or more factors make a product (when multiplied together). The words ‘factor’ and ‘factory’ have the same origin. A factory makes a product in the same way that factors multiplied together. The word ‘factor’ is the Latin word for ‘maker’. In this context, ‘factory’ is used to make products.

Consolidation

Students could play the game ‘Many Factors’. Have them form groups and take turns to roll all three wooden cubes and form a two- or three-digit number. They list the one-digit factors of their number and add the factors together to determine their score. For example; 2, 3, 4 and 6 are factors of 124 so the score is 15. They can only add the factors they identify.
Using Logical Reasoning: Solving Number Puzzles

In this lesson, students use their knowledge of multiples, factors, odd/even numbers, square and triangular numbers to identify numbers less than 100 that match certain conditions.

**Daily Number Sense**

Draw the number line below on the board.

```
0    1 metre    2 metres
```

Ask: Where would we draw an arrow to show the length 1060 mm? What are some other ways you could read this length? How far is this length from a whole metre on either side? Encourage students to describe the thinking they used to locate 1060 mm, and have volunteers record the length in tenths, eighths or fractions of a metre. They should explain how they worked out the 'distance' to each whole metre. Repeat the discussion for 160 cm and then 160 mm.

**Activity**

1. **Write the number 36 on the board and ask:** What are some facts that you know about this number? Have the students work with a partner to write at least five different facts about 36. Encourage them to use their knowledge about factors and multiples as well as any other pieces of information they might recall from previous years. Avoid obvious statements such as ‘36 is one more than 35’.

2. Move around the class and select six volunteers with interesting statements to write their facts on the board simultaneously. Discuss the examples and then ask questions to bring out other observations that might be made, such as: How would you check that 36 is a square number (triangular number or equal to 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8)?

3. **On the board write the following clues:**
   - It is a square number.
   - It has exactly two digits.
   - The sum of its digits is even.
   - It is _____.

   Allow time for the students to work with a partner to work out the number. Have the students describe the steps they used and give the answer. (64)

4. Have the students work independently to complete page 23 of the GO Maths student journal.

**Reflection**

1. Discuss the students’ answers to page 23 of the GO Maths student journal.
2. Ask: What is an odd number (even number, multiple, factor)? Encourage the students to describe each of these using their own words.

**Materials**

- GO Maths student journal, page 23

**Daily Computation Practice**

Write multiplication number sentences with three one-digit factors on the board. One of the factors should be a 5. Ask the students to copy and complete the sentences or simply write the answers.

**Extension**

Have the students make up their own number puzzles similar to the examples on page 23 of the GO Maths student journal.
Constructing Factor Trees

The ability to factor numbers assists students when they attempt to mentally divide. In this lesson, students factor numbers to build factor trees.

Daily Number Sense
Repeat the Daily Number Sense discussion from the previous lesson for lengths such as 1025 mm, 125 cm and 125 mm.

Activity
1. On the board, draw the diagram at right.
   Ask: What two factors could we write in the boxes so the product is 24? Invite students to suggest pairs of numbers such as 4 and 6.

2. Record 4 and 6 in the diagram and ask: Does 4 have factors between 1 and itself? What could we multiply to get 4? Repeat the questions for 6 and extend the diagram as shown. Establish that neither 2 nor 3 can be factored further (except for 1 and itself).

3. Ask: Is there another diagram we could have drawn for 24? What would be different? What would be the same? Have the students work with a partner to start with 24 and factor it initially another way. Encourage them to extend the diagram as far as possible until they reach numbers they cannot factor. Invite individuals to draw all of the possibilities on the board (one is shown above). Bring out the fact that the initial way they factored 24 might be different, but the four numbers at the base of the diagram are always the same. Reinforce the fact that the product of all of the numbers at the base is 24.

4. Have the students work independently to complete page 24 of the GO Maths student journal. Before they begin, explain that these diagrams are sometimes called factor trees. (More specifically, they represent the underground root system for a tree.)

Reflection
1. Discuss the students’ answers to page 24 of the GO Maths student journal.
2. Invite individuals to draw different factor trees for 120 to reinforce the idea that the numbers at the base are always the same.
1. Write the first 9 multiples of the number shown at the top of each strip.

<table>
<thead>
<tr>
<th>Number</th>
<th>Multiples</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6, 12, 18, 24, 30, 36, 42, 48, 54</td>
</tr>
<tr>
<td>9</td>
<td>9, 18, 27, 36, 45, 54, 63, 72, 81</td>
</tr>
<tr>
<td>12</td>
<td>12, 24, 36, 48, 60, 72, 84, 96, 108</td>
</tr>
<tr>
<td>15</td>
<td>15, 30, 45, 60, 75, 90, 105, 120, 135</td>
</tr>
<tr>
<td>18</td>
<td>18, 36, 54, 72, 90, 108, 126, 144, 162</td>
</tr>
<tr>
<td>21</td>
<td>21, 42, 63, 84, 105, 126, 147, 168, 189</td>
</tr>
<tr>
<td>24</td>
<td>24, 48, 72, 96, 120, 144, 168, 192, 216</td>
</tr>
<tr>
<td>27</td>
<td>27, 54, 81, 108, 135, 162, 189, 216, 243</td>
</tr>
<tr>
<td>30</td>
<td>30, 60, 90, 120, 150, 180, 210, 240, 270</td>
</tr>
</tbody>
</table>

2. a. Look at the multiples of 3. Write all the different digits that are in the ones place.

<table>
<thead>
<tr>
<th>Digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, 1, 2, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
</tbody>
</table>

   b. Which other strips use the same digits? 7 and 9

3. a. Look at the multiples of 4. Write all the different digits that are in the ones place.

<table>
<thead>
<tr>
<th>Digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, 4, 8, 2, 6</td>
</tr>
</tbody>
</table>

   b. Which other strips use the same digits? 6 and 8

4. Look at the multiples of 8. What pattern can you see in the ones place? There is a difference of 2.

5. Look at the multiples of 9. What pattern can you see? There is a difference of 1 in the ones place.

**Outcome N 4.3**

For each number wheel, colour numbers that are factors of the number in the centre. Then divide the number by the factors and write the answers in the outer circles.

**Working with Factors**

<table>
<thead>
<tr>
<th>Number Wheel</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1, 2, 3, 6</td>
</tr>
<tr>
<td>9</td>
<td>1, 3, 9</td>
</tr>
<tr>
<td>12</td>
<td>1, 2, 3, 4, 6, 12</td>
</tr>
<tr>
<td>15</td>
<td>1, 3, 5, 15</td>
</tr>
<tr>
<td>18</td>
<td>1, 2, 3, 6, 9, 18</td>
</tr>
<tr>
<td>21</td>
<td>1, 3, 7, 21</td>
</tr>
<tr>
<td>24</td>
<td>1, 2, 3, 4, 6, 8, 12, 24</td>
</tr>
<tr>
<td>27</td>
<td>1, 3, 9, 27</td>
</tr>
<tr>
<td>30</td>
<td>1, 2, 3, 5, 6, 10, 15, 30</td>
</tr>
</tbody>
</table>

**Extending Patterns Made by Multiples**

1. Colour in red all the multiples of 3. What pattern do you see?

   **The sum of the digits is a multiple of 3.**

2. Colour in blue all the multiples of 9. What pattern do you see?

   **The sum of the digits is a multiple of 9.**

3. Loop the multiples of 8. What do you notice?

   **The number one less than the tens digit is divisible by 4.**

4. Loop the multiples of 7. What do you notice?

   **The number made using the tens and ones is divisible by 47.**

5. Which other strips use the same digits? 6 and 8

6. What other thoughts do you think the multiples of 11 would make?

   **The sum of the digits in the hundreds and the ones places is equal to the digit in the tens place.**

**Solving Number Puzzles**

Use this hundred chart to help work out the mystery numbers from the clues below.

<table>
<thead>
<tr>
<th>Number</th>
<th>Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>It is a multiple of 5. The sum of the digits is 7.</td>
</tr>
<tr>
<td>99</td>
<td>It is an odd number. The difference between its digits is 0.</td>
</tr>
<tr>
<td>55</td>
<td>It is a multiple of 5. It has exactly 2 factors.</td>
</tr>
<tr>
<td>39</td>
<td>It is an odd number. It is a multiple of 3 and 13. The sum of its digits is 12.</td>
</tr>
<tr>
<td>37</td>
<td>It is less than 50. It is a triangular number. Some of its factors are 14, 7, 4 and 2.</td>
</tr>
<tr>
<td>66</td>
<td>It is a multiple of 2 and 3. The sum of its digits is 12.</td>
</tr>
<tr>
<td>49</td>
<td>It is a multiple of 7. It has exactly 3 factors.</td>
</tr>
</tbody>
</table>

**ANALYSIS**

Choose a number between 100 and 200. Write some clues about your number and give them to another fast thinker to solve.

**Answers will vary. This is one example.**
ANSWERS

Student Journal, page 24

Constructing Factor Trees

1. Complete these factor trees.
   a. [Factor tree image]
   b. [Factor tree image]
   c. [Factor tree image]
   d. [Factor tree image]

2. Draw a factor tree for each of these numbers.
   a. [Factor tree image]
   b. [Factor tree image]

GO Figure, page 9

FUNNY FACT

figure out each of these and rule a line to the correct answer. The line will pass through a number and a letter. Then write the letter above any matching number at the bottom of the page.

Some letters appear more than once and some answers are used more than once.

Draw a factor tree for this number.

GO Check, page 5

Working with Multiples and Factors

1. Loop the multiples of 3.
   Write how you decided.
   a. [Multiples]
   b. [Multiples]
   c. [Multiples]
   d. [Multiples]
   e. [Multiples]
   f. [Multiples]
   g. [Multiples]
   h. [Multiples]
   i. [Multiples]
   j. [Multiples]
   k. [Multiples]
   l. [Multiples]
   m. [Multiples]
   n. [Multiples]
   o. [Multiples]

2. The sum of the digits is divisible by 3.
   Write how you decided.
   a. [Number]
   b. [Number]
   c. [Number]
   d. [Number]
   e. [Number]
   f. [Number]
   g. [Number]
   h. [Number]
   i. [Number]
   j. [Number]
   k. [Number]
   l. [Number]
   m. [Number]
   n. [Number]
   o. [Number]

3. Divided the tens and ones parts.
   Write how you decided.
   a. [Number]
   b. [Number]
   c. [Number]
   d. [Number]
   e. [Number]
   f. [Number]
   g. [Number]
   h. [Number]
   i. [Number]
   j. [Number]
   k. [Number]
   l. [Number]
   m. [Number]
   n. [Number]
   o. [Number]

4. The sum of the digits is divisible by 9.
   Write how you decided.
   a. [Number]
   b. [Number]
   c. [Number]
   d. [Number]
   e. [Number]
   f. [Number]
   g. [Number]
   h. [Number]
   i. [Number]
   j. [Number]
   k. [Number]
   l. [Number]
   m. [Number]
   n. [Number]
   o. [Number]

5. Draw a factor tree for this number.

6. Use the factor tree in Question 5 to help you list all the factors of 80.
   a. [Factors]
   b. [Factors]
   c. [Factors]
   d. [Factors]
   e. [Factors]
   f. [Factors]
   g. [Factors]
   h. [Factors]
   i. [Factors]
   j. [Factors]
   k. [Factors]
   l. [Factors]
   m. [Factors]
   n. [Factors]
   o. [Factors]

Level 4A, Unit 5, Working with Multiples and Factors, Outcome N 4.3
Multiplication Grids
Blackline Master 5
Lesson 5.2
Extending Patterns Made by Multiples

Materials
Overhead transparency of a blank 10-by-10 grid (use Blackline Master 11 from Unit 11)
Overhead projector

Optional
1 copy of Blackline Master 5 for each pair of students

Lesson 5.3
Working with Factors

Materials
Optional
3 wooden cubes for each group of students, with the following on the faces:
- Cube 1: 1, 1, 2, 3, 4, 5
- Cube 2: 1, 1, 4, 5, 6, 7
- Cube 3: 1, 1, 6, 7, 8, 9

Lesson 5.4
Using Logical Reasoning: Solving Number Puzzles

Materials
None

Lesson 5.5
Conducting Factor Trees

Materials
None

GO Figure p. 9
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GO Figure p. 10
Student Journal p. 24

GO Maths

Components at a Glance

Lesson 5.1
Investigating Patterns Made by Multiples

Materials
Blackline Master 5 copied onto an overhead transparency
Overhead projector

Optional
1 copy of Blackline Master 5 for each pair of students

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Level 4A Unit 5 after the students have what they know and can do.

Extending Patterns Made by Multiples

Using Logical Reasoning: Solving Number Puzzles

Using Logical Reasoning: Solving Number Puzzles

Assessing the Outcomes

Use the diagnostic task for Unit 5 after the students have completed this unit to assess what they know and can do.

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