# Multiplying multiple ways

Students explore multiplying fractions that give a result of one. Students use this knowledge to develop how to simplify algebraic fractions when multiplying 2 terms, including those with variables in the numerator and denominator.

Students will need at least one digital device per pair to interact with Graspable Math during this lesson.

## Visible learning

This lesson incorporates Path content.

### Learning intention

* To be able to simplify expressions that involve the multiplication of algebraic fractions.

### Success criteria

* I can write a fraction that is equivalent to one.
* I can simplify fractions that contain variables in the numerator and denominator.
* I can explain the most efficient method to simplify an expression.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* simplifies algebraic fractions with numerical denominators and expands algebraic expressions **MA5-ALG-C-01**
* simplifies algebraic fractions involving indices, and expands and factorises algebraic expressions **MA5-ALG-P-01**

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Table 1: lesson summary

|  |  |  |  |
| --- | --- | --- | --- |
|  | Summary of activity | Teaching strategy | Teaching points |
| Warm up | Graspable activity [bit.ly/graspablemathfractions](https://bit.ly/graspablemathfractions) | Notice wonder strategy  Pose-Pause-Pounce-Bounce | This aims to revise simplifying fractions by identifying common factors. |
| Launch | Slide 3 of the PowerPoint *Multiplying multiple ways* displays fractions with a result of one. Three are true and one is a lie. | Three truths, one lie  Think-Pair-Share | The lie is the bottom left corner. |
| Explore | Students work through [Appendix A](#_Appendix_A), making expressions equal to one.  PowerPoint slides 5–12 contain explicit teaching for both the Core and Path content.  Students do [Appendix B](#_Appendix_B_-) ‘Faded examples’  Use PowerPoint slide 13 (Core) or 15 (Path) as a prompting question. | Visibly random groups of 3  Vertical non-permanent surfaces  Gallery walk  Explicit teaching – Your turn  Faded examples | Appendix A, Your turn examples and Appendix B contain examples from both Core and Path.  Link common factors from the Warm up and skills from Appendix A to explain multiplying fractions.  The focus is on multiple methods of multiplying algebraic fractions. |
| Summarise | Students create their own questions, solve it using their preferred method, and write notes. Students work through [Appendix C](#_Appendix_C_-) which contains incorrect examples. | Notes to future forgetful selves | Students may do as many methods as they like or just choose the method that they like. |
| Apply | Students find the area and perimeter of each shape in [Appendix D](#_Appendix__D). | Same surface different deep | All question areas contain Core outcomes and Questions 5 and 6 contain Path content. |

## Activity structure

Please use the associated PowerPoint *Multiplying multiple ways* to display images in this lesson.

### Warm up

1. With at least one device between pairs, students are to work through the Graspable Math activity ‘Fractions: Simplify’ ([bit.ly/graspablemathfractions](https://bit.ly/graspablemathfractions)).

Students can log into Graspable Math using their Google accounts (student@education.nsw.gov.au).

Teachers may want to highlight to students that Graspable Math uses a dot to denote multiplication.

To split a number into its factors, you need to select it.

To simplify a fraction, drag the common factors on top of each other.

For help with using Graspable Math with a class, use the tutorials on the webpage ‘Get Started’ ([activities.graspablemath.com/teacher/get-started](https://activities.graspablemath.com/teacher/get-started)).

1. Ask students to record what they notice and what they wonder ([bit.ly/noticewonderstrategy](https://bit.ly/noticewonderstrategy)) as they work through the activity.
2. Initiate sharing ideas and reasoning using the Pose-Pause-Pounce-Bounce questioning strategy (PDF 557 KB) ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)). Highlight the importance of there being a common factor in both the numerator and denominator if the fraction can be simplified.

This activity aims to revisit simplifying fractions.

Alternatively, teachers could replace this activity with activities from Stage 4 Lesson 6 – recipe for success of Unit 3 – representing numbers.

### Launch

1. Display slide 3 of the PowerPoint *Multiplying multiple ways* which shows Table 1: three truths, one lie.

Table 2: three truths, one lie

|  |  |
| --- | --- |
|  |  |
|  |  |

1. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), have students identify which one is the lie and explain their answer.
2. Using the Pose-Pause-Pounce-Bounce questioning strategy (PDF 557 KB) ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)), ask students how they knew the fractions were equal to one.

The lie in this example is in the bottom left corner.

### Explore

1. By working in visibly random groups of 3 ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) on vertical non-permanent surfaces ([bit.ly/VNPSstrategy](https://bit.ly/VNPSstrategy)), ask students to complete Appendix A ‘Products equal to one’. In this activity, students will place a value in each box to make the equation equal to one.

This Appendix provides the opportunity for students to revisit multiplying and simplifying fractions found in Lesson 6 – recipe for success of Unit 3 – representing number and Lesson 9 – cooking for one of Unit 5 – multiplicative thinking.

The Appendix has 2 sections, one for Core and one extending into Path content.

1. Students are to do a gallery walk ([bit.ly/DLSgallerywalk](https://bit.ly/DLSgallerywalk)) to check their work against others.
2. Using the Pose-Pause-Pounce-Bounce questioning strategy, ask students how they decided what number or variable to put in each box to make the expression equal to one.
3. Use slides 5–12 from the PowerPoint *Multiplying multiple ways* for explicit teaching of multiplying algebraic fractions.

There are 2 examples provided, one for Core and one for Path content. It is suggested that you use only one of the provided examples appropriate to the capabilities of your class.

To ensure student understanding, highlight that we can remove common factors in the numerator and denominator as they are equivalent to one.

1. Distribute Appendix B ‘Faded examples’ and ask each student to complete the faded examples ([bit.ly/fadedexamplesstrategy](https://bit.ly/fadedexamplesstrategy)).

There are 2 versions provided, one for each of Core and Path content. It is suggested that you use only one version, appropriate to the capabilities of your class.

1. Once students complete Appendix B, they are to pair with another student and share their work. If they differ, the students work together to explain the correct solution.
2. In a Think-Pair-Share, pose the question ‘Can these questions be solved using a more efficient method?’

Students may suggest using their calculators to multiply the numbers, using index laws to simplify expressions, simplifying the algebra before combining the fractions or simply visualising the number of each variable and adjusting the answer accordingly by crossing out values.

1. Display slide 13 or 15 from the PowerPoint *Multiplying multiple ways* and ask students to simplify the expression using whichever method they are comfortable with.

There are 2 versions provided, one for each of Core and Path content. It is suggested that you use only one version, appropriate to the capabilities of your class.

1. Ask students to turn and talk to view different solution methods.
2. Ask a random student to share someone else’s work and explain how they found the solution. Continue until there are no new methods.

Alternatively, use slide 14 or 16 to model 3 different methods. These methods include:

* expanding to prime factors and then cancelling common factors in the numerator and denominator
* multiplying each fraction and then simplifying using the highest common factor
* finding common factors in the numerator and denominator before multiplying.

1. In a Think-Pair-Share, ask students to justify which method they found the most efficient and why.

### Summarise

1. Have students create their own question and solve it, using their preferred method.
2. Ask students to write notes to their future forgetful selves ([bit.ly/notestofutureself](https://bit.ly/notestofutureself)) explaining why each method works.
3. Distribute Appendix C ‘Multiplying with indices’ and have students complete the questions using their preferred method.

### Apply

1. Distribute Appendix D ‘Area and perimeter’ to each student. Have them calculate the area and perimeter of each of the shapes.

The area questions contain Core outcomes only however the last 2 perimeter questions move into Path content.

1. Students should compare their answers with other students and, if answers differ, justify why they are convinced their answers are correct.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Warm-up**

* Students may benefit from revisiting simplifying fractions using repeated simplification, finding the highest common factor from Lesson 1 – highest common factor of integers of Unit 3 – representing numbers or reducing numbers to the product of their prime from Lessons 4 and 6 of Unit 5 – multiplicative thinking.
* The number of questions given in the Graspable Math activity could be modified to meet your students’ needs.

**Launch**

* Students may benefit from revisiting multiplying fractions found in Lesson 9 – cooking for one of Unit 5 – multiplicative thinking.
* To enable students, the expressions in the activity ‘three truths and a lie’ can be modified to include fewer factors.

**Explore**

* **To challenge students, modify Appendix A to include 3 terms in each expression.**
* **Students may benefit from using visual representations to complete the Core section of Appendix A.**
* **Challenge students by introducing fractions that involve factors that are in brackets.**
* All students will be able to answer the problem using one method but may explain how to do so at different depths.
* If students find it difficult to simplify fractions mentally, allow the use of a calculator.
* Challenge students by asking them how this differs if we multiply by a whole number.

**Summarise**

* To enable students, provide them with an expression to use as an example.
* Challenge students to decide which method is the most efficient and to justify their choice with a student who does not agree.
* For low-readiness students, adjust the questions in Appendix C to include fewer indices or easier factors.
* Challenge students to write their own expression by multiplying 3 fractions together.
* Enable students to justify a method they prefer by using only one question to support their claims.

**Apply**

* Students could be challenged to find the area and perimeter of a triangle they have created themselves.
* Low-readiness students could find only the area.

### Suggested opportunities for assessment

**Launch**

* Monitor responses in class discussions to check for student understanding of simplifying fractions.

**Explore**

* When placed in groups of 3, students provide and receive peer feedback on their understanding.
* Monitor student responses in the ‘Your turn’ section to check for understanding.
* The teacher could monitor student engagement and contributions to group work activities to check understanding.
* Students will demonstrate their working mathematically skills in discussions and justifications.

**Summarise**

* Review students’ notes to future forgetful selves to see the depth of the example they provide to gauge their confidence with the concept.
* Teachers could ask students to explain and justify their most efficient strategy as evidence of learning.

**Apply**

* Collect students’ Appendix D, this could be used as a summative assessment for this unit.

## Appendix A

### Products equal to one

Substitute values into the equation to make them true.

#### Core

#### Path

## Appendix B

### Faded examples

#### Core

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Question 1 | Question 2 | Question 3 | Question 4 | Question 5 |
|  |  |  |  |  |

#### Path

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Question 1 | Question 2 | Question 3 | Question 4 | Question 5 |
|  |  |  |  |  |

## Appendix C

### Multiplying with indices

#### Core

#### Path



## Appendix D

### Area and perimeter

Find a simplified expression for the area and perimeter of each of the shapes below.

|  |  |
| --- | --- |
| Question 1  square with side length x/6. | Question 2  Rectangle with slide lengths x/5 and x/6 |
| Question 3  Rectangle with side lengths 3n/5 and n/3. | Question 4  Rectangle with side lengths 7x/10 and 17x/30 |
| Question 5  Rectangle with side lengths 2/x^2 and 3x/4. | Question 6  Area with side lengths 3x/4 and 4/3x |

## Sample solutions

### Appendix A – products equal to one

Substitute values into the equation to make them true.

#### Core

#### Path

### Appendix B – faded examples

#### Core

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Question 1 | Question 2 | Question 3 | Question 4 | Question 5 |
|  |  |  |  |  |

#### Path

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Question 1 | Question 2 | Question 3 | Question 4 | Question 5 |
|  |  |  |  |  |

### Appendix C – multiplying with indices

#### Core

#### Path



### Appendix D – area and perimeter

|  |  |
| --- | --- |
| Question 1  Area  Perimeter | Question 2  Area  Perimeter |
| Question 3  Area  Perimeter | Question 4  Area  Perimeter |
| Question 5  Area  Perimeter | Question 6  Area  Perimeter |

## References

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