Lowest common denominator practice worksheet

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Welcome to our Simplifying Fractions Worksheet page. Here you will find a wide range of graded printable fraction worksheets which will help your child to practice converting fractions to their simplest form. We have a selection of worksheets designed to help your child understand how to simplify fractions. The sheets are graded so that the easier ones are at the top. The first sheet in the section is supported and the highest common factor is already provided. The last sheet is the hardest and is a great challenge for more able mathematicians. Using these sheets will help your child to: practice simplifying a range of fractions; apply their times tables knowledge. Want to test yourself to see how well you have understood this skill? Try our NEW quick quiz at the bottom of this page. Simplifying fractions is also sometimes called reducing fractions to their simplest (or lowest) form. This involves dividing both the numerator and denominator by a common factor to reduce the fraction to the equivalent fraction with the smallest possible numerator and denominator. The printable fraction page below contains more support, examples and practice about simplifying fractions. The Simplifying Fractions calculator will also show you how worked examples of how to simplify a fraction if you are really stuck! Take a look at some more of our worksheets and resources similar to these. Here you will find the Math Salamanders free online Math help pages about Fractions. There is a wide range of help pages including help with: fraction definitions; equivalent fractions; converting improper fractions; how to add and subtract fractions; how to convert fractions to decimals and percentages; how to simplify fractions. Here is our collection of Math games involving fractions. These games are suitable for kids aged from 3rd grade and upwards. Playing games is a great way to learn fraction skills in a fun way. Fraction equivalence, fraction to decimal conversion and properties of fractions are all explored in our fun games to play. Our quizzes have been created using Google Forms. At the end of the quiz, you will get the chance to see your results by clicking 'See Score'. This will take you to a new webpage where your results will be shown. You can print a copy of your results from this page, either as a pdf or as a paper copy. For incorrect responses, we have added some helpful learning points to explain which answer was correct and why. We do not collect any personal data from our quizzes, except in the 'First Name' and 'Group/Class' fields which are both optional and only used for teachers to identify students within their educational setting. We also collect the results from the quizzes which we use to help us to develop our resources and give us insight into future resources to create. For more information on the information we collect, please take a look at our Privacy Policy We would be grateful for any feedback on our quizzes, please let us know using our Contact Us link, or use the Facebook Comments form at the bottom of the page. The Math Salamanders hope you enjoy using these free printable Math worksheets and all our other Math games and resources. We welcome any comments about our site or worksheets on the Facebook comments box at the bottom of every page. Page 2 Welcome to our 2 Digit Multiplication Worksheets page. We have plenty of worksheets on this page to help you practice the skills of multiplying 2-digit numbers by 1 or 2 digits. We have split the worksheets on this page into two sections: 2-digit x 1-digit multiplication (3rd grade) 2-digit x 2-digit multiplication (4th grade) Each section ends with some trickier challenge sheets for more able students. Within each section, the sheets are carefully graded with the easiest sheets first. These sheets are aimed at 3rd graders. Sheets 1 to 4 consists of 15 problems; sheets 5 and 6 consist of 20 problems. Sheets 1 and 2 involve multiplying 2-digit numbers by 2, 3, 4 or 5. Sheets 3 to 6 involve multiplying a 2-digit number by single digit numbers and finding increasing trickier products. These 2-digit multiplication worksheets have been designed for more able students who need that extra challenge! These sheets are aimed at 4th graders. Sheet 1 involves 2-digit by 2-digit multiplication with smaller numbers and answers up to 1000. Sheets 2 to 4 have harder 2-digit numbers to multiply and answers that are generally larger than 1000. These 2-digit multiplication worksheets have been designed for more able students who need that extra challenge! We have more 2-digit multiplication worksheets, including 2-digit x 3-digit multiplication problems on this page. More Double digit Multiplication Worksheets (harder) Take a look at some more of our worksheets similar to these. Need to create your own long or short multiplication worksheets quickly and easily? Our Multiplication worksheet generator will allow you to create your own custom worksheets to print out, complete with answers. Here you will find a range of Multiplication Worksheets to help you become more fluent and accurate with your tables. Using these sheets will help your child to: learn their multiplication tables up to 10 x 10; understand and use different models of multiplication; solve a range of Multiplication problems. All the free 3rd Grade Math Worksheets in this section are informed by the Elementary Math Benchmarks for 3rd Grade. Here you will find a range of Free Printable Multiplication Games to help kids learn their multiplication facts. Using these games will help your child to learn their multiplication facts to 5x5 or 10x10, and also to develop their memory and strategic thinking skills. Multiplication Math Games How to Print or Save these sheets Need help with printing or saving? Follow these 3 easy steps to get your worksheets printed out perfectly! How to Print or Save these sheets Need help with printing or saving? Follow these 3 easy steps to get your worksheets printed out perfectly! The Math Salamanders hope you enjoy using these free printable Math worksheets and all our other Math games and resources. We welcome any comments about our site or worksheets on the Facebook comments box at the bottom of every page. Are your fraction skills a little rusty? Don't fear! In this article, we will guide you through everything you need to know about Year 7 fractions. Syllabus Outcomes This article deals with the following NESA Syllabus Outcomes:Develop your Fractions knowledge and skillsUse our free Fractions worksheet to test and develop your Maths skills.Your worksheet is on the way! Check your email for the downloadable link. (Please allow a few minutes for your download to land in your inbox) NESA Syllabus Outcomes Syllabus Outcomes Explanation Communicates and connects mathematical ideas using appropriate terminology, diagrams and symbols This means that you will be able to identify fractions in problem questions and solve them. Applies appropriate mathematical techniques to solve problems This means that you will be able to simplify, add/subtract, multiply/divide and order fractions. Recognises and explains mathematical relationships using reasoning This means that you will be able to identify and express equivalent fractions. Operates with fractions, decimals and percentages This means you will solve problems that deal with fractions, decimals and percentages. Outline Fractions are often difficult to grasp initially because of the multiple values involved, what they mean, and their relationship to each other. They may be hard to understand due to the complexity of the operations. Eg. When to add/subtract certain numbers versus when to multiply numbers. However, it is an extremely important fundamental topic that is heavily applied in all areas of maths. So, make sure you understand how to work with fractions! Assumed Knowledge Students should be familiar with elementary BODMAS operations (how to add, subtract, divide and multiply in the correct order) and simple equations. Students should know how to find the LCM (lowest common multiple) and HCF (highest common factor) of a group of numbers. Do you know it all, or just a fraction? What are fractions? Generally, we refer to fractions as part of a whole. For example: \(\frac{1}{2}\) (half) a pizza \(\frac{3}{4}\) (three-quarters) of an hour. \(3\frac{2}{3}\) means there are \(3\) whole objects, as well as \(\frac{2}{3}\) of an object. Example: You can picture \(2\frac{2}{3}\) like so: Fractions can also be used to describe the division of numbers into equal parts; \(\frac{2}{3} \) means dividing \(2\) into \(3\) equal parts. Fractions are written as one number divided by another. The top number is called the numerator, and the bottom number is called the denominator. The bar in between them is called the vinculum (you don't need to remember this), which is another way of writing \(\div\) (you need to remember this!). This then means that the numerator is divided by the denominator. Fractions are just another way to express division! Eg. \(\frac{2}{3}\) is just another way to write \(2 \div 3\). Types of fractions Proper fractions In proper fractions, the numerator is less than the denominator For example, \(\frac{3}{5}\) Improper fractions The numerator is greater than the denominator. For example, \(\frac{7}{2}\) Mixed numbers A combination of a whole number and a fraction. For example, \(3\frac{2}{3}\) Expressing mixed numbers as improper fractions and vice versa A mixed fraction can also be expressed as an improper fraction, and an improper fraction can be expressed as a mixed fraction. Expressing mixed fractions as improper fractions To do this, we: Multiply the whole number by the denominator of the fraction Add this number to the numerator Write the new number over the original denominator For example \begin{align*} \color{blue}{3}\frac{\color{red}{2}}{\color{blue}{5}} =\color{blue}{3} + \frac{\color{red}{2}}{\color{blue}{5}} = \frac{\color{blue}{3×5}+\color{red}{2}}{5} =\frac{17}{5} \end{align*} \begin{align*} 2\frac{7}{8} = 2 + \frac{7}{8} = \frac{2×8+7}{8} =\frac{25}{7}\\ \end{align*} Expressing improper fractions as mixed numbers To do this, we: Divide the numerator by the denominator Find the remainder The remainder becomes the new numerator (with the denominator remaining the same), and the number of times the denominator divides into the numerator becomes the whole number. Example: We can reverse the process of going from mixed numbers to improper fractions as follows: \begin{align*} \frac{25}{9} = \frac{2×9+7}{9} = 2\frac{7}{9} \end{align*} But this is a lot of work! Instead we do the following: Think: What is \(25 \div 9 \)? The answer is \(2\) remainder \(7\). Then write: \(2 \frac{7}{9} \) Think: What is \(17 \div 9 \)? The answer is \(8\) remainder \(1\). Then write: \(8 \frac{1}{2} \). Note: that there is a negative in this question. Keep the negative symbol where it is! The conversion still follows the same process. Equivalent fractions Equivalent fractions are fractions that have the same mathematical value but have different numerators and denominators. Although they may look different from each other, they are mathematically the same. Eg. \(\frac{1}{2} \), \(\frac{2}{4}\), and \(\frac{3}{6}\) are all the same. To change one fraction to another equivalent fraction, we multiply (or divide) the numerator and denominator by the same number. For example: We can find an equivalent for \(\frac{1}{2} \) by multiplying both the numerator and denominator by \(3\). \(\rightarrow\) This gives us \(\frac{3}{6} \). We can find an equivalent for\(\frac{10}{15} \)by dividing both number and denominator by \(5\). \(\rightarrow\) This gives us \(\frac{2}{3} \). Examples: 1. What are some equivalent fractions for\(\frac{3}{4} \) and \(\frac{16}{28} \)? \begin{align*} \frac{3}{4} \rightarrow \frac{6}{8}, \frac{9}{12}, \frac{30}{40} \end{align*} \begin{align*} \frac{16}{20} \rightarrow \frac{8}{14}, \frac{4}{7}, \frac{32}{56} \end{align*} Simplifying fractions Simplifying a fraction means to rewrite the fraction as an equivalent fraction, so that the numerator and denominator are as small as possible. Like equivalent fractions, you can simplify a fraction if its numerator and the denominator have a common factor. We can divide both numerator and denominator by this number to create a simplified fraction that is equivalent to the original fraction. You keep simplifying a fraction until the numerator and denominator don't have a common factor anymore – this is its simplest form. Examples: 1. Simplify \(\frac{14}{22} \) Both \(14\) and \(22\) are divisible by \(2\) , so we can divide both top and bottom: \begin{align*} \frac{14}{22} = \frac{7}{11} \end{align*} \(7\) and \(11\) don't have any common factors. So, this is its simplest form. What to ask yourself: Do both the numerator and denominator have a common factor? Yes – Divide both numerator and denominator by this number No – This is the fraction's simplest form. Repeat step 1 until there are no numbers which will divide exactly into the numerator and denominator. We usually look for the highest common factor when simplifying fractions. Don't worry if you can't identify it at first, you can always continue simplifying the fraction. 2. Simplify \(\frac{56}{64} \) This looks like a hard fraction to simplify, but we can start off with an easy factor: \(2\). Dividing both numerator and denominator by \(2\): \begin{align*} \frac{56}{64} = \frac{28}{32} \end{align*} Now it's a little easier to identify common factors. \(28\) and \(32\) are both divisible by \(4\), so: \begin{align*} \frac{28}{32} = \frac{7}{8} \end{align*} \(7\) and \(8\) don't have a common factor. So, this \(\frac{7}{8}\) is the simplest form! Ordering fractions Comparing the size of fractions In order to compare the size of two fractions, the first step is to choose a new denominator for both fractions. The new denominator should be a number which both denominators divide into exactly – preferably the Lowest Common Multiple (LCM) of the two numbers. Say we want to compare \(\frac{3}{4}\) and \(\frac{5}{7}\). The denominators are \(4\) and \(7\). We can choose \(28\) as the new denominator since it is the smallest number that both \(4\) and \(7\) are factors of. Then we change both fractions into an equivalent fraction with \(28\) as the denominator. \begin{align*} \frac{3}{4} = \frac{21}{28} \end{align*} (by multiplying both numerator and denominator by \(7\) to create an equivalent fraction) \begin{align*} \frac{5}{7} = \frac{20}{28} \end{align*} (by multiplying both numerator and denominator by \(4\) to create an equivalent fraction) We now compare the numerators ONLY \(-21\) is larger than \(20\). So we know that \(\frac{21}{28} > \frac{5}{7} \). However, we want to write it in terms of the original question. Hence, \(\frac{3}{4} > \frac{5}{7} \). Addition and subtraction of fractions Fractions can only be added or subtracted if they have the same denominator. With same denominator If the fractions in the question have the same denominator already, we simply add or subtract the numerators without changing the denominator. You should then simplify the answer (mixed fraction if applicable). For example \(\frac{1}{8} + \frac{5}{8} = \frac{6}{8} = \frac{3}{4} \) (simplified) \(\frac{5}{9} + \frac{7}{9} = \frac{14}{9} = 1\frac{5}{9} \) (simplified into mixed fraction) Examples: 1. What number should replace in the following? \begin{align*} \frac{1}{6} + \frac{\alpha}{6} = \frac{4}{6} \end{align*} Since both fractions have the same denominator, \(\alpha \) must add to \(1 \) to give \(4 \). Hence, \(\alpha \) is \(3\) . Different denominator If the two fractions have a different denominator (which is the case most of the time), we need to change them so that they have the same denominator. Remember, we can add or subtract fractions ONLY when they have the same denominator. To do this: Find a common denominator (lowest common multiple of the two denominators) Convert each fraction to an equivalent fraction with the new denominator Add/subtract the numerators without changing the denominator. Examples: 1. What is the common denominator of \(\frac{5}{8} \),\(\frac{7}{6} \) and \(\frac{2}{3} \)? The lowest common multiple of \(8\), \(6\) and \(3\) is \(24\). 2. Simplify \(\frac{2}{3} + \frac{5}{6} \) The lowest common multiple of \(3\) and \(6\) is \(6\). This means we have to change \(\frac{2}{3}\)into an equivalent fraction with \(6\) as the denominator, in order for us to add the two fractions. \begin{align*} \frac{2}{3} + \frac{5}{6} &= \frac{4}{6} + \frac{5}{6} \\ &= \frac{9}{6} \\ &= \frac{3}{2} \\ &= 1 \frac{1}{2}\\ \end{align*} 3. What number \(\alpha \) should replace in the following? After changing each fraction to an equivalent with denominator \(15\), we get: \begin{align*} \frac{5}{15} + \frac{3\alpha}{15} = \frac{11}{15} \end{align*} Then \(5 + 3\alpha = 11 \) So, \(\alpha = 2 \) Mixed fractions When a question involved mixed fractions, it is sometimes easier to add/subtract the whole numbers and then add/subtract the fractional parts. Example: 1. Simplify \(1 \frac{3}{4} + 2 \frac{1}{3} = 1\frac{1}{2} \) \begin{align*} 1\frac{3}{4} +2 \frac{1}{3} – 1 \frac{1}{2} &= (1+2-1) + \frac{3}{4} + \frac{1}{3} – \frac{1}{2} \\ &= \frac{7}{4} + \frac{7}{3} – \frac{3}{2} \\ &= \frac{21 + 28 – 18}{12} \\ &= \frac{31}{12} \\ &= 2 \frac{7}{12} \end{align*} Multiplication and division of fractions It is IMPORTANT that you rewrite all the fractions as improper fractions before starting operations. Unlike for addition and subtraction, it doesn't matter if the denominators are different in multiplication and division. Multiplication of fractions The product of two fractions is found by multiplying the numerators and multiplying the denominators separately. Example: \(\frac{3}{4} \times \frac{2}{7} = \frac{3\times 2}{4\times 7} = \frac{6}{28} = \frac{3}{14} \) (after simplification) Another trick here is that fractions can be simplified before multiplying… you can 'cancel' out numbers using common factors. This is similar to simplifying a single fraction, but this involves dividing a common factor into the numerator and denominator of different fractions. In the example above, we see that \(2\) (the numerator of the 2nd fraction) and \(4\) (the denominator of the 1st fraction) have a common factor of \(2\). Thus, we can divide both numbers by \(2\) first to convert our equation into a simpler multiplication step: \begin{align*} \frac{3}{\color{red}{4}}\times \frac{\color{red}{2}}{7} = \frac{3}{2}\times \frac{1}{7} = \frac{3}{14} \end{align*} Remember, you CANNOT do this for addition and subtraction. The cancellation technique between different fractions ONLY works for MULTIPLICATION (and division), when the numerator and denominator cancel. You cannot cancel across two numerators. Multiplying mixed numbers To multiply mixed numbers, we have to change them to improper fractions first. You cannot multiply the whole numbers and fractions separately. Once converted, we can multiply them as we usually do – by multiplying the numerator and denominator separately. Example: \begin{align*} \frac{1}{5} \times 2\frac{1}{7} &= \frac{6}{5} \times \frac{15}{7}\\ &=\frac{90}{35}\\ &=\frac{18}{7}\\ &=2\frac{2}{7} \end{align*} Note: In this question, we could also cancel before multiplication! \begin{align*} \frac{6}{5} \times \frac{15}{7} &= \frac{6}{1} \times \frac{3}{7}\\ &=\frac{18}{7} \end{align*} Division of fractions Reciprocal The reciprocal of a fraction is essentially the fraction turned upside down. For example, the reciprocal of \(\frac{5}{12}\) is \(\frac{12}{5}\). Reciprocals are always used in the division of fractions. Division To divide two fractions, we change the question into a multiplication. We keep one fraction the same, then multiply it by the reciprocal of the other fraction. Example: \begin{align*} \frac{3}{4} \div \color{red}{\frac{6}{7}} &= \frac{3}{4}\times \color{red}{\frac{7}{6}}\\ &=\frac{1}{4}\times \frac{7}{2}\\ &=\frac{7}{8} \end{align*} Applications The unitary method This is a technique for solving problems by first finding the value of ONE unit, then finding the value of \(X\) units by multiplication. Example: 1. If \(5\) pens cost \($10\) , how much do \(8\) pens cost? The cost of \(1\) pen is \(105 = $2\). The cost of \(8\) pens is \($28 = $16\) . This can be solved in one step by multiplying by \(\frac{8}{5}\). This fraction multiplication carries out the same division by \(5\), then multiplication by \(8\). Summary 1. Mixed fraction To express a mixed fraction as an improper fraction, multiply the denominator by the whole number and add the numerator (this is the new numerator). The denominator stays the same. 2. Equivalent fractions Multiply a number to both numerator and denominator, or divide the numerator and denominator by a common factor. 3. Simplifying fractions The lowest equivalent form that the fraction can have. 4. Ordering fractions Change each fraction to an equivalent fraction with the same denominator, then compare the numerators 5. Adding and subtracting fractions If the denominators are different, find the lowest common multiple of the two denominators. Then, find equivalents of each fraction with the new denominator. Add/subtract the numerators without changing the denominator 6. Multiplying fractions If the fraction is mixed, convert it to an improper fraction first. Multiply the numerators, then multiply the denominators separately. Your answer is \(\frac{top \times top}{bottom \times bottom}\). 7. Dividing fractions Multiply one fraction by the reciprocal (flipped) of the other. Checkpoint questions and solutions Questions 1. Rewrite \(\frac{-17}{2} \) as a mixed number. 2. Simplify \(\frac{84}{144}\) 3. What are \(\alpha \) and \(\beta \) in: 4. Arrange the following group of fractions in ascending order (from smallest to largest) 5. Simplify \(\frac{7}{13} – \Big{(} \frac{2}{13} – \frac{11}{13} \Big{)} \) 6. Simplify \(\frac{5}{8} – \Big{(} \frac{9}{10} – \frac{3}{4} \Big{)} \) 7. Calculate \(\frac{4}{21} \times \frac{5}{8} \times \frac{-13}{15}\) 8. Simplify \(\frac{3}{4} + 1\frac{1}{15} \times 4 \frac{2}{7} – 1\frac{1}{2}\) 9. Evaluate \(3\frac{5}{9} \div 9 \frac{1}{3}\) Solutions 1. Rewrite \(\frac{-17}{2} \) as a mixed number. Solutions: \begin{align*} – \frac{17}{2} = -\frac{(8 \times 2) + 1}{2} = -8 \frac{1}{2} \end{align*} 2. Simplify \(\frac{84}{144}\) Solutions: \begin{align*} \frac{84}{144} = \frac{7}{12} \end{align*} (both \(84\) and \(144\) are divisible by \(12\)) 3. What are \(\alpha \) and \(\beta \) in: \begin{align*} \frac{5}{7} = \frac{ \alpha}{63} = \frac{-35}{ \beta} \end{align*} Solutions: This question converts \(\frac{5}{7}\) to equivalent fractions. We multiply \(7\) in the denominator by \(9\) to get \(63\) , so we multiply the numerator by \(7\) as well. \begin{align*} \alpha = 5 \times 7 = 35 \end{align*} Similarly, for \(-35\) as the numerator, we have to multiply \(7\) by \(-7\) . \begin{align*} \beta = 7 \times -7 = 35 \end{align*} 4. Arrange the following group of fractions in ascending order (from smallest to largest) \begin{align*} \frac{3}{4}; \frac{13}{24}; \frac{5}{12}; \frac{5}{6} \end{align*} Solutions: To compare these fractions, we much change their denominators. The lowest common multiple of all the denominators is \(24\). Find the equivalent of each fraction with \(24\) as the denominator, then compare the numerator. \begin{align*} \frac{3}{4} = \frac{3\times 6}{4\times 6} &= \frac{18}{24} \\ \frac{5}{12} = \frac{5\times 2}{12\times 2} &= \frac{10}{24} \\ \frac{5}{6} = \frac{5\times 4}{6\times 4} &= \frac{20}{24} \end{align*} Now, \(\frac{10}{24} < \frac{13}{24} < \frac{18}{24} < \frac{20}{24} \). Using the original fractions, \(\frac{5}{12} < \frac{13}{24} < \frac{3}{4} < \frac{5}{6} \). 5. Simplify \(\frac{7}{13} – \Big{(} \frac{2}{13} – \frac{11}{13} \Big{)} \) Solution: Using BODMAS, we need to compute the inside of the brackets first. \begin{align*} \frac{2}{13} – \frac{11}{13} = \frac{-9}{13} \end{align*} (Note: be careful when subtracting negative fractions!) \begin{align*} \frac{7}{13} – \Big {(} \frac{-9}{13} \Big{)} = \frac{7}{13} + \frac{9}{13} = \frac{16}{13} \end{align*} 6. Simplify \(\frac{5}{8} – \Big{(} \frac{9}{10} – \frac{3}{4} \Big{)} \) Solution: The lowest common multiple of \(8\), \(10\) and \(4\) is \(40\). Changing all the fractions to this equivalent denominator gives us: \begin{align*} \frac{25}{40} – \Big{(} \frac{36}{40} – \frac{30}{30} \Big{)}\\ &= \frac{25}{40} – \Big{(} \frac{6}{40} \Big{)}\\ &= \frac{19}{40} \end{align*} 7. Calculate \(\frac{4}{21} \times \frac{5}{8} \times \frac{-13}{15}\) Solution: Try to cancel numbers before you start multiplying. \begin{align*} \frac{1}{21} \times \frac{1}{2} \times \frac{-13}{3}\\ &= – \frac{13}{21 \times 2 \times 3}\\ &= – \frac{13}{126} \end{align*} Do a quick check for your solution: based off the original question, should it be negative or positive? 8. Simplify \(\frac{3}{4} + 1\frac{1}{15} \times 4 \frac{2}{7} – 1\frac{1}{2}\) Solution: Using BODMAS, we should compute the multiplications first, then addition/subtraction. \begin{align*} \frac{3}{4} + 1\frac{1}{15} \times 4 \frac{2}{7} – 1\frac{1}{2}\\ &= \frac{3}{4} + \frac{4}{15} \times \frac{30}{7} – \frac{3}{2}\\ &= \frac{3}{4} + \frac{8}{7} – \frac{3}{2}\\ &= \frac{21}{28} + \frac{32}{28} – \frac{42}{28}\\ &=\frac{11}{28} \end{align*} 9. Evaluate \(3\frac{5}{9} \div 9 \frac{1}{3}\) Solution: In divisions, remember to convert all mixed fractions to improper fractions. \begin{align*} 3 \frac{5}{9} \div 9 \frac{1}{3} &= \frac{32}{9} \div \frac{28}{3}\\ &=\frac{32}{9} \times \frac{3}{2} \\ &=\frac{8}{3} \times \frac{1}{7} \\ &= \frac{8}{21} \end{align*} Get more Fractions practice! With Matrix+, we provide you with clear and structured online lesson videos, quality resources, and forums to ask your Matrix teachers questions and for feedback. 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