

Lesson 1: Using decimals in a shopping context

Goals

- Calculate sums and products of decimals in the context of money, and explain (orally and in writing) the calculation strategy
- Estimate sums, differences, products, and quotients of decimals in the context of money, and explain (orally) the estimation strategy.

Learning Targets

- I can use decimals to make estimates and calculations about money.

Lesson Narrative

In KS2, students learned how to add, subtract, multiply, and divide whole numbers and decimals to the hundredths place. In this unit, they will extend this knowledge to include to *all* positive decimals.

This lesson activates students' previous experiences with the four operations, all in the context of planning for a party while staying within a budget. To do so, students make reasoned estimates and then compare them to actual calculated values. The lesson offers insights into students' understanding of operations and the structure of base-ten numbers before new concepts are introduced.

Building On

- Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

Building Towards

- Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.

Instructional Routines

- Anticipate, Monitor, Select, Sequence, Connect
- Compare and Connect

Required Materials

Grocery store circulars

Grocery store advertisements from the newspaper or that are picked up at the store. If students have internet access, you could substitute an online version of this.

Required Preparation

Pick up newspaper circulars from a local grocery store for students to use. Prepare enough for each group of 2 students to have a copy. Alternatively, prepare access to grocery advertisements online.

Student Learning Goals

Let's use what we know about decimals to make shopping decisions.

1.1 Snacks from the Concession Stand

Warm Up: 10 minutes

This activity allows students to review decimal work in a money context. This activity also offers insights into how they estimate and calculate sums, differences, and products of decimals. Both questions allow multiple paths of reasoning.

Monitor how students reason about situations involving adding, subtracting, and multiplying decimals. Also monitor for students using estimation to solve problems and how they go about doing so. Do they round the pence to the closest pound or do they look only at the pound value to the left of the decimal point? (E.g. Some may round £1.85 to £2.00 because it is the closest whole pound. Others may round to £1.00 because "1" is the amount in pounds in front of the decimal point.)

As students work, select those using different strategies so they can share during discussions. Note any misconceptions so that they can be addressed later.

Instructional Routines

- Anticipate, Monitor, Select, Sequence, Connect

Launch

Give students 2–3 minutes of quiet work time, and follow with a whole-class discussion.

Student Task Statement

Clare went to a concession stand that sells pretzels for £3.25, drinks for £1.85, and bags of popcorn for £0.99 each. She bought at least one of each item and spent no more than £10.



1. Could Clare have purchased 2 pretzels, 2 drinks, and 2 bags of popcorn? Explain your reasoning.
2. Could she have bought 1 pretzel, 1 drink, and 5 bags of popcorn? Explain your reasoning.

Student Response

1. No, one pretzel, one drink, and one bag of popcorn cost about £6. So two of each would cost twice this much, about £12.
2. No, one pretzel and one drink cost £5.10. Five bags of popcorn cost £4.95. Buying these items would cost 5 pence more than £10.

Activity Synthesis

Ask selected students to share their responses. Record and display their strategies for adding, subtracting, and multiplying decimals for all to see. To involve more students in the conversation, consider asking some of the following questions:

- “Who can restate ___’s reasoning in a different way?”
- “Did anyone solve the problem the same way but would explain it differently?”
- “Did anyone solve the problem in a different way?”

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- “Does anyone want to add on to ____’s strategy?”
 - “Do you agree or disagree? Why?”

1.2 Planning a Dinner Party

30 minutes

In this activity, students perform decimal operations and estimate with money in a real-world context. They are asked to plan a dinner party for 8 guests with a £50 budget. Students use an actual grocery store price list, select the foods they wish to serve, and determine an appropriate amount of each item. It is important to observe how students make choices in determining the amount of items and the cost of the items. Here are some ways they apply decimal skills along the way:

- Determine estimated costs: rounding
- Determine unit costs (per item or per guest): division
- Determine the subtotal and total costs: multiplication and addition
- Remove items if they go over budget: subtraction

Students are likely to check if their choices are within budget in two ways: by comparing their estimated total costs to £50, or by comparing cost per guest to £6.25 (which is $50 \div 8$). As students work, monitor for students who use each approach.

Instructional Routines

- Anticipate, Monitor, Select, Sequence, Connect
- Compare and Connect

Launch

Ask students if they have ever planned a party and what types of decisions are involved in the planning of a party. After hearing a few responses, arrange students in groups of 2. Provide each group with access to circulars from a local grocery store or to grocery advertisements online. Give students a minute to read the task statement. Give them another minute to preview a grocery store circular with a partner and briefly discuss which items they are interested in including at their party.

- Consider reviewing serving size and going over the second example in the table, in which the quantity sold is in bulk.
 - Consider reviewing subtotal, which is among the values students are asked to find.
 - Let students know that a good estimation for the amount of meat, poultry, or fish for each guest is 0.5 pound. Consider giving an example: "If you were going to serve turkey to 10 guests, how many pounds should you buy?" (At least 5 pounds, because $10 \times 0.5 = 5$.)
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- For other items (such as chips or pizza), students will have to use their best judgment to decide how much is needed. Encourage them to discuss these decisions in their groups.
 - Encourage students to focus on choosing items from the flier and keeping the choices relatively simple (e.g., if a student wants to make a salad, suggest choosing a prepared salad instead of individual ingredients).

Give students 15 minutes of quiet work time, but encourage them to make selections within the first 5–7 minutes so that they have ample time check their budget and to make revisions if necessary. Save at least 10 minutes for the sharing of menus and a whole-class discussion of the selection process. If time is a concern, consider removing an item from the budget worksheet (e.g., beverages) or pre-selecting some items.

Action and Expression: Internalise Executive Functions. To support development of organisational skills, check in with students within the first 2–3 minutes of work time. Check to make sure groups have decided how much of each item on their menu is needed prior to estimating the subtotal and cost per person.

Supports accessibility for: Memory; Organisation

Anticipated Misconceptions

When dividing prices to determine unit cost, students might not know what to make of a remainder in this context. For example, if lemons cost £1 for 6, students may write "16 pence and a remainder of 2 pence" for the unit price. Prompt them to think about how the remainder could be divided as well.

Some students might write unit costs as fractions or mixed numbers, e.g., $\frac{100}{3}$ or $33\frac{1}{3}$ pence. Prompt them to think about rounding these numbers to the nearest penny.

Student Task Statement

You are planning a dinner party with a budget of £50 and a menu that consists of 1 main dish, 2 side dishes, and 1 dessert. There will be 8 guests at your party.

Choose your menu items and decide on the quantities to buy so you stay on budget. If you choose meat, fish, or poultry for your main dish, plan to buy at least 0.5 pound per person.

1. The budget is £ _____ per guest.
2. Use the worksheet to record your choices and estimated costs. Then find the estimated total cost and cost per person. See examples in the first two rows.

item	quantity needed	advertised price	estimated subtotal (£)	estimated cost per person (£)
example main dish: fish	4 pounds	£6.69 per pound	$4 \times 7 = 28$	$28 \div 8 = 3.50$
example dessert: cupcakes	8 cupcakes	£2.99 per 6 cupcakes	$2 \times 3 = 6$	$6 \div 8 = 0.75$
main dish:				
side dish 1:				
side dish 2:				
dessert:				
estimated total				

- Is your estimated total close to your budget? If so, continue to the next question. If not, revise your menu choices until your estimated total is close to the budget.
- Calculate the actual costs of the two most expensive items and add them. Show your reasoning.
- How will you know if your total cost for all menu items will or will not exceed your budget? Is there a way to predict this without adding all the exact costs? Explain your reasoning.

Student Response

- The budget per person is $50 \div 8$, which is £6.25.
- Answers vary. Sample response:

item	quantity needed	advertised price	estimated subtotal (£)	estimated cost per person (£)
main dish: beef	4 pounds	£5.89 per pound	$4 \times 6 = 24$	$24 \div 8 = 3$
side dish 1: corn on the cob	8 ears	£2.00 for a bag of 6	$2 \times 2 = 4$	$4 \div 8 = 0.50$
side dish 2: chips	2 bags	£2.89 per bag	$2 \times 3 = 6$	$6 \div 8 = 0.75$
dessert: ice cream	1 tub	£2.29 per tub	$1 \times 2 = 2$	$2 \div 8 = 0.25$
estimate total			£36	£4.50

- Answers vary.

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4. Answers vary. Sample response: Most expensive: beef, which costs £23.56. $4 \times (5.89) = 23.56$. Second most expensive: Chips, which cost £5.78. $2 \times (2.89) = 5.78$. The combined cost of the two most expensive items is $23.56 + 5.78$, which is £29.34.
5. Answers vary. Sample responses:
- The exact costs (not just the estimates) could be added up for one guest to check if £50 is enough to buy all of the food.
 - Without finding the exact costs, all estimates per guest could be made *too large*. If these numbers that are too large add up to less than £6.25 then all of the items can be purchased without exceeding the budget. (even without knowing the exact cost). In the table for question 1, the first three estimates are all too high. The last two estimates are too low but only by a few pennies. Since the total was less than £5, this food can be bought with £50.

Are You Ready for More?

How much would it cost to plant the grass on a football field? Explain or show your reasoning.

Student Response

Answers vary.

Activity Synthesis

The goal of this discussion is to highlight the decimal operations and estimations students did while planning the dinner party. Select a few students to share their menus with the entire class. Consider displaying some of these questions for all to see and discuss. Choose questions that are relevant based on misconceptions you observed, if any, in the warm-up and in this activity.

- “How did you decide how much of each item to get?”
 - “Were there any sale items that were sold in multiple quantities? If so, how did you decide how much to get?”
 - “Were there any items that you did not choose because they were sold in an amount that was more than you needed?”
 - “How did you determine if your menu choices are within budget? Did you look at total estimated cost, or estimated cost per person? Why?”
 - “Were there items where it was difficult to estimate the cost per person? How so?”
 - “Was your first planned menu in the right price range or did you need to revise?”
 - “How did you decide which items to remove?”
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Select previously identified students to share two ways of meeting the budget constraint (by comparing total cost or by comparing cost per guest). Briefly ask a few groups to share the approach they took and the merits of their approach. Invite other students to share how they divided the prices to find unit costs or cost per guest, and how they multiplied and added the prices to find sub-totals.

Speaking: Compare and Connect. Use this routine when students present their menu and share strategies for meeting the budget constraint. Ask students to consider what is the same and what is different about each approach. In this discussion, emphasise language used to make sense of strategies for estimating and calculating with decimals. These exchanges can strengthen students' mathematical language use and reasoning of decimals.

Design Principle(s): Maximise meta-awareness; Support sense-making

Lesson Synthesis

In this lesson, we used what we know about decimals to make decisions about shopping and money. We noticed that sometimes it was helpful to round the pounds and pence and estimate, and other times it was necessary to be precise. Consider asking some of the following questions:

- “When was it appropriate to make an estimate, and when was it appropriate calculate the numbers precisely?”
- “How did you estimate sums and differences of decimals?”
- “How did you estimate products of decimals and whole numbers? What about quotients of decimals and whole numbers?”
- “How did you go about adding and subtracting decimals precisely?”
- “What strategies did you use to multiply and divide decimals precisely?”

1.3 How Did You Calculate With Decimals?

Cool Down: 5 minutes

Launch

As students review their calculation strategies, remind students that the sums and products of decimals should be exact. For example, if a student summed £5.89 and £1.45, they should not estimate the sum using £6 and £2.

Student Task Statement

Planning your menu involved many calculations with decimals. Reflect on how you made these calculations:

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1. How did you calculate sums of pound amounts that were not whole numbers? For example, how did you calculate the sum of £5.89 and £1.45? Use this example to explain your strategy.
 2. How did you calculate products of pound amounts that were not whole numbers? For example, how did you calculate the cost of 4 pounds of beef at £5.89 per pound? Use this example to explain your strategy.

Student Response

1. Answers vary. Sample response: My strategy was to add the pounds and pence separately, and then combine the sums at the end. In this example, £5 and £1 would be added together to get £6, and then add the 89 pence and 45 pence would be added together to get £1.34. So the total would be £7.34.
2. Answers vary. Sample response: My strategy was to first round the £5.89 to £5.90 to make it easier to multiply. Then, I found 4 times £5, which is £20, and 4 times £0.90, which is £3.60. These two products were added together to get £23.60. The exact cost would be 4 pence less than £23.60, because £5.89 is 1 penny less than £5.90, and 4 times 1 penny is 4 pence.

Student Lesson Summary

We often use decimals when dealing with money. In these situations, sometimes we round and make estimates, and other times we calculate the numbers more precisely.

There are many different ways we can add, subtract, multiply, and divide decimals. When we perform these calculations, it is helpful to understand the meanings of the digits in a number and the properties of operations. We will investigate how these understandings help us work with decimals in upcoming lessons.

Lesson 1 Practice Problems

1. Problem 1 Statement

Mai had £14.50. She spent £4.35 at the snack bar and £5.25 at the arcade. What is the exact amount of money Mai has left?

- a. £9.60
- b. £10.60
- c. £4.90
- d. £5.90

Solution C

2. Problem 2 Statement

A large cheese pizza costs £7.50. Diego has £40 to spend on pizzas. How many large cheese pizzas can he afford? Explain or show your reasoning.

Solution

5 pizzas. Sample reasoning: Each pizza costs about £8, and $8 \times 5 = 40$.

3. Problem 3 Statement

Tickets to a show cost £5.50 for adults and £4.25 for students. A family is purchasing 2 adult tickets and 3 student tickets.

- Estimate the total cost.
- What is the exact cost?
- If the family pays £25, what is the exact amount of change they should receive?

Solution

- £24 ($6 + 6 + 4 + 4 + 4 = 24$)
- £23.75 ($5.50 + 5.50 + 4.25 + 4.25 + 4.25 = 23.75$)
- £1.25 ($25.00 - 23.75 = 1.25$)

4. Problem 4 Statement

Chicken costs £3.20 per pound, and beef costs £4.59 per pound. Answer each question and show your reasoning.

- What is the exact cost of 3 pounds of chicken?
- What is the exact cost of 3 pounds of beef?
- How much more does 3 pounds of beef cost than 3 pounds of chicken?

Solution

- £9.60 ($3.20 \times 3 = 9.60$)
- £13.77 ($4.59 \times 3 = 13.77$)
- £4.17 ($13.77 - 9.60 = 4.17$)

5. Problem 5 Statement

- How many $\frac{1}{5}$ litre glasses can Lin fill with a $1\frac{1}{2}$ litre bottle of water?

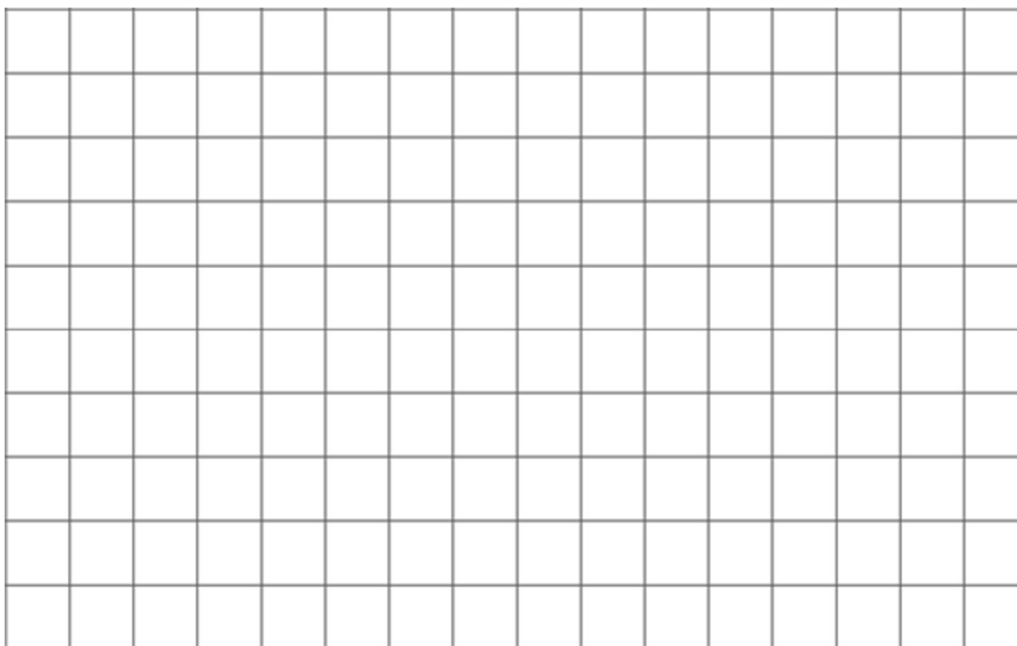
- b. How many $1\frac{1}{2}$ litre bottles of water does it take to fill a 16 litre jug?

Solution

- a. $7\frac{1}{2}$ (or $\frac{15}{2}$). (She can fill 5 of the glasses with 1 litre and then another half of that or $2\frac{1}{2}$ with the other half litre, so that is $7\frac{1}{2}$ glasses. $1\frac{1}{2} \div \frac{1}{5} = \frac{15}{2}$ or $7\frac{1}{2}$.)
- b. $10\frac{2}{3}$ (or $\frac{32}{3}$). (This can be obtained by computing $16 \div 1\frac{1}{2}$, which is $16 \div \frac{3}{2}$ or $10\frac{2}{3}$. This is correct as 10 bottles give 15 litres, and then 1 more litre is $\frac{2}{3}$ of the bottle.)

6. Problem 6 Statement

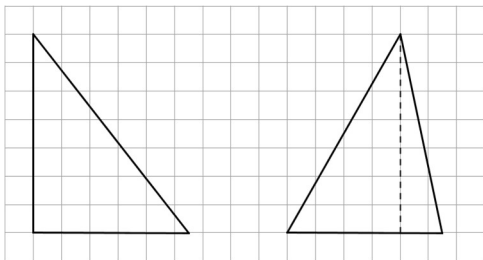
Let the side length of each small square on the grid represents 1 unit. Draw two different triangles, each with base $5\frac{1}{2}$ units and area $19\frac{1}{4}$ units².



Why does each of your triangles have height 7 units? Explain or show your reasoning.

Solution

Drawings vary but should show a height of 7 units. Sample reasoning: The base times the height is 2 times the area of the triangle: (base) \times (height) = $2 \times (19\frac{1}{4})$. Since $(19\frac{1}{4}) \div (5\frac{1}{2}) = 3\frac{1}{2}$, that means the height should be $2 \times (3\frac{1}{2}) = 7$.



7. Problem 7 Statement

Find each quotient.

a. $\frac{5}{6} \div \frac{1}{6}$

b. $1\frac{1}{6} \div \frac{1}{12}$

c. $\frac{10}{6} \div \frac{1}{24}$

Solution

a. 5

b. 14

c. 40



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