17 Ratio

Learning objectives

- How to use ratio notation
- How to use ratios to compare quantities
- How to simplify ratios
- How to write ratios in different ways
- How to use ratios to find totals or missing quantities
- The connection between ratios and fractions
- How to use ratios to solve problems in everyday life

Prior knowledge

- How to simplify fractions. In KS2, pupils will have divided numerators and denominators by common factors.
- How to find a fraction of a quantity. Pupils will be familiar with percentage notation.
- The equivalence between simple fractions and percentages. Pupils should be familiar with simple fractions such as three-quarters or one-tenth, and the corresponding percentages.

Context

- Ratios are a very useful way to compare quantities without the distraction of the actual values. For example, saying that the diameter of Saturn is 10 times the diameter of the Earth (or the ratio is 10 : 1) provides an immediate mental image. This would not be as obvious just by quoting the diameters.
- Many pupils will have experience of riding a bicycle with gears. It may come as a surprise to them to learn that ratios are used to compare one gear with another. If you know the gear ratio, you know if it will be easy or difficult to pedal in that gear.

Discussion points

- Provide pupils with questions to activate prior knowledge and exercise mathematical 'fluency', that is, the ability to manipulate mathematical language and concepts and apply them in different contexts.

Associated Collins ICT resources

- Chapter 17 interactive activities on Collins Connect online platform
- *Zodiac map* Wonder of Maths on Collins Connect online platform
- *Lines of the form $x + y = a$* Worked solution on Collins Connect online platform
- Ratio and proportion tool on Collins Connect platform

Curriculum references

Ratio, proportion and rates of change

- Use ratio notation, including reduction to simplest form
- Divide a given quantity into two parts in a given part : part or part : whole ratio; express the division of a quantity into two parts as a ratio
- Understand that a multiplicative relationship between two quantities can be expressed as a ratio or a fraction

Fast track for classes following a 2-year scheme of work

- Pupils will have worked with ratio in KS2, when comparing quantities, and in problems involving unequal sharing. Pupils may have been introduced to the $a : b$ notation. If pupils can show understanding by answering one or more of the later questions in Lesson 17.1, they can move on to simplifying ratios in Lesson 17.2.
- Similarly, if pupils are confident about simple sharing problems, as provided in Lesson 17.3, then they can move on to concentrate on the mixed questions in Lesson 17.4.

Lesson 17.1 Introduction to ratios

Learning objectives
- To use ratio notation
- To use ratio to compare quantities

Resources and homework
- Pupil Book 1.3, pages 333–336
- Intervention Workbook 2, pages 43–45
- Intervention Workbook 3, pages 40–42
- Homework Book 1, section 17.1
- Online homework 17.1, questions 1–10

Links to other subjects
- **Science** – to compare quantities in experiments or compounds; to compare distances in astronomy
- **Geography** – to compare populations, areas, heights or other physical measures

Key words
- ratio
- quantity

Problem solving and reasoning help
- In question 9B of Exercise 17A in the Pupil Book, pupils are required to work from a ratio to a value and then back to a ratio.
- In **MR** question 10, pupils must approximate values in order to show the required ratio.
- The investigation at the end of the exercise encourages pupils to choose their own ratios to evaluate

Common misconceptions and remediation
- Pupils sometimes have difficulty remembering how to pronounce ‘ratio’. They may pronounce it as rat-i-o, with a ‘t’ sound rather than with an ‘sh’ sound. Help pupils by saying the word often and asking them to use it. Point out that ratio is related to the word ‘ration’, and that sometimes spell checkers change ‘ratio’ to ‘ration’.
- The order of the numbers in a ratio is important and relates to the order of the quantities being compared. Emphasise this by asking for the ratio the other way round and what it means when looking at examples.

Probing questions
- The ratio of two distances is 10 : 1. Do you know either of the distances? (No)
- Do you know if they are both a whole number of centimetres? (No)
- What do you know about the distances? (One distance is 10 times greater than the other distance.)

Part 1
- Write or place these numbers on the board, randomly scattered:
- 15, 4, 27, 24, 9, 20, 45, 60, 8, 12.
- Ask pupils to arrange the numbers in two sets in any way they choose.
- Ask one or two pupils to give their sets, with reasons.
- Odd and even numbers is one obvious way. Try to find a pupil who has put: 4, 8, 9, 15, 20 in one group and 12, 24, 27, 45, 60 in the other. If no one has done this, do it yourself and ask pupils what is the logic behind your choice. (In these sets, the numbers in one set are three times the numbers in the other set.)
- Write these numbers on the board and ask pupils to divide them into two sets in a similar way: 2, 5, 10, 20, 25, 40, 50, 100, 200, 250.

- Here we are looking for: 2, 5, 20, 40, 50 and 10, 25, 100, 200, 250. Here, the multiple is 5.
- If pupils need extra multiplication practice, give them a number by which to multiply (such as 4 or 20) and then some quick-fire numbers to multiply by that. So if the number is 4, you might ask them to multiply by, for example: 5, 7, 20, 11 ….

Part 2

- Look at the numbers in the first set in Part 1. They can be paired as 4 and 12, 8 and 24 … Explain that we would say: 'The *ratio* for each pair is 1 to 3 or 1 : 3'. Explain this notation. (Each time, the second number is three times the first.)
- Ask for some other pairs of numbers in the same ratio.
- **Less able** pupils may find a visual representation helpful. Draw two columns of equal width, one three times the height of the other. Say that the ratio of the heights is 1 : 3 and divide the second column into three parts to demonstrate this.
- Pupils should be able to say that the numbers in the second example give pairs in the ratio 1 : 5. A visual representation would help **less able** pupils.
- Look at the example of the giraffe and the antelope at the start of section 17.1 in Pupil Book 1.3. The ratio of the height of the giraffe to the height of the antelope is 4 : 1. Point out that we do not know the height of either animal. What the ratio tells us is that one animal is four times the height of the other animal.
- Explain that the ratio can be written the other way around, so the ratio of the height of the antelope to the height of the giraffe is 1 : 4.
- Try to have available two bottles. The capacity of one bottle should be one-and-a-half times the capacity of the other bottle. If you do not have any bottles, use Example 2 in section 17.1 of the Pupil Book.
- Explain how we can write the ratio as 3 : 2 by dividing each bottle into sections of equal size. The diagram in Example 2 illustrates this.
- **Pupils can now do Exercise 17A in Pupil Book 1.3.**

Part 3

- After pupils have completed the investigation at the end of Exercise 17A, ask them to share their findings. In particular, they should compare the ratios of the number of coins with the ratios of the values.
- If pupils have not done the investigation, ask individuals to draw a diagram to illustrate a particular ratio such as 1 : 6 or 5 : 2.

Answers

1 **a** 1 : 4 **b** 4 : 1
2 **a** 2 : 1 **b** 3 : 2 **c** 5 : 3
3 **a** 2 : 3 **b** 3 : 4 **c** 1 : 2
4 3 : 1 **5** 8 : 1 **6** 1 : 100 **7** 4 : 5 **8** 1 : 3
9 **a i** 7 : 1 **ii** 7 : 2 **iii** 1 : 2 : 4 **b** 25% **c** 1 : 7
10 **a i** 2 : 1 **ii** 4 : 5 **iii** 5 : 2 **b** 3 : 16
11 84 ÷ 3.4 = 24.7 or approximately 25
12 21 : 1
13 **a** 1 : 4 **b** 1 : 17 **c** 1 : 54
14 **a** 6 : 1 **b** 39 : 1 **c** 70 : 1
15 It should be 1 : 9
Investigation: Bagging coins
A **a** 1 : 2 **b** No, the ratio of the values is 2 : 1
B Pupil's own values

Lesson 17.2 Simplifying ratios

Learning objectives
- To write a ratio as simply as possible with whole numbers
- To write ratios in the form 1 : *x* where *x* could be a decimal.

Resources and homework
- Pupil Book 1.3, pages 336–339
- Intervention Workbook 3, pages 40–42
- Homework Book 1, section 17.2
- Online homework 17.2, questions 1–10

Links to other subjects
- **Science** – to compare the amounts of two elements in a chemical formula
- **Geography** – to compare the area of one country to the area of another

Key words
- aspect ratio
- simplify
- fraction

Problem solving and reasoning help
- In **PS** question 7 of Exercise 17B, percentages are given rather than quantities. This is normal practice on clothing labels. The ratio can be written using the percentages in the same way as if quantities had been given. You could ask pupils why percentages rather than quantities are used here. (Food labelling, by contrast, provides quantities.)
- In **PS** question 9b, pupils will need to apply their understanding ratios expressed in the form *x* : 1 to a real problem.
- **PS** question 10 introduces area ratios in a real-life context. These will be different to the length : width ratios.

Common misconceptions and remediation
- Pupils do not have units. In this section of the Pupil Book, pupils are comparing lengths, masses and so on, but the units of measurement do not appear in the ratio. Emphasise this point when calculating or working with ratios.
- The quantities being compared must be in the same units. The activity in Part 3, below, addresses this point clearly.

Probing questions
- When you are given a ratio, how do you know if it is in its simplest form?
- Is the ratio 1 : 5 the same as the ratio 5 : 1?

Part 1
- Write some fractions on the board and ask pupils to write them in their simplest forms. Start with fractions that simplify to 1 in the numerator; then progress to more complicated examples.
- Emphasise the fact that you want the simplest possible form. For example, the simplest form of $\frac{12}{20}$ is $\frac{3}{5}$, not $\frac{6}{10}$.
- Match the difficulty to the ability of your pupils. Ask individual pupils to give answers. For **more able** pupils, choose examples where the common factor is more or less obvious, such as 7, or where there are multiple factors.

Part 2
- Draw two lines, one line that is 24 cm long and one that is 40 cm long. Do not reveal the lengths yet.
- Ask pupils to estimate the ratios of the lengths. Do not comment on whether suggestions are correct or not. If you get several suggestions, you could ask pupils to say which they think is best, and why.

- Now write the lengths on the lines and say that we could use these to write the ratio of the shorter length to the longer length as 24 : 40. Imagine each line marked in centimetre sections. There will be 24 on one line and 40 in the other.
- Say that we can simplify ratios in the same way that we simplify fractions – by dividing by a common factor.
- Ask pupils to simplify $\frac{24}{40}$ to its simplest form. The answer is $\frac{3}{5}$.
- In the same way, the ratio 24 : 40 simplifies to 3 : 5. Did anyone have this as their estimate?
- What does this mean? Divide the 24 cm line into three equal sections (8 cm each) and the 40 cm line into five equal sections (also 8 cm each). This provides a visual representation of the ratio.
- Explain that we could also write the ratio as $1 : 1\frac{2}{3}$
- This is because $40 \div 24 = 1\frac{2}{3}$ and the length of the longer line is $1\frac{2}{3}$ times the length of the smaller line. We tend to use the whole number representation of a ratio when the numbers are reasonably small.
- Give an example of two masses. Two books of different sizes would be suitable, or any two objects you have in the classroom. Ask how we could find the ratio of these masses.
- Tell pupils the masses, which you can make up, as long as the masses seem reasonable and simplify to small numbers. Ask pupils to find the ratio of the masses in its simplest form. Ask for it both ways: lighter to heavier and heavier to lighter.
- Point out that ratios can be used in this way to compare any measurable quantity. You have looked at length and mass. Ask for other examples. Area, volume, capacity, and length of time are possible answers.
- **Pupils can now do Exercise 17B from Pupil Book 1.3.**

Part 3

- Write on the board: ‘The lengths of two lines are 25 cm and 100 mm’.
- Say that the ratio of the lengths is *not* 1 : 4 and ask a pupil to explain why this is the case. (The two lines are different units of measurement.)
- Ask for the correct ratio in its simplest form. The answer is 5 : 2. Ensure that all pupils understand this. Emphasise that the units must be the same when comparing two quantities (converted to same units = 250 mm or $\underline{5} \times 50$: 100 mm or $\underline{2} \times 50$).
- Give more examples using mixed units and ask for the ratio. Possible examples are 50 cm and 2 m; 250 ml and 2 litres; 200 g and 1 kg; 5000 m and 10 km. **Less able** pupils will benefit if you use very simple examples.
- At the end of the lesson, ask pupils to share their findings from the investigation at the end of the exercise. Check that pupils can a work out all the ratios required.

Answers

1 **a** 1 : 8 **b** 3 : 4 **c** 5 : 1
d 4 : 3 **e** 2 : 3
2 **a** 2 : 7 **b** 7 : 2 **c** $\frac{2}{7}$ **d** 3.5
3 **a** 2 : 7 **b** $\frac{2}{7}$
4 **a** 2 : 3 **b** 9 : 4 **c** 4 : 5
5 **a** 3.4 : 1 **b** 14.3 : 1 **c** 4.6 : 1
d 30.2 : 1 **e** 1.4 : 1
6 **a** i 2 : 5 **ii** 5 : 3 **iii** 3 : 2 **b** 14 : 1
7 **a** 6 : 1 **b** examples are viscose to angora is 6 : 1 or viscose to polyamide is 1.33 : 1
8 **a** copper and titanium **b** silver and aluminium because 10.5 ÷ 2.7 = 3.9
c 7.15 : 1
9 **a** Spain 3.8 : 1, Australia 1.9 : 1, Germany 1.5 : 1, NZ 5 : 1, Italy 2.3 : 1
b 104
10 **a** They are all 1.414 : 1 **b** 1 : 2
c 1 : 4 **d** 840 mm × 594 mm
11 **a i** 15 : 2 **ii** 2 : 1 **b** 1.58 : 1
c 17 : 8 or 2.125 : 1

Activity: Aspect ratios

A $\frac{9}{16}$, $\frac{3}{4}$, $\frac{5}{12}$ **B** 1. 8 : 1, 1.3 : 1, 2.4 : 1

C 1.8 : 1 **D** Pupil’s own values

Lesson 17.3 Ratios and sharing

Learning objectives

- To use ratios to find totals or missing quantities
- To write ratios to compare more than two items

Resources and homework

- Pupil Book 1.3, pages 340–342
- Intervention Workbook 3, pages 43–44
- Homework Book 1, section 17.3
- Online homework 17.3, questions 1–10

Links to other subjects

- **Science** – to compare quantities in different types of materials
- **Food technology** – to combine recipe ingredients in the correct quantities

Key words

- No new keywords for this topic

Problem solving and reasoning help

- In **MR** question 6 of Exercise 17C in the Pupil Book, the crucial step is finding the fraction of the crowd of 150 people who are women. This is best achieved by changing the ratio to make the calculation easier. Change it from 1.5 : 1 to 3 : 2.
- In the challenge at the end of the exercise, the link between carat and percentage of gold can be illustrated by a horizontal line with a scale from 0 to 24 carats at the top and 0 to 100% on the bottom. This way, pupils can see easily that 24 carats is 100% gold, 12 carats is 50% gold, 18 carats is 25% gold, and so on.

Common misconceptions and remediation

- Pupils sometimes get confused about the exact relationship between ratios and fractions. Emphasise the link between the ratio numbers and the numerators of the fractions, as outlined in the lesson plan.

Probing questions

- If the ratio of boys to girls in a class is 3 :1 could there be exactly 30 children in the class?
- Could there be 25 boys? Why?

Part 1

- Pupils can work in pairs on this activity.
- Write £20 on the board. Ask pupils to find what fractions of this will be a whole number of pounds. If they need clarification, show that $\frac{1}{2}$ is £10, which is a whole number of pounds; $\frac{1}{3}$ is £3.33 with 1p left over, which is not a whole number.
- After a few minutes check answers.
- Check that pupils remember how to find a fraction: For example, $\frac{1}{5}$ of £20 = 20 ÷ 5 = £4; of £20 = 3 × £4 = £12
- **Less able** pupils may need more practice with finding fractions. If so, repeat the activity with £18 and/or £12.

Part 2

- Draw a 4 × 3 grid of 12 squares. Colour three of the squares. Ask what fraction is coloured, and then what fraction is uncoloured. The answers should be one-quarter and three-quarters.
- Say that so far they have used ratios to compare two quantities. They can also use ratios to compare the shares when dividing one quantity.

- In the example we have just done, the ratio of shaded to unshaded parts is 1 : 3. Make sure that pupils are happy with this.
- Repeat this activity but shade different numbers of squares each time. For example, 4 or 2, or 1 or 6. Each time, ask for the fraction shaded, the fraction unshaded and the ratio of the two. Pupils should be able to see that the numerators of the fractions give the numbers in the ratio.
- Now work through examples 5 and 6 in Lesson 17.3 of the Pupil Book. In Example 5, £20 000 is divided into shares in a given ratio. This is done by working out the fraction required, and reinforcing the link between fractions and ratios. In Example 6 the whole is given and one share is found. Again, fractions are used to tackle this problem.
- **Pupils can now do Exercise 17C from Pupil Book 1.3.**

Part 3

- Say that Eve has 20 apples to share with Adam. Can they share them in the ratio 2 : 1 and have an equal number each? What about sharing them in the ratio 2 : 3?
- What is the smallest number that can be divided equally in the ratio 2 : 1 or 2 : 3? (The answer is 15; the lowest whole number is divisible by both 3 and 5.)
- A question for **more able** pupils is to find the smallest number that can be divided equally in the ratio 2 : 1 or 2 : 5.

Answers

1 30
2 £23.70 and £15.80
3 **a** 60% **b** 36 cows and 6 goats
4 1080
5 Harriet 64, Richard 80, Steve 96
6 60
7 $\frac{5}{8}$ are children and $\frac{5}{8}$ of 400 is 250.
8 405
9 65
10 **a** 1046 **b** 45
11 **a** 35 **b** 25%
12 266 m

Challenge: Mixing gold

A **a** 3 : 1 **b** 7 : 1 **c** 3 : 5
B **a** 13.33 g **b** 6.67 g **c** 5.71 g
C **a** 91.7% **b** 11 : 1
D 1 : 2
E The current price can be found on the internet.

Lesson 17.4 Solving problems

Learning objectives
- To understand the connections between fractions and ratios
- To understand how ratios can be useful in everyday life

Resources and homework
- Pupil Book 1.3, pages 343–345
- Homework Book 1, section 17.4

Links to other subjects
- **Science** – to find unknown quantities of substances
- **Geography** – to compare the resources of different countries

Key words
- No new keywords for this topic

Problem solving and reasoning help

- Note that all questions in this lesson are Level 6.
- In **PS** question 4 of Exercise 17D of the Pupil Book, pupils need to be clear about the ratio of the number of coins and the ratio of their values.
- In **PS** question 5, pupils first need to work out the number of green and brown bottles and then remember to take account of the change in the total number of bottles. A possible extension for **more able** pupils is to ask for the ratio if another green bottle falls (1 : 12).

Common misconceptions and remediation

- Pupils can make mistakes by not being clear about whether they know the whole or a part when working out missing values. Encourage pupils always to ask themselves if they know the whole or a part before they try to answer a question.

Probing questions

Ann and Baz share some money in the ratio 3 : 2
- If you know the total amount, how can you work out what Ann has?
- If you know what Ann has, how can you work out what Baz has?
- If you know what Baz has, how can you work out what Ann has?

Part 1

- Write down the following sentences: '*Tim and Claire bake 60 biscuits in total. Tim bakes 24 of them.*'
- Ask pupils to work in pairs and find different ways to write this information. They can use fractions, percentages or ratios.
- After a few minutes take answers from selected pupils. Possible statements are:
  - Tim bakes $\frac{2}{5}$ and Claire bakes $\frac{3}{5}$.
  - Tim bakes 40% and Claire bakes 60%.
  - Tim and Claire bake biscuits in the ratio 2 : 3.
- Make sure that pupils can remember the equivalences between simple fractions and percentages. If not, ask more questions about this, for example, writing tenths, fifths or quarters as percentages.
- This should remind pupils of the work covered in the last lesson.

Part 2

- This lesson is about using the ideas about ratios that pupils have met so far in questions, in a realistic context.
- Tell pupils that the ratio of teachers to pupils in a school is 1 : 12 (or use your own figure if you know it, but round it to a whole number).
- Ask a volunteer to explain what this means. A possible answer is that there is one teacher for every 12 pupils.
- Ask questions that require pupils to use this information in different ways, for example:
- If there are 30 teachers, how many pupils are there?
- If there are 60 teachers, how many pupils are there?
- If there are 1300 pupils and teachers, how many of each are there?
- Ask pupils to explain how they work out the answers each time and check that their reasoning is correct.
- Set the following problem for pupils to tackle in pairs: 100 pupils are going on a trip and the ratio of teachers to pupils must be at least 1 : 9. What is the smallest possible number of teachers?
- The answer is 12. Discuss with pupils different ways to work out the answer. A suitable method for **less able** pupils is to say that one teacher can take nine pupils, two teachers can take 18 pupils, three teachers can take 27 pupils, and so on.
- **More able** pupils may prefer a method based on fractions $\frac{9}{10}$ of the total number is 100, so $\frac{1}{10}$ of the total number is 9, remainder 1. Nine teachers are not quite enough.
- Example 7 in section 17.4 of the Pupil Book has a similar question for comparison.
- **Pupils can now do Exercise 17D from Pupil Book 1.3.**

Part 3

- Pupils can work in twos or threes on this task.
- Ask pupils to produce a concise statement that will help them to remember the key points about ratios. This could be an example, a diagram or a sentence or two.
- Ask one or two groups to share what they have done with the rest of the class.
- As an extension, pupils could use these ideas to produce posters for a wall display.

Answers

1 250 girls, 200 boys
2 1.3 : 1
3 4 : 1 : 1
4 £6.00
5 **a** 1 : 4.8 **b** 1 : 4.6
6 25 and 41
7 **a** England to Wales 6.33:1, Scotland to Wales 3.81:1, NI to Wales 1:1.5 or 0.67:1
b divide the area of the country by the area of Wales
8 **a i** 1.24 : 1 **ii** 1.19 : 1 **b i** 1.57 : 1 **ii** 5.37 : 1 **c** Con have less than twice the votes of Lib Dem but more than 5 times the number of MPs.
9 42
10 A is 108°, B is 100°, C is 80°, D is 72°

Investigation: Patterns of squares

A 2 : 1 **B** 1 : 2 **C** 3 : 2
D The pattern continues in this way. For 2*N* coloured rings the ratio is *N* + 1 : *N*, and for 2*N* + 1 coloured rings the ratio is *N* : *N* + 1

Review questions (Pupil Book pages 346–347)

- The review questions will help to determine pupils' abilities with regard to the material within Chapter 17.
- They also draw on the maths covered in earlier chapters of the book to encourage pupils to make links between different topics.
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Problem solving – Smoothie bar (Pupil Book pages 348–349)

- This activity is designed to reinforce the use of the techniques from this chapter in realistic contexts, asking questions that customers or shopkeepers may reasonably be expected to ask.
- The questions can be answered in any order as each section is independent.
- Different groups of pupils could take on the roles of shopkeeper or customer and devise similar questions for each other.
- Discuss strategies for increasing sales or for saving money.
- Pupils will find the information they need in various places on the double page spread of the Pupil Book. They will need to use the appropriate information in each question.
- Pupils should be familiar with grams and millilitres as measures of mass and capacity, respectively.
- The level of difficulty can be changed by adjusting the prices or the quantities.

Answers

1 **a** 12.5 g **b** 3 kg

2 **a i** 2 : 1 **ii** 2 : 3 **b i** 9 : 5 **ii** 2 : 3

3 **a** Jaguar 10.6 : 1 Porsche 16.5 : 1 Bugati 21.8 : 1

b Porsche to Bugati is 1 : 1.32

c 1.56 and 2.06

d Bluebird to Bugati is 1.6 : 1

4 **a** Brighton 1.27 : 1 Middlesbrough 2.11 : 1 Crewe 1.74 : 1

b Brighton to Middlesbrough to Crewe is 4.58 : 4.31 : 1

c 12 296 and 4381

5 **a** 5 : 2 or 2.5 : 1 **b** 2.5 times **c** 21 **d** 4.36 : 1 and 0.875 : 1

6 **a** Saturn and Neptune

b Venus and Earth, or Earth and Mars, or Uranus and Neptune

c 1 : 78 d. 0.72 : 1 : 1.52

Answers

1 **a** 2 : 3 **b** 3 : 4 **c** size 2: 5, cost 5 : 8

d Yes. If the ratios were the same then the large would cost either £4.50 or £6.25 instead of just £4.00

2 **a** 4 : 2 : 3 **b** 4 : 2 : 3 **c** $\frac{4}{9}$ **d** $\frac{3}{5}$ **e** 5 : 4

3 For example Breakfast Boost : Fruity Surprise = 2 : 1
Chocolate : Tropical Fruit = 3 : 4
Breakfast Boost : Chocolate = 3 : 2

4 **a** 20 Fruity Surprise, 33 Breakfast Boost, 25 Chocolate Smoothies, 50 Tropical Fruit

b i 66 **ii** 166

5 **a i** £6 **ii** £5.50 **iii** £4.25

b £23.25

c i Using the offer 2 small smoothies cost £3.75, so she could buy 10 for £18.75.

ii 4 medium smoothies or 3 large smoothies would cost £18 leaving her with £2 change.