3. Addition and Subtraction

Addition

	L	TTh	Th	H	T	O
	2	1	2	1	1	
	5	6	0	9	4	8
+	2	7	9	7	5	0
+		8	4	5	2	3
	9	2	5	2	2	1

- Adding numbers in any order gives the same sum.
- A number + 0 = 0 + the number = the same number.
- Sum of 2 numbers – one of the numbers = the other number.

Filling in the missing digits in addition sums

	TTh	Th	H	T	O
	4	3		6	4
+		7	3	2	
+		9	8		1
	9		4	7	8

O: 4 + 1 = 5.
Missing digit = 8 – 5 = 3.

	TTh	Th	H	T	O
	4	3		6	4
+		7	3	2	3
+		9	8		1
	9		4	7	8

T: 6 + 2 = 8.
As 7 < 8, missing digit
= 10 + 7 – 8 = 9.
Check: 6 + 2 + 9 = 17.
Keep: 7. Carry: 1.

	TTh	Th	H	T	O
	4	3		6	4
+		7	3	2	3
+		9	8	9	1
	9		4	7	8

H: 1 + 3 + 8 = 12.
Ones digit in 12 is 2.
Missing digit = 4 – 2 = 2.
Check: 1 + 2 + 3 + 8 = 14.
Keep: 4. Carry: 1.

	TTh	Th	H	T	O
	4	3	2	6	4
+	2	7	3	2	3
+		9	8	9	1
	8	0	4	7	8

Th: 1 + 3 + 7 + 9 = 20.
Keep: 0. Carry: 2.
TTh: 2 + 4 = 6.
Missing digit = 8 – 6 = 2.
Check: 2 + 4 + 2 = 8.

Subtraction

	L	TTh	Th	H	T	O
			9	13		
		5	~~10~~	~~3~~	11	
	3	~~6~~	~~0~~	~~4~~	~~1~~	7
–	2	1	4	6	3	2
	1	4	5	7	8	5

minuend (starting number) 3 6 0 4 1 7
– subtrahend (take away) – 2 1 4 6 3 2
difference 1 4 5 7 8 5

- Subtrahend = minuend – difference.
- Minuend = subtrahend + difference.

Use these relations to check the answer.

Filling in the missing digits in subtraction sums

	L	TTh	Th	H	T	O
	5			3	5	
–	2	6	9			6
	2	7	8	7	1	3

O: ? – 6 = 3 Top digit = 3 + 6 = 9.
T: 5 – ? = 1 Lower digit = 5 – 1 = 4.
H: 3 – ? = 7 As 3 < 7, borrow 1 Th = 10 H to make 10 + 3 = 13 H.
Then, lower digit is 13 – 7 = 6.
Th: Add back the borrowed 1 Th to the top number.
Top number = 1 + 9 + 8 = 18. This is 1 TTh and 8 Th.
TTh: Top number = 1 + 6 + 7 = 14. This is 1 L and 4 TTh.
L: Check top number. 1 + 2 + 2 = 5.

	L	TTh	Th	H	T	O
	5	4	8	3	5	9
–	2	6	9	6	4	6
	2	7	8	7	1	3

Addition and subtraction shortcuts

1. To add up to a number ending in all 0s (like 100, 2000 or 40000), find what to add to reach 1 less than the number (like 99, 1999 and 39999). Then add 1.

Examples

44 + ___?___ = 100

44 + 55 = 99. (99 – 44 = 55)
44 + 56 = 100.

389 + ___?___ = 2000

389 + 1610 = 1999.
Answer: 1610 + 1 = 1611.

1295 + ___?___ = 40000

1295 + 38704 = 39999.
Answer: 38704 + 1 = 38705.

2. To subtract a number ending in all 9s (like 89, 5999 or 99999), subtract the next higher number. Then add back 1.

Examples

357 – 89 = ___?___

357 – 90 = 267. 267 + 1 = 268.
357 – 89 = 268.

7608 – 5999 = ___?___

7608 – 6000 = 1608.
Answer: 1608 + 1 = 1609.

278639 – 99999 = ___?___

278639 – 100000 = 178639.
Answer: 178639 + 1 = 178640.

1. Fill in, as shown.

a. 37 + 162 + 1 = 200
b. 51 + ________ = 100
c. 465 + ________ = 1000
d. 708 + ________ = 3000
e. 2964 + ________ = 50000
f. 6660 + ________ = 90000
g. 658 – 89 = 568 + 1
h. 172 – 99 = ________
i. 396 – 99 = ________
j. 224 – 199 = ________
k. 2914 – 799 = ________
l. 8567 – 3999 = ________

2. See the example and fill in. 142 – ? = 99. 142 – 42 = 100. 142 – 42 – 1 = 99. 142 – 43 = 99.

a. 256 – 56 – 1 = 199
b. 175 – ________ = 99
c. 297 – ________ = 199
d. 1234 – ________ = 999
e. 968 – ________ = 799
f. 4024 – ________ = 2999

Word sums

A grocery shop held a weekend sale. It earned Rs 12,680 on Friday, Rs 21,450 on Saturday and Rs 16,905 on Sunday. Find the total amount earned.

The total amount earned is Rs 12680 + Rs 21450 + Rs 16905.
It earned Rs 51035.

$$\begin{array}{rr} & \text{Rs } 12680 \\ + & \text{Rs } 21450 \\ + & \text{Rs } 16905 \\ \hline & \text{Rs } 51035 \end{array}$$

An e-learning site uploaded 5,374 video clips this year. Last year, it had uploaded 1,395 fewer clips than this year. How many clips were uploaded at the site last year?

The number of video clips uploaded last year was 5374 – 1395.
3979 clips were uploaded last year.

$$\begin{array}{r} 5374 \\ -1395 \\ \hline 3979 \end{array}$$

11. Aarav planned a trip with his cousins. They had ₹43,000. Their parents gave them ₹8,500 more. They spent ₹21,750 on travel and ₹9,680 on food. How much money remained?

12. Lisa bought a piece of land for Rs 18 60 485 and built a house on it for Rs 29 98 700. She then sold the house for Rs 65 84 000. How much did she gain?

A game of counters

In this game, there are two piles of counters or coins. Each pile has the same number of counters. On a player's turn, the player can take any number of counters (at least one) from only one pile. The one who takes the last counter wins the game. What should you do to win?

Suppose the piles have eight counters each. Your friend starts the game and takes all the counters from one pile. If you follow the move and take all the counters from the other pile, you win!

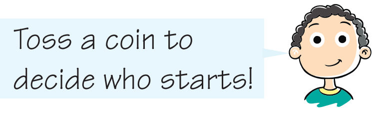
Suppose your friend starts the game and takes four counters, then three, then one counter from one pile. You are the second player. The clever thing for you to do is to become the 'follower'. You follow your friend's moves and take the same number of counters from the other pile. Since you follow your friend's moves, you will always win because you get to pick the last counter.

So, to win, you have to try to become the follower. If the piles are equal, the second player can become the follower and win by copying the first player's moves on the other pile. One who knows this trick and is the follower, will have an advantage.

Now the game changes!

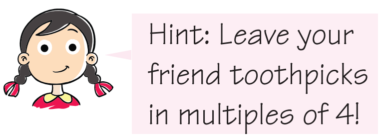
Suppose one pile has more counters than the other. The first player can win by taking the extra counters from the larger pile. The two piles will then have the same number of counters. So the game becomes a game with equal counters. After this, it is the second player's turn. That makes the first player the follower, and the follower has an advantage.

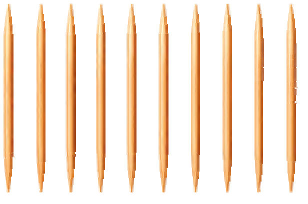
Winning rule: First make the two piles equal. Then copy the other player's move on the other pile.



A toothpick game

This is a two-player game. There are ten toothpicks arranged in a row. On each turn, a player can take one, two or three toothpicks. The player who takes the last toothpick wins. Take turns with your friend to play the game. Play four games in pairs and see who wins.





We can show 13 × 5 as:

×	10	3
5	10 × 5 50	3 × 5 15
	50 + 15 **65**	

$$\begin{array}{r} 5 \\ \times\ 1\ 3 \\ \hline 1\ 5 \\ +\ 5\ 0 \\ \hline 6\ 5 \end{array}$$

Let us see other examples.

23 × 38

23 × 38
= 20 + 3 × 30 + 8 = 20 × 30 + 8 + 3 × 30 + 8
= 20 × 30 + 20 × 8 + 3 × 30 + 3 × 8
= 600 + 160 + 90 + 24
= 874.

×	30	8
20	600 20 × 30	160 20 × 8
3	90 3 × 30	24 3 × 8
	690 600 + 90	184 160 + 24
	874 690 + 184	

$$\begin{array}{rl} 3\ 8 & 30 + 8 \\ \times\ \ 2\ 3 & 20 + 3 \\ \hline 1\ 1\ 4 & 90 + 24 \\ +\ 7\ 6\ 0 & 600 + 160 \\ \hline 8\ 7\ 4 & 690 + 184 \end{array}$$

6 × 624

6 × 624
= 6 × 600 + 20 + 4
= 6 × 600 + 6 × 20 + 6 × 4
= 3600 + 120 + 24 = 3744.

×	600	20	4
6	3600	120	24
	3744		

531 × 49

×	40	9
500	20000	4500
30	1200	270
1	40	9
	21240	4779
	26019	

Here are two more ways to show multiplication.

$$\begin{array}{rl} 4\ 8 & 40 + 8 \\ \times\ \ 2\ 3 & 20 + 3 \\ \hline 2\ 4 & 3 \times 8 \\ 1\ 2\ 0 & 3 \times 40 \\ 1\ 6\ 0 & 20 \times 8 \\ 8\ 0\ 0 & 20 \times 40 \\ \hline 1\ 1\ 0\ 4 & \end{array}$$

$$\begin{array}{rl} 4\ 8 & 40 + 8 \\ \times\ \ 2\ 3 & 20 + 3 \\ \hline 120 + 24 = 144 & 3 \times 48 \\ 800 + 160 = 960 & 20 \times 48 \\ \hline = 1104 & \end{array}$$

Multiplication by a simple number ending in zeros (like 10, 20 or 100) is also very simple.
In **27 × 4,** the simple number nearest to 27 is 30.
27 = 30 – 3. So, 4 × 27 = 4 × 30 – 3 = 4 × 30 – 4 × 3 = 120 – 12 = 108.
In **503 × 13,** the simple number nearest to 503 is 500.
503 = 500 + 3. So, 13 × 503 = 13 × 500 + 3 = 13 × 500 + 13 × 3 = 6500 + 39 = 6539.

Common multiples and factors

Let us write some multiples of 4 and 5.

First 10 multiples of 4:	**4**	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**
First 8 multiples of 5:	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**		

The first 2 common multiples of 4 and 5 are 20 and 40.

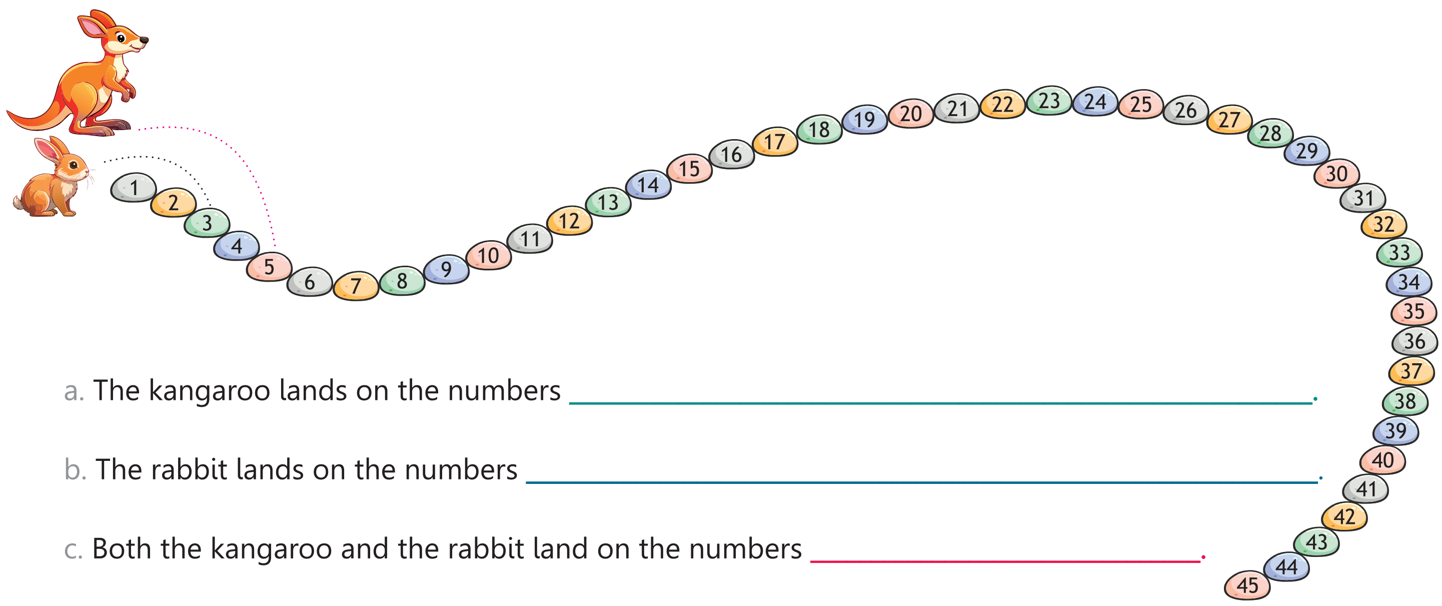
They are divisible by both 4 and 5.

The common multiples of two or more numbers are exactly divisible by each of them.

The smallest common multiple is called the lowest common multiple (LCM).

The lowest common multiple (LCM) of 4 and 5 is 20.

On a path with 45 stones, a kangaroo jumps in steps of 5, and a rabbit jumps in steps of 3. Which stones does each one reach? Which common stones do both land on? What is the first stone they both reach?



a. The kangaroo lands on the numbers ____________________.

b. The rabbit lands on the numbers ____________________.

c. Both the kangaroo and the rabbit land on the numbers ____________________.

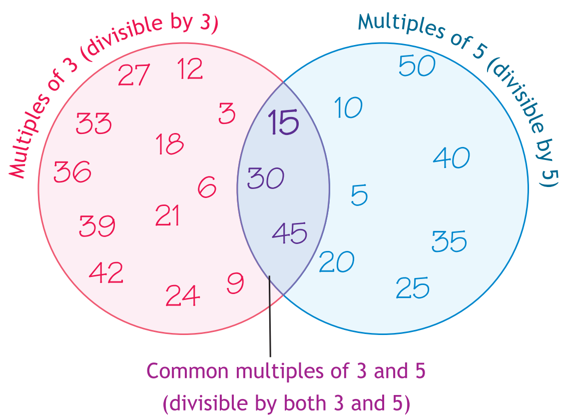
d. The first common number they both reach is ________.

The kangaroo lands on the multiples of 5.
The rabbit lands on the multiples of 3.
The multiples of 3 and 5 can be put in shapes for sorting.

The common numbers, like 15, 30 and 45, that both reach are common multiples of 3 and 5.

Their smallest common multiple is 15.

So, the first number they both reach (15) is the lowest common multiple.



11. Write T for always true, S for sometimes true and F for never true.

a. The sum of two numbers is even. ☐

b. Adding an odd number to an even number gives an even number. ☐

c. The sum of two odd numbers is even. ☐

d. Multiplication by an odd number gives an even number. ☐

e. The difference of a 2-digit number and its reverse is a multiple of 9. ☐

f. A number divisible by 5 is also divisible by 10. ☐

g. The sum of three consecutive numbers is odd. ☐

rocket maths

1. Swap numbers between the two boxes so that the sums of the boxes become equal.

A	B
6	7
+ 9	+ 8
+ 11	+ 10
+ 14	+ 23
40	48

The sums will be equal if each is exactly midway between 40 and 48, that is, 44. The sum in column A must increase by 4 and the sum in column B must decrease by 4. So, column A gets a number 4 more than the number it gives to column B. Here, 10 is 4 more than 6. So 6 and 10 interchange places. Now both columns add up to 44.

In a sum, if the sums do not match in one swap, make more swaps.

10	7
+ 9	+ 8
+ 11	+ 6
+ 14	+ 23
44	44

a.

A	B
22	28
+ ~~30~~ 34	+ ~~34~~ 30
+ ~~32~~ 35	+ ~~35~~ 32
+ 40	+ 41
~~124~~ 131	~~138~~ 131

b.

A	B
5	12
+ 16	+ 17
+ 21	+ 19
+ 8	+ 10
50	58

c.

A	B
62	65
+ 64	+ 66
+ 66	+ 68
+ 68	+ 71
260	270

d.

A	B
7	10
+ 15	+ 18
+ 24	+ 25
+ 16	+ 17
62	70

2. Fill in the grid with numbers 1–9 so that each row (left to right) and column (top to bottom) follows the given order. 'I' means increasing and 'D' means decreasing.

a.

	D	D	D
I			
I			
I			

b.

	D	D	I
D			
D			
I			

c.

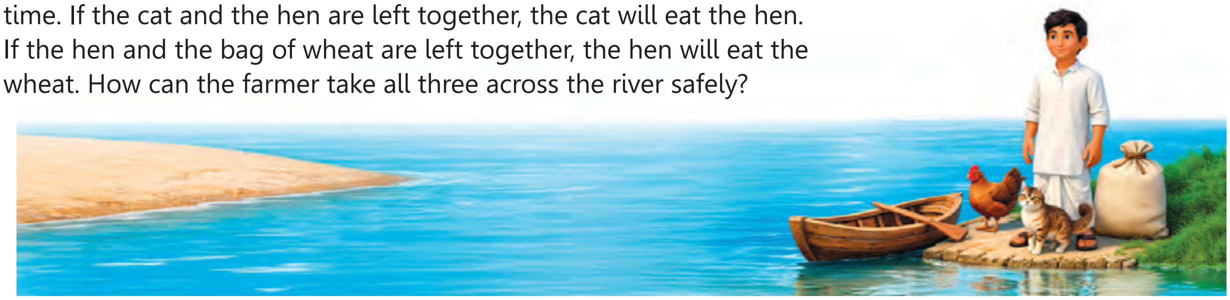
	I	D	D
I			
I			
D			

d.

	I	I	D
I			
D			
D			

Some puzzles and games

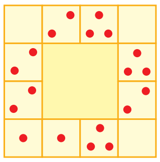
1. A farmer wants to cross a river with a cat, a hen and a bag of wheat. The boat can carry the farmer and only one other thing or animal at a time. If the cat and the hen are left together, the cat will eat the hen. If the hen and the bag of wheat are left together, the hen will eat the wheat. How can the farmer take all three across the river safely?

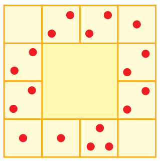


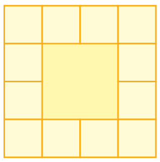
The farmer takes the hen across and comes back alone. He then takes the cat across and brings the hen back. Next, he takes the wheat across and comes back alone. Finally, he takes the hen across again.

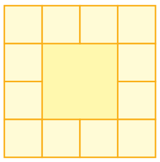
2. There are 3 jars: P holds 6 litres, Q holds 4 litres and R holds 1 litre. Jar P has water and is full. The other jars are empty. You may pour water from one jar to another. You may stop pouring only when the jar you pour from is empty or the jar you pour into is full. Can you get exactly 4 L water in Jar P and 2 L in Q?

3. A game board had 20 counters, 5 on each side. 1 counter is removed and the rest rearranged as shown. But, if you add the counters on each side you still get 5 counters! Take out another counter and rearrange so that you still get 5 along each side. Draw the next two arrangements, removing one counter each time, but keeping 5 on each side. What is the maximum number of counters you can remove?


19 counters


18 counters


17 counters


16 counters

A corner square is common to two sides, so a counter in a corner is counted twice.

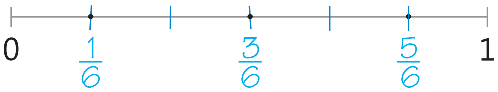
4. In a board game, you earn points using one booster card for 5 rounds. You must choose only one card. Card A starts with 6 points and your points become double after each round. Card B starts with 4 points and your points become triple after each round. Card C starts with 1 point and your points become five times after each round. Fill in the table to find which card gives the largest number of points.

	Round 0	Round 1	Round 2	Round 3	Round 4	Round 5
Card A	6	12				
Card B	4	12				
Card C	1	5				

5. A snail climbs 3 metres during the day and slips 2 metres at night. How many days will it take to climb a 10-metre wall?

2. Divide the gap between numbers into roughly equal parts. Then mark the fractions.

a. $\frac{1}{6}, \frac{3}{6}, \frac{5}{6}$



b. $\frac{1}{5}, \frac{2}{5}, \frac{3}{5}, \frac{4}{5}$

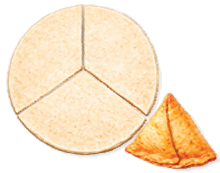
c. $\frac{4}{3}, \frac{7}{3}, \frac{8}{3}$

d. $\frac{5}{4}, \frac{7}{4}, \frac{8}{4}, \frac{10}{4}$

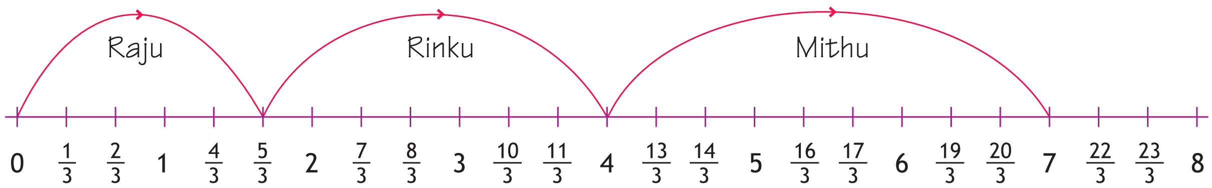
3. Raju, Rinku and Mithu are making samosas. They cut round rotis into 3 equal pieces each. Each piece is $\frac{1}{3}$ of a whole roti and makes 1 samosa. Raju made 5 Samosas. Rinku made 7 and Mithu made 9. How many rotis did each child use? How many rotis altogether?

Raju: $\underbrace{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}_{1} + \frac{1}{3} + \frac{1}{3} = 1\frac{2}{3}$

Rinku: $\underbrace{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}_{1} + \underbrace{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}_{1} + \frac{1}{3} = 2\frac{1}{3}$



Mithu: $\underbrace{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}_{1} + \underbrace{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}_{1} + \underbrace{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}_{1} = 3$



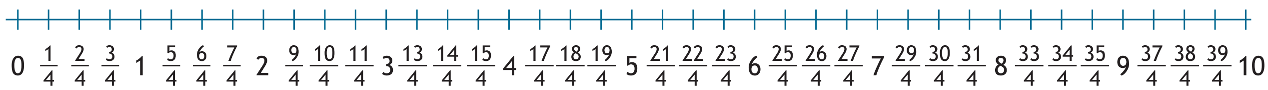
Raju used ____ rotis, Rinku used ____ rotis and Mithu used ____ rotis. They used ____ rotis altogether.

4. A class made bags to recycle old newspapers. They cut each sheet into 4 equal pieces. Each piece made 1 bag. One group of children made 14 bags. Another group made 15. The teacher made 4, and 3 pieces of paper got spoilt. How many bags did the class make? How many whole sheets did they use?

Group 1: $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} =$

Group 2: $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} =$

Teacher: $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} =$ Spoilt: $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} =$



The class made ____ bags. They used ____ whole sheets.

So, $\frac{1}{5}$, $\frac{2}{10}$, $\frac{3}{15}$, $\frac{4}{20}$ and $\frac{5}{25}$ are equivalent fractions and each is equal to $\frac{1}{5}$.

$\frac{1}{5} = \frac{2}{10}$. We can write this as $\frac{1}{5} = \frac{1 \times 2}{5 \times 2} = \frac{2}{10}$.

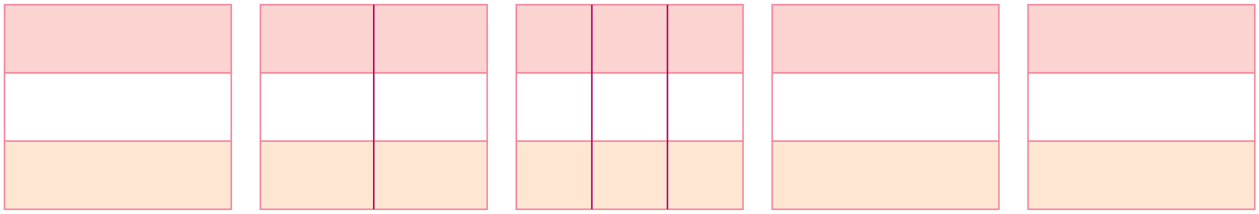
Similarly, $\frac{1}{5} = \frac{1 \times 3}{5 \times 3} = \frac{3}{15}$ $\quad \frac{1}{5} = \frac{1 \times 4}{5 \times 4} = \frac{4}{20}$ $\quad \frac{1}{5} = \frac{1 \times 5}{5 \times 5} = \frac{5}{25}$.

Also, $\frac{2}{10} = \frac{2 \div 2}{10 \div 2} = \frac{1}{5}$ $\quad \frac{3}{15} = \frac{3 \div 3}{15 \div 3} = \frac{1}{5}$ $\quad \frac{4}{20} = \frac{4 \div 4}{20 \div 4} = \frac{1}{5}$ $\quad \frac{5}{25} = \frac{5 \div 5}{25 \div 5} = \frac{1}{5}$

> *Multiplying or dividing the numerator and the denominator of a fraction by the same number (other than zero) gives an equivalent fraction.*

1. The coloured parts show fractions of the whole. Make equivalent fractions by drawing lines, as shown. Write the fractions shown and continue the pattern.

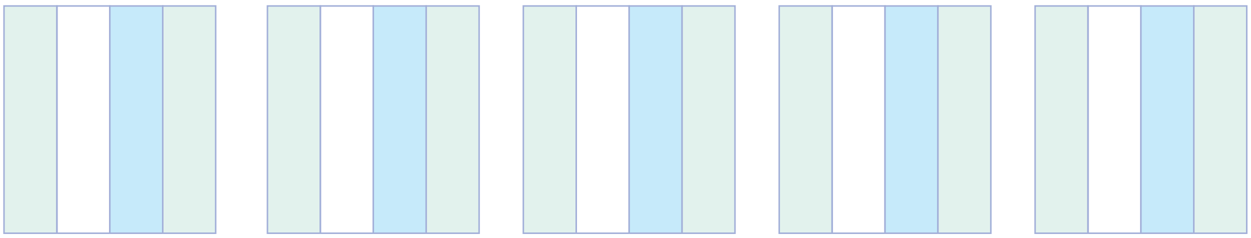
a.



$\frac{2}{3}$ $\quad$ $\frac{4}{6}$

$\frac{2}{3} = \frac{4}{6} = \frac{\ }{\ } = \frac{\ }{\ } = \frac{\ }{\ } = \frac{12}{18} = \frac{14}{21} = \frac{\ }{\ } = \frac{\ }{\ } = \frac{20}{30}$

b.



$\frac{\ }{\ } = \frac{\ }{\ } = \frac{\ }{\ } = \frac{\ }{\ } = \frac{\ }{\ } = \frac{18}{24} = \ldots = \frac{27}{36} = \frac{\ }{40} = \frac{\ }{44} = \frac{\ }{48}$

2. Fill in: a. $\frac{2}{5} = \frac{\square}{50}$ $\qquad$ b. $\frac{25}{40} = \frac{5}{\square}$

a. *As $5 \times 10 = 50$, we have to multiply the numerator also by 10.*
$2 \times 10 = 20$. So, $\frac{2}{5} = \frac{20}{50}$.

b. *As $25 \div 5 = 5$, we have to divide the denominator also by 5.*
$40 \div 5 = 8$. So, $\frac{25}{40} = \frac{5}{8}$.

Tia makes 48 rolls in 2 h. Joe makes 36 rolls in 3 h. Working together, how many rolls will they make in 2 h? How long will it take them together to make 144 rolls?

Rolls made in 1 h by Tia = 48 ÷ 2 = 24.

Rolls made in 1 h by Joe = 36 ÷ 3 = 12.

Total rolls made together in 1 h = 24 + 12 = 36.

Rolls made together in 2 h = 2 × 36 = 72.

Time taken to make 144 rolls = 144 ÷ 36 = 4 h.

A machine fills 18 bottles in 6 minutes. In 54 minutes, it takes a break of 9 minutes. How many bottles does it fill in that time?

Number of bottles filled in 1 minute = 18 ÷ 6 = 3.

Working time = 54 min – 9 min = 45 min.

Bottles filled in 45 min = 3 × 45 = 135.

Eight workers lay 384 tiles in 6 hours. How many tiles will 5 workers lay in 7 hours?

Number of tiles laid in 1 hour by 8 workers = 384 ÷ 6 = 64.

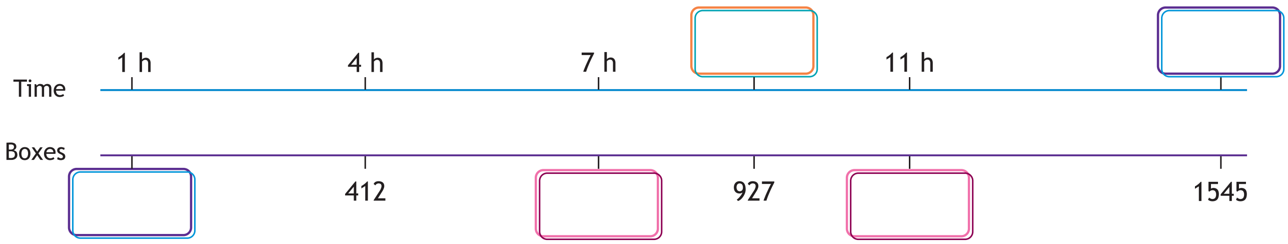
Number of tiles laid by 1 worker in 1 hour = 64 ÷ 8 = 8.

Number of tiles 5 workers will lay in 1 hour = 5 × 8 = 40. Tiles laid in 7 h = 7 × 40 = 280.

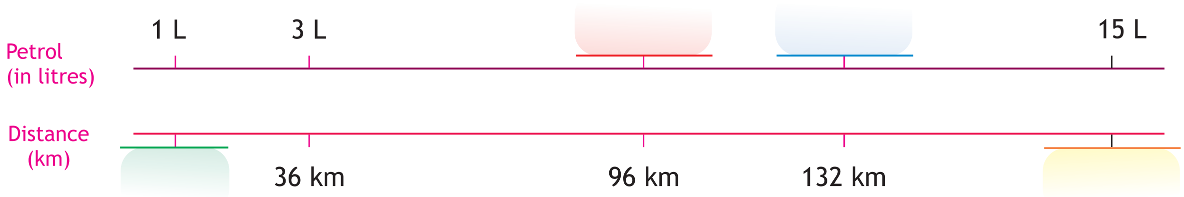
Exercise 11A

Do these sums on double number lines.

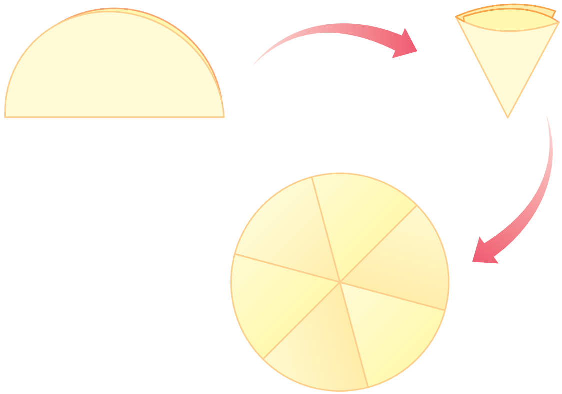
1. A machine makes a fixed number of boxes per hour. Fill in.



2. A car uses 3 L of petrol to travel 36 km. How much petrol does it need for 96 km and 132 km? How far can it travel with 15 L?



Fold a circular sheet of paper in half.
Fold it again into 3 equal parts, as shown.
Make sure the edges lie exactly on the folds.
Press the folds well. Unfold the sheet. It is now divided into 6 equal parts.

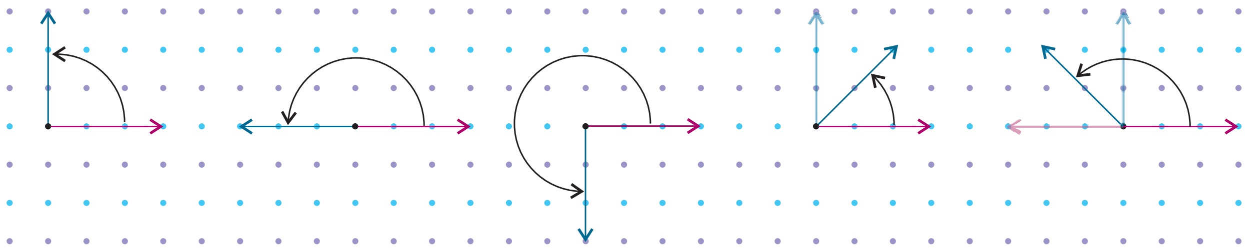


Each part shows $\frac{1}{6}$ of a full turn.
$\frac{1}{6}$ of 360° = 60°.
So, a $\frac{1}{6}$ of a full turn = 60°.

If you again fold the folded sheet into half and unfold it, you get 12 equal parts of the circle.
Each part shows $\frac{1}{12}$ of a full turn. $\frac{1}{12}$ of 360° = 30°, which is half of 60°.
So, a $\frac{1}{12}$ of a full turn = half of a $\frac{1}{6}$ turn = 30°.

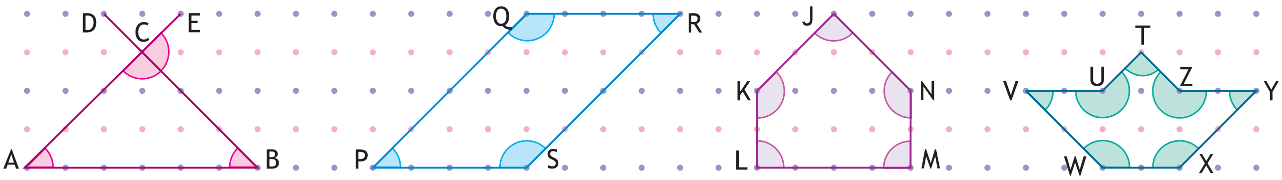
Turns on dot grids

See how we count the turns in angles drawn on a square dot grid. In this kind of grid, every dot is a corner of a square.



$\frac{1}{4}$ turn = 90° $\frac{1}{2}$ turn = 180° $\frac{3}{4}$ turn = 270° $\frac{1}{8}$ turn = 45° $\frac{3}{8}$ turn = 135°

1. Write the angles in terms of number of turns. Choose from the given options.



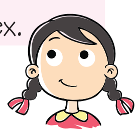
a. ∠ABC = ∠BAC = ___ turn. ∠BCA = ∠BCE = ___ turn. [$\frac{1}{8}$ $\frac{1}{4}$]

b. ∠QPS = ∠QRS = ___ turn. ∠PQR = ∠PSR = ___ turn. [$\frac{3}{8}$ $\frac{1}{8}$]

c. ∠L =∠M = ∠J = ___ turn. ∠K = ∠N = ___ turn. [$\frac{1}{8}$ $\frac{1}{4}$ $\frac{3}{8}$]

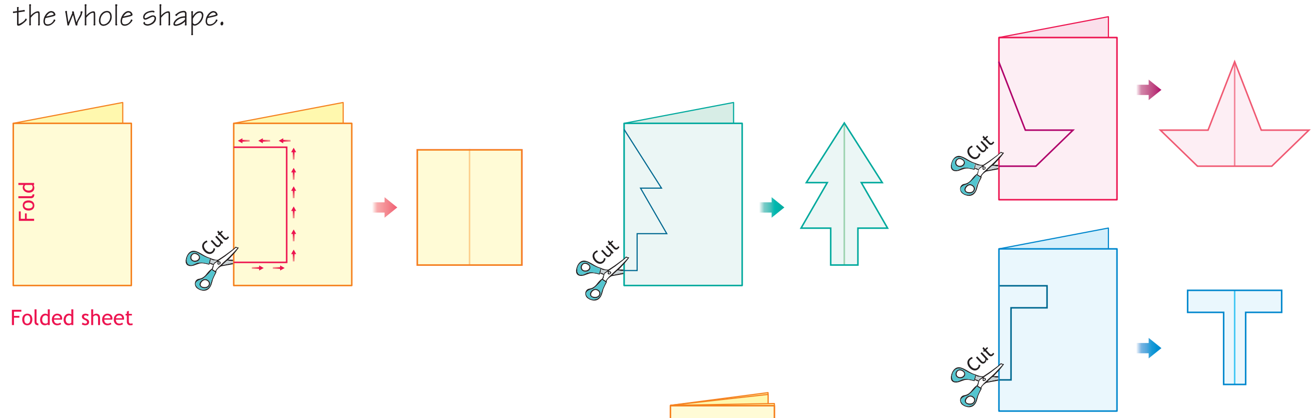
d. ∠T = ___ , ∠V = ∠Y = ___ , ∠W = ∠X = ___ , ∠U = ∠Z = ___ turn. [$\frac{1}{8}$ $\frac{1}{4}$ $\frac{3}{8}$ $\frac{5}{8}$]

An angle name in short is the name of its vertex.

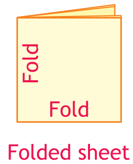


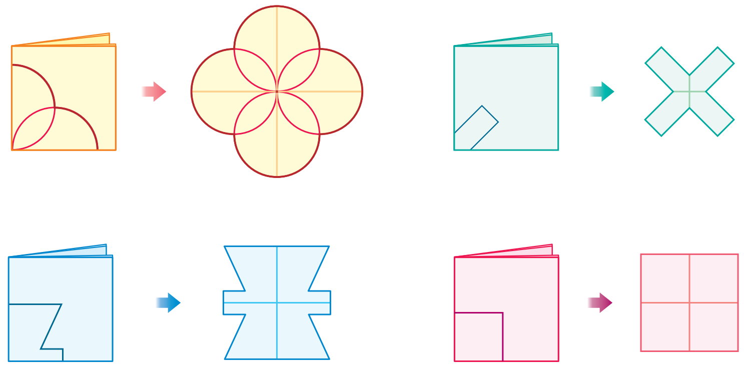
We can easily make cutouts of symmetrical shapes with folded paper.

For shapes with one line of symmetry, we fold a sheet of paper in half. We draw one half of the shape touching the folded edge and cut along the outline. When we unfold the cutout, we get the whole shape.

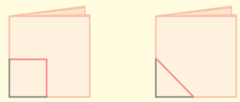


For shapes with two lines of symmetry, we may fold the sheet in half or in quarters. If we fold in quarters, we draw only a quarter of the shape.

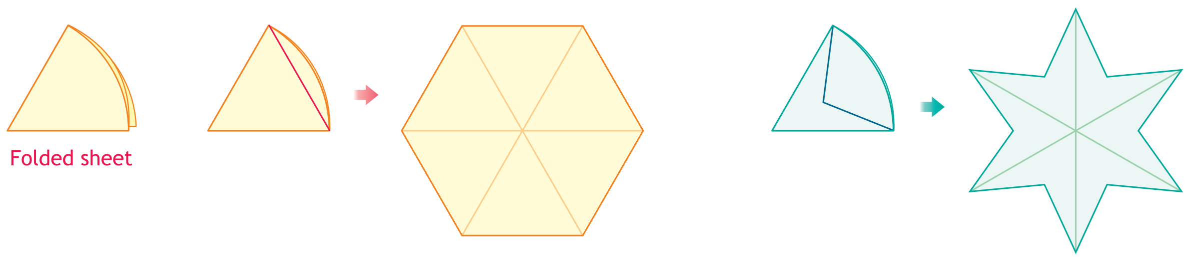




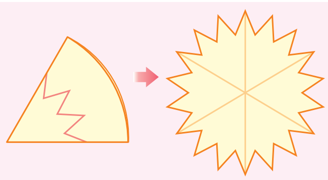
For a square, either of these will do, but the parts of the folded edges shown in grey must be equal.



For shapes with six lines of symmetry, like a hexagon, it is often easier to fold a circular paper into six equal parts. We draw only one sixth of the shape.

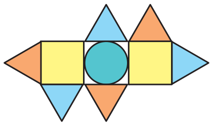


For shapes with many lines of symmetry, folding a circular paper into 6 equal parts and drawing one sixth of the shape usually works.

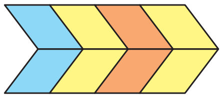


Symmetry in designs

A design is made by putting together units in a certain way. A design may or may not be symmetrical. A design made up of symmetrical units is not always symmetrical. And a design may be symmetrical even if its units are not.



Each unit has reflection symmetry and rotational symmetry, but the design has neither.



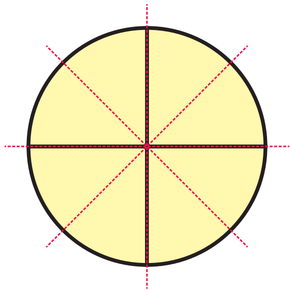
The design has only reflection symmetry, but the unit has only rotational symmetry.

Explore

Symmetry in coloured designs

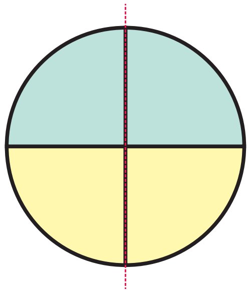
Coloured designs need matching colours or patterns for symmetry.

A design has symmetry when folding it makes both sides match or turning it makes it look the same, including colour.

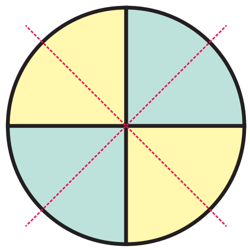


The design on the right has countless lines of reflection symmetry and rotational symmetry at all positions. No colour matching is needed.

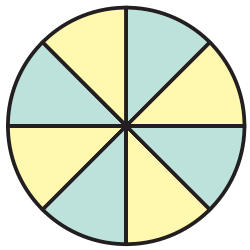
If we colour the same design in two colours, the lines of reflection symmetry or the positions of rotational symmetry or both may change. Because, we now need to match colours for symmetry.



Only 1 line of reflection symmetry, no rotational symmetry

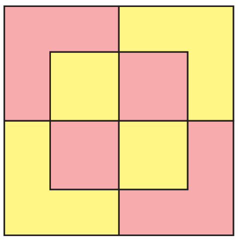


Only 2 lines of reflection symmetry, rotational symmetry only at $\frac{1}{2}$ turn



No reflection symmetry, rotational symmetry at $\frac{1}{4}$ turn, $\frac{1}{2}$ turn and $\frac{3}{4}$ turn

1. Fill in the blanks with the correct option.



a. Does this design have reflection symmetry? _______ [Yes/No]

b. This design has ____ lines of reflection symmetry. [0/2/4]

c. Does this design have rotational symmetry at $\frac{1}{4}$ turn? _______ [Yes/No]

d. Does this design have rotational symmetry at $\frac{1}{2}$ turn? _______ [Yes/No]

e. This design looks the same at ____ position(s) during a full turn. [0/1/2/3]

Here is the code for a pattern that has more detail than the patterns we have done.

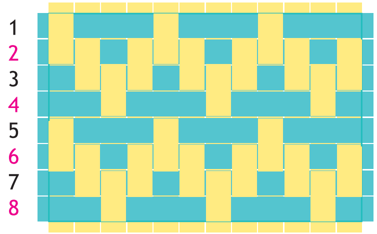
Row 1: U OOO U OOO U OOO ...

Row 2: UU O UUU O UUU O ...

Row 3: O UUU O UUU O UUU ...

Row 4: OO U OOO U OOO U ...

Repeat from Row 1 to Row 4.



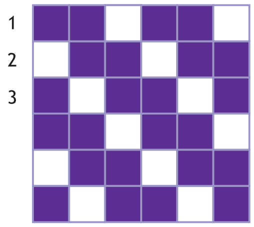
Here is a weaving design. Let us use the code C for colour and B for blank/white. The code for the first row is given. Can you write the codes for the other rows?

Row 1: CC B CC B

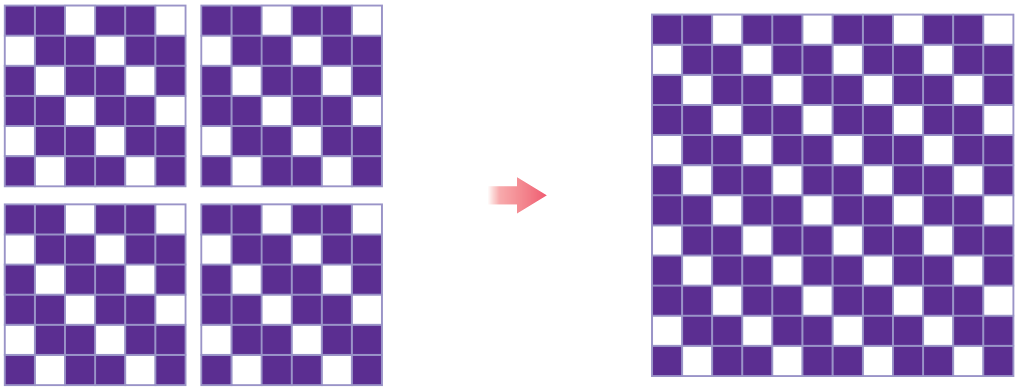
Row 2: ______________________________

Row 3: ______________________________

Repeat from Row 1 to Row 3.



If we repeat this tile, this is the design we get:



The code below will give a pattern in green and white. It uses the code C for colour and B for blank/white. Some rows have been done for you. Colour the remaining rows according to the code and see what pattern you get.

Row 1: CC B CCCCC B CCC

Row 2: C B C B CCC B C B CC

Row 3: B CCC B C B CCC B C

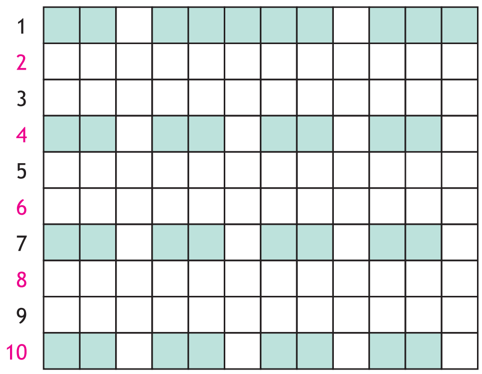
Row 4: CC B CC B CC B CC B

Row 5: Same as Row 3

Row 6: Same as Row 2

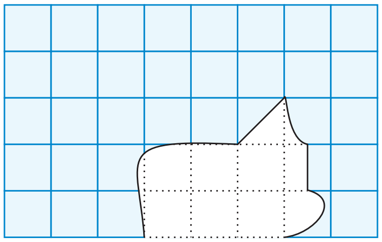
Row 7: Same as Row 4

Repeat Rows 2, 3 and 4



Estimating shapes

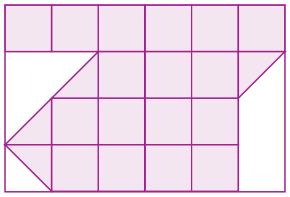
Look at the rectangle below. How many squares are missing from it?

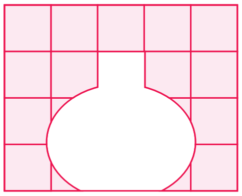


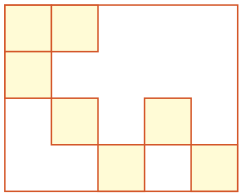
1. Imagine or draw the lines of the grid to fill the empty part. Count the number of squares formed. These are the whole squares missing.
2. Count missing half-square pairs. 2 missing half squares make 1. Only 1 half square or less than a half square counts 0.
3. Count more than half missing as 1.

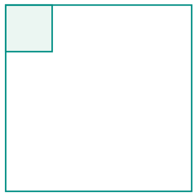
Answer: Missing squares = $\underbrace{6}_{1} + \underbrace{1}_{2} + \underbrace{1}_{3} = 8$ roughly

1. Roughly, how many squares will you add to fill the given rectangle? Estimate.

a. 

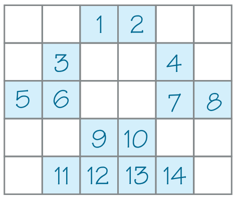
b. 

c. 

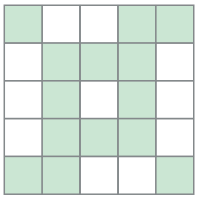
d. 

Exercise 15C

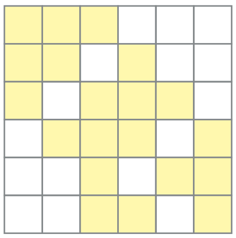
1. If the side of each small square is 1 cm, find the area of the shaded part.

a. 

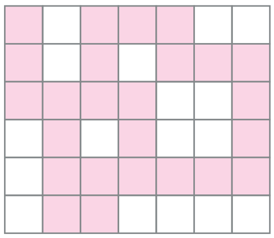
Area = 14 sq cm

b. 

Area = ________

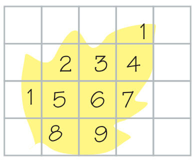
c. 

Area = ________

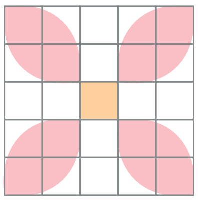
d. 

Area = ________

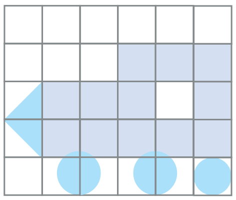
2. Each small square has a side length of 1 cm. Estimate the area of the shaded part. Count a square if more than half of it is shaded. If about half of a square is shaded, pair it with another half to make 1. If less than half is shaded, do not count it.

a. 

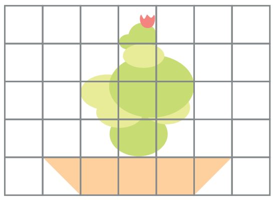
Area = about ________

b. 

Area = about ________

c. 

Area = about ________

d. 

Area = about ________

5. Use the bus-route map to fill these in.

a. To reach Science Museum, Molly gets on Bus ______ at Grand Mall. She changes to Bus ______ at ___________________.

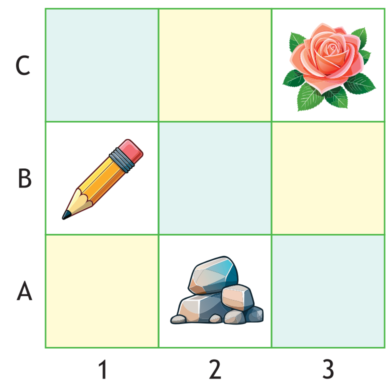
b. Ali wants to reach Hind Fort from Court. He gets off at ___________________, then rides Bus ______.

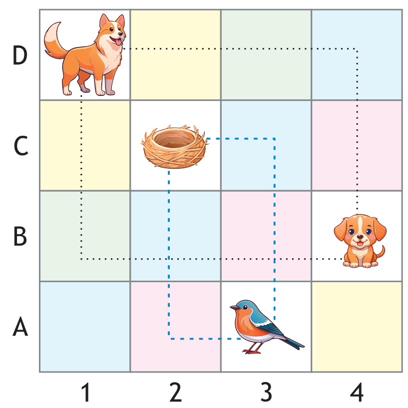
c. Jane takes Bus 45 from Airport. She must change at ___________________ to reach City School. If she takes Bus 39 from Airport, she has to change at ___________________.

d. To reach Library from Clock Tower, Rajan rides Bus 39, gets off at ___________________, takes Bus ________, again gets off at ___________________, then takes Bus ___________. A shorter route is to ride Bus ___________ from Clock Tower and change at ___________________ to reach Library.

Positions in a grid

A grid has boxes arranged in rows and columns. Each box is called a cell. We tell the position of a cell by its row and column. We can name rows with letters and columns with numbers. In the grid shown, the flower is at C3, the stones are at A2 and the pencil is at B1.





We can move from one cell to another in a grid. We move one cell at a time—up, down, left or right. Each move is a step. For example, these are two ways the dog can reach its puppy in the fewest steps (5 steps):

3 steps right and 2 steps down
2 steps down and 3 steps right

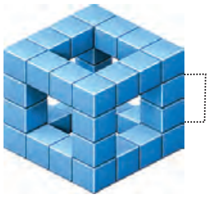
We can also write the steps by writing the cell names in the order we move. Here, the bird is at A3 and its nest is at C2. To reach its nest, the bird can take these two paths:

A3 B3 C3 C2

A3 A2 B2 C2

How many cubes in each? Here is one way to find.

Cubes in each layer = 4 × 4 = 16.
Total cubes in 4 layers
= 4 × 16 = 64.



Missing cubes in the centre = 4 cubes per layer × 4 layers = 16.
Missing cubes on the 4 sides = 4 cubes per side × 4 sides = 16.
Total cubes = total - missing = 64 - (16 + 16) = 32.
OR Cubes top and bottom + 'pillars' = 2 × 12 + 4 × 2 = 32.

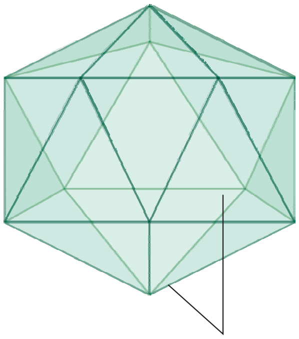
If hollow, 32 cubes.
4 cubes come in.
Total cubes =
32 + 4 = 36.

Icosahedron

An icosahedron is a polyhedron with 20 faces. All the faces are equilateral triangles of the same size. So, all the faces look the same. In an icosahedron, 5 faces meet at each vertex.

Each triangular face has 3 edges.
So we should have 20 × 3 = 60 edges in all.
Here, each edge is common to two triangles.
So, the number of edges is 60 ÷ 2 = 30.

Number of vertices for 20 triangles = 20 × 3 = 60.
But each vertex is common to 5 triangles.
So, the number of vertices is 60 ÷ 5 = 12.

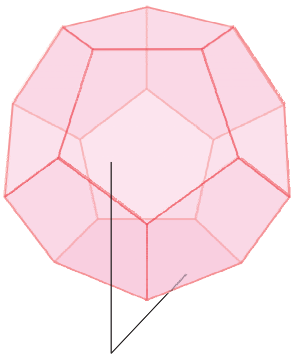


Each face is an equilateral triangle.

Viruses are germs that can make us sick. Viruses may have an icosahedron shape. This shape is very strong. It helps a virus protect the parts inside it. Many viruses have this twenty-sided shape, including some viruses that cause the common cold.

Dodecahedron

A polyhedron with 12 faces is called a dodecahedron. All the faces are regular pentagons of the same size. So, all the faces look the same. In a dodecahedron, 3 faces meet at each vertex.



Each face is a regular pentagon.

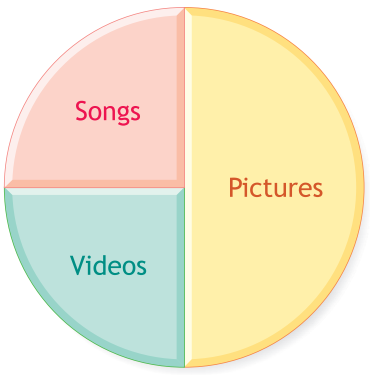
Each pentagonal face has 5 edges.
12 faces have 12 × 5 = 60 edges.
Here, each edge is common to two pentagons.
So the number of edges is 60 ÷ 2 = 30.

Each pentagon has 5 vertices.
12 pentagons have 60 vertices.
But each vertex here is shared by 3 pentagons.
So the number of vertices is 60 ÷ 3 = 20.

Pie chart

A pie chart is a circular chart. It is divided into slices that show parts of the total number. Bigger slices mean bigger parts of the whole.

Sai made this pie chart to show the different kinds of files in a computer folder. The folder has 100 files.



Pie chart

In the folder:

a. 50 files are picture files.

The fraction of the files that are picture files

$= \frac{50}{100} = \frac{50 \div 50}{100 \div 50} = \frac{1}{2}$.   Also, $\frac{50}{100}$ is 50%.

So, half of the files, or 50%, are picture files.

b. 25 files are song files.

The fraction of the files that are song files

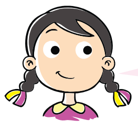
$= \frac{25}{100} = \frac{25 \div 25}{100 \div 25} = \frac{1}{4}$.   Also, $\frac{25}{100}$ is 25%.

So, one fourth, or 25%, of the files are song files.

c. 25 files are videos.

The fraction of the files that are videos $= \frac{1}{4}$.

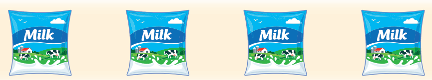
So, a quarter (25%) of the files are video files.



If we know the total number and the fractions, we can find the number shown by each part. Here, $\frac{1}{2}$ of 100 = 50 and $\frac{1}{4}$ of 100 = 25.

Exercise 17A

1. The chart shows the number of milk packets delivered to four housing colonies in a day. Fill in the blanks in the table. Then, answer the questions that follow.

Colony	Milk packets delivered		
A		______	 = 35
B		______	
C		______	
D		______	