

Ages 12–13 · Maths

LESSON SLIDES

Integers

Maths · Number line, the four operations and key properties

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Integers

SPEAKER NOTES

Ask the class: which floor is below the ground floor in a mall, and what number would you give it? Collect answers such as B1 or minus one. Tell students that today we learn how such numbers behave when we add, subtract, multiply and divide them.

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By the end of this lesson you can

- 🎯 Show and compare integers on a number line
- 🎯 Add and subtract integers without sign errors
- 🎯 Multiply and divide integers using sign rules
- 🎯 Use the properties of integer operations
- 🎯 Solve problems on lifts, temperature and money

By the end of this lesson you can

SPEAKER NOTES

Read the objectives aloud. Tell students there is a five-question quiz at the end, so they should note one rule from each part of the lesson.

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What are integers?

- Integers: ..., -3, -2, -1, 0, 1, 2, 3, ...
- Positive integers are greater than 0
- Negative integers are less than 0
- Zero is neither positive nor negative
- 2.5 and $\frac{1}{2}$ are not integers



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What are integers?

SPEAKER NOTES

Write the list on the board with dots on both sides to show it never ends. Ask: is -0 different from 0? A common mistake is to think fractions such as $-\frac{1}{2}$ are integers; they are not.

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Integers in daily life

- Lift: ground floor is 0, first basement is -1
- Temperature: 5°C below zero is -5°C
- Money: a debt of USD 200 is -200
- Height: 50 m below sea level is -50 m

Integers in daily life

SPEAKER NOTES

Ask students for one more situation where a negative number makes sense, such as a loss in a shop. Point out that every example has a natural zero: ground floor, freezing point, no money owed, sea level. In $^{\circ}\text{F}$ classrooms, use the same idea: -5°F is colder than 5°F .

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Comparing integers on a number line

- Values increase as you move right
- $-2 > -5$, because -2 lies to the right
- Every negative integer is less than 0
- Every positive integer is greater than every negative

Comparing integers on a number line

SPEAKER NOTES

Draw a number line from -6 to 6 . Ask: which is colder, -2°C or -5°C ? Many students say -2 is smaller because 2 is smaller than 5 ; the temperature question fixes this misconception quickly.

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Adding integers: think of a lift

- Add a positive: move up, to the right
- Add a negative: move down, to the left
- Floor 2 + $(-3) = -1$, one level below ground
- $(-4) + (-3) = -7$ and $6 + (-8) = -2$

Adding integers: think of a lift

SPEAKER NOTES

Act it out with a vertical number line drawn like a lift shaft. Ask a student to start at floor 2 and press minus 3. Stress that adding a negative number gives a smaller result.

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Two rules for adding integers

Same signs

- Add the sizes
- Keep the common sign
- $(-4) + (-3) = -7$
- $5 + 2 = 7$

Different signs

- Subtract the smaller size from the larger
- Keep the sign of the larger size
- $(-8) + 5 = -3$
- $9 + (-4) = 5$

Two rules for adding integers

SPEAKER NOTES

Size means the value without its sign (the absolute value). Ask students to copy both rules into a box in their notebooks. Check with the number line: from -8 , move 5 steps right and you land on -3 .

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Subtracting integers: add the opposite

- The additive inverse of 7 is -7 , and of -7 is 7
- $a - b$ means $a + (\text{inverse of } b)$
- $5 - (-3) = 5 + 3 = 8$
- $(-2) - 4 = (-2) + (-4) = -6$
- From $3\text{ }^{\circ}\text{C}$ to $-4\text{ }^{\circ}\text{C}$: $(-4) - 3 = -7\text{ }^{\circ}\text{C}$ change

Subtracting integers: add the opposite

SPEAKER NOTES

Repeat the phrase: subtracting means adding the opposite. Ask: why does $5 - (-3)$ give more than 5? Taking away a debt of 3 leaves you better off by 3. The temperature change is final minus initial.

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Multiplying integers: spot the pattern

- $3 \times (-4) = -12$ and $2 \times (-4) = -8$
- $1 \times (-4) = -4$ and $0 \times (-4) = 0$
- Each step adds 4, so $(-1) \times (-4) = 4$
- A negative multiplier reverses the direction

Multiplying integers: spot the pattern

SPEAKER NOTES

Build the table on the board and let students predict the next line before you write it. Ask: what is $(-2) \times (-4)$? The pattern gives 8. A frequent mistake is to use the addition rule, giving -8 .

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Sign rules for $\times$ and $\div$

Same signs: positive

- $(+) \times (+) = (+)$
- $(-) \times (-) = (+)$
- $(-6) \times (-5) = 30$
- $(-100) \div (-4) = 25$

Different signs: negative

- $(+) \times (-) = (-)$
- $(-) \times (+) = (-)$
- $7 \times (-3) = -21$
- $(-100) \div 25 = -4$

Sign rules for $\times$ and $\div$

SPEAKER NOTES

Stress that the same rules work for division because division undoes multiplication. Ask: what is the sign of $(-2) \times (-3) \times (-4)$? Three negatives give a negative answer, -24 .

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Dividing integers

- Division undoes multiplication
- $(-100) \div 25$ asks: $25 \times ? = -100$, so -4
- $(-48) \div 6 = -8$ and $(-48) \div (-6) = 8$
- Division by zero is not defined

Dividing integers

SPEAKER NOTES

Turn each division into a missing-number multiplication. Ask: what is $0 \div (-5)$? It is 0. Then ask why $(-5) \div 0$ has no answer: no number times 0 gives -5 .

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Early rules for negative numbers

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CE: Brahmagupta wrote rules for multiplying and dividing negatives

- He called positive numbers fortunes and negative numbers debts
- Product of two debts is a fortune: $(-) \times (-) = (+)$

Early rules for negative numbers

SPEAKER NOTES

Brahmagupta, an Indian mathematician and astronomer, set out these rules in his Brahmasphutasiddhanta, written in 628 CE. Ask students to restate his rule for a debt times a fortune; the answer is a debt, a negative number.

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Properties of integer operations

- Closure: $+$, $-$ and $\times$ of integers give an integer
- Not closed under $\div$: $(-7) \div 2 = -3.5$
- Commutative: order does not change $+$ or $\times$
- Associative: grouping does not change $+$ or $\times$
- Subtraction is neither: $5 - 3 \neq 3 - 5$

Properties of integer operations

SPEAKER NOTES

Test each property with small numbers on the board, such as $(-2) + 5$ and $5 + (-2)$. Ask students to find one example that shows subtraction is not associative, for instance $(8 - 5) - 2$ and $8 - (5 - 2)$.

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Distributive property and identities

- $a \times (b + c) = a \times b + a \times c$
- $(-2) \times (4 + (-3)) = -8 + 6 = -2$
- 0 is the additive identity: $a + 0 = a$
- 1 is the multiplicative identity: $a \times 1 = a$

Distributive property and identities

SPEAKER NOTES

Show that both sides of the distributive example give -2 . Ask: how does the property help with $99 \times (-5)$? Write it as $100 \times (-5) - 1 \times (-5) = -500 + 5 = -495$.

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 Example

Negative marking in a test

- 1 A test gives +4 per correct answer and –1 per wrong one
- 2 Priya answers 18 correctly and 7 wrongly
- 3 Marks = $18 \times 4 + 7 \times (-1)$
- 4 = $72 + (-7) = 65$ marks

Negative marking in a test

SPEAKER NOTES

Many multiple-choice tests and competitions use negative marking, so this example feels real. Ask: how many marks would Priya lose if she guessed 10 more questions wrongly? Each wrong answer adds –1, so $10 \times (-1) = -10$.

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 Quick check

A cold-storage room is at 6 °C. It is cooled by 3 °C every hour. What is its temperature after 4 hours?

A -12 °C

B -6 °C

C 6 °C

D 18 °C

Quick check

SPEAKER NOTES

Answer: B, -6 °C. The change is $4 \times (-3) = -12$, and $6 + (-12) = -6$. Students who pick -12 °C forgot the starting temperature.

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Key takeaways

- ✓ Integers are whole numbers, their negatives and zero
- ✓ On a number line, values increase to the right
- ✓ To subtract, add the opposite
- ✓ $\times$ and $\div$: same signs positive, different signs negative
- ✓ $+$ and $\times$ are commutative and associative

Key takeaways

SPEAKER NOTES

Recap one rule per bullet with a quick oral example. Then move to the five-question quiz on the page and set practice questions on integer operations.