# Addition of integers using vectors

In this activity, students are introduced to vectors and how to represent them using a number line. Students learn to add integers using vectors and model this on a number line.

## Visible learning

### Learning intentions

* To be able to add positive and negative integers.

### Success criteria

* I can represent a number as a vector on a number line.
* I can represent addition of positive integers using vectors on a number line.
* I can represent addition of positive and negative integers using vectors on a number line.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* compares, orders and calculates with integers to solve problems **MA4-INT-C-01**

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## Activity structure

### Launch

This game should be played outside with space for students to walk forwards and backwards.

1. Explain the rules of ‘Teacher says’:
2. If the teacher gives an instruction that starts with ‘Teacher says…’ then you must obey that instruction.
3. If the teacher gives an instruction that doesn’t start with ‘Teacher says…’ then you must do the inverse of the instruction.
4. If you make a mistake, you are out. The last person left is the winner.
5. For example, if the teacher says, ‘Walk 5 steps forward’, they did not say ‘Teacher says’ and so the students should walk 5 steps backwards, which is the inverse.

The instructions given in this game should target several outcomes, including:

* Building students’ confidence with vector representation by giving instructions that have a direction and magnitude.
* Establishing subtraction as the inverse of addition, rather than its own separate operation.
* Establishing that the inverse of subtraction is addition.

1. Play 2 rounds of the game, before returning inside. A sample set of instructions is provided below:
2. ‘Teacher says walk forward 3 steps.’
3. ‘Teacher says walk backwards 3 steps.’
4. ‘Walk forward 5 steps.’
5. ‘Teacher says walk forward 5 steps.’
6. ‘Walk backwards 2 steps.’
7. ‘Teacher says walk forward 2 steps.’
8. ‘Teacher says walk backwards 10 steps.’

More complicated instructions could be given to make the game more challenging. Some examples are provided below:

* Teacher says walk forwards half a step.
* Teacher says walk forward half as many steps as you just walked backwards.
* Walk 3 times as many steps backwards as you just walked forward.

1. Ask students to represent the instructions ‘Teacher says walk forward 3 steps’ and ‘Walk forward 5 steps’ in any way they choose.
2. Use a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)) for students to compare their representations and discuss the benefits of each representation.
3. Use a Pose-Pause-Pounce-Bounce question strategy ([PDF 200KB] [bit.ly/pausepouncebounce](https://bit.ly/pausepouncebounce)) to enable the sharing of student strategies.
4. Use the slides 2–6 from the Addition of integers using vectors PowerPoint to introduce vectors. These slides define vectors and give examples of how to draw vectors.
5. Compare the use of vectors with the strategies that students used.
6. Ask students to re-draw each scenario using the vector representation.

### Explore

This activity requires students to have access to a device per pair of students. An alternative is provided if this is not possible.

1. Assign students the Desmos activity ‘Adding Integers’ <https://bit.ly/DesmosAddingIntegers>
2. Students will work through the activity which introduces them to adding integers using a vector representation.

For information on how to assign and use Desmos classroom activities, visit the website ‘Getting started: Classroom activities’ (<https://bit.ly/ClassroomActivitiesHelp>)

1. Alternatively, or additionally, use slides 7–14 from the Addition of integers using vectors PowerPoint to progress students from drawing vectors to adding vectors.

The explicit teaching technique used in the PowerPoint from slide 7–14 is ‘Your turn’. The first slide is a worked example which should be displayed for the students and then use the following steps.

1. Reveal the question to the students and its solution.
2. Students read in silence.
3. Students individually think and explain to themselves what is happening in each step.
4. Students hold up a thumbs up to the teacher when they have finished reading and have some sort of understanding.
5. Think-Pair-Share. Students explain the solution to their partner.
6. In pairs students then answer the self-explanation questions.
7. Finally, randomly select students to share their answers with the whole class, using a technique such Pose-Pause-Pounce-Bounce question strategy [PDF 119KB] ([bit.ly/pausepouncebounce](https://bit.ly/pausepouncebounce)).

### Summarise

Students are to write notes to their future forgetful self ([bit.ly/notesstrategy](https://bit.ly/notesstrategy)). The notes should model the examples in the Desmos activity and PowerPoint. Some examples the students may like to use to ensure they have covered all possibilities are listed below.

* 4 + 7
* 3 - 7
* -5 - 8
* -10 + 3

### Apply

Students will be using vectors to recognise patterns and make generalised statements about adding and subtracting 2 numbers, when one is bigger than the other.

The use of R and B to represent 2 different red and blue vectors is an introduction to pronumerals.

1. Ask students to draw:
2. A red vector, labelled R, starting from the centre and pointing in the positive direction.
3. A blue vector, labelled B, starting from the centre and pointing in the positive direction. It should be longer than R.
4. Using their red and blue vectors, ask students to draw a vector diagram representing the expressions in Appendix A ‘B is bigger than R’.
5. For each expression, students should comment whether the answer will be a positive or negative number.
6. In visibly random ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) groups of 3, ask the students to compare their answers. What do they notice, what do they wonder? Prompt students to notice the different sizes of each person's vectors and how it effects the outcome.
7. Ask students to repeat steps 1–3 above using Appendix B ‘B is smaller than R’
8. Ask students to compare their results from Appendix A and B. Did each expression give the same result? Consider the conditions under which the results would be the same and when they would be different.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* Teachers could include fractions and decimals in their instructions. For example, walk forward half a step.

**Explore**

* Students can test their theories by entering numbers into the Desmos activities and observing the results.
* Challenge students to consider using decimals in their solutions.

**Summarise**

* **The examples given to students can vary depending on student understanding of vectors and integers.**

**Apply**

* **Instead of using R and B the teacher could provide the students with actual lengths.**

### Suggested opportunities for assessment

**Explore**

* Teachers can use the Desmos teacher dashboard to monitor student progress and their understanding.

**Summarise**

* The teacher could collect the students’ notes to future self and use as formative assessment for this section of the topic.

**Apply**

* Teachers could ask students to explain and justify the conclusions reach.

## Appendix A

### B is bigger than R

1. On the number line below, draw:
2. A red vector, labelled R, starting from the centre and pointing in the positive direction.
3. A blue vector, labelled B, starting from zero and pointing in the positive direction. It should be longer than R.

Number line with the half way point marked.

|  |  |  |
| --- | --- | --- |
| Expression | Vector diagram | Is the answer positive or negative |
| R + B | Number line with the half way point marked. |  |
| R - B | **Number line with the half way point marked.** |  |
| B - R | **Number line with the half way point marked.** |  |
| B + R | **Number line with the half way point marked.** |  |
| R + (- B) | **Number line with the half way point marked.** |  |

## Appendix B

### B is smaller than R

1. On the number line below, draw
2. A red vector, labelled R, starting from the centre and pointing in the positive direction.
3. A blue vector, labelled B, starting from zero and pointing in the positive direction. It should be shorter than R.

Number line with the half way point marked.

|  |  |  |
| --- | --- | --- |
| Expression | Vector diagram | Is the answer positive or negative |
| R + B | Number line with the half way point marked. |  |
| R - B | Number line with the half way point marked. |  |
| B - R | Number line with the half way point marked. |  |
| B + R | Number line with the half way point marked. |  |
| R + (- B) | Number line with the half way point marked. |  |

## References

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