# Subtraction of integers using vectors

In this activity, students learn to subtract both positive and negative integers using vectors on a number line.

## Visible learning

### Learning intention

* To be able to subtract positive and negative integers using vectors.

### Success criteria

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

1. Take students outside and play the ‘Walk the plank’ game with students (<https://mathematicscentre.com/taskcentre/131walkp.htm>)
2. Bring students back inside and question students about how this game relates to integer addition and subtraction.

Students should identify that walking forwards is equivalent to a positive number and walking backwards is equivalent to a negative number.

Facing the ship is equivalent to addition and facing the shark is equivalent to subtraction.

1. Roll the dice again and challenge students to write addition and subtraction sums from the numbers on the dice.

### Explore

Students will require a device per pair of students. Alternatively, students can use a physical number line and ‘walk’ their fingers forwards and backwards along the number line.

1. Ask students to visit the website ‘Directed Number’ ([[bit.ly/DirectedNumbers](https://bit.ly/DirectedNumbers)](https://bit.ly/DirectedNumbers)). Students select the + and − radio buttons to change between addition and subtraction and use the sliders to adjust the numbers in each sum.
2. Distribute Appendix A ‘Walking Stefan’ to each student.
3. Ask students to model each question using the website and record Stefan’s movements in words. An example has been provided for students to follow.
4. Challenge students to see if Stefan could walk in a different way but still start and end in the same place, for each question.

This question is designed to get students to realise that facing backwards and walking backwards is the same as facing forwards and walking forwards.

1. Using a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)) ask students to record what they have noticed during the activity.
2. Randomly choose pairs of students to share their thoughts.

### Summarise

1. Use slides 2–13 of the *Subtraction of integers using vectors* PowerPoint for the explicit teaching of using vectors to subtract directed numbers.

The explicit teaching technique used in the associated PowerPoint 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 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 as Pose-Pause-Pounce-Bounce teaching strategy ([bit.ly/pausepouncebounce](https://bit.ly/pausepouncebounce)).
8. Students are to write notes to their future forgetful selves ([bit.ly/notesstrategy](https://bit.ly/notesstrategy)). The notes should model the examples in the PowerPoint. Some examples the students may like to use to ensure they have covered all possibilities are listed below.
9. 5 – (−2)
10. -8 – (−4)

If students have previously been shown how to use counters to model the addition and subtraction of directed numbers, teachers may like to ask students to compare both methods.

The vector representation allows for the addition and subtraction of fractions and decimals, whereas counters work best with discrete quantities.

### Apply

In this activity students represent as many different expressions as possible on number lines using vectors. The aim is for students to use vectors to recognise which expressions equate to the same value.

1. Give students the Appendix B ‘Cards for apply*’* and ask them to cut out each square.
2. Students will work in visibly random groups of 3 ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) at vertical non-permanent surfaces ([bit.ly/VNPSstrategy](https://bit.ly/VNPSstrategy)).
3. Ask one student to write their birth date and month on the appropriate cards. For example, if my birthday was 25 July, I would use 25 as my birth date and 7 as the month.
4. Using only 2 addition symbols, 2 subtraction symbols and the 2 numbers, students are to create as many expressions as possible. Students can use the symbols as either addition and subtraction symbols or to make the numbers positive or negative.
5. Students should draw vector diagrams for each expression.
6. Ask students to group the expressions that have the same answer.
7. Ask students to do a gallery walk ([bit.ly/DLSgallerywalk](https://bit.ly/DLSgallerywalk)) to gather ideas from other students to complete their list of expressions.
8. Repeat the activity again using a different student’s birthday.
9. Ask students to consider what generalisations they can make.
10. Challenge students to repeat the activity with 3 numbers, 3 addition signs and 3 subtraction signs. A suggestion for the third number could be the student’s age or the number of months until their next birthday.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* Teachers could challenge students by including fraction or decimal distances on the dice.
* Teachers are encouraged to take students outside for this activity so they can physically walk forwards and backwards.

**Explore**

* Students could come up with their own questions, that involve more than 2 numbers.
* Students could be given questions that involve distances with fractions and decimals.

**Summarise**

* **If students have been shown how to add and subtract integers using counters, they should be encouraged to compare the 2 methods.**

**Apply**

* **Students could roll a die to get 2 numbers if the birthday produces numbers that are difficult to add to a number line.**

### Suggested opportunities for assessment

**Summarise**

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

**Apply**

* Teachers could ask students to explain and justify their strategy.
* The teacher could observe students working in groups and check for understanding.

## Appendix A

### Walking Stefan

1. Use the website ‘Directed Number’ ([[bit.ly/DirectedNumbers](https://bit.ly/DirectedNumbers)](https://bit.ly/DirectedNumbers)) to model each of the questions below, and record Stefan’s movements in words.

Table 1 – Stefan's movements and direction

|  |  |
| --- | --- |
|  | Describe Stefan’s movements and direction |
| 5 − 3 | Faces forwards and walks forwards 5 steps and then facing forwards, walks backwards 3 steps. |
| 4 + 2 |  |
| (− 4) + 2 |  |
| 4 + (− 2) |  |
| 4 − 2 |  |
| 4 − (− 2) |  |
| (− 4) − 2 |  |
| (− 4) − (− 2) |  |

1. For each question above, could Stefan walk in a different way, but still start and end in the same place?

## Appendix B

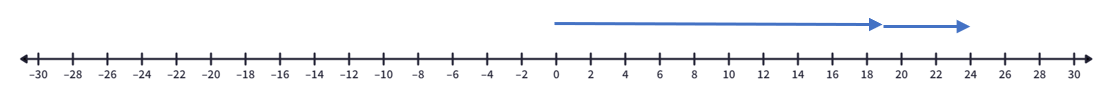
### Cards for Apply

|  |  |  |
| --- | --- | --- |
| Birth date | Birth month | Number of months until next birthday (or age) |
|  |  |  |
|  |  |  |

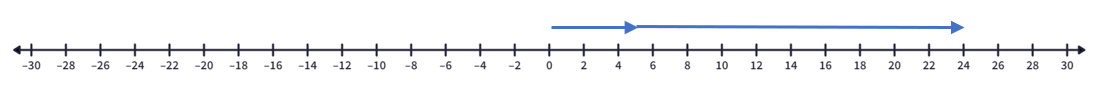
## Sample solutions

### Appendix B

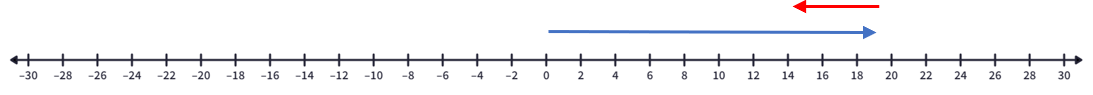
19 + 5



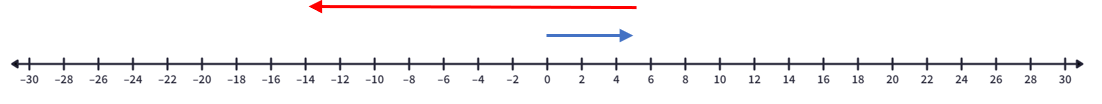
5 + 19



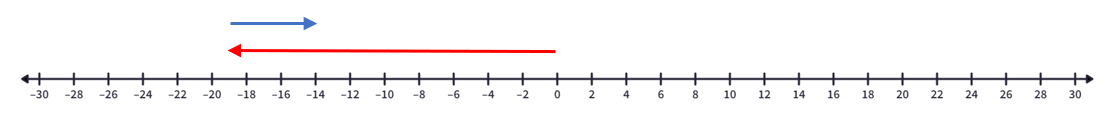
19 − 5



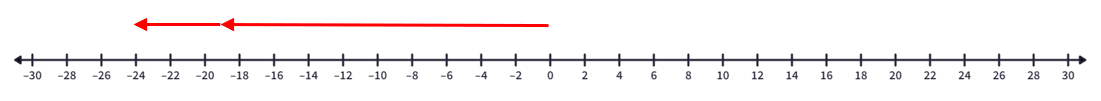
5 − 19



−19 + 5



− 19 + (−5)



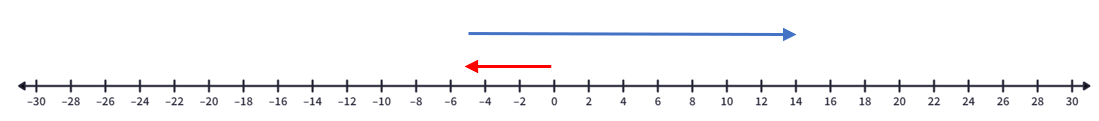
5 − −19



−5 + (−19)



−5 + 19



## References

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