# Simple and compound interest

Students define compound interest as repeated applications of simple interest by exploring an investment of candies.

## Visible learning

### Learning intentions

* To understand the difference between simple and compound interest.
* To be able to calculate compound interest.

### Success criteria

* I can calculate repeated applications of simple interest.
* I can calculate compound interest using the formula .
* I can solve problems involving the formula .
* I can explain the difference between simple and compound interest.

### 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**
* solves financial problems involving compound interest and depreciation **MA5-FIN-C-02**
* identifies connections between algebraic and graphical representations of quadratic and exponential relationships in various contexts **MA5-NLI-C-01**

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Table 1: lesson summary

|  |  |  |  |
| --- | --- | --- | --- |
| Section | Summary of activity | Teaching strategies | Teaching points |
| Launch | Students compare simple interest (1:36) ([bit.ly/simpleskittles](https://bit.ly/simpleskittles)) and compound interest (1:37) ([bit.ly/compoundskittles](https://bit.ly/compoundskittles)) using a simulation, table of values and graphs. Students predict the value of each after 10 years using [Appendix A](#_Appendix_A). | Think-Pair-ShareNotice and wonder | Inform students of the 2 different methods for calculating interest. |
| Explore | Students use repeated applications of the simple interest formula to build an understanding of compound interest.Students calculate compound interest using simple interest (*Simple and compound interest* PowerPoint slides 7–12).Students are asked to find compound interest after 30 years using the simple interest formula and discuss the totals found in the video (1:25) ([bit.ly/comparingskittles](https://bit.ly/comparingskittles)). | Think-Pair-ShareWorked examples (Your turn)Visibly random groups of 3Vertical non-permanent surfacesAssessing and advancing questionsPose-Pause-Pounce-Bounce | Define ‘compound’ as ‘made up of several parts’ to help students.Assessing question:* What is similar about simple and compound interest?

Advancing question:* Can you make a rule or generalisation?
 |
| Summarise | Students describe the graph of compound interest as exponential.Students are explicitly taught the formula for compound interest (slides 16–20) and how to use it before completing faded examples ([Appendix B](#_Appendix_B)). Students complete variation problems ([Appendix C](#_Appendix_C)). | Worked examples (Your turn)Visibly random groups of 3Vertical non-permanent surfacesFaded worked examplesVariation theory | Students are introduced to exponential graphs through the lens of compound interest. |
| Apply | Students work through Fry’s bank balance ([bit.ly/frysbank](https://bit.ly/frysbank)*)* based on the TV show Futurama discussing their findings in pairs. | Think-Pair-Share | Students explore the effect of investing for long periods of time. |

## Activity structure

Please use the associated PowerPoint *Simple and compound interest* to display images in this lesson.

### Launch

1. Show students the first 15 seconds (after 3 years of interest) of the video ‘Simple interest’ (1:36) ([bit.ly/simpleskittles](https://bit.ly/simpleskittles)) or use candy and a container to model the same scenario in front of students.

For copyright purposes, the candy in the video will be referred to as ‘candy’ in this learning episode.

The scenario starts by investing 50 candies, adding 5 as interest, each year.

1. Explain to students that there are 2 ways we can calculate interest, simple interest and compound interest.

Students should be familiar with the simple interest formula prior to this learning episode. Simple interest was studied in Lesson 10 – watch money grow of Unit 5 – financial mathematics.

1. Show students the first 15 seconds, pausing after Year 3 of the video ‘Compound interest’ (1:37) ([bit.ly/compoundskittles](https://bit.ly/compoundskittles)).
2. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), students discuss what they notice and wonder ([bit.ly/noticewonderstrategy](https://bit.ly/noticewonderstrategy)). Use student responses to facilitate a class discussion, focusing on:
* How do you think the second method was calculated?
* Would you end up with more candies using the first or second method?
1. Display slide 3 of the PowerPoint *Simple and compound interest*. Ask students what they notice and wonder about the graphs.
* Students might notice that the simple interest graph is linear with a gradient of 5 candies per year, whereas in the compound interest graph the gradient becomes steeper with time.
* Students might wonder what shape the compound interest graph will make.
1. Distribute Appendix A ‘Simple and compound interest graphs’ to each pair of students. These graphs are also displayed on slide 4 of the PowerPoint.
2. Pairs are to use the graphs to estimate the number of candies after 10 years. Students’ estimates will be referred to later in the learning episode.

The purpose of students comparing the graphs and making an estimate is to draw out that compound interest is not linear.

Students will need to closely examine the 2 graphs to see any discernible differences. They may need to use a table of values or any other method to inform their estimates.

### Explore

1. Explain to students that we’ll use our knowledge of simple interest to help us understand how compound interest is being calculated.
2. By referring to the scenario in the video ‘Simple interest’ (1:36), remind students of the simple interest formula and in a Think-Pair-Share have students:
* Define the principal ().
* Define the interest rate .
* Calculate the number of candies for each of the first 5 years.

 candies
 or
Year 1:
Year 2: Year 3:
Year 4:
Year 5:
The video ‘Simple interest’ (1:36) ([bit.ly/simpleskittles](https://bit.ly/simpleskittles)) can be shown to verify students’ calculations.

1. Use slide 6 of the PowerPointto display the calculations for the first 3 years using simple and compound interest.
2. In a Think-Pair-Share, ask students to discuss what the difference is between the 2 types of interest.
3. Define compound interest as repeated applications of simple interest, meaning the principal is the total number of candies at the start of each year.

It may be beneficial to define ‘compound’ as ‘made up of several parts’. This definition may help students relate compound interest to interest calculated in parts.

1. Use slide 7 to display compound interest calculated as repeated applications of simple interest.
2. Ask pairs to use the same method to calculate the final value of candies after 4 and 5 years. Solutions can be displayed using slide 8.
3. Use slides 9–12 of the PowerPoint for explicit teaching of calculating compound interest as repeated applications of simple interest using the Worked examples (Your turn) method ([bit.ly/supportingstrategies](https://bit.ly/supportingstrategies)).
4. By working in visibly random groups of 3 ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) on vertical non-permanent surfaces ([bit.ly/VNPSstrategy](https://bit.ly/VNPSstrategy)), ask students to calculate the total number of candies after 30 years of compound interest.
5. Use assessing and advancing questions ([bit.ly/supportingstrategies](https://bit.ly/supportingstrategies)) to formatively assess student progress and move them towards generalising the formula.

Table 2: assessing and advancing questions

|  |  |
| --- | --- |
| Assessing questions | Advancing questions |
| What have you noticed so far? | Is there a more efficient way to solve this problem? |
| What do you notice about the total interest earned each year? | Can you make a rule or generalisation? |
| How are you setting out your thinking? | Consider the candies videos, what if the compound interest rate remained the same but the simple interest rate was doubled? |

1. Show students the video ‘Simple and compound interest’ (1:25) ([bit.ly/comparingskittles](https://bit.ly/comparingskittles)), which reveals the total number of candies for 30 years to be 879 for compound interest, compared to 200 candies for simple interest.
2. Ask groups of 3 to reflect and discuss how their initial estimate compared to the total number of candies.
3. Use a questioning strategy such as Pose-Pause-Pounce-Bounce (PDF 557 KB] ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)) to facilitate a class discussion, asking:
* Were you surprised by how many more candies were earned with compound interest?
* What strategies did you use to make the problem simpler to solve?
* How would you find the total number of candies after 100 years?

### Summarise

1. Display slide 14 of the PowerPoint to compare the graphs of simple and compound interest. Students discuss in a Think-Pair-Share what they notice and wonder.
* Students may notice that the compound interest graph is a curve that becomes steeper as it approaches a large number.
* Students may wonder what the graphs will look like after 100 years.
1. Display slide 15 of the PowerPoint to define the terms ‘linear’ and ‘exponential’ by referring to the graphs.
* Linear graphs are a straight line with a constant gradient. A linear pattern is created by the regular repetition of units with the same difference between terms.
* Exponential graphs are curved, with an increasing gradient.
1. Use slide 16 of the PowerPoint to facilitate a Think-Pair-Share of the compound interest formula, using the prompts provided.
2. Use slides 17–21 of the PowerPoint for explicit teaching of calculating compound interest using the formula using the Worked examples (Your turn) method.
3. Distribute Appendix B ‘Faded worked examples’ to each student. Students are to complete the faded worked examples using the Faded examples strategy ([bit.ly/fadedexamplesstrategy](https://bit.ly/fadedexamplesstrategy)).
4. Assign pairs and distribute one copy of Appendix C ‘Variation problems’ which uses variation theory ([variationtheory.com/introduction](https://variationtheory.com/introduction/)) to each pair. ‘Finding the principal’ questions require students to solve for the principal using the compound interest formula.
5. Students are to calculate the final value of each investment, checking their answers are reasonable.
6. Once all questions have been completed, they are to find another pair that is finished to compare and agree upon answers.

The final 3 investments are for a period of months. Students will be required to convert the number of months to years, as the investment is compounded annually.

For example, if is 6 months, can be written in terms of years as or or .

### Apply

1. Navigate to ‘Fry’s bank’ task by Dan Meyer ([bit.ly/frysbank](https://bit.ly/frysbank)).
2. Select the video under **Act one** to download and watch ‘Fry’s bank’ (0:43) (MOV 7.7 MB).
3. Ask students to write down any information required to use the compound interest formula as the video is played once more.

Students should record that $0.93 was invested at 2.25% per annum for 1000 years.

1. In a Think-Pair-Share, students estimate the present value of Fry’s bank balance before calculating the accurate present value using the formula.

Students should calculate .

Students may be interested to learn that Futurama writer Ken Keeler holds a PhD in applied mathematics. There are many instances such as this in Futurama that are mathematically correct.

1. Use a questioning strategy such as Pose-Pause-Pounce-Bounce to facilitate a class discussion. Question prompts such as the ones below could be used:
* Were you surprised by the present value of Fry’s bank balance?
* What causes compound interest to grow more substantially, the value invested or the number of periods?
* Do you think the show will have calculated the balance correctly?
1. Select the video under **Act three** to download and play ‘Fry’s bank balance’ (0:15) (MOV 2.4 MB). Which will reveal that Fry’s bank balance is currently 4.3 billion dollars.
2. Have students return to their previously assigned groups of 3 at vertical non-permanent surfaces to consider the following extensions:
* It took Fry 1000 years to earn that much money. How many more years will it take him to double it?
* How long will it take him to earn a trillion dollars?

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* If required, the launch could be used as an opportunity to explicitly teach the simple interest formula. Rather than asking students to calculate the number of candies after 30 years, they could estimate and then use the formula to find the answer.

**Explore**

* Low readiness students may benefit from finding the total number of candies after a smaller period, such as 10 years, as the numbers will be easier to work with.
* Challenge students to calculate the number of years required to reach specific numbers of candies.

**Summarise**

* Challenge students to describe compound interest as repeated percentage increases.
* Worked examples could be used to provide further scaffolding for students as the questions in Appendix C involve months and solving equations to find the principal.

**Apply**

* Students could be encouraged to further explore instances of mathematics in their favourite shows such as Futurama.
* Additional prompts could be provided to ensure students can confidently solve compound interest problems. For example, changing the principal or number of years that Fry’s money was invested.

### Suggested opportunities for assessment

**Launch**

* Use the launch activity to assess students’ prior knowledge of simple interest. If students are not confident with simple interest, it should be explicitly taught before commencing with this learning episode.

**Explore**

* Use assessing questions to monitor students’ communication and reasoning as they work at vertical non-permanent surfaces.
* Observe students’ reasoning and communication within the class discussion to assess their confidence with simple and compound interest.

**Summarise**

* Observe student responses to your turn problem to ensure they have understood how to solve problems using the compound interest formula.
* Appendix B could be collected as a student work sample, demonstrating students can solve problems using the compound interest formula.

**Apply**

* Student responses to the problems posed in the apply section should act as an opportunity to assess that they have understood how to use the compound interest formula. If student estimates and calculations are far from accurate, additional support could be required.

## Appendix A

### Simple and compound interest graphs

|  |  |
| --- | --- |
| Simple interest | Compound interest |
| Simple interest table. The first column lists the years zero, one, 2 and 3. The second column lists the number of candies for each of those years in order: 50, 55, 60 and 65. | Compound interest table. The first column lists the years zero, one, 2 and 3. The second column lists the number of candies for each of those years in order: 50, 55, 61 and 67.  |
| Graph of candy over years with points (0,50) (1,55) (2,60) (3,65). | Graph of candy over years with points (0,50) (1,55) (2,61) (3,67). |

## Appendix B

### Faded worked examples

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| $500 is invested for 4 years, earning interest at the rate of 3% per annum, compounded annually. | $500 is invested for 3 years, earning interest at the rate of 4% per annum, compounded annually. | $5000 is invested for 3 years, earning interest at the rate of 4% per annum, compounded annually. | $5000 is invested for 6 years, earning interest at the rate of 4% per annum, compounded annually. | $5000 is invested for 6 years, earning interest at the rate of 8% per annum, compounded annually. |
|  |  |  |  |  |

## Appendix C

### Variation problems

Find the future value of each investment.

1. $1000 invested over 8 years at a rate of 4% per annum, compounded annually.
2. $1000 invested over 4 years at a rate of 4% per annum, compounded annually.
3. $1000 invested over 4 years at a rate of 12% per annum, compounded annually.
4. $1000 invested over 4 years at a rate of 12.5% per annum, compounded annually.
5. $1000 invested over 6 months at a rate of 12.5% per annum, compounded annually.
6. $1000 invested over 18 months at a rate of 12.5% per annum, compounded annually.
7. $1000 invested over 4 months at a rate of 12.5% per annum, compounded annually.

### Finding the principal

Find the present value of each investment.

1. Principal invested over 2 years at a rate of 4% per annum, compounded annually, resulting in a future value of $540.80.
2. Principal invested over 2 years at a rate of 8% per annum, compounded annually, resulting in a future value of $699.84.
3. Principal invested over 2 years at a rate of 12.5% per annum, compounded annually, resulting in a future value of $885.94.

## Sample solutions

### Appendix B – faded worked examples

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| $500 is invested for 4 years, earning interest at the rate of 3% per annum, compounded annually. | $500 is invested for 3 years, earning interest at the rate of 4% per annum, compounded annually. | $5000 is invested for 3 years, earning interest at the rate of 4% per annum, compounded annually. | $5000 is invested for 6 years, earning interest at the rate of 4% per annum, compounded annually. | $5000 is invested for 6 years, earning interest at the rate of 8% per annum, compounded annually. |
|  |  |  |  |  |

### Appendix C

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2. $1000 invested over 4 years at a rate of 4% per annum, compounded annually.
3. $1000 invested over 4 years at a rate of 12% per annum, compounded annually.
4. $1000 invested over 4 years at a rate of 12.5% per annum, compounded annually.
5. $1000 invested over 6 months at a rate of 12.5% per annum, compounded annually.
6. $1000 invested over 18 months at a rate of 12.5% per annum, compounded annually.
7. $1000 invested over 4 months at a rate of 12.5% per annum, compounded annually.

#### Finding the principal

1. Principal invested over 2 years at a rate of 4% per annum, compounded annually, resulting in a Future value of $540.80.
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## References

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