Mathematics Stage 5
(Year 10) – teacher information

The rule of 72 investigation

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# Task description

**Type of task**: Investigation

**Outcomes being assessed**

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**
* identifies and compares features of parabolas and exponential curves in various contexts **MA5-NLI-C-02**

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## Task details

### Part 1 − compound interest formula

1. Research a term deposit offer associated with a financial institution. Provide a screenshot, including the percentage interest rate and period of the offer.
2. Use this interest rate, the compound interest formula and a principal investment of $10 000 to create a graph showing the growth of the term deposit over the advertised period.
3. Use the graph to determine how many years it would take to reach a future value of $20 000, double the principal investment.

### Part 2 − the rule of 72

The rule of 72 is a commonly used method to determine how long it will take for an investment to double. The formula for the rule of 72 is:

* Number of years to double = $\frac{72}{r} $
* Where $r$ is the interest rate (per annum), written as a percentage without the symbol, %. For example, a rate of $4.75\% p.a.$ would have an $r$ value of $4.75$.
1. Use the rule of 72 to find how many years it will take for a principal investment of $10 000 to reach a future value of $20 000, using the interest rate found in Part 1.
2. Would you trust the rule of 72 to predict when an investment of $10 000 would double at the rate you found in Part 1?
3. For what range of interest rates would you trust the rule of 72 to predict when an investment would double. Justify your reasoning using graphs and calculations.

### Part 3 − changing compounding period

Could you use the rule of 72 to find how many months, weeks or days it would take for an investment to reach double its value? Justify your reasoning using graphs and/or calculations.

### Part 4 − declining value

1. Could you use the rule of 72 to predict when a $10 000 asset would depreciate to $5 000 (half the initial value), using the interest rate found in Part 1? Justify why.
2. Describe the graph representing the declining value of an asset over time and identify the limitations of the graph.

### Part 5 − adjusting the rule of 72

Create a new rule, like the rule of 72, to accurately predict when an asset would triple in value. Justify your reasoning using graphs and calculations.

## Submission details

A written response is expected for this task. It should contain answers to the questions as well as graphs, tables and calculations to support your findings. Your submission may include subheadings to assist with organising your response.

# What is the teacher looking for?

This outline highlights what is expected in your written response.

The teacher is looking to see how well you:

* choose and apply mathematical techniques to solve problems
* communicate your thinking and reasoning
* justify your decisions when solving problems
* solve problems involving compound interest and depreciation
* examine the connection between algebraic and graphical representations of exponentials
* graph exponentials using digital technology
* describe key features of an exponential graph such as $y$-intercept, asymptotes, and the nature of the graph as $x$-values become very large or very small
* identify changes in the graph and equations from doubling an investment to halving an investment.

# Marking guidelines

The following marking guidelines have been grouped into outcomes and aligned content to help assign an overall grade when reporting. The task should be viewed holistically when assigning a grade for each criterion. Specific tasks from the assessment have been identified for each criterion which would provide evidence to assign a grade and provide feedback.

Table 1 – assessment marking guidelines

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcomes | Working towards developing | Developing | Developed | Well developed |
| Financial mathematics |  |  |  |  |
| MAO-WM-01MA5-FIN-C-02Parts 2 and 4 | Substitutes **some correct** values into a formula. | Substitutes correctly into the formulas to **justify at least one** interest rate. | Substitutes correctly into the formulas to **justify a variety** of interest rates. |  |
| MAO-WM-01MA5-FIN-C-02Part 3 | Changes the interest rate **or** time period to test changing compounding periods. | Changes the interest rate **and** time period to test changing compounding periods. | **Explains** the effects that changing the compounding period has on the future value of an investment. | **Justifies** the accuracy of the rule of 72 when compounding periods are changed. |
| Non-linear relationships |  |  |  |  |
| MAO-WM-01MA5-NLI-C-01MA5-NLI-C-02 Parts 1−4 | Creates a graph of an investment with or without technology. | Creates a graph of an investment **and uses the graph** to identify when an investment would double, or an asset would halve in value. |  |  |
| MAO-WM-01MA5-NLI-C-01MA5-NLI-C-02Part 4 | Describes **one feature** of an exponential graph. | Describes **all the relevant features** of an exponential graph. | Describes all relevant features of an exponential graph **and explains the limitations** of the graphs. | Describes all relevant features of an exponential graph, limitations **and links the shape of the graph to the equation** to justify changes. |
| Working mathematically |  |  |  |  |
| MAO-WM-01Parts 1−5 | Attempts to use informal mathematical reasoning and **very limited mathematical language** to communicate and explain solutions. | Uses informal mathematical reasoning and **limited mathematical language** to communicate and explain solutions. | Uses appropriate **formal and informal** **mathematical language** to communicate reasoning and explain solutions and justify results. | Uses appropriate **formal mathematical language** to communicate reasoning, explain solutions and justify results. |
| MAO-WM-01Part 5 | Uses a graph or calculation to find when an asset would triple in value. | **Provides a rule** to accurately predict when an asset would triple in value, with **reasoning based on calculations and related graphs**. | Provides a rule to accurately predict when an asset would triple in value, with reasoning based on calculations and related graphs.**Explains how the rule was developed.** | Provides a rule to accurately predict when an asset would triple in value, **for a specified range of interest rates**, with reasoning based on calculations and related graphs.Explains how the rule was developed and **discusses the limitations of the rule**. |

# Student support material

## Worked example for the rule of 72

How long will an investment take to double, given it has an interest rate of 8% p.a?

$$r=8$$

Number of years to double $=\frac{72}{r}$

Number of years to double $=\frac{72}{8}$

Number of years to double $=9$

Therefore, it will take approximately 9 years for the investment to double in value.

Note that a compound annual return of 8% is substituted into this equation as 8, and not 0.08, giving a result of 9 years (and not 900).

# Teacher support material

## Launching the task

When teachers launch the assessment task with students it is suggested they work through the example provided in the student support material. Alternatively, teachers could choose to show the video ‘This formula will change your life [Rule of 72]’ (8:21) ([bit.ly/ruleof72video](https://bit.ly/ruleof72video)) until 1:17. The video introduces the rule of 72 and provides an example of how it is used.

## Suggestions for differentiation

* Some students may benefit from scaffolding of the task to provide more direction on how to investigate the values that the rule of 72 is accurate for.
* The teacher can provide students with a worked example of how to use the rule of 72 when launching the task. An example of this is provided in the student support material.
* Students can use online software, such as spreadsheets and Desmos, to help create graphs for their investigations. If students have not been shown how to use these tools previously during learning activities, provide time to teach them how to use the tools before completing the task.
* Students can prove the rule of 72 using logarithms if they have studied this Path content.
* Students can explain, using transformations, the difference between a graph of an investment and a declining asset, or when compounding periods change.

## Assessing using the Course performance descriptors

[Course performance descriptors](https://curriculum.nsw.edu.au/learning-areas/mathematics/mathematics-k-10-2022/assessment) provide holistic descriptions of typical achievement at different grade levels in a specific course. They are used to identify and report a student’s level of achievement in a Board Developed Course at the end of Stage 5.

This task provides an opportunity to establish where students are in their learning, in reference to the course performance descriptors, so that teaching can be differentiated, and further learning progress can be monitored over time. This task can be used as evidence of a student’s level of achievement or an opportunity to give feedback to students on where they can improve before assigning an overall grade at the end of Stage 5.

# Evidence base

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