 NESA exemplar question solutions

A4.2 Non-linear equations

Solutions for questions from the NESA topic guidance related to types of relationships.

1. An exponential expression such as can be used to calculate the mass kg of a baby orangutan at age months. This model applies for a limited time, up to . Calculate the mass of a baby orangutan at the age of three months.

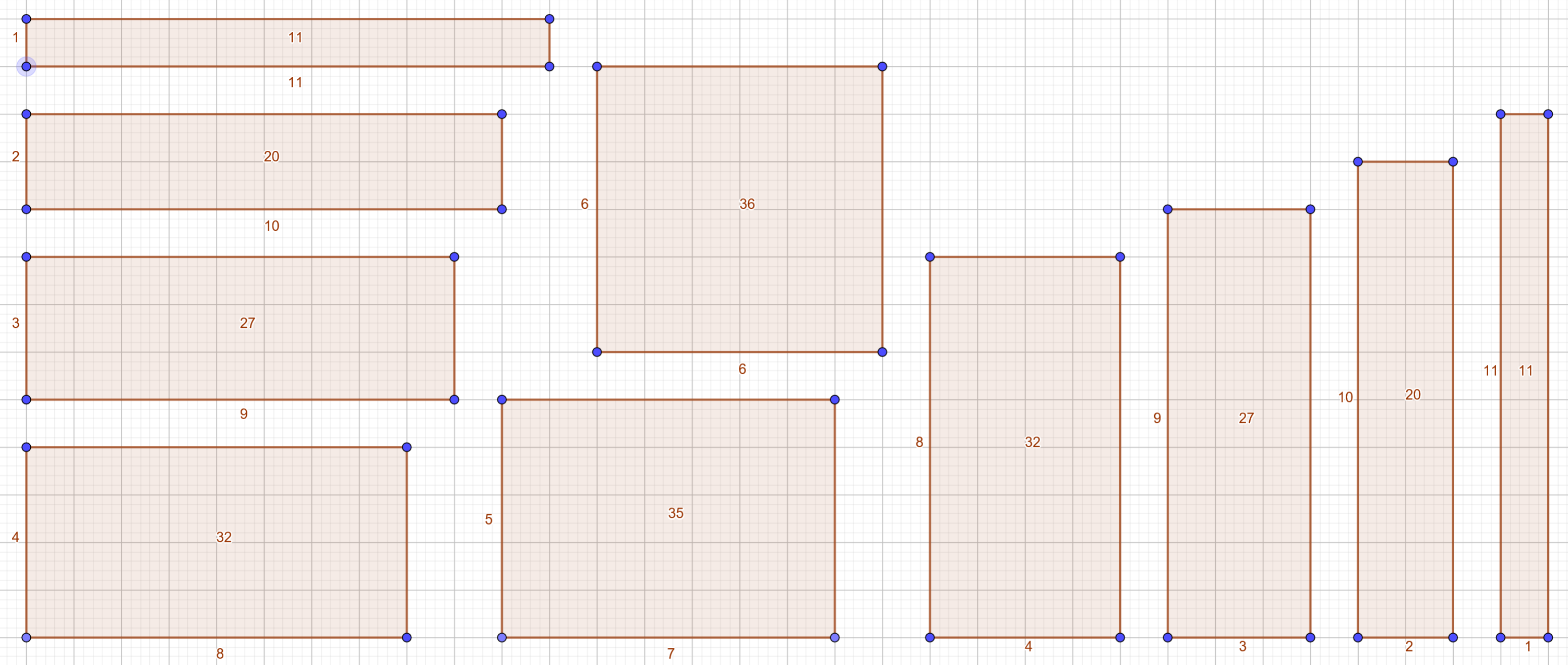
Solution: When

(correct to 1 decimal place)

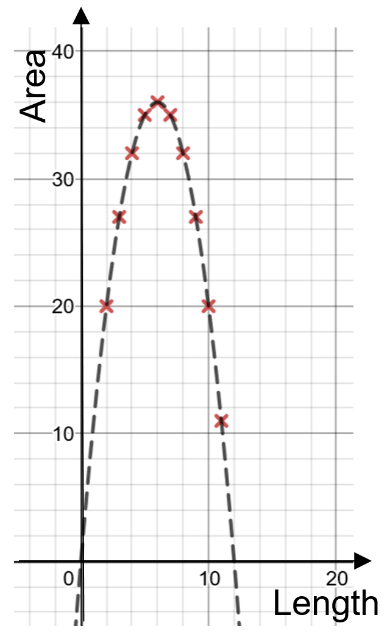
The mass of a baby orangutan at the age of three months is 2.6 kg (correct to 1 decimal place).

1. Sketch at least 10 rectangles that have the same perimeter. Record length versus area in a table. Sketch the resulting function and use the graph to determine the rectangle with maximum area. Describe this rectangle.

*Solution:*



| **Length** | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Area** | 11 | 20 | 27 | 32 | 35 | 36 | 35 | 32 | 27 | 20 |



The resulting function forms a parabola. The maximum turning point represents the side length which will result in a rectangle with the maximum area. This rectangle will actually be a square. In this example the rectangle with the maximum area is a square with side lengths equal to cm.

On the Earth, the equation can be used to express the distance ( metres) that an object falls in seconds, if air resistance is ignored. Investigate the equations for the moon and for other planets: for example, on the moon the equation is .

Create a table of values for the function either manually or by using a spreadsheet, and use the table to answer questions such as: How long does it take for an object to fall 300 m?

*Solution:*

| Time ( seconds) | 2 | 4 | 6 | 8 | 10 | 12 |
| --- | --- | --- | --- | --- | --- | --- |
| Distance ( metres) | 19.6 | 78.4 | 176.4 | 313.6 | 490 | 705.6 |

Using the table, it would take between and seconds for an object to drop 300 m on Earth.

Using substitution:

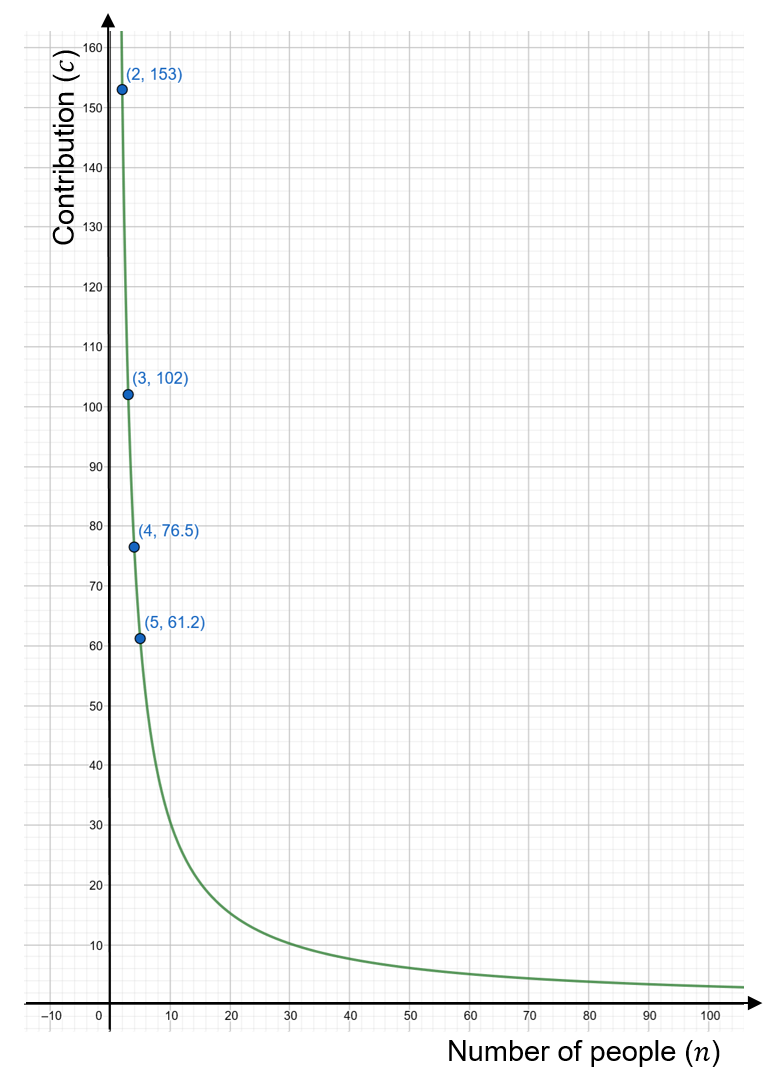
When

seconds (correct to the nearest second)

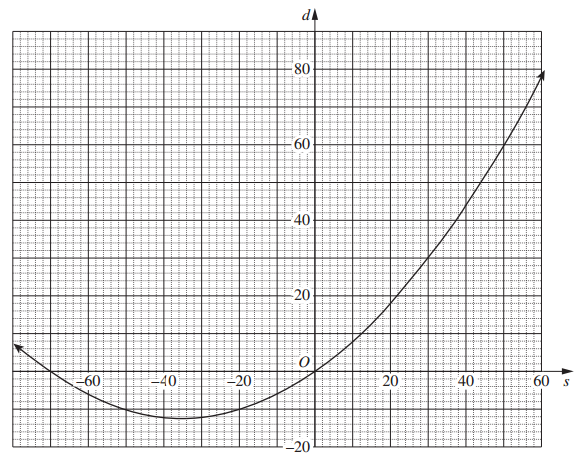
1. Inverse variation can be used to find how much each person contributes when a cost is shared. For example, a household has $306 in bills. Create a table and draw a graph to show how much each person pays if there are 2, 3, 4 or 5 people contributing equally to pay bills.

*Solution:*

| Number of people () | 2 | 3 | 4 | 5 |
| --- | --- | --- | --- | --- |
| Each person’s contribution () | $153 | $102 | $76.50 | $61.20 |

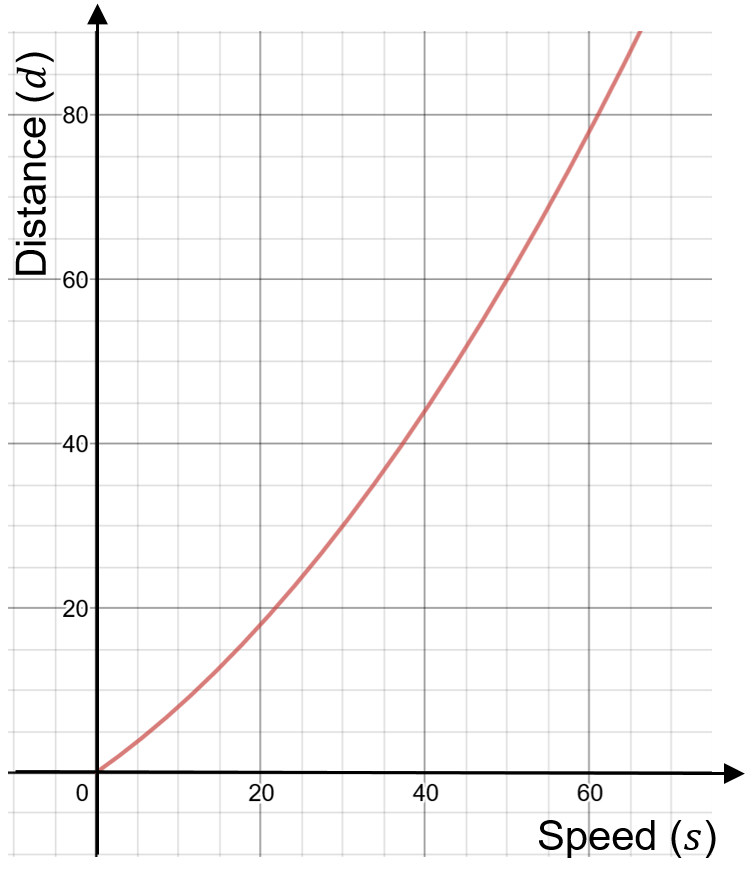


1. Anjali is investigating stopping distances for a car travelling at different speeds. To model this she uses the equation , where is the stopping distance in metres and is the car’s speed in km/h. The graph of this equation is drawn below.



1. Anjali knows that only part of the curve applies to her model for stopping distance. In your writing booklet, using a set of axes sketch the part of this curve that applies for stopping distances.

*Solution:* The only part of the curve that applies is as it is impossible to have negative time or distance.



1. What is the difference between the stopping distances in a school zone when travelling at a speed of km/h and when travelling at a speed of km/h?

*Solution:* When

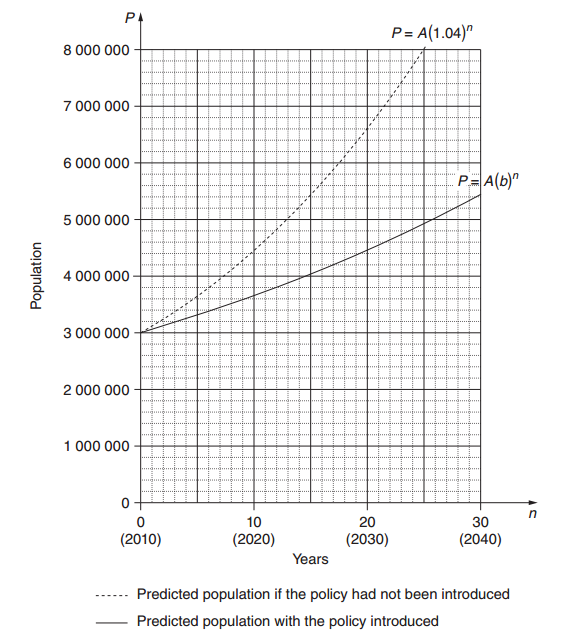
When

Difference

Difference

The difference between the stopping distances in a school zone when travelling at a speed of km/h and when travelling at a speed of km/h is metres.

1. In 2010, the city of Thagoras modelled the predicted population of the city using the equation . That year, the city introduced a policy to slow its population growth. The new predicted population was modelled using the equations In both equations, is the predicted population and is the number of years after 2010. The graph shows the two predicted populations.



1. Use the graph to find the predicted population of Thagoras in 2030 if the population policy had NOT been introduced.

Solution: from the graph the predicted population in 2030 is people.

1. In each of the two equations given, the value of is . What does represent?

Solution: represents the initial population in 2010 before the policy was introduced.

1. The guess-and-check method is to be used to find the value of , in
2. Explain, with or without calculations, why is not a suitable first estimate for .

Solution: It is not suitable for the first estimate for to be as is greater than which represents a population increasing at a faster rate than the predicted population if the policy had not been introduced. The policy aimed to slow the population and thus the value for needs to be less than in order to do so.

1. With and , use the guess-and-check method and the equation to estimate the value of to two decimal places. Show at least TWO estimate values for , including calculations and conclusions.

Solution*:* When and

Try: When

Try: When

Try: When

The value for is between and .

(correct to two decimal places)

1. The city of Thagoras was aiming to have a population under in 2050. Does the model indicate that the city will achieve this aim? Justify your answer with suitable calculations.

Solution: When and using

The model indicates that the population will reach approximately people. This is under the required and thus achieves this aim.