# Linear models

Year 12 Further Maths
Units 3 and 4

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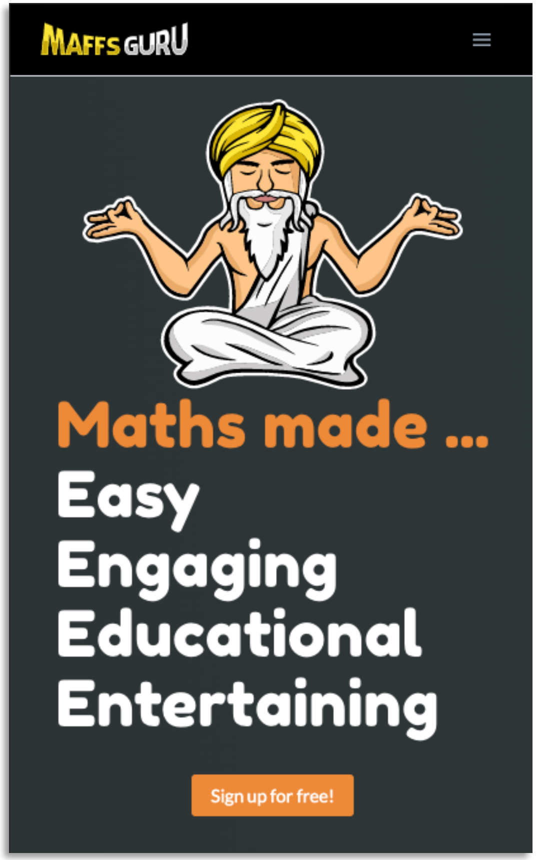


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## Learning Objectives

By the end of the lesson I would hope that you have an understanding and be able to apply to questions the following concepts:

- Understand how to apply the learnings from previous lessons to linear model questions

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## Recap

Much of what we do in life can be modelled by straight line relationships.

For example, if we travel at a constant speed, we can plot a linear relationship between time and distance.

When I get into a cab, if we were dealing with a per Km pricing model, we can relate the distance travelled to the cost of the cab journey.

We can model the cost of hiring a car.

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## Language, language and more language

We need to remember that Barry loves tricking us!

When we deal with money or costs we need to think of two terms; fixed costs and variable costs.

Fixed costs are those which don’t change regardless of how much I use something.

A cab has a fixed cost when then get into the cab.

Hiring a car for a day has a fixed cost which has nothing to do with the distance you travel.

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## Fixed costs are the intercept!

Fixed costs are, generally, the question telling you the value of a y-axis intercept.

For example:

*Austcom's rates for local calls from private telephones consist of a quarterly rental fee of $40 plus 25c for every call. Construct a linear rule that describes the quarterly telephone bill and sketch the graph.*

m =

c =

Here, the fixed cost is called a "Rental fee"


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## What about the gradient?

The gradient can be found from the other information given in the question.

For example:

*Austcom's rates for local calls from private telephones consist of a quarterly rental fee of $40 plus 25c for every call. Construct a linear rule that describes the quarterly telephone bill and sketch the graph.*

Here, the gradient would be 0.25 (**not 25!**).

c

$40

$0·25 ← m

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## Decimals to fractions

In the example:

*Austcom's rates for local calls from private telephones consist of a quarterly rental fee of \$40 plus 25c for every call. Construct a linear rule that describes the quarterly telephone bill and sketch the graph.*

We found the gradient to be 0.25.

But, to be able to plot this on a graph, we need to know what this is as a fraction.

There are a number of fractions we really should learn.

$c = 40$

$m = 0.25$

$= \frac{1}{4}$ ← $\frac{\text{rise}}{\text{run}}$

$0.5 = \frac{1}{2}$

$0.25 = \frac{1}{4}$

$0.125 = \frac{1}{8}$

$0.1 = \frac{1}{10}$

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## Completing the question

Let's now construct the rule and sketch the graph:

*Austcom's rates for local calls from private telephones consist of a quarterly rental fee of $40 plus 25c for every call. Construct a linear rule that describes the quarterly telephone bill and sketch the graph.*

**Note**: Assume that the minimum number of calls is 0. Plot the point which corresponds to the number of calls being 200.

$m = \frac{1}{4}$

$y = mx + c$

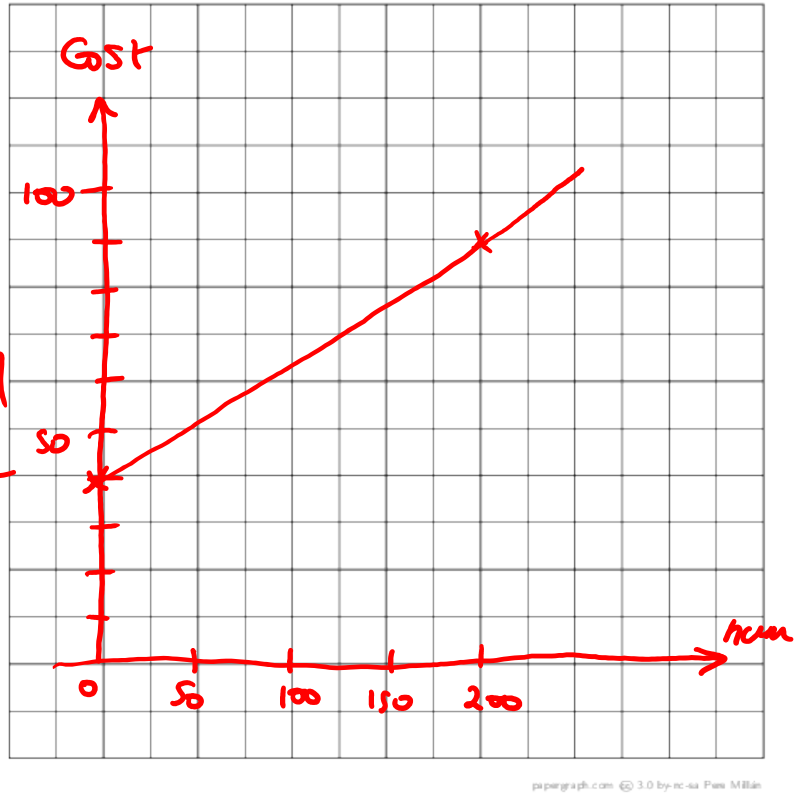
$\boxed{\text{Cost} = \frac{1}{4} \times \text{num} + 40}$

$c = 40$

$\boxed{\text{Cost} = \frac{1}{4} \times 200 + 40}$

$= 50 + 40$

$= \$90$

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## A more complex example: Being given two coordinates

The tyres on a racing car had lost 3 mm of tread after completing 250 km of a race and 4 mm of tread after completing 1000 km. Assuming that the loss of tread was proportional to the distance covered, find the total loss of tread, $d$ mm, after $s$ km from the start of the race. What would be the tread loss by the end of a 2000 km race? Give your answer correct to one decimal place.

In the above example, they have given us two coordinates.

Let's find the relationship between d and s (which is assumed to be linear relationship).

$(250, 3) \quad (1000, 4)$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4-3}{1000-250} = \frac{1}{750}$$

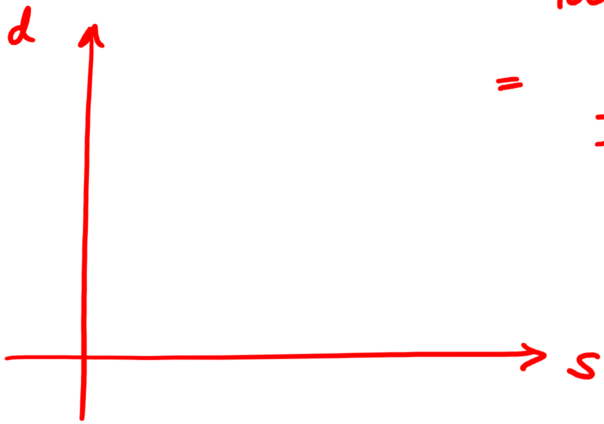
$$y - 4 = \frac{1}{750}(x - 1000)$$

$$y = \frac{1}{750}(x - 1000) + 4$$

$$= \frac{1}{750}x - \frac{1000}{750} + 4$$

$$y = \frac{1}{750}x + 2.67$$

$$d = \frac{1}{750}.s + 2.67$$

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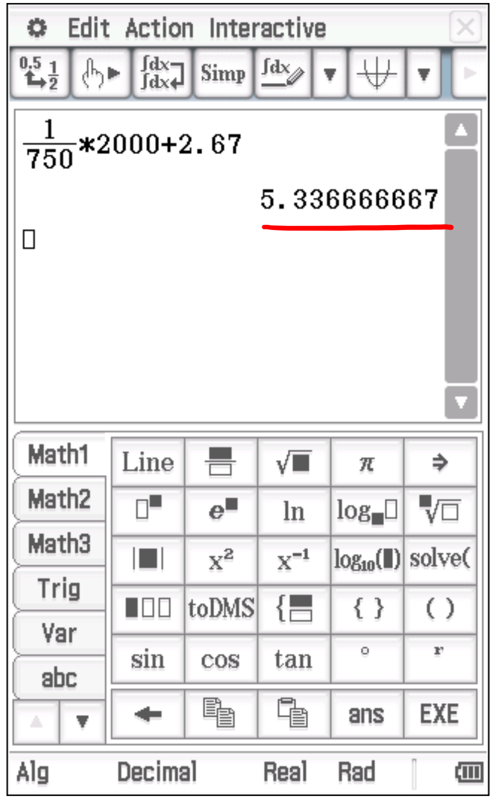
Now we have a relationship, we can use it to find the answer to the question.

$$\boxed{d = \frac{1}{750}s + 2.67}$$

$$d = \frac{1}{750} \cdot s + 2.67$$

$$d = \frac{1}{750} \times 2000 + 2.67$$

$$= 5.3 \text{ mm}$$

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