Cup of coffee

In this activity you will model data from measuring how long caffeine from tea, coffee or cola stays in the human body's bloodstream.

This will involve drawing graphs, and then finding functions and parameters to fit different models to your graphs.

Information sheet

Many popular drinks such as coffee, tea and cola contain caffeine. This stimulates the central nervous system, heart muscles and respiratory system of those who consume these drinks, often making them feel more alert and energetic.

The level of caffeine in the bloodstream reaches a peak between 15 and 45 minutes after the drink is consumed and then begins to fall (assuming that the person does not have another drink containing caffeine). The time taken for the caffeine to be eliminated from the body varies widely with the person.

The table below gives estimates of the amounts of caffeine remaining in the bodies of a group of people after they have had a drink.

The amounts of caffeine are given to the nearest milligram and the time, t hours, is measured from the time the caffeine level reached its peak value.

	Non-smoking adult		Smoker		Pregnant woman		Child
t	Coffee	Tea	Coffee	Tea	Coffee	Tea	Cola
0	125	45	130	46	124	44	40
1	111	39	108	38	119	42	32
2	98	34	89	30	115	40	25
3	87	30	74	25	110	39	20
4	77	26	61	20	106	38	16
5	69	22	50	16	102	36	13
6	61	19	41	13	98	35	10
7	54	17	34	11	94	34	8
8	47	15	28	9	91	32	6
9	42	13	23	7	87	31	5
10	38	11	19	6	84	30	4
11	34	9	16	5	81	29	3
12	30	8	13	4	78	28	3
13	26	7	11	3	75	27	2
14	23	6	9	2	72	26	2
15	21	6	7	2	69	25	1
16	18	5	6	2	66	24	1
17	16	4	5	1	64	23	1
18	14	4	4	1	61	22	1
19	13	3	3	1	59	21	1
20	11	3	3	1	57	21	0
21	10	3	2	1	55	20	
22	9	2	2	0	53	19	
23	8	2	1		51	18	
24	7	2	1		49	18	

This data is available as an Excel file.

Think about…

- What are the striking differences between the different drinks?
- What are the striking differences between the different adult groups?
- Which functions are likely to give you good models for this type of data?

Try these

1 Choose just one set of data from the data sheet.
Draw a graph to show the amount of caffeine remaining in the person's body over the 24-hour period after the caffeine level reaches its peak value.
(You could use a graphic calculator or computer or plot graphs by hand.)

2 Find ***two*** different functions to model different parts of the data set – one type of function for the ***full*** data set, and another type for just the ***first part*** of the data set.

3 Explain how you chose the parameters of your functions, and how your functions are related to basic functions of their type.

Consider how errors or inaccuracies in the given data may affect your models and explain how, in general terms, the functions you found could be different.

4 Plot graphs and compare values given by your models with the data.

5 Use your functions to predict how long it takes for the level of caffeine to reduce to:

- 80% of its peak value
- half of its peak value
- 40% of its peak value.

How do the values you have found compare with the real data?

6 Summarise your findings. Consider the effectiveness of each of your functions as a model of the data. Indicate clearly when your functions can be considered valid models for the data, and describe any limitations they have.

Reflect on your work

- What types of functions did you use to model the data?
- Which method of finding parameters did you use?
  Do you think it was the most effective?
- How well did your models fit the data?
- Compare your models with those found by other students.
  Which model gave the best fit?