Piecewise functions from text

In general, the data to generate a model in a realistic situation is far from evident, and electricity is not the exception. Most of the times, the only available data is a description of the behavior in form of a paragraph: it is not a table, nor a graph, nor an equation, as you may use to.

This set of exercises aims to increase your ability to plot data or compute an equation coming from a text, especially in the case of a piecewise function including, constants, lines, and parabolas.

Exercises

1. The electric charge in a material has been increasing at 3,2 mC per millisecond until 2,5 ms. Then it remains constant for another 3.6 ms, when started to change as a parabola. The minimum, equal to 7,3 mC is right there, and it is also known that it is 10,4 mC after 2,1 ms. Plot a graph of the behavior and compute the mathematical model.

2. The electric charge in a circuit can be described using two parabola functions. One with maximum at 5 μs and 16 nC, another one with minimum at 11 μs and 8 nC. They joint their behavior at the average time and average charge, considering the critical points. Plot a graph of the behavior and compute the mathematical model.

3. The story of my savings can be divided in three parts, and somebody said that that is exactly how the electric charge change in certain circuit. When I was a student, I had $ 152 k. That truly changed when I finished collage. An expert told me that the next part looks like a parabola with minimum at the graduation ceremony, and just six months later my savings grew seven times. Since then, I could not increase nor decrease the pace at which I was saving. Plot a graph of the behavior and compute the mathematical model.

4. The amount of electric charge passing through a wire changes as the temperature in a room. It is known that it was decreasing at 2 °/hour until 10 p.m., when it reaches 10° C. The minimum temperature was 7° C at 1 a.m., and it is again 10° at 4 a.m. If the temperature started to increase linearly again and it is 14° at 10 a.m., compute an equation to describe

the changes in temperature. Plot a graph of the behavior and compute the mathematical model.

5. The number of trees in a forest changes as the electric charge passing through a point in a circuit. That number was growing 200 trees per month until 12 months ago, when the number was 25.000 trees. Human intervention changes that path, and there was an initial decreasing, but the forest recovered its growth. It had the same number of trees six months ago, and it is 27.000 in this moment. In order to be conservative, we should estimate that the number won't change since this moment. Then, compute a mathematical model describing the number of trees, starting two years ago and going one year into the future.

6. The population of fish in a lake behaves as the electric charge passing through a wire. It was the same number for years, but the lack of food made them to linearly decrease at 100 fish per day beginning five months ago, until three months ago when the number was 11.000 fish. Fortunately, a change in the lake made that two months ago the number were 12.000 and a month ago was 20.000 fish. Compute an equation to describe the population of fish in that lake.

7. The electric charge passing through a cable changes as the available minerals in the planet. That amount was 100% in the year 1, and decreases to 90% after the following 1000 years, then it remains equal for 7 centuries, only to decrease as a second order polynomial, in such a way that it was 70% for the 19th century and 50% for the 20th century. Write an equation to describe the amount of available minerals in the planet.

8. The total number of books I read increases as the electric charge passing through a wire. When I was a child It was only one book, but that number drastically changed at the collage. It was eight books at the end of the second semester, and fifty at the end of the sixth semester at the university. If I'm reading just two new books per year after my graduation, compute an equation describing the amount of read books.
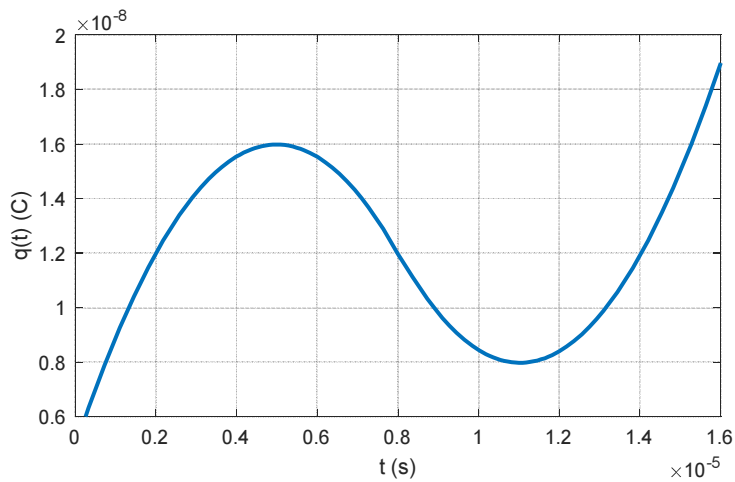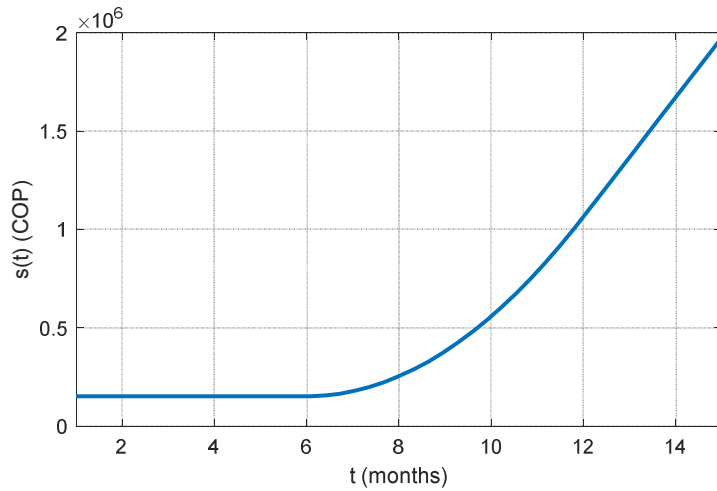
Answers

1. Electric charge in a material:
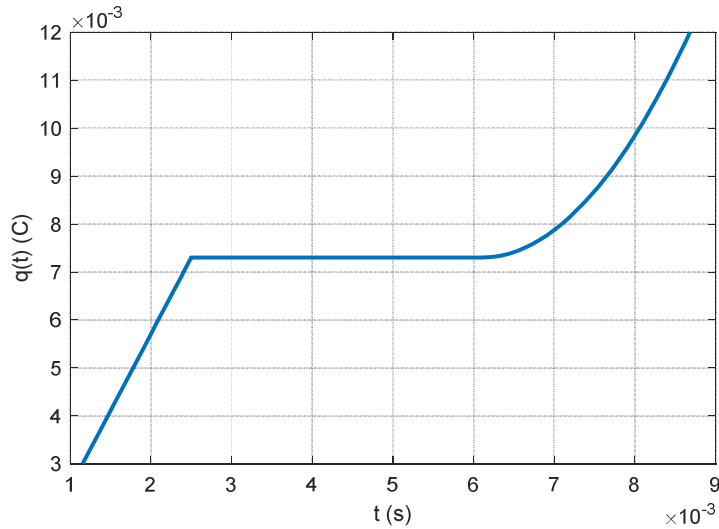

```
q(t) = piecewise(           t<=2.5e-3, 3.2*t - 0.7e-3,...
                   t>2.5e-3 & t<=6.1e-3, 7.3e-3,...
                             t>6.1e-3, 702.95*t^2 - 8.57*t + 33.42e-3)
```

2. Electric charge in a circuit:


```
q(t) = piecewise( t<=8e-6, -444.44*t^2 + 4.44e-3*t + 4.89e-9,...
                   t>8e-6, 444.44*t^2 - 9.80e-3*t + 62e-9)
```

3. My savings in a bank account:


```
q(t) = piecewise(        t<=6, 152e3,...
                  t>6 & t<=12, (152e3/6)*t^2 - 304e3*t + 7*152e3,...
                         t>12, 2*152e3*t - 17*152e3)
```

4. Temperature in a room:
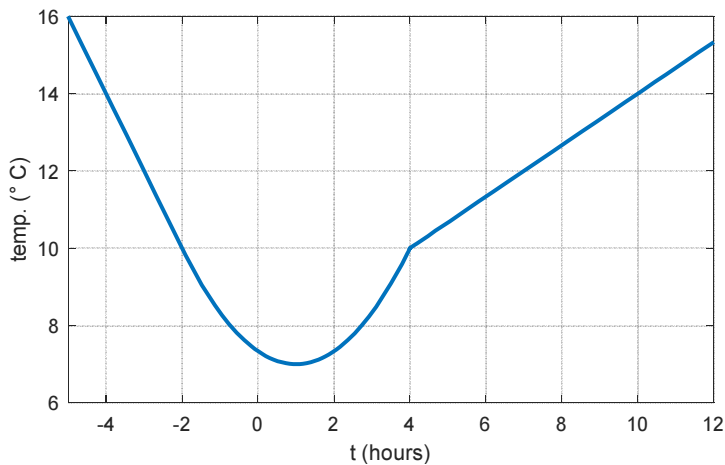

```
q(t) = piecewise(        t<=-2, -2*t + 6,...
                  t>-2 & t<=4, (1/3)*t^2 - (2/3)*t + (22/3),...
                         t>4, (2/3)*t + (22/3))
```

5. Number of trees in a forest:
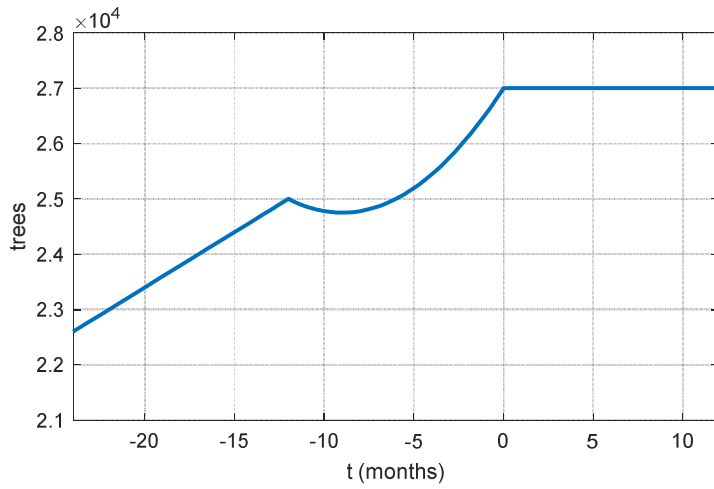

```
q(t) = piecewise(        t<=-12, 200*t + 27400,...
                  t>-12 & t<=0, (250/9)*t^2 + (500)*t + (27000),...
                           t>0, 27000)
```

6. Population of fish in a lake:
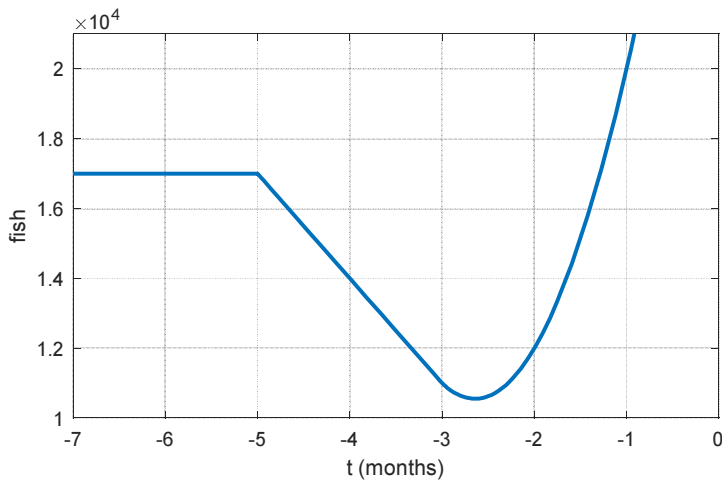

```
q(t) = piecewise(        t<=-5, 17e3,...
                  t>-5 & t<=-3, -3e3*t + 2e3,...
                           t>-3, 3.5e3*t^2 + 18.5e3*t + 35e3)
```

7. Amount of available minerals in the world:
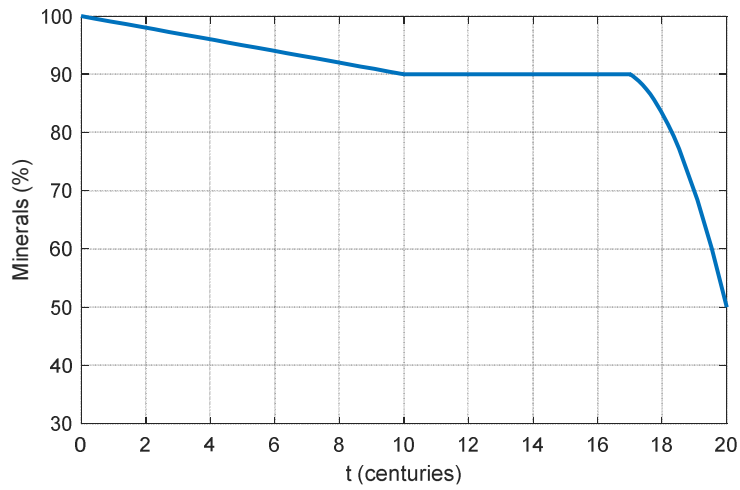

```
q(t) = piecewise(        t<=10, -t + 100,...
                  t>10 & t<=17, 90,...
                          t>17, (-10/3)*t^2 + 110*t - 2450/3)
```

8. Number of read books:
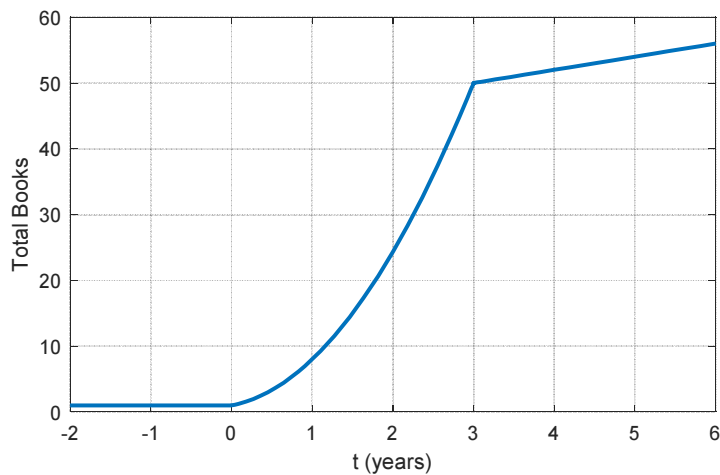

```
q(t) = piecewise(       t<=0, 1,...
                  t>0 & t<=3, (14/3)*t^2 + (7/3)*t + 1,...
                        t>3, 2*t + 44)
```