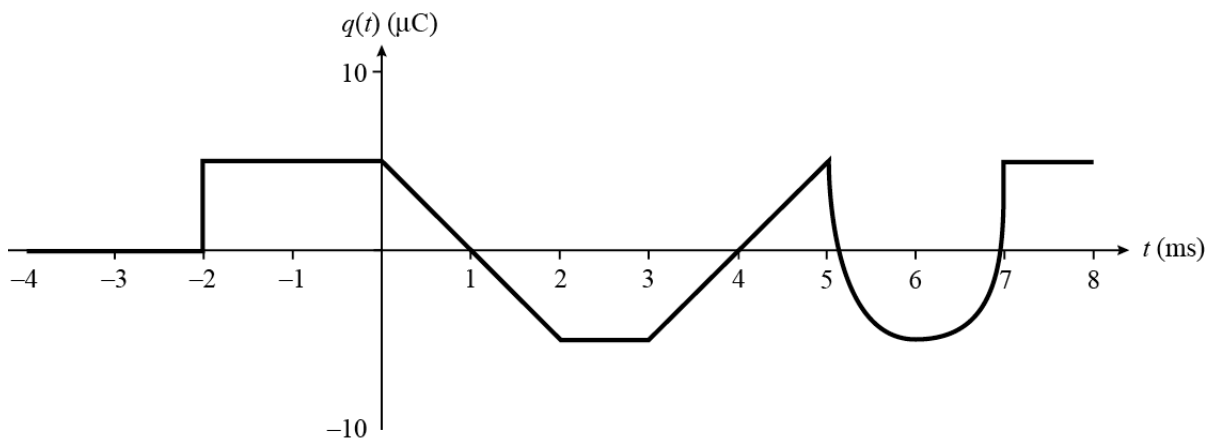


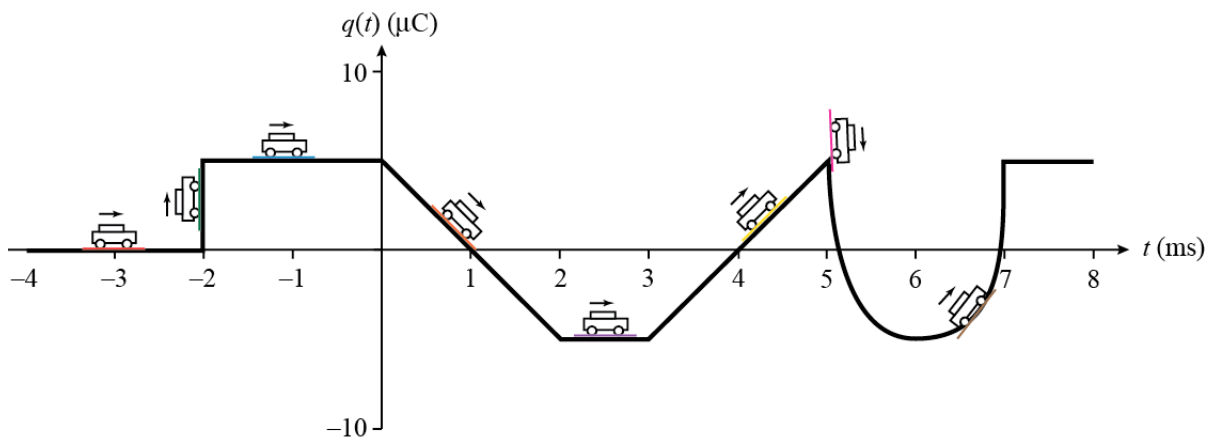
TOOL: The derivative of a curve is the slope of the curve at each point. Imagine a car driving on the curve from left to right. The derivative at time t is the slope the car is driving up or down at time t on the curve.

Ex: Sketch the current, i , for the charge, q , passing through a resistor as a function of time. The equation relating current to charge is $i = \frac{dq}{dt}$.



Note: above curve resembles actual data from the following source (8/28/2014):
<http://www.solarchoice.net.au/blog/how-do-i-use-electricity-throughout-the-day-the-load-curve/>

SOL'N: The illustration below shows the slopes encountered by the imaginary car driving from left to right on the given curve.



The slope as a function of time is shown below. The spike at $t = -2$ ms means the slope goes to infinity as the car drives straight uphill. This is called an impulse function, and engineers use it in systems theory, even though mathematicians had to invent the theory of generalized functions to explain why it works.

Between $t = -2$ ms and 0, the slope is zero, even though the car is now on top of a mesa. At $t = 0$, the car starts downhill at a slope of $-5 \mu\text{C/ms} = -5 \text{ mC/s}$. (The slope is the change in altitude over the change in time.) The slope is constant and negative from $t = 0$ to 2 ms.

At $t = 5$ ms, the car suddenly goes straight downhill, so the slope goes to negative infinity. Between $t = 5$ ms and 7 ms, our sketch is approximate. We would have to have a formula for $q(t)$ in order to calculate the exact slopes.

For $t > 7$ ms, the car is again on a mesa, and it sees no slope as it drives to the right.

