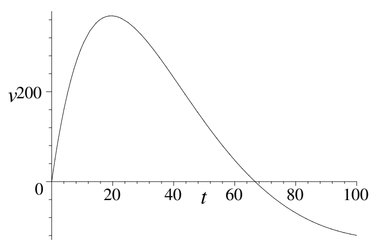
99. (a) With the understanding that these are good to three significant figures, we write the function (in SI units) as

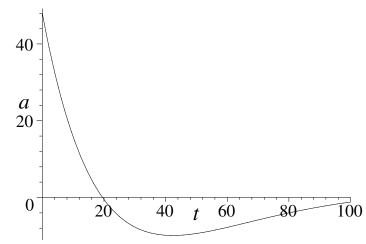
$$x(t) = -32 + 24t^2 e^{-0.03t}$$

and find the velocity and acceleration functions by differentiating (calculus is reviewed Appendix E). We find

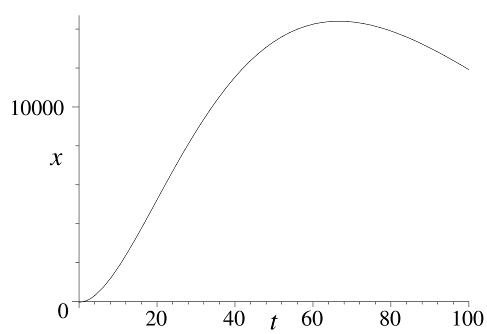
$$v(t) = 24t(2 - 0.03t)e^{-0.03t} \quad \text{and} \quad a(t) = 24\left(2 - 0.12t + 0.0009t^2\right)e^{-0.03t}\ .$$

(b) The $v(t)$ and $a(t)$ graphs are shown below (SI units understood). The time axis in both cases runs from $t = 0$ to $t = 100$ s. We include the $x(t)$ graph in the next part, accompanying our discussion of its root (which is, as suggested by the graph, a small positive value of t).





(c) We seek to find a positive value of t for which $24t^2 e^{-0.03t} = 32$. We turn to the calculator or to a computer for its (numerical) solution. In this case, we ignore the roots outside the $0 \le t \le 100$ range (such as $t = -1.14$ s and $t = 387.77$ s) and choose $t = 1.175$ s as our answer. All of these are rounded-off values. We find $v = 53.5$ m/s and $a = 43.1$ m/s^2 at this time.



(d) It is much easier to find when $24t(2 - 0.03t)e^{-0.03t} = 0$ since the roots are clearly $t_1 = 0$ and $t_2 = 2/0.03 = 66.7$ s. We find $x(t_1) = -32.0$ m and $a(t_1) = 48.0$ m/s^2 at the first root, and we find $x(t_2) = 1.44 \times 10^4$ m and $a(t_2) = -6.50$ m/s^2 at the second root.