6. [10 points] The force F, in Newtons, between two atoms a distance r femtometers (fm) apart in a molecule is given by $F(r) = b\left(\frac{a^2}{r^3} - \frac{a}{r^2}\right)$ for some positive constants a and b.

Note: Your answers below might involve the constants a and b.

a. [3 points] Find and interpret any horizontal intercept(s) of the graph of $F(r)$.

Solution: Horizontal intercepts occur when $F(r) = 0$. Note that $F(r) = b\left(\frac{a^2 - ar}{r^3}\right) = ba\left(\frac{a - r}{r^3}\right)$. Thus, $F(r) = 0$ when $r = a$. Under this condition, the force between the atoms is zero.

b. [3 points] Find any asymptote(s) of the graph of $F(r)$.

Solution: As $r \to \pm\infty, F(r) \to 0$, so there is a horizontal asymptote of $F(r) = 0$. Also, $F(r)$ is undefined at $r = 0$ and since the numerator is not zero there, we have a vertical asymptote at $r = 0$.

c. [4 points] Give the practical interpretation of $F'(1) = -1.2 \times 10^{-9}$.

Solution: When the distance between atoms is 1 femtometer, if the distance increases another femtometer (to two femtometers), the force between the atoms would decrease by approximately 1.2×10^{-9} Newtons.