PHYS 132 HW #1

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11, 16, 20, 31, 44, 54, 59, 79

Problem 11:

(a): The initial force experienced by the proton is $F = kq_1q_2/r^2 = k(q^2)/(0.0025^2)$ where q is the charge of a proton. By $F = ma$, we have

$$a = F/m = \frac{kq^2}{0.0025^2 \cdot m} = \frac{(9 \cdot 10^9)(1.6 \cdot 10^{-19})^2}{(2.5 \cdot 10^{-3})^2 \cdot 1.67 \cdot 10^{-27}} = 2.2 \cdot 10^4 m/s^2.$$

(b): The force will decrease over time as the protons get further apart, so acceleration will decrease as well. But it will always be positive, so velocity will always increase, though at a decreasing rate. I hope this description is sufficient.

Problem 16: q_3 must be to the left of q_1 to make q_1 accelerate to the left, so we can let the position of q_3 be $-x$ where $x > 0$. Then the total force on q_1 can be calculated by Coulomb's Law as

$$F = \frac{kq_1q_2}{0.2^2} - \frac{kq_1q_3}{x^2}$$

using the known values for F, q_1, q_2, q_3 gives

$$\begin{aligned}
-7 &= (9 \cdot 10^{-9})(3 \cdot 10^{-6})\left(\frac{(5 \cdot 10^{-6})}{0.2^2} - \frac{(8 \cdot 10^{-6})}{x^2}\right) \\
-7 &= 2.7 \cdot 10^{-14}\left((1.25 \cdot 10^{-4}) - (8 \cdot 10^{-6})/x^2\right) \\
-2.6 \cdot 10^{14} &= (1.25 \cdot 10^{-4}) - (8 \cdot 10^{-6})/x^2 \\
-(8 \cdot 10^{-6})/x^2 &= 1.25 \cdot 10^{-4} - 2.6 \cdot 10^{14} \\
x^2 &= -\frac{8 \cdot 10^{-6}}{1.25 \cdot 10^{-4} - 2.6 \cdot 10^{14}} \\
x^2 &= 3.1 \cdot 10^{-20} \\
x &= 1.8 \cdot 10^{-10}
\end{aligned}$$