Exam 1, Physics 208   **Name Printed in Ink:** Key   Pink

Dr.Saslow, 6/15/01   **Section:** ______

Don't waste time on questions you aren't sure of. Be clear and concise. A cluttered response will not get full credit.

1. (10 pts) A non-conducting rod lies on the x-axis from $(-2a, 0, 0)$ to $(a, 0, 0)$, where a is a constant. It has charge per unit length $\lambda = 6\alpha x^2$, where α is a constant. What units must a and α have? In terms of α and a, find the total charge Q on the rod, and the average charge per unit length $\bar{\lambda}$.

a is in meters, α is in C/m^3.

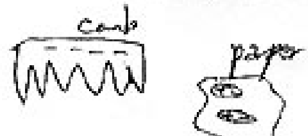
$$Q = \int dQ = \int \frac{dQ}{ds} ds = \int \lambda \, dx = \int_{-2a}^{a} 6\alpha x^2 dx$$

-2a -a 0 a 2a

$$= 6\alpha \frac{x^3}{3}\Big|_{-2a}^{a} = 2\alpha\left[a^3 - (-2a)^3\right] = 18\alpha a^3$$

$$\bar{\lambda} = \frac{Q}{\ell} = \frac{18\alpha a^3}{3a} = 6\alpha a^2$$

2. (10 pts) For the benefit of Bart Simpson's teacher, concisely explain the amber effect and why it is attractive. In your figure use a negative source charge.



1. Charge on comb polarizes molecules of paper.
2. Near (far) end of each molecule is attracted (repelled).
3. Since force falls off with distance, near end force wins: net attraction.

3. Consider two infinite conducting parallel plates, the top with total charge per unit area $3\sigma_0$ and the bottom with total charge per unit area $5\sigma_0$ ($\sigma_0 > 0$).

a. (5 pts) Find the total field (magnitude and direction) between the plates.

} total $3\sigma_0$

$$\vec{E} = \underbrace{2\pi k(3\sigma_0)\downarrow}_{\text{top sheet}} + \underbrace{2\pi k(5\sigma_0)\uparrow}_{\text{bottom sheet}} = 4\pi k\sigma_0 \uparrow$$

} total $5\sigma_0$

b. (5 pts) Find the charge density on the top surface of the bottom sheet.

$$\vec{E}_{out}\cdot\hat{n} = 4\pi k\sigma_s \; ; \; \vec{E}_{out} = 4\pi k\sigma_0 \uparrow, \; \hat{n} = \uparrow$$

$$\Rightarrow \sigma_s = \frac{\vec{E}_{out}\cdot\hat{n}}{4\pi k} = \frac{(4\pi k\sigma_0 \uparrow)\cdot\uparrow}{4\pi k} = \sigma_0$$