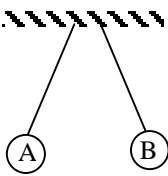
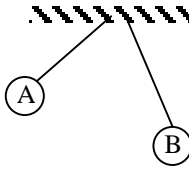
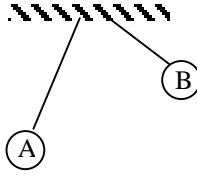
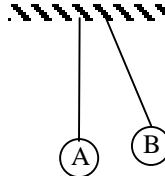
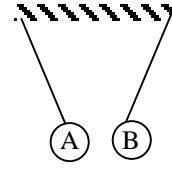
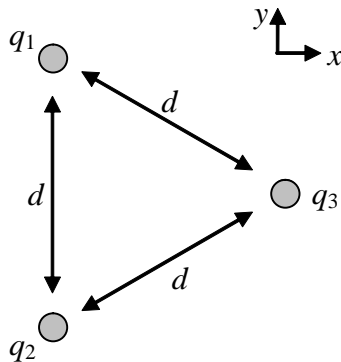


1. A neutral metal ball is suspended by a string. A positively charged insulating rod is placed near the ball, which is observed to be attracted to the rod. This is because:
 - A. the ball becomes positively charged by induction.
 - B. the ball becomes negatively charged by induction.
 - C. the number of electrons in the ball is more than the number in the rod.
 - D. the string is not a perfect insulator.
 - E. there is a rearrangement of electrons in the ball.

2. The figures show two positively charged spheres of equal mass, each suspended by a string of equal length. Sphere A has twice as much charge as B. Which of the following figures correctly depicts the entire system in static equilibrium?
 - A. 
 - B. 
 - C. 
 - D. 
 - E. 

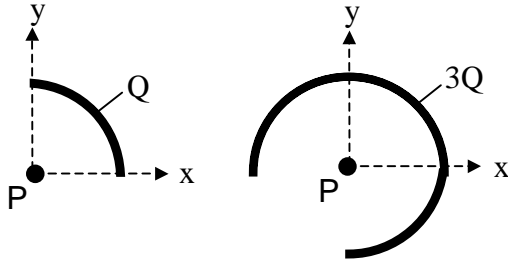
- A. A
- B. B
- C. C
- D. D
- E. E

3. The figure shows two charges $q_1 = q_2 = 20\mu\text{C}$ held at a fixed distance $d = 2\text{ m}$ apart. A third charge $q_3 = 40\mu\text{C}$ is brought and placed as shown in the figure, forming an equilateral triangle with the other two. What is the magnitude and direction (with respect to the positive x axis) of the total electrostatic force on q_1 .

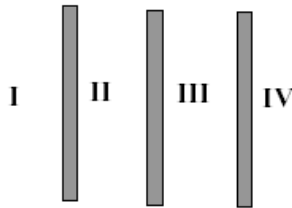


- A. 2.4 N, 131°
 B. 2.7 N, 152°
 C. 0.9 N, 90°
 D. 0.9 N, 47°
 E. 2.7 N, 180°
4. A $+50\mu\text{C}$ is fixed at the origin ($x = 0$) and a $+30\mu\text{C}$ charge is fixed on the x axis at $x = 4\text{ m}$. What is the x component of the force on a $-40\mu\text{C}$ charge when it is placed at $x = 2\text{ m}$ on the x axis?
- A. 0
 B. 20.7 N
 C. -20.7 N
 D. 3.6 N
 E. -1.8 N
5. A 200-N/C electric field is in the positive x direction. The force on an electron in this field is:
- A. 200 N in the positive x direction
 B. 200 N in the negative x direction
 C. $3.2 \times 10^{-17}\text{ N}$, in the positive x direction
 D. $3.2 \times 10^{-17}\text{ N}$, in the negative x direction
 E. 0

6. Positive charge $+Q$ is uniformly distributed on the rod to the left and positive charge $+3Q$ is uniformly distributed on the rod to the right. What is the ratio of the magnitude of the electric field at P due to these two charge configurations?

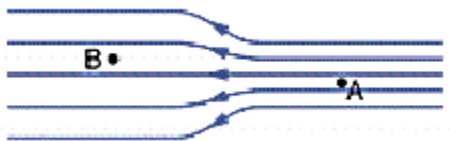


- A. $\frac{E_1}{E_2} = 3$
 B. $\frac{E_1}{E_2} = 3\pi$
 C. $\frac{E_1}{E_2} = \pi/3$
 D. $\frac{E_1}{E_2} = 1/3$
 E. $\frac{E_1}{E_2} = 1$
7. The figure shows an edge-on view of three extremely large, parallel insulating sheets positively charged with uniform and identical surface charge densities. In which of the regions shown is the electric field a maximum?

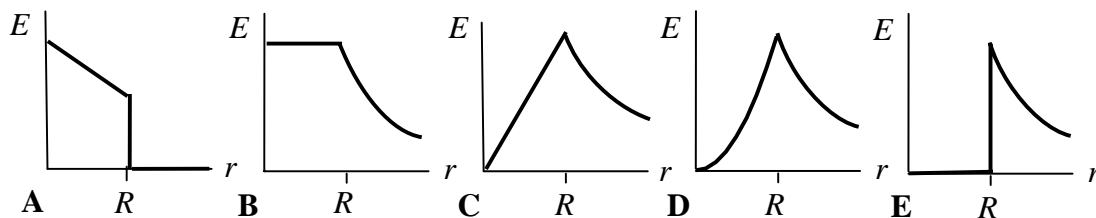


- A. The field is everywhere uniform - all are the same
 B. II & III
 C. III
 D. IV
 E. I & IV

8. The electric field lines in some region of space are shown in the figure below. At B the density of lines is half that at A. If a proton placed at A experiences a force of magnitude 10 pN, what is the direction and magnitude of the force experienced by an electron at point B?

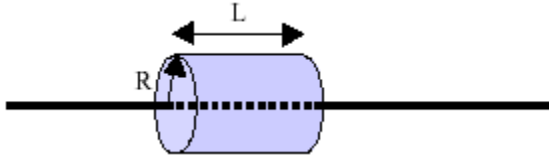


- A. 5 pN to the right.
 B. 5 pN to the left.
 C. 20 pN to the left.
 D. 20 pN to the right.
 E. 10 pN to the right.
9. A solid insulating sphere of radius R contains a uniform volume distribution of positive charge. Which of the graphs correctly gives the magnitude E of the electric field as a function of r from the center of the sphere?

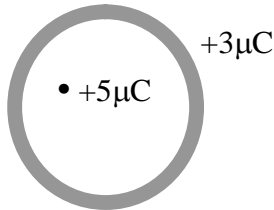


- A. **A**
 B. **B**
 C. **C**
 D. **D**
 E. **E**
10. The flux of the electric field $(24\hat{i} + 30\hat{j} + 16\hat{k})$ N/C through a 2.0m^2 portion of the yz plane is:
- A. $32 \text{ N} \cdot \text{m}^2 / \text{C}$
 B. $34 \text{ N} \cdot \text{m}^2 / \text{C}$
 C. $42 \text{ N} \cdot \text{m}^2 / \text{C}$
 D. $48 \text{ N} \cdot \text{m}^2 / \text{C}$
 E. $60 \text{ N} \cdot \text{m}^2 / \text{C}$

11. The figure shows a cylindrical Gaussian surface that surrounds a section of an infinitely long line of charge. The cylinder has a length L and a radius R . The line of charge has a uniform linear charge density λ . What is the total flux through the surface of the Gaussian cylinder?

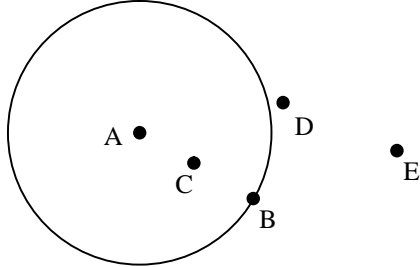


- A. 0
 B. $2\pi RL\lambda\epsilon_0$
 C. $(2\pi R^2 + 2\pi RL)(\lambda/\epsilon_0)$
 D. $(2\pi R^2 + 2\pi RL)/\epsilon_0$
 E. $\lambda L/\epsilon_0$
12. Consider a conducting spherical shell with a excess charge of $+3\mu\text{C}$, and a point charge of $+5\mu\text{C}$ inside the shell, but not at the center. What is the distribution of charge on the inner and outer surfaces of the shell?



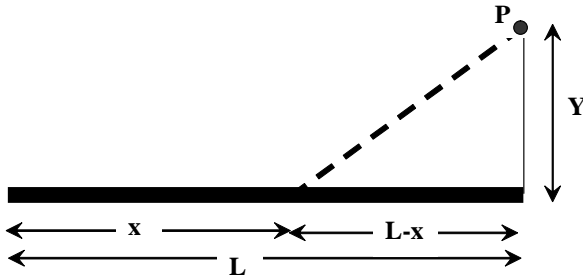
- A. $+1.5\mu\text{C}$ are uniformly distributed in the inner surface, $+1.5\mu\text{C}$ are uniformly distributed on the outer surface.
 B. $-5\mu\text{C}$ are uniformly distributed in the inner surface, and $+8\mu\text{C}$ are uniformly distributed on the outer surface.
 C. $-5\mu\text{C}$ are non-uniformly distributed in the inner surface, and $+8\mu\text{C}$ are uniformly distributed on the outer surface.
 D. $-5\mu\text{C}$ are non-uniformly distributed in the inner surface, and $+8\mu\text{C}$ are non-uniformly distributed on the outer surface.
 E. We can't say without knowing the distance of the inner point charge to the shell.
13. You are located at distance of a 5 m from the axis of an extremely long uniformly charged cylinder of radius 1 mm. If you double your distance from the cylinder, what happens to the electric field?
- A. Remains the same.
 B. Decreases by a factor of 2.
 C. Decreases by a factor of 4.
 D. Decreases by a factor of 8.
 E. Increases by a factor of 4.

14. Positive charge is distributed uniformly throughout a solid non-conducting sphere. The highest electric potential occurs:



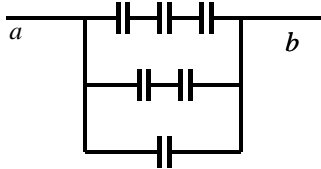
- A. at the center
B. at the surface
C. halfway between the center and surface
D. just outside the surface
E. far from the sphere
15. A 5.5×10^{-8} C charge is fixed at the origin. A -2.3×10^{-8} C charge is moved from $x = 3.5$ cm on the x -axis to $y = 3.5$ cm on the y axis. The change in the potential energy (final – initial) of the two-charge system is:
- A. 3.2×10^{-4} J
B. -3.2×10^{-4} J
C. 9.3×10^{-3} J
D. -9.3×10^{-3} J
E. 0
16. The electric field in some region of space points along the $+x$ axis and decreases in magnitude as x increases. The potential then:
- A. is zero everywhere on the x -axis.
B. is constant but non-zero on the x -axis.
C. increases as x increases.
D. decreases as x increases.
E. none of the above.

17. The figure below shows a thin, straight rod of length L over which a charge Q is uniformly distributed. Which of the expressions below gives the magnitude of the electric potential at point P located a perpendicular distance Y away from one end of the rod?

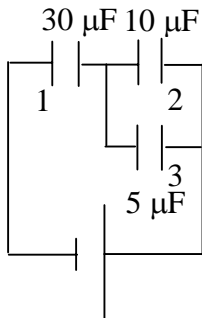


- A. $\frac{kQ}{L} \int_0^L \frac{dx}{(L^2 + x^2)^{3/2}}$
- B. $\frac{kQ}{L} \int_0^L \frac{dx}{\sqrt{(L-x)^2 + Y^2}}$
- C. $\frac{kQ}{L} \int_0^L \frac{dx}{Y^2 + x^2}$
- D. $\frac{kQ}{L} \int_0^L \frac{dx}{\sqrt{L^2 + Y^2}}$
- E. $\frac{kQ}{L} \int_0^L \frac{dx}{L^2 + x^2}$
18. A parallel plate capacitor is charged using a battery until the energy stored on the capacitor is 1 J. The battery is then disconnected. If the plates of the capacitor are pulled apart so that the distance between them is doubled, what happens to the energy stored on the capacitor?
- A. The energy stored is now 0.5 J.
- B. The energy stored is now 2 J.
- C. The energy stored is still 1 J.
- D. The energy stored is now 4 J.
- E. The energy stored is now 8 J.

19. The diagram shows six $6 \mu\text{F}$ capacitors. The capacitance between points a and b is:



- A. $3 \mu\text{F}$
 - B. $4 \mu\text{F}$
 - C. $6 \mu\text{F}$
 - D. $9 \mu\text{F}$
 - E. $11 \mu\text{F}$
20. What is the charge on the $30 \mu\text{F}$ capacitor in the included circuit?



120 V

- A. $12 \mu\text{C}$
- B. $800 \mu\text{C}$
- C. $400 \mu\text{C}$
- D. $1200 \mu\text{C}$
- E. $3600 \mu\text{C}$