Name: _____ **Class:** _____ **Date:** _____ **ID: A**

Cp physics web review ch 18 Electric Fields and Capacitors

Please do not write on my tests

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Two point charges, initially 1 cm apart, are moved to a distance of 3 cm apart. By what factor do the resulting electric and gravitational forces between them change?
a. 9
b. 3
c. $\frac{1}{3}$
d. $\frac{1}{9}$

____ 2. A conductor that is in electrostatic equilibrium has an electric field inside the conductor that
a. depends on the radius of the conductor.
b. is zero.
c. is greatest near the conductor's surface.
d. is parallel to the surface of the conductor.

____ 3. The electric field just outside a charged conductor in electrostatic equilibrium is
a. zero.
b. at its minimum level.
c. the same as it is in the center of the conductor.
d. perpendicular to the conductor's surface.

____ 4. Electric field strength depends on
a. charge and distance.
b. charge and mass.
c. Coulomb constant and mass.
d. elementary charge and radius.

____ 5. When a capacitor discharges,
a. it must be attached to a battery.
b. charges move through the circuit from one plate to the other until both plates are uncharged.
c. charges move from one plate to the other until equal and opposite charges accumulate on the two plates.
d. it cannot be connected to a material that conducts.

____ 6. A capacitor consists of two metal plates; ____ is stored on one plate, and ____ is stored on the other.
a. negative charge, positive charge
b. potential energy, kinetic energy
c. potential difference, internal resistance
d. residual charge, induced charge

____ 7. What effect will be produced on a capacitor if the separation between the plates is increased?
a. It will increase the charge.
b. It will decrease the charge.
c. It will increase the capacitance.
d. It will decrease the capacitance.

____ 8. Increasing the potential difference between the plates of a capacitor will produce what effect on the capacitor?
a. It will increase the charge on each plate.
b. It will decrease the charge on each plate.
c. It will increase the capacitance.
d. It will decrease the capacitance.

____ 9. A 0.25 μF capacitor is connected to a 9.0 V battery. What is the charge on the capacitor?

a. 1.2×10^{-12} C
c. 2.5×10^{-6} C
b. 2.2×10^{-6} C
d. 2.8×10^{-2} C

____ 10. A 0.50 μF capacitor is connected to a 12 V battery. Use the expression $PE = \frac{1}{2}C(\Delta V)^2$ to determine how much electrical potential energy is stored in the capacitor.

a. 3.0×10^{-6} J
c. 1.0×10^{-5} J
b. 6.0×10^{-6} J
d. 3.6×10^{-5} J

____ 11. What is the potential difference across a 5.0 Ω resistor that carries a current of 5.0 A?

a. 1.0×10^{2} V
c. 10.0 V
b. 25 V
d. 1.0 V

Problem

12. Two point charges are 4.0 cm apart and have values of 30.0 μC and –30.0 μC, respectively. What is the electric field at the midpoint between the two charges? ($k_C = 8.99 \times 10^9$ N•m^2/C^2)

13. Charges of 4.0 μC and –6.0 μC are placed at two corners of an equilateral triangle with sides of 0.10 m. What is the magnitude of the electric field created by these two charges at the third corner of the triangle?

14. An electric field of 3279 N/C is produced by a charge of 5.72×10^{-11} C. For this field strength, what is the distance to the charge? ($k_C = 8.99 \times 10^9$ Nm^2/C^2)

15. Two equal but oppositely charged points are 1.0 m apart in a vacuum. The electric field intensity at the midpoint between the charges is 2.4×10^5 N/C. What is the magnitude of each charge? ($k_C = 8.99 \times 10^9$ N•m^2/C^2)

16. What is the capacitance of a parallel-plate capacitor made of two square aluminum plates that are 4.0 cm in length on each side and are separated by 5.0 mm? ($\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N•m^2)

17. A 0.75 μF capacitor holds 6.0 μC of charge on each plate. How much potential energy is stored in the capacitor?

Cp physics web review ch 18 Electric Fields and Capacitors
Answer Section

MULTIPLE CHOICE

1. D
2. B
3. D
4. A
5. B
6. A
7. D
8. A
9. B
10. D
11. B

PROBLEM

12. 1.3×10^{9} N/C

Given

$r_1 = r_2 = 2.0 \text{ cm} = 2.0 \times 10^{-2} \text{ m}$

$\theta_1 = 0°$

$\theta_2 = 180°$

$q_1 = 30 \ \mu\text{C} = 3.0 \times 10^{-5} \text{ C}$

$q_2 = -30 \ \mu\text{C} = -3.0 \times 10^{-5} \text{ C}$

$k_C = 8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2$

Solution

$$E_1 = k_C \frac{q_1}{r_1^{\,2}} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right) \left(\frac{3.0 \times 10^{-5} \text{ C}}{\left(2.0 \times 10^{-2} \text{ m}\right)^2} \right) = 6.7 \times 10^{8} \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^{\,2}} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right) \left(\frac{-3.0 \times 10^{-5} \text{ C}}{\left(2.0 \times 10^{-2} \text{ m}\right)^2} \right) = -6.7 \times 10^{8} \text{ N/C}$$

For E_1 : $E_{x,1} = (E_1)(\cos 0°) = (6.7 \times 10^{8} \text{ N/C})(\cos 0°) = 6.7 \times 10^{8} \text{ N/C}$

$E_{y,1} = 0 \text{ N/C}$

For E_2 : $E_{x,2} = (E_2)(\cos 180°) = (-6.7 \times 10^{8} \text{ N/C})(\cos 180°) = 6.7 \times 10^{8} \text{ N/C}$

$E_{y,2} = 0 \text{ N/C}$

$E_{x,tot} = E_{x,1} + E_{x,2} = 6.7 \times 10^{8} \text{ N/C} + 6.7 \times 10^{8} \text{ N/C} = 1.3 \times 10^{9} \text{ N/C}$

$E_{y,tot} = E_{y,1} + E_{y,2} = 0 \text{ N/C} + 0 \text{ N/C} = 0 \text{ N/C}$

$$E_{tot} = \sqrt{\left(E_{x,tot}\right)^2 + \left(E_{y,tot}\right)^2} = \sqrt{\left(1.3 \times 10^{9} \text{ N/C}\right)^2 + 0} = 1.3 \times 10^{9} \text{ N/C}$$

$E_{tot} = 1.3 \times 10^{9} \text{ N/C}$

13. 4.8×10^{6} N/C

Given

$q_1 = 4.0 \times 10^{-6}$ C

$q_2 = -6.0 \times 10^{-6}$ C

$\theta = 60°$

$r_1 = 1.0 \times 10^{-1}$ m

$r_2 = 1.0 \times 10^{-1}$ m

$k_C = 8.99 \times 10^{9}$ Nm^2/C^2

Solution

$$E_1 = k_C \frac{q_1}{r_1^{\,2}} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right) \left(\frac{4.0 \times 10^{-6} \text{ C}}{\left(1.0 \times 10^{-1} \text{ m}\right)^2} \right) = 3.6 \times 10^{6} \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^{\,2}} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right) \left(\frac{-6.0 \times 10^{-6} \text{ C}}{\left(1.0 \times 10^{-1} \text{ m}\right)^2} \right) = -5.4 \times 10^{6} \text{ N/C}$$

For E_1 : $E_{x,1} = (E_1)(\cos 60°) = (3.6 \times 10^{6} \text{ N/C})(\cos 60°) = 1.8 \times 10^{6}$ N/C

$E_{y,1} = (E_1)(\sin 60°) = (3.6 \times 10^{6} \text{ N/C})(\sin 60°) = 3.1 \times 10^{6}$ N/C

For E_2 : $E_{x,2} = -(E_2)(\cos 60°) = -(-5.4 \times 10^{6} \text{ N/C})(\cos 60°) = 2.7 \times 10^{6}$ N/C

$E_{y,2} = (E_2)(\sin 60°) = (-5.4 \times 10^{6} \text{ N/C})(\sin 60°) = -4.7 \times 10^{6}$ N/C

$E_{x,tot} = E_{x,1} + E_{x,2} = 1.8 \times 10^{6} \text{ N/C} + 2.7 \times 10^{6} \text{ N/C} = 4.5 \times 10^{6}$ N/C

$E_{y,tot} = E_{y,1} + E_{y,2} = 3.1 \times 10^{6} \text{ N/C} + (-4.7 \times 10^{6} \text{ N/C}) = -1.6 \times 10^{6}$ N/C

$$E_{tot} = \sqrt{\left(E_{x,tot}\right)^2 + \left(E_{y,tot}\right)^2} = \sqrt{\left(4.5 \times 10^{6} \text{ N/C}\right)^2 + \left(-1.6 \times 10^{6} \text{ N/C}\right)^2} = 4.8 \times 10^{6} \text{ N/C}$$

$E_{tot} = 4.8 \times 10^{6}$ N/C

14. 1.25×10^{-2} m

Given
$E = 3279$ N/C
$q = 5.72 \times 10^{-11}$ C
$k_C = 8.99 \times 10^9$ Nm^2/C^2

Solution
$$\mathrm{E} = k_C \frac{q}{r^2}$$
Rearrange to solve for r.
$$r = \sqrt{k_C \frac{q}{E}} = \sqrt{\left(8.99 \times 10^9 \text{ Nm}^2/\text{C}^2\right)\left(\frac{5.72 \times 10^{-11} \text{ C}}{3279 \text{ N/C}}\right)}$$
$r = 1.25 \times 10^{-2}$ m

15. 3.3×10^{-6} C

Given
$q_1 = q_2$
$r_{total} = 1.0$ m
$r_1 = r_2 = 0.50$ m
$E_{total} = 2.4 \times 10^5$ N/C
$k_C = 8.99 \times 10^9$ Nm^2/C^2

Solution
$$E_1 = E_2 = \frac{E_{total}}{2} = \frac{2.4 \times 10^5 \text{ N/C}}{2} = 1.2 \times 10^5 \text{ N/C}$$
$$E_1 = k_C \frac{q_1}{r_1^{\,2}}$$
Rearrange to solve for q_1.
$$q_1 = \frac{E_1 r_1^{\,2}}{k_C} = \frac{\left(1.2 \times 10^5 \text{ N/C}\right)(0.50 \text{ m})^2}{8.99 \times 10^9 \text{ Nm}^2/\text{C}^2} = 3.3 \times 10^{-6} \text{ C}$$
$q_1 = q_2 = 3.3 \times 10^{-6}$ C

16. 2.8×10^{-12} F

Given

$l = 4.0 \text{ cm} = 4.0 \times 10^{-2} \text{ m}$

$d = 5.0 \text{ mm} = 5.0 \times 10^{-3} \text{ m}$

$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \bullet \text{m}^2$

Solution

$A = l^2 = (4.0 \times 10^{-2} \text{ m})^2 = 1.6 \times 10^{-3} \text{ m}^2$

$$C = \varepsilon_0 \frac{A}{d} = (8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2)\left(\frac{1.6 \times 10^{-3} \text{ m}^2}{5.0 \times 10^{-3} \text{ m}} \right)$$

$C = 2.8 \times 10^{-12}$ F

17. 2.4×10^{-5} J

Given

$C = 0.75 \ \mu\text{F} = 7.5 \times 10^{-7}$ F

$Q = 6.0 \ \mu\text{C} = 6.0 \times 10^{-6}$ C

Solution

Find the voltage across the capacitor, using the equation for capacitance.

$$C = \frac{Q}{\Delta V}$$

Rearrange to solve for ΔV.

$$\Delta V = \frac{Q}{C} = \frac{6.0 \times 10^{-6} \text{ C}}{7.5 \times 10^{-7} \text{ F}} = 8.0 \text{ V}$$

Find the potential energy.

$$PE_{electric} = \frac{1}{2} C(\Delta V)^2 = \frac{1}{2}(7.5 \times 10^{-7} \text{ F})(8 \text{ V})^2$$

$PE_{electric} = 2.4 \times 10^{-5}$ J