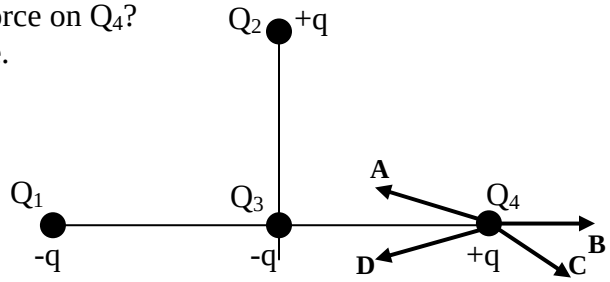
1. A comb that is rubbed through your hair attracts small bits of paper, even though the paper is uncharged. Which of the following best explains why?

A) The electric field inside the paper is zero.
B) The electric force is always attractive.
C) The paper becomes polarized.
D) Rubber and paper always attract each other.
E) None of these.

2. Four point charges are arranged as in the figure below with their magnitudes and signs given. Which arrow shows the direction of the net force on Q_4? The distances between the charges are drawn to scale.

A) A
B) B
C) C
D) D
E) None of these.



3. A negatively charged particle moving at constant speed from right to left enters a region of space where a uniform electric field exists (see figure). Once the particle enters the field, it slows, momentarily stops, and then moves back out of the field from left to right along the same initial path. What is the direction of the electric field?

A) Up
B) Down
C) Right
D) Left
E) Into the page.

4. Refer to problem 3. Which region of the field is at a higher potential?

A) Top
B) Left
C) Right
D) Bottom
E) The potential is the same everywhere.

5. Three capacitors are connected in series to a battery. Which of the following is definitely true?

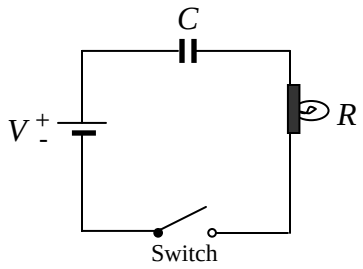
A) The voltage drop across each capacitor is the same.
B) The voltage drop across the middle capacitor is greater than the battery voltage.
C) The charge on the plates of the first capacitor is equal to the charge on the plates of the middle capacitor.
D) The equivalent capacitance is just the sum of the three capacitances.
E) None of these.

6. A circular piece of copper wire has a resistance R. What would the resistance be if we tripled both the wire's length and its radius?

A) 3R
B) R/9
C) R
D) R/3
E) None of these.

7. Consider the simple circuit shown below, in which a light bulb with resistance *R* and a capacitor with capacitance *C* are connected in series with a battery and an open switch. The capacitor has a large capacitance and is initially uncharged. The battery provides enough power to light the bulb when it is connected directly to the battery. What happens when the switch is closed?

A) Nothing
B) The light bulb glows with a constant intensity.
C) The light bulb gradually gets brighter as time passes.
D) The light bulb starts out at its brightest and then gradually gets dimmer as time passes.
E) The light bulb blinks on and off.



8. A proton is released from rest at $t = 0$ in a uniform electric field whose magnitude is 2.5×10^{-8} N/C. How far has the proton traveled after 0.5 s?

A) 0.3 m
B) 1.2 m
C) 0.6 m
D) 550 m
E) None of these.

9. An electron is released from rest at the negative plate of a parallel plate capacitor. When released, it accelerates toward the positive plate and strikes it with a velocity of 1.5×10^6 m/s. If the separation distance between the plates is 4.0 cm, what is the surface charge density on each plate?

A) 0
B) 1.4×10^{-9} C/m^2
C) 2.8×10^{-9} C/m^2
D) 9.4×10^{-16} C/m^2
E) None of these.

10. A gun that fires charged particles accelerates a 5-μC charge from rest through a potential difference of 50,000 V. The particle has a mass of 0.025 kg. With what speed does it leave the gun?

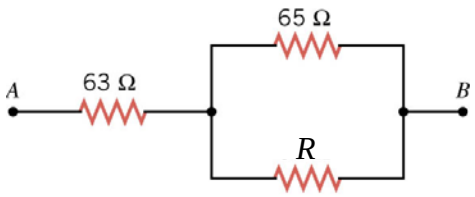
A) 20 m/s
B) 4.5 m/s
C) 3.2 ms
D) 0.14 m/s
E) None of these.

11. A 2-Ω and a 6-Ω resistor are connected in series to a battery with V = 12 V. Calculate the power dissipated in the 6-Ω resistor.

A) 9 W
B) 12 W
C) 13.5 W
D) 2.67 W
E) None of these.

12. The equivalent resistance between points A and B is 99.83 Ω. What is the value of R?

A) 37 Ω
B) 85 Ω
C) 28 Ω
D) 65 Ω
E) None of these.



13. Two capacitors C_1 and C_2 are connected in series to a 9-V battery. The magnitude of the charge on each plate of C_1 is 7.5 μC. The value of C_1 is 2 μF. What would be the equivalent capacitance if these two capacitors were wired in parallel?

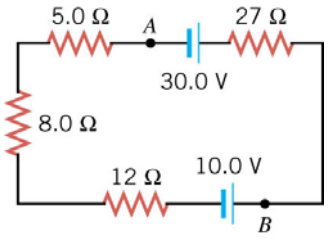
A) 3.43 μF
B) 3.75 μF
C) 5.25 μF
D) 0.83 μF
E) None of these.

14. An electron is accelerated from rest through a potential difference of 35,000 V. What is the electron's kinetic energy in Joules?

A) 1.12×10^{-14} J
B) 5.61×10^{-15} J
C) 2.18×10^{23} J
D) 35,000 J
E) None of these.

15. What is the magnitude and direction of the current in the following circuit?

A) 0.77 A, counter clockwise
B) 0.77 A, clockwise
C) 0.38 A, counter clockwise
D) 0.38 A, clockwise
E) None of these.



16. Each plate of an empty parallel plate capacitor has a surface charge density of 5.4×10^{-9} C/m^2. What is the value of the electric field between the plates of this capacitor if we fill it with Teflon, which has a dielectric constant $\kappa = 2.1$?

A) 610 N/C
B) 305 N/C
C) 291 N/C
D) 1280 N/C
E) None of these.

17. A point charge of +2.5 μC is fixed at the origin of the *x*-axis. An alpha particle is placed at the 2-m position and released. What is the initial acceleration of the alpha particle? Remember that the alpha particle is the nucleus of a helium atom, so it contains two protons and two neutrons. The alpha particle has a mass of 6.64×10^{-27} kg.

A) 2.71×10^{11} m/s^2
B) 1.36×10^{11} m/s^2
C) 5.72×10^{11} m/s^2
D) 2.67×10^{-10} m/s^2
E) None of these.

18. What percentage of the equilibrium charge value has built up on the plates of a capacitor if it is initially uncharged and then charged for a length of time equal to two time constants?

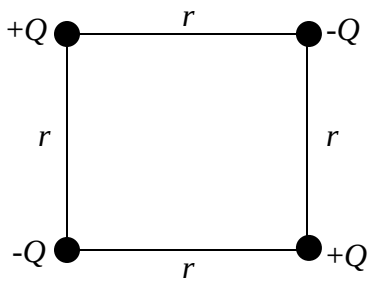
A) 100%
B) 95.2%
C) 86.5%
D) 63.2 %
E) None of these.

19. Four point charges are fixed at the vertices of a square as shown. The square has a side of length *r*. What is the value of the electric potential at the center of the square?

A) $\sqrt{2}kQ/r$ B) $-\sqrt{2}kQ/r$

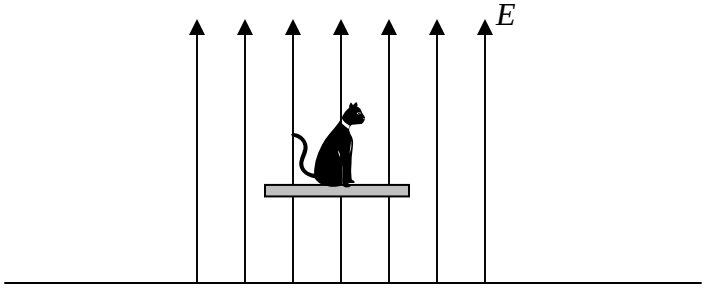
C) $2\sqrt{2}kQ/r$ D) 0

E) None of these.



20. My favorite cat Socola sits on a charged metal dish. He and the dish are placed in a uniform electric field such that he levitates motionless above the ground. The combined mass of Socola and the dish is 6.8 kg. If the dish carries a charge of $+1.5 \times 10^{-3}$ C, then what is the value of the electric field?

A) 8.88×10^4 N/C
B) 4.44×10^4 N/C
C) 4.53×10^3 N/C
D) 1.27×10^3 N/C
E) None of these.



Answers

1. C
2. D
3. D
4. C
5. C
6. D
7. D
8. A
9. B
10. B
11. C
12. B
13. A
14. B
15. D
16. C
17. A
18. C
19. D
20. B