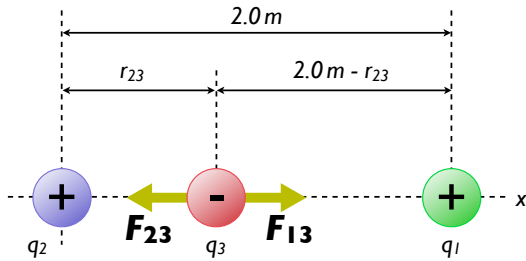


PH 102 Exam I

1. A “free” electron and a “free” proton are placed in an identical electric field. Which of the following statements are true? *Check all that apply.*

- Each particle is acted on by the same electric force and has the same acceleration.
 The electric force on the proton is greater in magnitude than the force on the electron, but in the opposite direction.
 The electric force on the proton is equal in magnitude to the force on the electron, but in the opposite direction.
 The magnitude of the acceleration of the electron is greater than that of the proton.
 Both particles have the same acceleration.

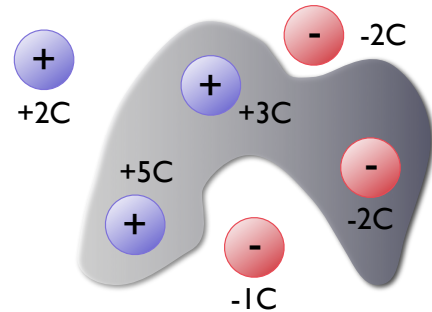


2. Three point charges lie along the x axis, as shown at left. A positive charge $q_1 = 15 \mu\text{C}$ is at $x = 2 \text{ m}$, and a positive charge of $q_2 = 6 \mu\text{C}$ is at the origin. Where must a *negative* charge q_3 be placed on the x -axis such that the resulting electric force on it is zero?

- $x = +0.77 \text{ m}$
 $x = -3.44 \text{ m}$
 $x = +1.34 \text{ m}$
 $x = -1.44 \text{ m}$

3. What is the electric flux through the surface at right?

- $+5 \text{ C}/\epsilon_0$
 $-3 \text{ C}/\epsilon_0$
 0
 $+6 \text{ C}/\epsilon_0$



4. A point charge q is located at the center of a (non-conducting) spherical shell of radius a that has a charge $-q$ uniformly distributed on its surface. What is the electric field *for all points outside the spherical shell*?

- none of these
 $E = 0$
 $E = q/4\pi r^2$
 $E = kq/r^2$
 $E = kq^2/r^2$

5. What is the electric field inside the same shell a distance r from the center?

- $E = kq/r^2$
- $E = kq^2/r^2$
- none of these
- $E = 0$
- $E = q/4\pi r^2$

6. A spherical conducting object A with a charge of $+Q$ is lowered through a hole into a metal (conducting) container B that is initially uncharged (and is not grounded). When A is at the center of B , but not touching it, the charge on the inner surface of B is:

- $+Q$
- $-Q$
- 0
- $+Q/2$
- $-Q/2$

7. Consider a collection of charges in a given region, and suppose all other charges are distant and have negligible effect. The electric potential is taken to be zero at infinity. If the electric potential at a given point in the region is zero, which of the following statements must be true?

- The electric field is zero at that point.
- The electric potential energy is a minimum at that point.
- There is no net charge in the region.
- Some charges in the region are positive and some are negative.
- The charges have the same sign and are symmetrically arranged around the given point.

8. Electrons in a TV tube are accelerated from rest through a potential difference of 2.00×10^4 V from an electrode towards the screen 25.0 cm away. What is the magnitude of the electric field, if it assumed to be constant over the whole distance?

- 800 V/m
- 5.00×10^5 V/m
- 8.00×10^4 V/m
- 5.00×10^3 V/m

9. A proton moves 1.5 cm parallel to a uniform electric field of $E = 240$ N/C. How much work is done by the field on the proton?

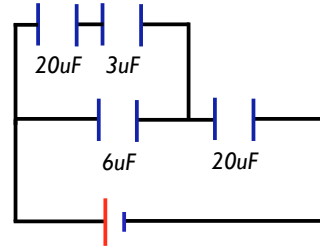
- 3.84×10^{-17} J
- 5.76×10^{-19} J
- 5.76×10^{-17} J
- 1.60×10^4 J

10. To recharge a 12 V battery, a charger must move 3.3×10^5 C of charge from the negative to the positive terminal. How much work is done by the charger, in Joules?

- 7.92×10^6 J
- 3.31×10^5 J
- 2.75×10^4 J
- 3.96×10^6 J

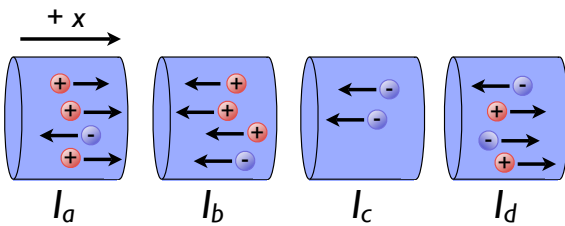
11. What is the effective capacitance of the four capacitors shown at right?

- 4.84 μF
- 6.02 μF
- 24.8 μF
- 49.0 μF



12. Calculate the speed of a proton that is accelerated from rest through a potential difference of 104 V.

- $6.04 \times 10^6 \text{ m/s}$
- $2.01 \times 10^5 \text{ m/s}$
- $3.96 \times 10^4 \text{ m/s}$
- $1.41 \times 10^5 \text{ m/s}$



13. Consider the positive and negative charges moving horizontally through the four regions at left. Rank the magnitudes of the currents in these four regions *from highest to lowest*. Positive current is defined as positive charges moving in the $+x$ direction.

- $I_a > I_c = I_d > I_b$
- $I_a > I_d > I_c > I_b$
- $I_d > I_a > I_b > I_c$
- $I_a > I_d = I_b > I_c$

14. In a time interval of 1.37 sec, the amount of charge that passes through a light bulb is 1.73 C. How many electrons pass through the bulb in **5.00 sec**?

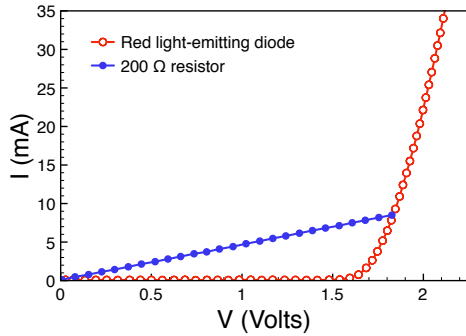
- 8.47×10^{19}
- 4.58×10^{17}
- 3.95×10^{19}
- 7.90×10^{18}

15. A toaster is rated at 550 W when connected to a 130 V source. What current does the toaster carry?

- 5.04 A
- 1.83 A
- 2.12 A
- 4.23 A

17. A potential difference of 11 V is found to produce a current of 0.45 A in a 3.8 m length of wire with a uniform radius of 0.38 cm. What is the resistivity of the wire?

- $204 \Omega \cdot \text{m}$
- $2.04 \times 10^6 \Omega \cdot \text{m}$
- $2.94 \Omega \cdot \text{m}$
- $2.94 \times 10^{-4} \Omega \cdot \text{m}$



16. The figure at right shows the current-voltage relationship for a light-emitting diode (LED) and a resistor. When the voltage is 1.0 V, which has the higher resistance? *Hint: what does the slope of this plot mean?*

- The resistor.
- The LED.
- Cannot be determined.
- They have the same resistance.

18. Suppose a (cylindrical) electrical wire is replaced with one of the same material, but having every linear dimension doubled - the length and radius are twice their original values. Does the new wire have:

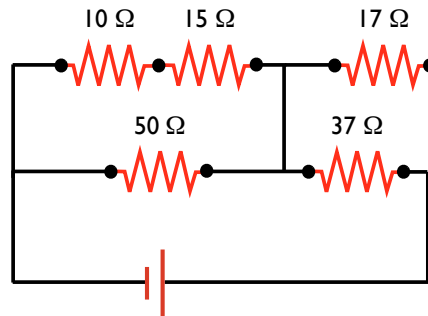
- the same resistance
- twice the resistance
- half the resistance
- four times the resistance
- one quarter the resistance

19. Suppose a current-carrying wire has a cross-sectional area that gradually becomes smaller along the wire, so that the wire has the shape of a very long cone. How does the drift speed vary along the wire?

- It slows down as the cross section becomes smaller
- It speeds up as the cross section becomes smaller
- It doesn't change
- More information is needed

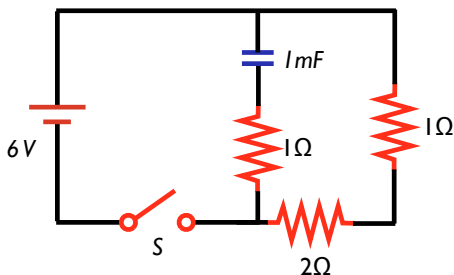
20. What is the equivalent resistance of the five resistors at right?

- 28 Ω
- 74 Ω
- 22 Ω
- 54 Ω



21. Kirchhoff's rules result from two basic physical laws. What are they?

- Conservation of Energy and Charge quantization
- Conservation of Energy and Conservation of Momentum
- Conservation of Charge and Conservation of Energy
- Coulomb's law and Conservation of Charge



22. The switch S is suddenly closed in the figure at left. After a long time compared to the time constant of the capacitor, what will the current be in the 2Ω resistor? *Hint: what is the capacitor doing after a long time?*

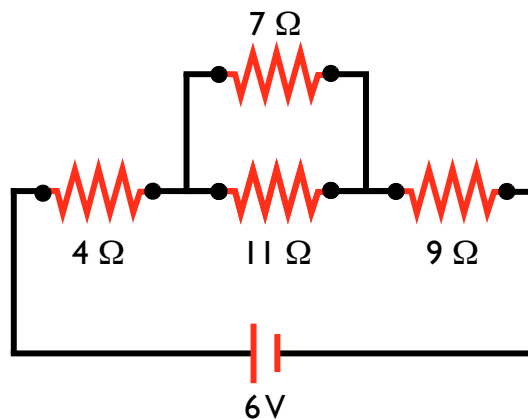
- 2 A
- 4 A
- 3 A
- 1 A

23. Two 1.60 V batteries - with their positive terminals in the same direction - are inserted in series into the barrel of a flashlight. One battery has an internal resistance of 0.270Ω , the other has an internal resistance of 0.151Ω . When the switch is closed, a current of 0.600 A passes through the lamp. What is the lamp's resistance?

- 2.25 Ω
- 3.73 Ω
- 4.91 Ω
- 6.80 Ω

24. What is the current through the 9Ω resistor in the figure at right?

- 347 mA
- 581 mA
- 716 mA
- 1.32 A



Quadratic formula:

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Basic Equations:

$$\vec{F}_{\text{net}} = m\vec{a} \quad \text{Newton's Second Law}$$

$$\text{KE} = \frac{1}{2}mv^2 \quad \text{Kinetic energy}$$

$$\text{KE}_{\text{initial}} + \text{PE}_{\text{initial}} = \text{KE}_{\text{final}} + \text{PE}_{\text{final}}$$

Useful Things

Constants:

$$k_e \approx 9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

$$e = 1.602 \times 10^{-19} \text{ C}$$

$$\epsilon_0 = 8.85 \times 10^{12} \text{ C}^2/\text{N} \cdot \text{m}^2$$

$$m_{e^-} = 9.11 \times 10^{-31} \text{ kg} \quad \text{Electron mass}$$

$$m_{p^+} = 1.67 \times 10^{-27} \text{ kg} \quad \text{Proton mass}$$