

Name: __solution__

May 16, 2019

Total Score: 120/120

Write clearly in the space provided on this Answer Sheet the letter which you believe to be the best answer to each question found on the following pages. Only answers on this page will be graded.

Each question is worth 5 points.

1) B9) B17) C2) A10) C18) D3) A11) B19) D4) B12) B20) A5) D13) B21) B6) B14) C22) D7) D15) C23) A8) C16) B24) ABCD

1. Object A has a charge of +4 C and object B has a charge of -8 C. Which is true?

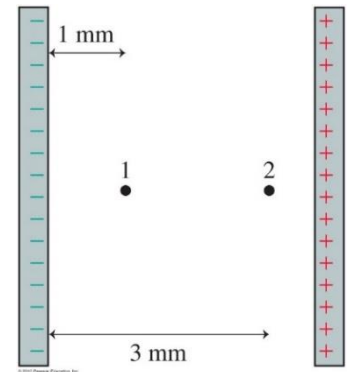
- A) $\vec{F}_{B \text{ on } A} = 2\vec{F}_{A \text{ on } B}$ B) $\vec{F}_{B \text{ on } A} = -\vec{F}_{A \text{ on } B}$
 C) $\vec{F}_{B \text{ on } A} = -2\vec{F}_{A \text{ on } B}$ D) $\vec{F}_{B \text{ on } A} = \frac{1}{2}\vec{F}_{A \text{ on } B}$

2. A small glass bead has been charged to +12 nC. A plastic sphere 3cm away from the bead feels a 0.024N electric force. The charge on the sphere is

- A) $2.0 \times 10^{-7} \text{C}$ B) $6.7 \times 10^{-6} \text{C}$ C) $6.7 \times 10^{-4} \text{C}$ D) $2.0 \times 10^{-3} \text{C}$

3. The figure shows a parallel plate capacitor. Let $V=0$ be the electric potential at the negative plate. Which of the following is true about the of the electric potential V_1 and V_2 and the electric field strengths E_1 and E_2 at the two points, respectively?

- A) $V_1 = \frac{1}{3}V_2$ and $E_1 = E_2$ B) $V_1 = \frac{1}{3}V_2$ and $E_1 = \frac{1}{3}E_2$
 C) $V_1 = V_2$ and $E_1 = E_2$ D) $V_1 = V_2$ and $E_1 = \frac{1}{3}E_2$



4. An electric dipole is placed in a uniform electric field. Which is **FALSE**?

- A) The net force on the dipole does not depend on the electric field strength.
 B) The net torque on the dipole is always zero.
 C) The dipole wants to align so that the dipole moment is parallel to the electric field.
 D) A dipole in a uniform electric field experiences zero net force.

5. The potential difference between two plates of a parallel plate capacitor equals 1,000 V. An electron is released from rest at the negative plate. The kinetic energy of the electron as it arrives at the positive plate equals

- A) $1.6 \times 10^{-16} \text{ eV}$ B) 1,600 J C) 1kJ D) 1keV

6. The electron in problem 5 arrives at the positive plate with speed:

- A) $1.33 \times 10^7 \text{m/s}$ B) $1.87 \times 10^7 \text{m/s}$ C) $4.60 \times 10^7 \text{m/s}$ D) $3.5 \times 10^{14} \text{m/s}$

7. A parallel plate capacitor consists of two circular plates of radius 10cm that are spaced 2mm apart with air between the plates. The potential difference between the plates is 600 V. The amount of charge stored on each plate is

- A) 140 pC B) 26 nC C) $0.83 \mu\text{C}$ D) 83 nC

8. A light atom and a heavy atom are singly ionized – one electron is removed from each. The ions are accelerated from rest by the electric field between two plates with a potential difference of 500V. After accelerating from one plate to another

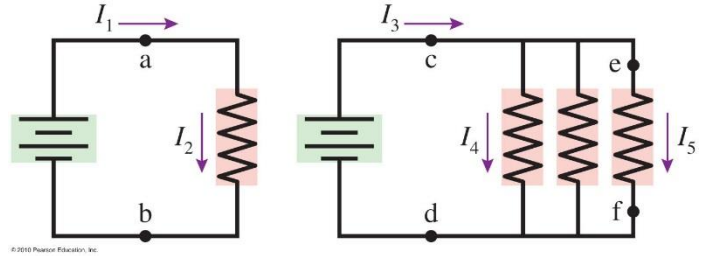
- A) the light ion has more kinetic energy. B) the heavy ion has more kinetic energy.
 C) both have the same kinetic energy. D) Not enough information to determine.

9. The potential difference between the plates of a parallel plate capacitor is doubled. Which of these quantities remains unchanged?

- A) Charge B) Capacitance C) Electric field

10. In the two circuits on the right, the batteries are identical and all resistors are identical. Which of the statements is true?

- A) $I_1 > I_2$ B) $I_1 = I_3$
 C) $I_1 = I_4$ D) $I_1 = 3 I_3$

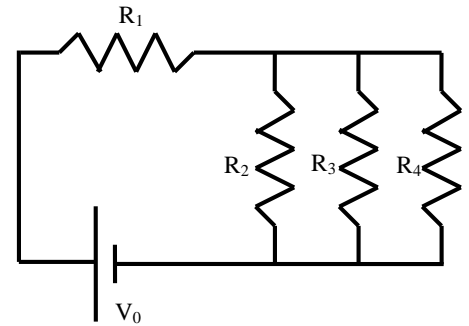


11. A potassium ion channel in a cell membrane is filled with intracellular fluid. The potassium ions have charge e . If the channel is open for 2ms, 1.5×10^4 ions flow through the channel. The potential difference across the channel is 70mV. The resistance of the channel equals

- A) $1.2 \times 10^{-12} \Omega$ B) $5.8 \times 10^{10} \Omega$ C) $5.8 \times 10^7 \Omega$ D) $3 \times 10^{10} \Omega$

12. For the resistor circuit shown $R_1 = 4\Omega$, $R_2 = 1\Omega$, $R_3 = 2\Omega$, and $R_4 = 2\Omega$. The equivalent resistance of the circuit equals:

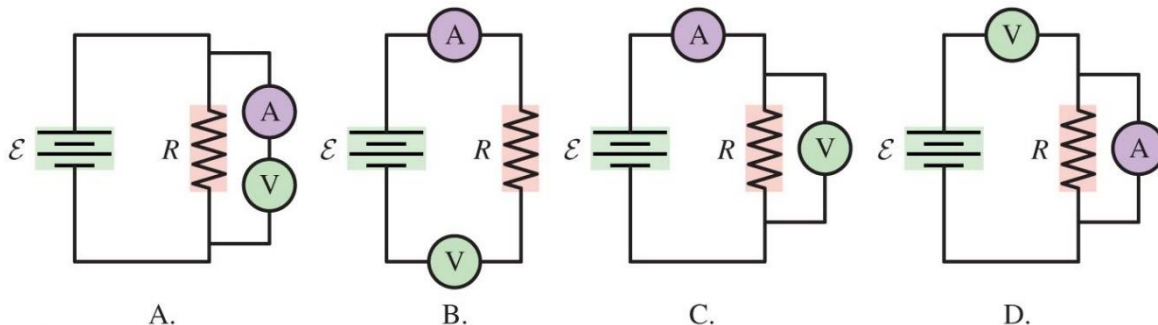
- A) 1.33Ω B) 4.5Ω C) 6Ω D) 9Ω



13. Light bulbs are rated by their power dissipation when operated at a given voltage. Which of the following light bulbs has the largest current through it when operated at the voltage for which it is rated?

- A) 0.8W, 1.5V B) 6W, 3V C) 4W, 4.5 V D) 8W, 6V

14. Which is the right way to connect the meters to measure the potential difference across and the current through the resistor?



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15. A capacitor is **charged** through a resistor. Which of the graphs at the right represent best the capacitor voltage and the current?

16. A capacitor of capacitance $5 \mu\text{F}$ has been charged so that the potential difference between its plates is 20 V . The capacitor is then connected to a $10 \text{ k}\Omega$ resistor. The time constant of the circuit is

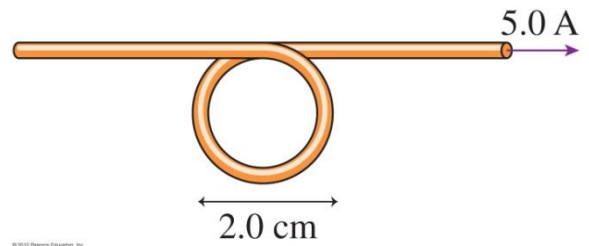
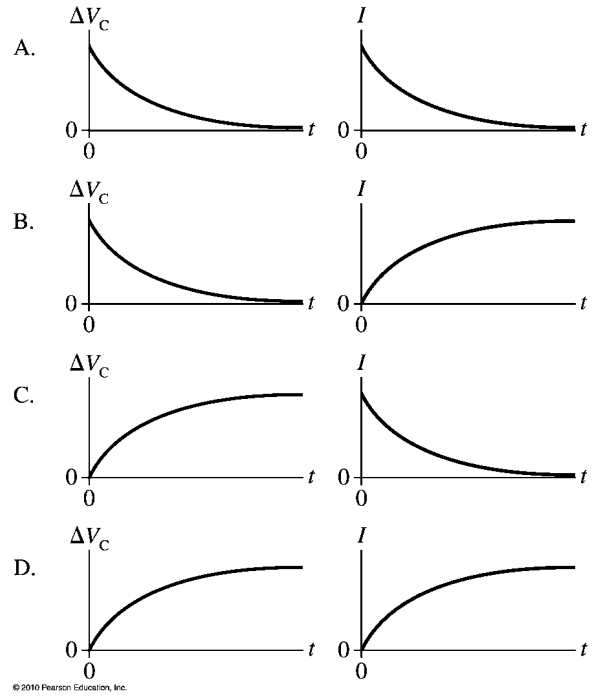
- A) 0.1 ms B) 50 ms C) 20 s D) 100s

17. Which of the following is true?

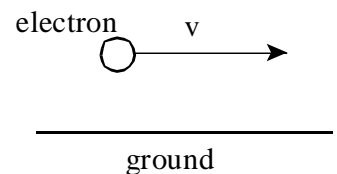
- A) The magnetic field of a current loop is independent of the loop radius.
 B) The magnetic field of a long straight wire increases with increasing distance.
 C) The magnetic field of a solenoid is independent of the solenoid radius.
 D) The magnetic field of a long straight wire is independent of the distance from the wire.

18. What is the magnetic field at the center of the loop?

- A) $1.0 \times 10^{-4} \text{ T}$ B) $2.1 \times 10^{-4} \text{ T}$
 C) $3.0 \times 10^{-4} \text{ T}$ D) $4.1 \times 10^{-4} \text{ T}$

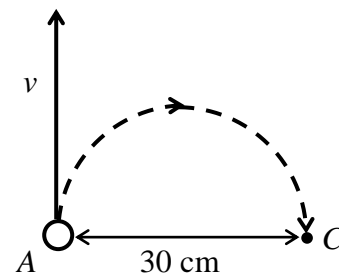


19. An electron is traveling parallel to the surface of the earth at constant speed to the right. The electron is under the influence of the earth's gravitational force, but there is a constant magnetic field in this region which causes the electron to move in a straight line without falling to the ground. This magnetic **field** is directed



- A) left B) up (i.e. towards the top of the page)
 C) into the page D) out of the page

20. A particle with charge magnitude $1.6 \times 10^{-19} \text{ C}$ has a speed of $2.5 \times 10^5 \text{ m/s}$ at point A. It enters a region of uniform magnetic field of magnitude 0.4 T directed **into the page** and follows a semicircular path from A to C as shown in the figure. The mass of the particle is _____ and the particle's charge is _____.



- A) $3.84 \times 10^{-26} \text{ kg}$, negative B) $3.84 \times 10^{-26} \text{ kg}$, positive
 C) $7.68 \times 10^{-26} \text{ kg}$, positive D) A) $9.6 \times 10^{-26} \text{ kg}$, negative

21. The diagram shows a side view of two current loops in a uniform magnetic field. The loops are identical and carry the same current. Which statement is true about magnetic flux and torque?

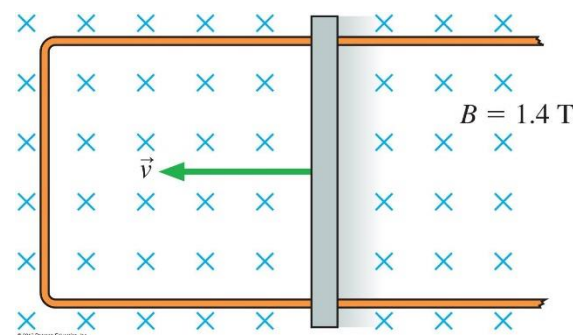


- A) Loop 1 has zero flux and loop 2 has maximum torque.
 B) Loop 1 has maximum flux and loop 2 has maximum torque.
 C) Loop 2 has maximum flux and loop 1 has zero torque.
 D) Loop 2 has zero flux and loop 1 has maximum torque.

22. Two parallel wires, each of length 40 cm and carrying a current of 5 A in opposite directions, are 0.5 cm apart. The force of wire 1 on wire 2 is

- A) $4 \times 10^{-4} \text{ N}$, attractive B) 0.4 N , attractive
 C) $4 \times 10^{-3} \text{ N}$, repulsive D) $4 \times 10^{-4} \text{ N}$, repulsive

23. The figure shows a 40 cm long metal rod pulled along two frictionless conducting rails at constant speed of 5 m/s . The rails have negligible resistance and rod has a resistance of 0.7Ω . The induced current is



- A) 4.0 A clockwise B) 4.0 A counter clockwise
 C) 2.8 A clockwise D) 0.25 A counter clockwise

24. You have earned an easy last question. Which of the following do you plan to do over the summer?

- A) sleep late – after a semester of 8am classes I deserve it!
 B) forget all my Physics
 C) get away from Rolla
 D) all of the above