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PHYSICS 202 FALL 1997
SECOND MIDTERM EXAM, FORM A

1. The circuit of the figure below starts with the switch open and the left capacitor with a potential difference among its plates of 10V. The right capacitor is initially not charged. The switch is later closed, and remains closed, so the two capacitors end up connected in parallel. What is the final potential difference on the plates of the right capacitor?

A) 1 V  
B) 10 V  
C) 5 V  
D) 0.5 V  
E) 2 V (correct)

2. A capacitor C is charged to a voltage V as shown in the figure. After the switch is closed, the capacitor discharges and its voltage eventually drops to zero. What is the total energy dissipated (as heat) in the resistor R when the capacitor has completely discharged?

A) \( V^2 R \)  
B) \( CV/2 \)  
C) \( CV^2/2 \) (correct)  
D) \( V^2/R \)  
E) \( CV^2 \)
3. In the figure, the battery has a potential difference of 20V and the five capacitors have a capacitance of 10\(\mu\)F. What is the charge on capacitors \(C_1\) and \(C_2\)?

A) \(2 \times 10^{-4}C, 6 \times 10^{-5}C\)  
B) \(4 \times 10^{-5}C, 4 \times 10^{-4}C\)  
C) \(2 \times 10^{-4}C, 2 \times 10^{-5}C\)  
D) \(5 \times 10^{-7}C, 2 \times 10^{-5}C\)  
E) \(2 \times 10^{-4}C, 4 \times 10^{-5}C\) (correct)

4. A parallel plate 4\(\mu\)F capacitor is connected with parallel with a 1.5V battery through a 1\(\Omega\) resistor. The plates of the capacitor are pulled apart and end up at twice their original separation. How much charge and in which direction does the current flow along the resistor?

A) 6\(\mu\)C, towards the battery  
B) 6\(\mu\)C, towards the capacitor  
C) 3\(\mu\)C, towards the capacitor  
D) 3\(\mu\)C, towards the battery (correct)  
E) no net flow.
5. For a cylindrical resistor made of ohmic material, the resistance DOES NOT depend on:

A) The current (correct)
B) The length
C) The cross-sectional area
D) The resistivity
E) The electron drift velocity (correct)

6. A nichrome-copper wire is 3m long and has a uniform cross-sectional area of $10^{-6} m^2$. When connected to a potential difference of 12V, a current of 40A develops in the wire. The RESISTIVITY of this material is,

A) $1 \times 10^{-7} \Omega \cdot m$ (correct)
B) $2 \times 10^{-7} \Omega \cdot m$
C) $1 \times 10^{-6} \Omega \cdot m$
D) $2 \times 10^{-7} \Omega \cdot m$
E) $1 \times 10^{7} \Omega \cdot m$
7. A capacitor of capacitance $C$ is connected to a battery of voltage $V$ through a resistor $R$. The current goes as $(V/R) \exp(-t/\tau)$ where $\tau$ is the time constant of the circuit. At the end of one time constant, the charge has reached a value 63% of what it will be when $t \to \infty$. How much is the charge after two time constants have passed?

A) 39.7%
B) 86.5% (correct)
C) 13.5%
D) 23.3%
E) Need more data to answer

8. A portion of a circuit is shown, with the values of the currents given for some branches. What is the direction and value of the current $i$?

A) ↓, 3A
B) ↑, 3A
C) ↓, 4A
D) ↑, 4A
E) ↓, 7A (correct)
9. If in the circuit below, the potential at point \( A \) is defined to be \( V_A = 40V \), what is the potential at point \( B \)?

A) \( V_B = 18V \)  
B) \( V_B = 21V \)  
C) \( V_B = 41V \)  
D) \( V_B = 32V \) (correct) 
E) \( V_B = 53V \)

10. The equivalent resistance between points 1 and 2 of the circuit shown is,

A) 4.5Ω  
B) 6Ω  
C) 2Ω  
D) 3Ω  
E) 2.5Ω (correct)
11. In the circuit shown, both resistors have the same value, 5Ω, the capacitor has capacitance 10μF and the battery is a regular 1.5V battery. Suppose the switch has been closed for a long time, and is suddenly opened. What is the time constant of the circuit after the switch is opened?

A) $2 \times 10^{-4} \text{s}$
B) $1 \times 10^{-4} \text{s}$ (correct)
C) $5 \times 10^{-5} \text{s}$
D) 50s
E) 100s

12. The current in the 6Ω resistor in the shown circuit is,

A) 2.4
B) 4.4A
C) 6.4A
D) 1.4 (correct)
E) 0.5A
13. A wire of 1m in length and mass 20g is suspended from an insulator block by a pair of massless flexible leads in a magnetic field of 0.4T, as shown in the figure. What are the magnitude and direction of the current that one needs to circulate through the wire in order to have no tension in the supporting leads (g = 9.8m/s²)? (Ignore all magnetic effects on the flexible leads)

A) 0.07A, →
B) 1.59A, →
C) 1.59A, ←
D) 0.49A, → (correct)
E) 0.49A, ←

14. The figure shows the path of an electron that passes through three regions containing uniform magnetic fields of magnitudes $B_1$, $B_2$ and $B_3$. Which of the following statements is correct,

A) cannot deduce it from the figure alone
B) $B_1 > B_2 > B_3$ (correct)
C) $B_3 > B_2 > B_1$
D) $B_2 > B_1 > B_3$
E) $B_1 = B_2 = B_3$
15. A particle of charge $+2C$ moves along a magnetic field $\mathbf{B} = (0.03T)i - (0.15T)j$ with velocity $\mathbf{v} = (2 \times 10^6 m/s)i + (3 \times 10^6 m/s)j$. The force on the particle is,

A) $-7.8 \times 10^5 Nk$ (correct)
B) $-6.2 \times 10^5 Ni$
C) $-4.2 \times 10^5 Nj$
D) $4.2 \times 10^5 Nk$
E) $6.2 \times 10^5 Nk$

16. A metal wire of mass $m$ slides freely on two horizontal rails, spaced a distance $d$ apart, as shown in the figure. The tracks are connected to a battery that supplies a constant current $i$ through the circuit formed by the rails and the moving wire. There is an externally applied uniform vertical magnetic field $B$ pointing upwards out of the paper. The switch is closed at $t = 0$, when the wire is at rest. The speed and direction of the wire’s motion at time $t$ are,

A) $iBdt^2/2m$, left
B) $iBdt/m$, right
C) $iBdt/m$, left (correct)
D) $iB/dm$, left
E) $iBdt^2/2m$, right
17. A uniform magnetic field is directed into the page. A charged particle, moving in the plane of the page, follows a counter-clockwise spiral of increasing radius as shown. A reasonable explanation is,

A) the charge is positive and slowing down  
B) the charge is negative and slowing down  
C) the charge is positive and speeding up (correct)  
D) the charge is negative and speeding up  
E) this cannot happen (correct)

18. A particle of charge $20\mu C$ enters a $50m$ long ‘region of crossed electric and magnetic fields with velocity $200m/s$. The electric field, of $20V/m$, is vertical. The magnetic field is perpendicular to the page. What is the direction and intensity of the magnetic field that is needed for the particle to follow a straight trajectory?

A) $4T$, into the paper  
B) $4T$, out of the paper  
C) $0.1T$, into the paper (correct)  
D) $0.1T$, out of the paper  
E) $10T$, into the paper
19. Two ions $a$ and $b$, of equal mass and of equal magnitude of their charges are found travelling around circular orbits in the same uniform magnetic field, as shown in the figure. The field is into the page of the diagram. $b$ travels clockwise and $a$ travels counterclockwise. Which of the following statements is true?

A) The speed of $a$ is equal to the speed of $b$. $a$ is positively charged and $b$ is negatively charged.

B) The speed of $a$ is larger than that of $b$. $a$ is positively charged and $b$ is negatively charged.

C) The speed of $a$ is smaller than that of $b$. $a$ is positively charged and $b$ is negatively charged. (correct)

D) The speed of $a$ is smaller than that of $b$. $a$ is negatively charged and $b$ is positively charged.

E) $a$ is positively charged and $b$ is negatively charged but cannot decide the relative speeds from the information given.
20. The figure shows a rectangular, 20 turn coil of wire, 10 cm by 5 cm. It carries a current of 100 mA and is hinged along one side. It is mounted in the xy plane, at an angle of 30 degrees to the direction of a uniform magnetic field of 0.5 T. The magnitude of the torque vector acting on the coil about the hinge line is,

A) $8.6 \times 10^{-3} \text{N} \cdot \text{m}$
B) $5 \times 10^{-3} \text{N} \cdot \text{m}$
C) $4.3 \times 10^{-3} \text{N} \cdot \text{m}$ (correct)
D) $8.6 \times 10^{-2} \text{N} \cdot \text{m}$
E) $2.5 \times 10^{-3} \text{N} \cdot \text{m}$