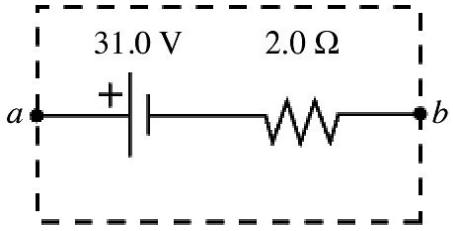
Practice problems, Physics 121 Common Exam 3, Fall 2023

Chapters: 26, 27, 28

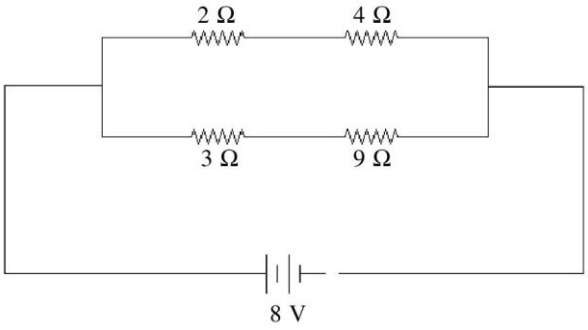
1. The emf and the internal resistance of a battery are as shown in the figure. When the terminal voltage V_{ab} is equal to 17.4 V, what is the current through the battery, including its direction?



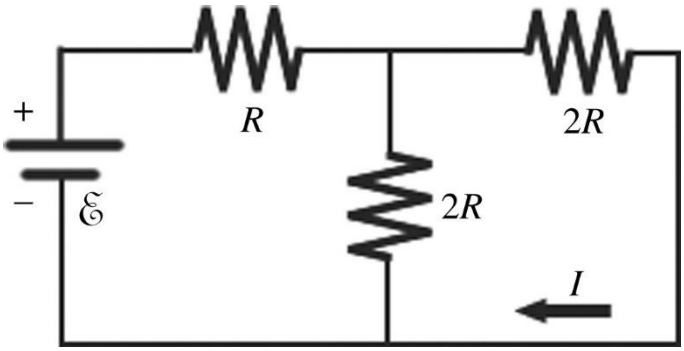
A) 6.8 A, from *b* to *a*
B) 8.7 A, from *b* to *a*
C) 6.8 A, from *a* to *b*
D) 8.7 A, from *a* to *b*
E) 16 A, from *b* to *a*

2. Four resistors are connected across an 8-V DC battery as shown in the figure. The current through the 9-Ω resistor is closest to

A) 1 A.
B) 0.7 A.
C) 0.5 A.
D) 0.9 A.
E) 2 A.

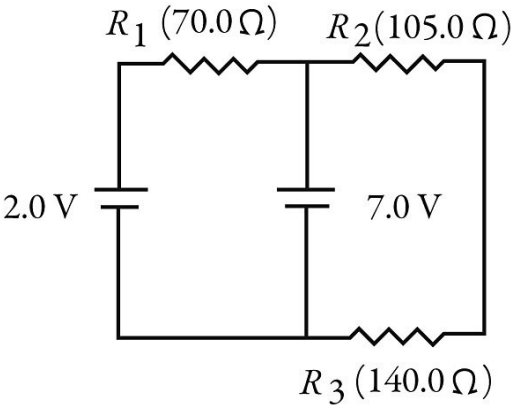


3. Resistors in combination: For the circuit shown in the figure, $I = 0.50$ A and $R = 12\ \Omega$. What is the value of the emf ε?



A) 18 V
B) 24 V
C) 6.0 V
D) 12 V
E) 48 V

4. For the circuit shown in the figure, what is the current through resistor R_1?

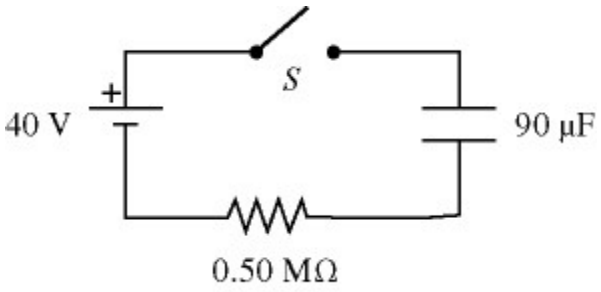


A) 0.071 A
B) 0.13 A
C) 0.029 A
D) 0.016 A

5. A 6.0-μF capacitor is connected in series with a 5.0 MΩ resistor, and this combination is connected across an ideal 15-V DC battery. What is the current in the circuit when the capacitor has reached 20% of its maximum charge?

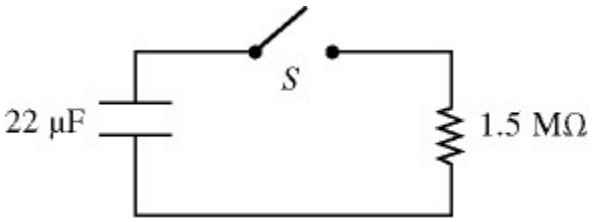
A) 6.5 μA
B) 2.4 μA
C) 1.3 μA
D) 4.7 μA
E) 9.1 μA

6. For the circuit shown in the figure, the switch *S* is initially open and the capacitor is uncharged. The switch is then closed at time $t = 0$. How many seconds after closing the switch will the energy stored in the capacitor be equal to 50.2 mJ?



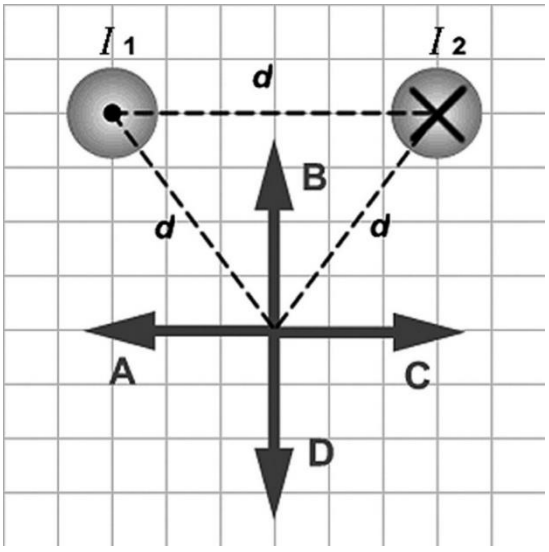
A) 81 s
B) 65 s
C) 97 s
D) 110 s
E) 130 s

7. For the circuit shown in the figure, the switch *S* is initially open and the capacitor voltage is 80 V. The switch is then closed at time $t = 0$. What is the charge on the capacitor when the current in the circuit is 33 μA?



A) 1100 μC
B) 1000 μC
C) 960 μC
D) 890 μC
E) 830 μC

8. The figure shows two long wires carrying equal currents I_1 and I_2 flowing in opposite directions. Which of the arrows labeled A through D correctly represents the direction of the magnetic field due to the wires at a point located at an equal distance d from each wire?



A) A
B) B
C) C
D) D
E) The magnetic field is zero at that point.

9. Force on moving charges: A particle with charge -5.00 C initially moves at $\vec{v}$ = (1.00 $\hat{i}$ + 7.00 $\hat{j}$) m/s. If it encounters a magnetic field $\vec{B}$ = 10.00 T $\hat{k}$, find the magnetic force vector on the particle.

A) (- 350 $\hat{i}$ + 50.0 $\hat{j}$) N

B) (- 350 $\hat{i}$ - 50.0 $\hat{j}$) N

C) (350 $\hat{i}$ + 50.0 $\hat{j}$) N

D) (350 $\hat{i}$ - 50.0 $\hat{j}$) N

10. A point charge *Q* moves on the *x*-axis in the positive direction with a speed of 280 m/s. A point *P* is on the *y*-axis at $y = +70$ mm. The magnetic field produced at the point *P*, as the charge moves through the origin, is equal to -0.30 μT $\hat{k}$. What is the charge *Q*? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) - 53 μC

B) + 53 μC

C) - 39 μC

D) + 39 μC

E) + 26 μC

11. Two long parallel wires carry currents of 20 A and 5.0 A in opposite directions. The wires are separated by 0.20 m. What is the magnitude of the magnetic field midway between the two wires? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) 1.0×10^{-5} T

B) 2.0×10^{-5} T

C) 3.0×10^{-5} T

D) 4.0×10^{-5} T

E) 5.0×10^{-5} T

12. A circular loop of wire of radius 10 cm carries a current of 6.0 A. What is the magnitude of the magnetic field at the center of the loop? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

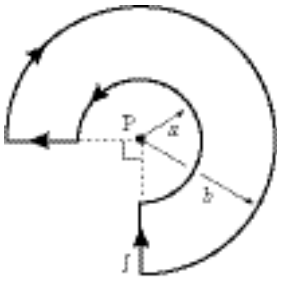
A) 3.8×10^{-5} T
B) 3.8×10^{-7} T
C) 1.2×10^{-5} T
D) 1.2×10^{-7} T
E) 3.8×10^{-8} T

13. A solenoid with 400 turns has a radius of 0.040 m and is 40 cm long. If this solenoid carries a current of 12 A, what is the magnitude of the magnetic field near the center of the solenoid? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) 16 mT
B) 4.9 mT
C) 15 mT
D) 6.0 mT
E) 9.0 mT

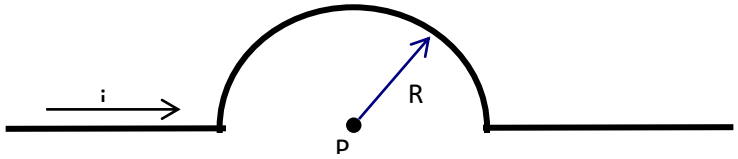
14. What is the magnitude of the magnetic field at point P if *a = 5 mm* and *b = 12 mm* and current *I = 16 A*?

A) 0.28 mT
B) 0.44 mT
C) 0.88 mT
D) 1.08 mT
E) 1.50 mT



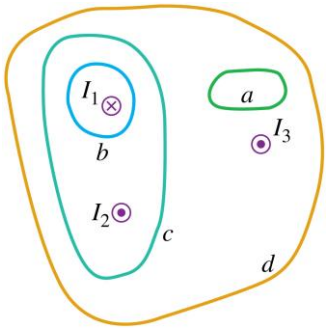
15. Point P is the center of the semicircle in the accompanying sketch, with current I flowing from left to right as shown. The magnitude and direction of the magnetic field at P are:

A) $\mu_0 i/4R$, out of paper
B) $\mu_0 i/4\pi R$, into paper
C) $\mu_0 i/4\pi R$, out of paper
D) $\mu_0 i/4R$, into paper
E) $\mu_0 i/2R$, into paper



16. The figure shows, in cross section, three conductors that carry currents perpendicular to the plane of the figure. If the currents I_1, I_2, and I_3 all have the same magnitude, for which path(s) is/are the line integral of the magnetic field equal to zero?

A) path *a* only
B) paths *a* and *c*
C) paths *b* and *d*
D) paths *a*, *b*, *c*, and *d*
E) depends on whether the integral goes clockwise or counterclockwise around the path



17. A proton is moving with a speed of $3x10^5$ m/s in an uniform magnetic field of B = 0.01 Tesla. The field points directly out of the page, and the velocity of the proton lies within in the plane of the page. Find the frequency of revolution and the direction (CW or CCW) The frequency is the reciprocal of the period. The mass of the proton is approximately $1.7x10^{-27}$ kg. The answer is closest to:

A) 150 kHz, CCW
B) 150 kHz, CW
C) 150 MHz, CCW
D) 150 MHz, CW
E) the particle keeps moving in a straight line

18. Two parallel wires are each 5 meters long. They are separated by a perpendicular distance of 100 cm and carry currents of 40 A. and 50 A. in the same direction. Find the interaction force between the wires:

A) zero
B) 0.2 N, attraction
C) 0.2 N, repulsion
D) 2×10^{-3} N, attraction
E) 2×10^{-3} N, repulsion

19. A flat circular coil of wire has 100 turns each of which is carrying current I = 10 A. in the counterclockwise direction as shown. The radius of each loop in the coil is r = 10 mm. The magnetic field at the center of the loop is closest to:

A) zero
B) 0.063 T , out of the page
C) 0.063 T , into the page
D) 0.63 mT , into the page
E) 0.63 mT, out of the page

20. A long solenoid has 500 turns of wire per meter. It carries a current of 10 A. Find the magnetic field at the center of the solenoid.

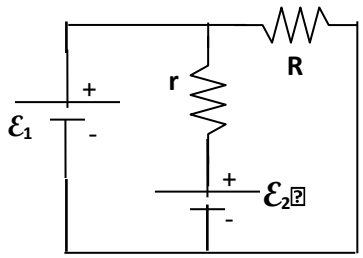
A) 0.63 mT
B) 0.0063 T
C) 0.063 T
D) 0.63 T
E) 6.3 T

21. A negatively charged particle (an electron) with charge -1.6×10^{-19} C is moving at a velocity $v = 10^6$ m/s in the positive x direction. It is crossing a region where a uniform magnetic field with B = 500 kT (kilo-Teslas) points in the negative y direction. Find the force acting on the particle.

A) 8.0×10^{-8} N, -x direction
B) 8.0×10^{-8} N, -y direction
C) 8.0×10^{-8} N, +y direction
D) 8.0×10^{-8} N, -z direction
E) 8.0×10^{-8} N, +z direction

22. The figure at right shows an ideal battery (on the left) with $\mathcal{E}_1$ = 4 V connected to a "realistic" battery with $\mathcal{E}_2$ = 1 V and internal resistance r = 2 Ω. The combination is connected to the external resistor R = 4 Ω. Find the current through the "realistic" battery labeled $\mathcal{E}_2$ (center branch on the sketch).

A) 1.5 A, down
B) 1.5 A, up
C) 2.5 A, down
D) 2.5 A, up
E) 3.0 A, up



23. For the circuit of the previous problem find the current through the ideal battery labeled ε_1

A) 1.0 A, down
B) 1.5 A, up
C) 1.5 A, down
D) 2.5 A, up
E) 2.5 A, down

24. (a) What is the speed of a beam of electrons when the simultaneous influence of an electric field of 1.56×10^4 V/m and a magnetic field of 4.62×10^{-3} T, with both fields normal to the beam and to each other, produces no deflection of the electrons? (b) In a diagram, show the relative orientation of the vectors **v**, **E**, and **B** . (c) When the electric field is removed, what is the radius of the electron orbit? What is the period of the orbit?

Answer Key:

1. A
2. B
3. B
4. A
5. B
6. A
7. A
8. B
9. A
10.E
11.E
12.A
13.C
14.C
15.D
16.B
17.B
18.D
19.B
20.B
21.E
22.A
23.D
24. a)3.38×10^6 m/s, c) 4.17×10^{-3} m; 7.74×10^{-9}s