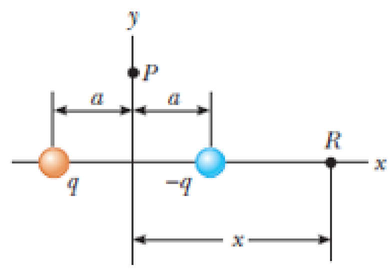
PRACTICE PROBLEMS, PHYSICS 121 Final Exam

1. An electric dipole consists of two charges of equal magnitude and opposite sign separated by a distance 2a as shown in figure. The dipole is along the x axis and is centered at the origin.
A) Calculate the electric potential at point P on the +y axis.

B) Calculate the electric potential at point R on the +x axis.

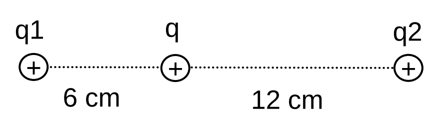
A) Ans. zero

B) Ans. $-\frac{2k_e qa}{x^2-a^2}$

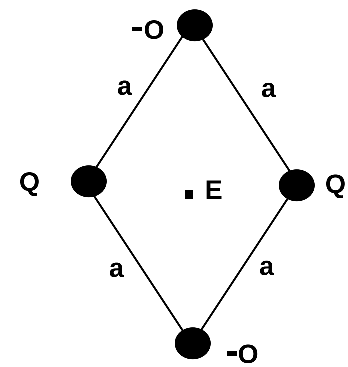


2. A positively charged particle with q= 2 μC is placed between two other positively charged particles with q_1= 9 x 10^{-3} C and q_2= 3 x 10^{-3} C as shown on the figure. The distance between q_1 and q is 6 cm and the distance from q to q_2 is 12 cm. What are the magnitude and direction of the total force acting on the middle particle?

A) 4.1 x 10^{+4} N. right
B) 2.8 x 10^{+9} N, right
C) 4.9 x 10^{+4} N, left
D) 4.9 x 10^{+4} N, right
E) 9.0 x 10^{+9} N, left



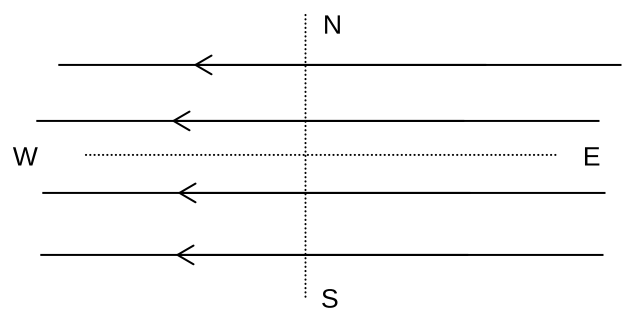
3. The magnitude Q of the charge on each of the four balls is 12 μC distributed uniformly on the surface of each one. Two are positive and two are negative as shown in the sketch. They are placed at the corners of the diamond as shown in the diagram. Each of the sides has length a = 3 cm. What are the magnitude and direction of the electric field at the center of the diamond shape?



A) 24.1 x 10^{13} N/C. Down
B) 1.6 x 10^{12} N/C. Up
C) 7.9 x 10^{19} N/C. Left
D) 1.4 x 10^{10} N/C. Right
E) Zero

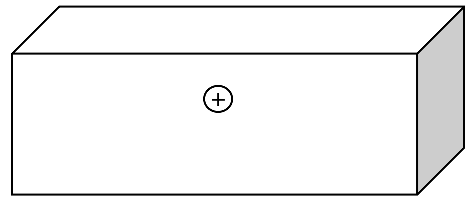
4. A negatively charged particle is placed in a uniform electric field directed West. What are the magnitude and direction of the particle's acceleration if its charge is q= -6 μC, its mass m = 2 grams, and the value of electric field E is 6 x10^{-6} N/C? Select the closest answer:

A) West. a = 1.8 x10^{-8} m/s^2
B) East. a = 1.8 x10^{-3} m/s^2
C) West. a = 1.8 x10^{+3} m/s^2
D) East. a = 1.8 x10^{-8} m/s^2
E) East. a = 1.8 x10^{-5} m/s^2



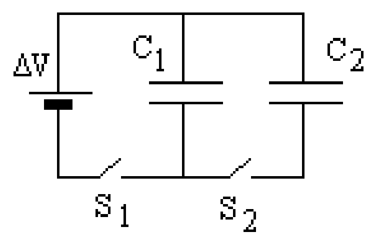
5. Find the electric flux through the surface of a rectangular Gaussian surface with a charge of 3.1 C. placed at it's center. The ends of the box are squares whose sides are 4.0 cm. The length is 8.0 cm.

A) 4.5 x 10^{+11} N m^2/C
B) 3.5 x 10^{+11} N m^2/C
C) 0.1 x 10^{-16} N m^2/C
D) 4.4 x 10^{-10} N m^2/C
E) Insufficient information

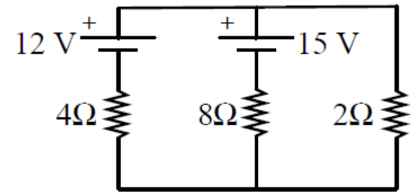


6. In the circuit shown capacitor C_1 = 2nF is first charged by closing of switch S, and connecting it to battery of ΔV = 42 V. Switch S_1 is then opened, and charged capacitor is connected to the uncharged capacitor C_2 by closing switch S_2. If the final potential across C_2 is 15 V, what is the capacitance of capacitor C_2?

A) 1 . 6 nF
B) 2 .0 nF
C) 3.6 nF
D) 6.0 nF
E) 4.2 nF

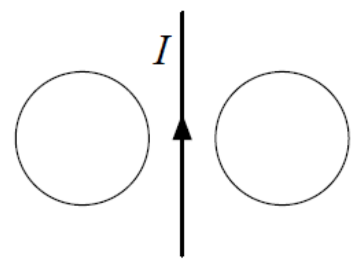


7. In the circuit shown, what is the current through the 15 V battery?
Answer: 1.18 A upwards



8. The current I in a long wire is going up as shown in the figure and increasing in magnitude. What is the direction of the induced current in the left loop and the right loop? List the direction of the induced current in the left loop first. (CW = clockwise, CCW = counterclockwise)

Answer: CW, CCW



9. A 6.0-μF capacitor is connected in series with= 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?

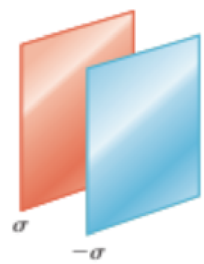
A) 6.5 μA
B) 2.4 μA
C) 1.3 μA
D) 4.7 μA
E) 9.1 μA

10. Two infinite, nonconducting sheets of charge are parallel to each other as shown in Figure. The sheet on the left has a uniform surface charge density σ, and the one on the right has a uniform charge density −σ. Calculate the electric field at points (a) to the left of, (b) and in between

Answers as below:

A) E= 0

B) E=σ/ε_0

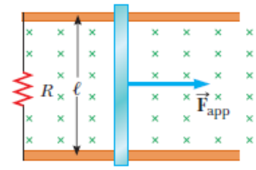


11. Find the product $(\boldsymbol{A} \times \boldsymbol{B}) \cdot \boldsymbol{C}$ when**,** A = 5**i +** 10**k**, and B = -2**i +** 8**k, C** = 8**j**

A) 0
B) -100
C) 600
D) 12**k**
E) -480

12. Consider the arrangement shown in Figure. Assume R= 6 Ohm, l= 1.20 m, and a uniform 2.50-T magnetic field is directed into the page. At what speed should the bar be moved to produce a current of 0.500 A in the resistor?

A) 1m/s

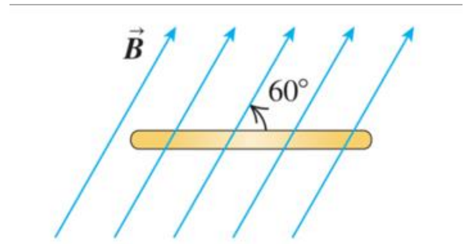


13. The capacitor in a single-loop *RC* circuit is discharged to 25% of its initial potential difference in 60 s. What is the time constant for this circuit?

A) 0.5 s
B) 60 s
C) 23.0 s
D) 0.043 s
E) 43.3 s

14. A flat, circular, steel loop of radius 75 cm is at rest in a uniform magnetic field, as shown in an edge-on view in Figure. The field is changing with time, according to $B(t) = (1.4T)e^{-(0.057s^{-1})t}$ (a) Find the emf induced in the loop as a function of time. (b) When is the induced emf equal to 1/10 of its initial value?

A) $|\boldsymbol{\varepsilon}_{\mathbf{ind}}| = (\mathbf{0.12V})\mathbf{e}^{-(\mathbf{0.057s^{-1}})\mathbf{t}}$



B) t=40.4 s

15. An alpha particle with charge q = 3.2 x 10^{-19} C and mass m = 6.7 x 10^{-27} kg is moving in a magnetic field whose magnitude is 0.004 T. The speed of the particle is 800 m/s and its velocity vector makes an angle of 25° with the magnetic field vector. What is the magnitude of the acceleration of the particle?

A) 0.53 m/s^2
B) 0.75 m/s^2
C) 6.5 x 10^7 m/s^2
D) 2.1 m/s^2
E) 0.29 m/s^2

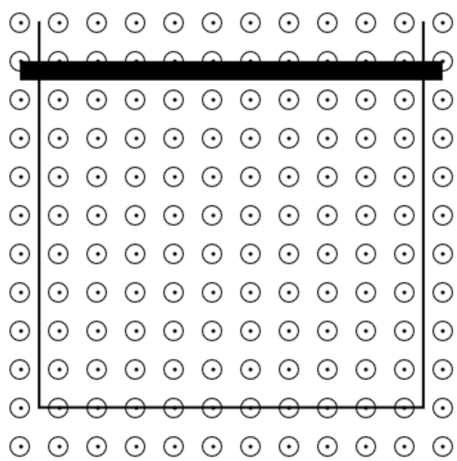
16. A inductor with an inductance L = 8.0 x 10^{-3} H is in a circuit with a total resistance R = 5.0 Ω. A current (In amps) I=20*sin(10t) (time in seconds) flows in the circuit. What is the maximum induced EMF?

A) 32 V
B) 320 V
C) 24 V
D) 64 V
E) 1.6 V

17. A wire loop of area A= 15 cm^2 is placed in a magnetic field B that is normal to the plane of the loop. The field B in Teslas varies in time according to the function B = 10(t^2-t+1), with time in seconds. Find an expression for the Emf $\mathcal{E}_{ind}$ *(in volts)* induced in the loop?

A) $\mathcal{E}_{max}$ **=-0.015 (2t-1)**

The picture below relates to the following 4 questions. A horizontal slider is 10 cm long and can move up or down the conducting rails in the plane of the page. The net resistance of the circuit formed by the slider and the rails is 3.0 kOhm. A magnetic field points out of the page. In each case find the magnitude and direction of the induced current.



18. Slider is not moving but the field increasess at a rate of 6.0 T/s. The veritcal distance between the slider and the horizontal rail is 10 cm.

Ans. 2 x 10^-5 amp, CW

19. Same as above but the field *decreases* at 6 T/s.

Ans. 2 x 10^-5 amp, CCW

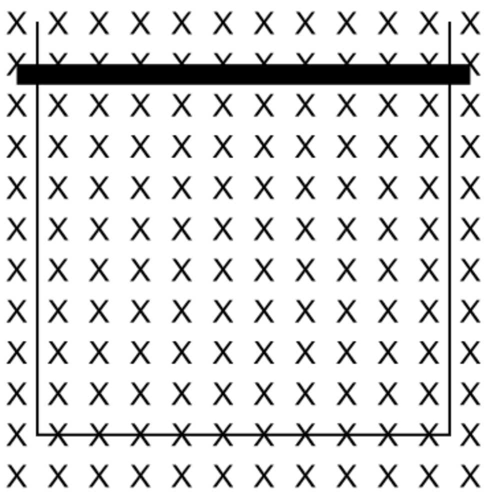
20. Field B=2.4 T is costant but the slider is moving up at 18 m/s.

Ans. 0.00144 amp, CW

21. Same as above but the slider is moving *down* at 18 m/s.

Ans. 0.00144 amp, CCW

The figure below relates to the same set of 4 questions as above but now the field point *into* the page.



22. Stationary slider but field increases at 6.0 T/s. (Vertical distance between the slider and the horizontal rail is 10 cm).

Ans. 2 x 10^-5 amp, CCW

23. Stationary slider but field decreases at 6 T/s.

Ans. 2 x 10^-5 amp, CW

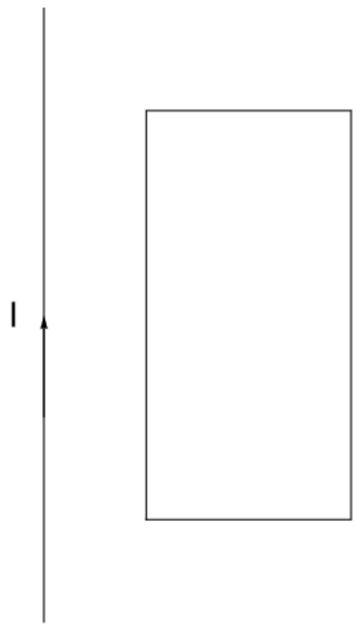
24. Constant field B=2.4 T , but slider moves up at 18 m/s .

Ans. 0.00144 amp, CCW

25. Constant field B=2.4 T but the slider moves down at 18 m/s,

Ans. 0.00144 amp, CW

The figure below relates to the following 5 questions. A straight wire carries current I up in the plane of the page. A conducting rectangular frame is to the right of the straight wire. In each case find the direction of the induced current in the frame.



26. Current I increases with time.
Ans,: CCW

27. Current decreases with time.
Ans, CW

28. Current is constant but the frame moves right in the plane of the page.
Ans. CW

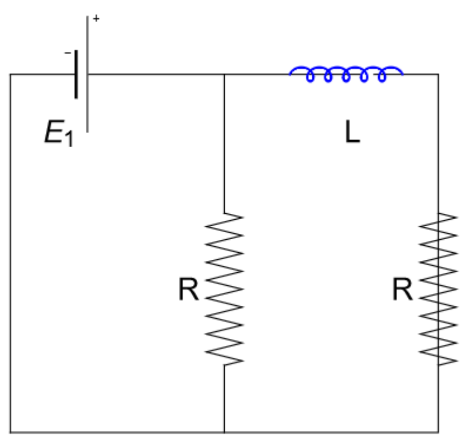
29. Current is constant but the frame moves left in the plane of the page, without crossing the wire.
Ans. CCW

30. The frame moves up in the plane of the page, parallel to the wire.
Ans. zero

31. A solenoid has N turns of wire, cross-sectional area A, and length s . The current flowing in its coils is i amperes. Find the formula for the self-inductance of the solenoid? Assume that the field is constant across the cross section of each turn of wire and equal to the field at the center.

A) $L = \mu_0 iN$
B) $L = \mu_0 N^2 A/s$
C) $L = \mu_0 N A /i$
D) $L = \mu_0 NA/s$
E) $L = \mu_0 N^2 A/2$

32. In the figure below the resistances are each 75 Ω, L = 0.1 H, and the battery potential E = 12 V. Find the current through the left resistor R immediately after the switch (not shown in the figure) is closed at t=0.



ans. 0.16 A

33. For the circuit used in the previous problem, find the current through resistor R_1 at time $t = \infty$, after the current through the inductance has reached a constant value.

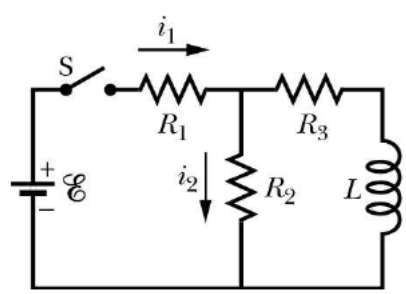
A) 0 A
B) 2.4 A
C) 0.08 A
D) 0.32 A
E) 12 A

34. During free oscillations in the LC circuit the maximum charge on the capacitor is Q=1 nC while the maximum current achieved in the inductor is 1 A. Find the resonant frequency in Hz.

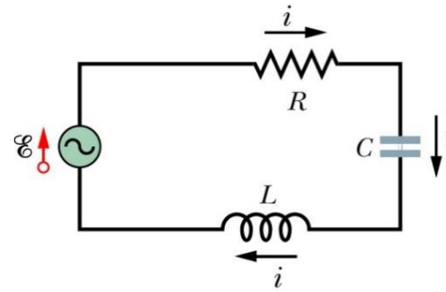
Ans. 1.6 x 10^8

35. In the circuit ε = 120 V, R_1 = 30 W, R_2 = 20 W, and R_3 = 10 W. What is the current i_1 a long time after the switch has been closed?

A) 0.0 A
B) 2.4 A
C) 3.3 A
D) 8.0 A
E) 18 A



The following six questions refer to a series LCR circuit driven by an AC voltage with frequency 75 Hz and R.M.S. voltage of 150 V. The circuit contains a capacitor with C = 50 μF, an inductor with L = 0.75 H., and a resistor with R = 100 Ω, all connected in series.



36. Find the impedance of the circuit (select the closest answer).

A) 326 Ω
B) 106 Ω
C) 216 Ω
D 53 Ω
E) 1109 Ω

37. For the LCR circuit defined above, find the average (R.M.S.) current. Select the closest answer.

A) 1.1 A
B) 12.0 A
C) 0.14 A
D) 0.46 A
E) 6.4 A

38. The average (RMS) power dissipated in the circuit is closest to:

A) 4.15 Watts
B) 2.72 Watts
C) 1.83 Watts
D) 8.90 Watts
E) 21.1 Watts

39. The phase angle for the circuit is closest to:

A) +72°
B) -90°
C) +90°
D) -18°
E) +80°

40. Find the value of the resonant frequency (in Hertz).

A) 37 Hz
B) 75 Hz
C) 26 Hz
D) 50 Hz
E) 60 Hz

41. Find the value of the R.M.S. current that would flow at resonance.

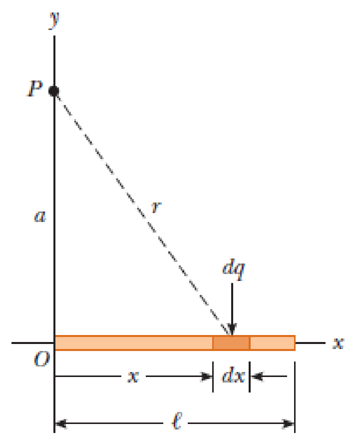
A) 4.0 A
B) 0.45 A.
C) 12.0 A.
D) 1.5 A.
E) 0.46 A.

42. The primary of a step-down transformer has 300 turns and is connected to a 120 V RMS power connection. The secondary is to supply 12,000 V RMS at 300 mA. Find the number of secondary turns.

A) 40 turns
B) 30,000 turns
C) 400 turns
D) 25 turns
E) 100 turns

43. A rod of length **l** located along the x axis has a total charge **Q** and a uniform linear charge density **λ=Q/l.** Find the electric potential at a point P located on the y axis a distance **a** from the origin

Ans: $V = k_e \frac{Q}{l} ln\left(\frac{l+\sqrt{a^2+l^2}}{a}\right)$



44. Each of the three identical capacitors in the sketch has capacitance C = 1000 μF. Initially they are uncharged. The potential difference supplied by the battery is V = 240 Volts. When the switch is closed, how many Coulombs of charge flow through the meter A until the capacitors are fully charged?

A) 0.16 Coulombs
B) 0.24 Coulombs
C) 0.40 Coulombs
D) 0.48 Coulombs
E) 0.64 Coulombs