

Clicker Summary

Physics 122 Winter 2013

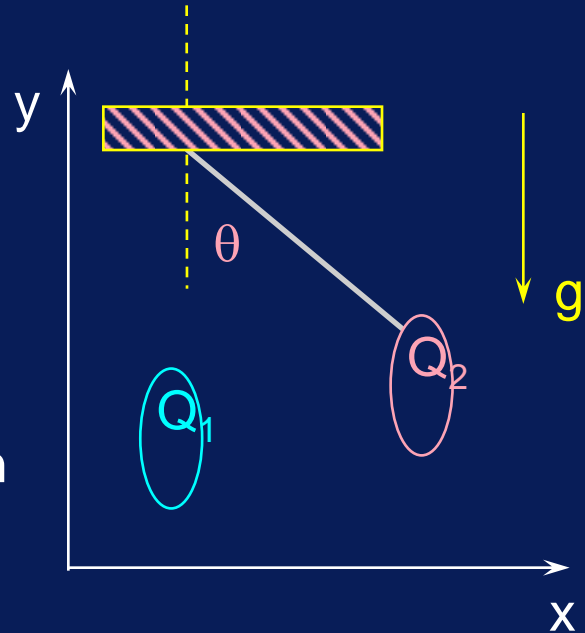
D. Hertzog

Clicker 1-1

A charged ball Q_1 is placed next to another charged ball Q_2 which is connected to a string. Q_2 comes to equilibrium at angle θ as shown.

–What is the sign of F_{Ex} ?

- A) $F_{Ex} < 0$
- B) $F_{Ex} > 0$
- C) Cannot determine sign of F_{Ex} from this information

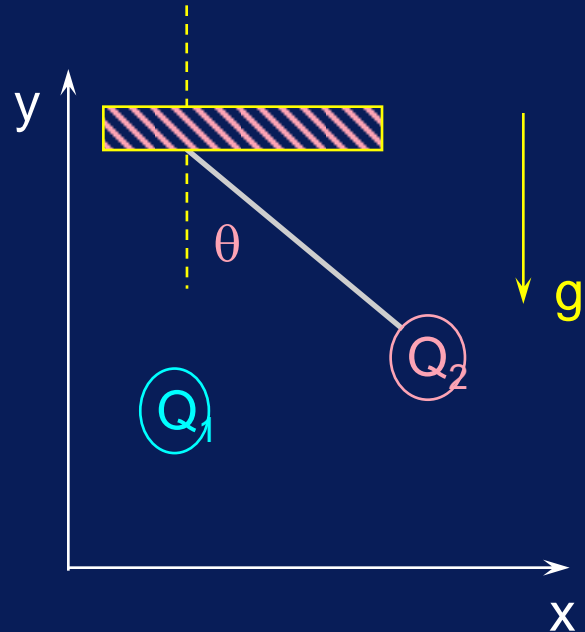


Clicker 1-2

A charged ball Q_1 is placed next to another charged ball Q_2 which is connected to a string. Q_2 comes to equilibrium at angle θ as shown.

–What is the sign of F_{Ey} ?

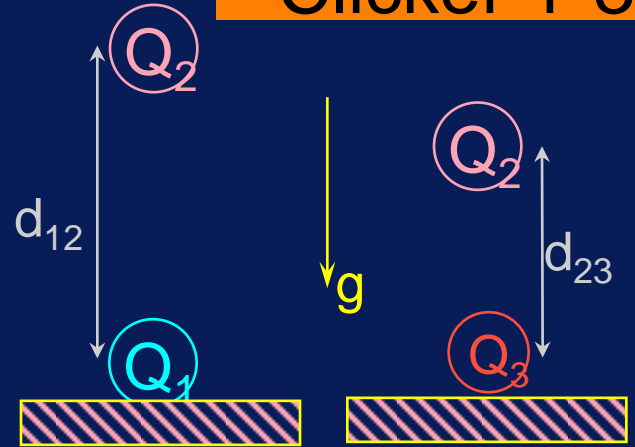
- A) $F_{Ey} < 0$
- B) $F_{Ey} > 0$
- C) Cannot determine sign of F_{Ey} from this information



Clicker 1-3

A charged ball Q_1 is fixed to a horizontal surface.
Another charged ball Q_2 is brought near
It achieves equilibrium at a distance d_{12} above Q_1 .

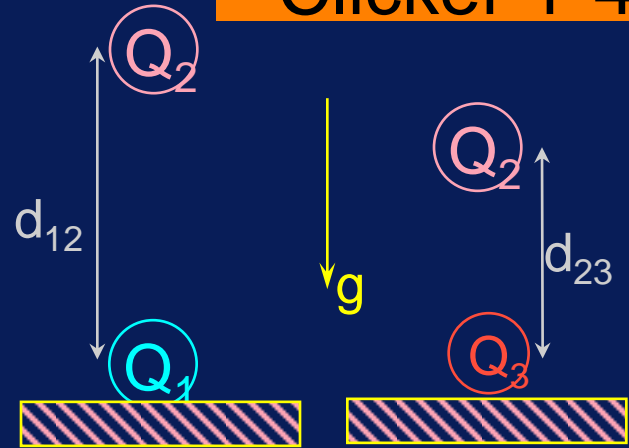
Q_1 is replaced by Q_3 , and
 Q_2 achieves equilibrium at $d_{23} (< d_{12})$



- A) The charge of Q_3 has the same sign of the charge of Q_1
- B) The charge of Q_3 has the opposite sign as the charge of Q_1
- C) Cannot determine the relative signs of the charges of Q_3 & Q_1

A charged ball Q_1 is fixed to a horizontal surface.
 Another charged ball Q_2 is brought near
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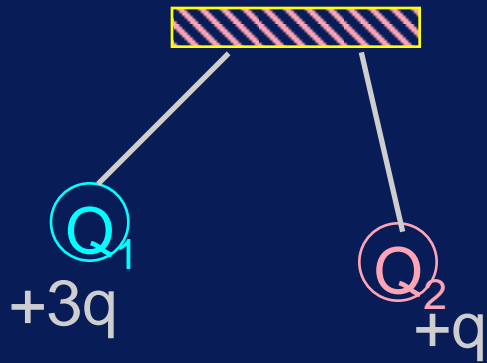


- A) The magnitude of charge $Q_3 <$ the magnitude of charge Q_1
- B) The magnitude of charge $Q_3 >$ the magnitude of charge Q_1
- C) Cannot determine relative magnitudes of charges of Q_3 & Q_1

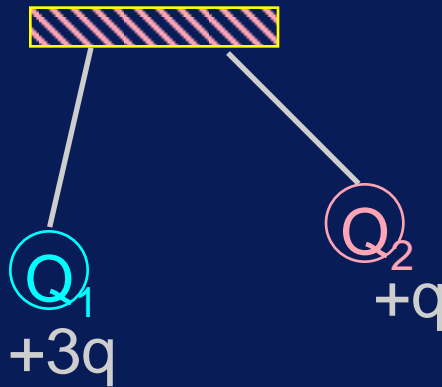
Lecture 2

Two equal mass balls are suspended from the ceiling with equal length nonconducting threads as shown. Ball 1 has charge $Q_1 = +3q$ and Ball 2 has charge $Q_2 = +q$.

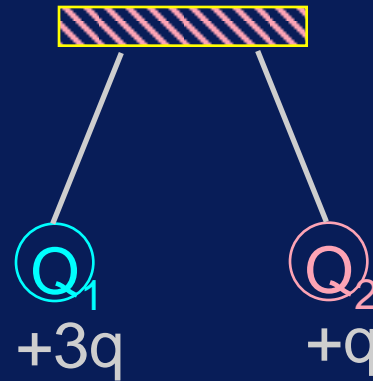
– Which of the following pictures best represents the equilibrium position?



(a)



(b)

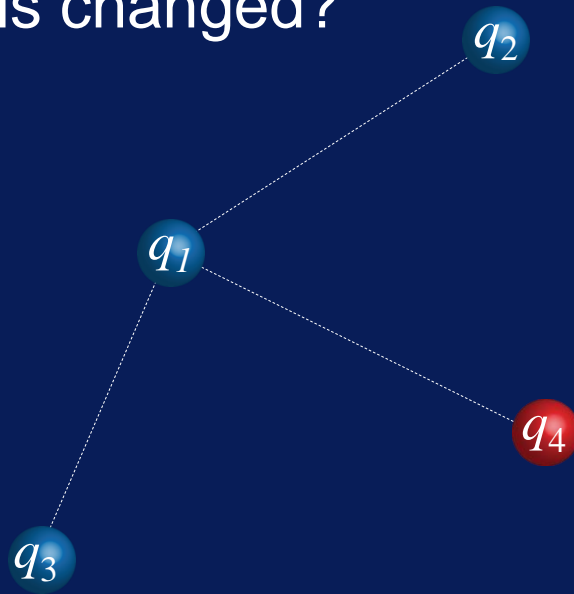


(c)

Clicker 2-1

What happens to the Force on q_1 if its sign is changed?

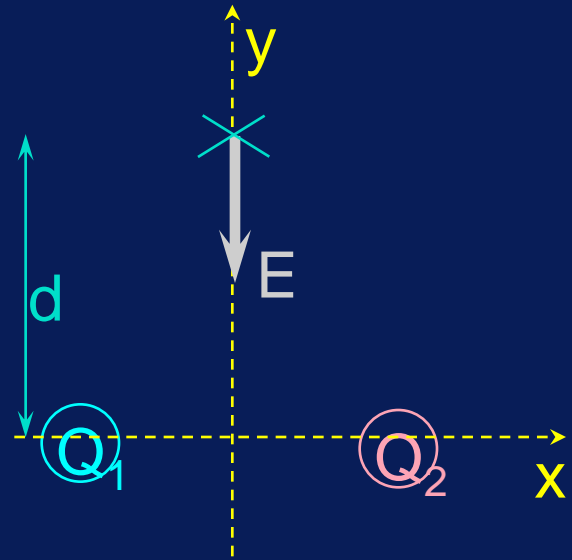
- A) $|F_1|$ increases
- B) $|F_1|$ remains the same
- C) $|F_1|$ decreases
- D) Need more information to determine



- Two charges, Q_1 and Q_2 , fixed along the x-axis as shown, produce an electric field E at a point $(x,y) = (0,d)$ which is directed along the negative y-axis.

– Which is true?

- (a) Both charges Q_1 and Q_2 must be positive.
- (b) Both charges Q_1 and Q_2 must be negative.
- (c) The charges Q_1 and Q_2 must have opposite signs.



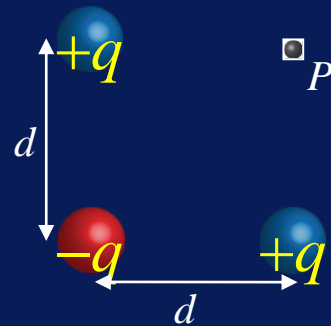


- Q_1 has charge $+Q$
- Q_2 has charge $+2Q$
- They are separated by d .
- Charge q is a distance a away from Q_1

Is there a place – the value for a -- between Q_1 and Q_2 where the force on ANY charge (positive or negative) is zero?

- (a) NO
- (b) Yes, but I can't find it with all this time pressure.
- (c) Yes and my answer is _____ from Q_1 . I will volunteer to specify if you ask me

What is the direction of the electric field at point P , the unoccupied corner of the square?



A) 

B) 

C) $E = 0$

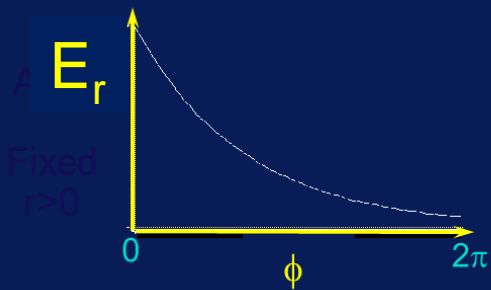
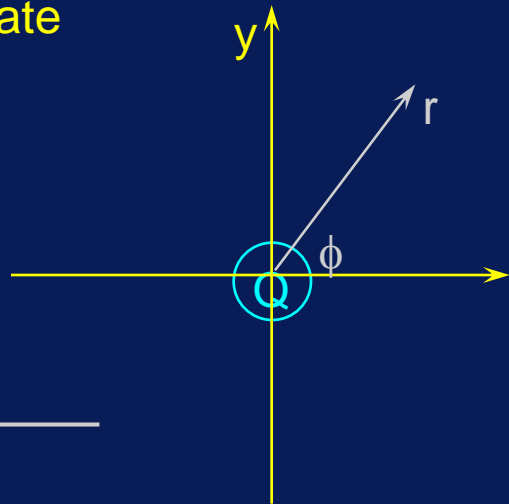
D) Need to know d

E) Need to know d & q

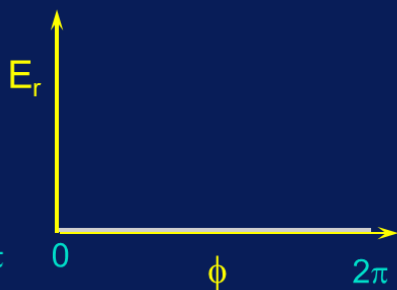
Lecture 3

Consider a point charge fixed at the origin of a co-ordinate system as shown.

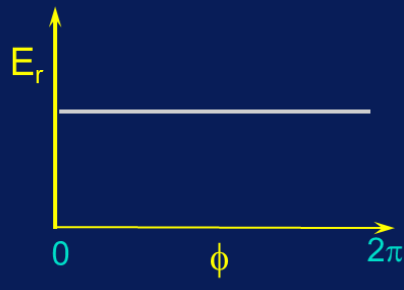
Which of the following graphs best represents the functional dependence of the Electric Field?



(a)



(b)

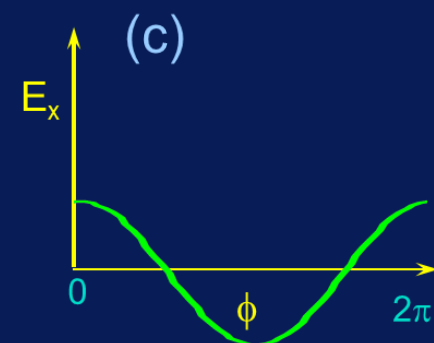
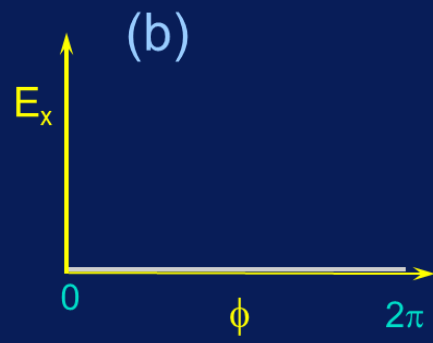
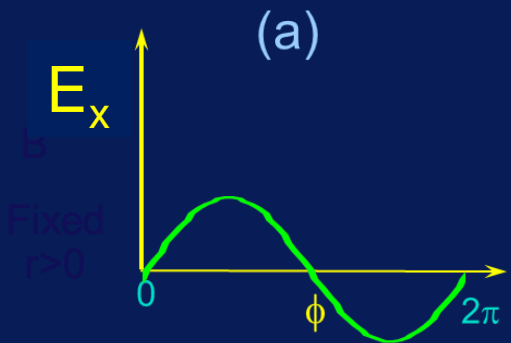
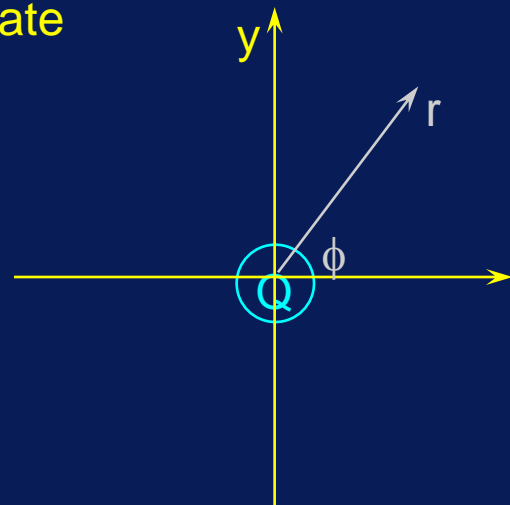


(c)

Clicker 3-1

Consider a point charge fixed at the origin of a co-ordinate system as shown.

Which of the following graphs best represents the functional dependence of the Electric Field?



Clicker

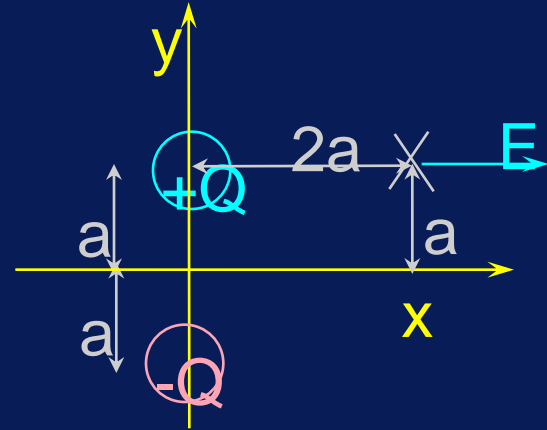
Consider a dipole aligned with the y -axis as shown.

Which of the following statements about $E_x(2a, a)$ is true?

(a) $E_x(2a, a) < 0$

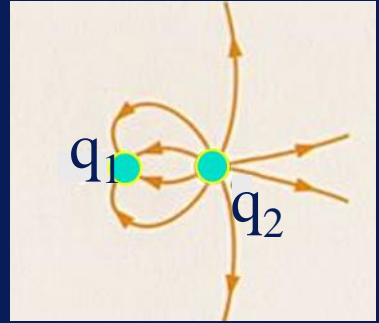
(b) $E_x(2a, a) = 0$

(c) $E_x(2a, a) > 0$



Examine the electric field lines produced by the 2 charges in this figure.

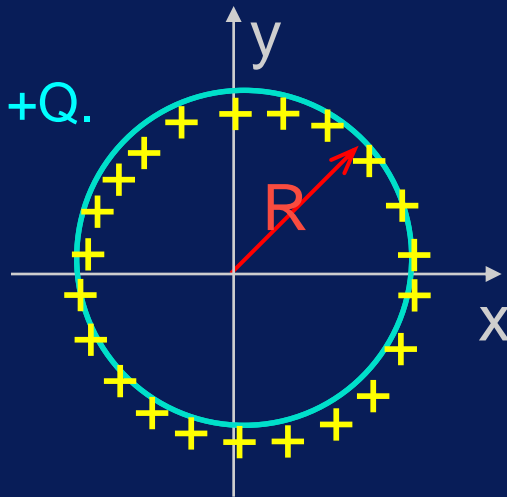
Which statement is true?



- (a) q_1 and q_2 have the same sign
- (b) q_1 and q_2 have the opposite signs and $|q_1| > |q_2|$
- (c) q_1 and q_2 have the opposite signs and $|q_1| < |q_2|$

Lecture 4

Consider a circular ring with a uniform charge distribution (λ charge per unit length). The total charge of this ring is $+Q$.

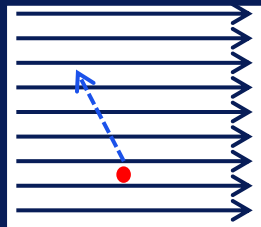
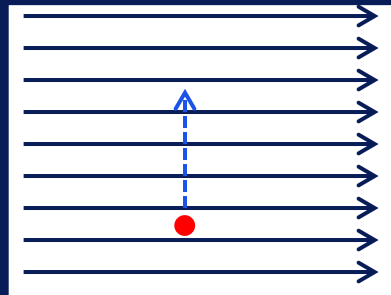


The electric field at the origin is

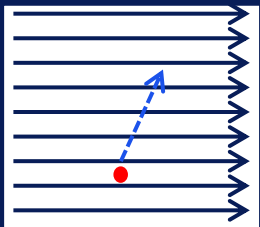
- (a) zero (b) $\frac{1}{4\pi\epsilon_0} \frac{2\pi\lambda}{R}$ (c) $\frac{1}{4\pi\epsilon_0} \frac{\pi R\lambda}{R^2}$

An electron is fired upward at speed v_0 toward the top of the page as shown. A uniform electric field points to the right.

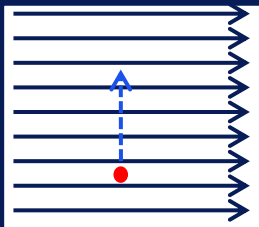
Which trajectory best represents its motion:



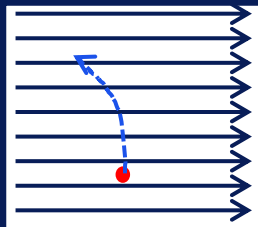
(A)



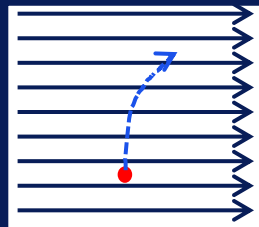
(B)



(C)



(D)

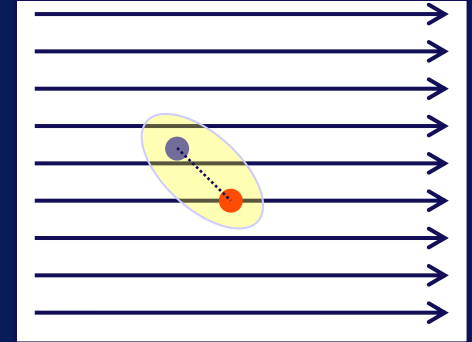


(E)

Clicker 4-2

An electric dipole consists of two equal and opposite charges, fixed a distance $2a$ apart. It is placed in a uniform electric field as shown. It will

- A. Not translate in any direction
- B. Translate horizontally
- C. Translate vertically
- D. Start to rotate clockwise
- E. Start to rotate counter-clockwise



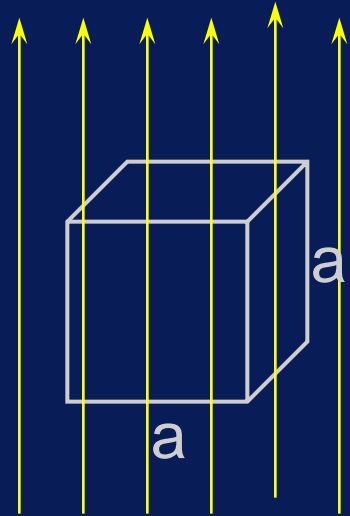
Imagine a cube of side a positioned in a region of constant electric field as shown.

- Which of the following statements about the electric flux Φ_E through the surface of this cube is true?

(a) $\Phi_E = 0$

(b) $\Phi_E \propto 2a^2$

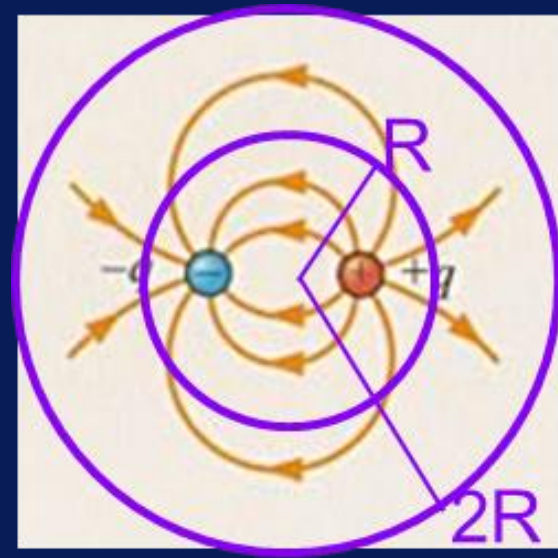
(c) $\Phi_E \propto 6a^2$



Consider 2 spheres (of radius R and $2R$)
drawn around an electric dipole

Which of the following statements about the net electric
flux through the 2 surfaces (Φ_{2R} and Φ_R) is true?

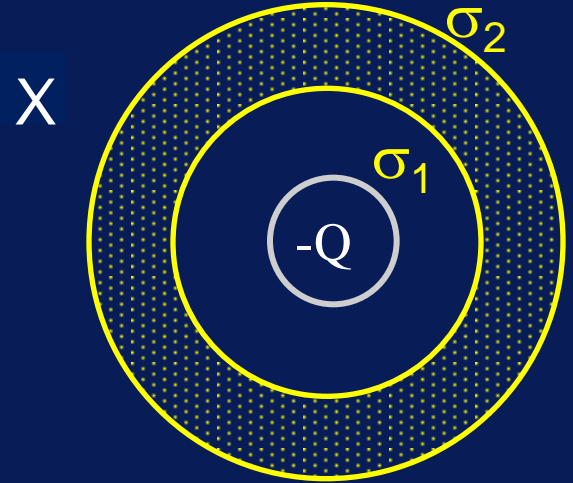
- (a) $\Phi_R < \Phi_{2R}$ (b) $\Phi_R = \Phi_{2R}$ (c) $\Phi_R > \Phi_{2R}$



Lecture 5

A $Q = -3 \mu\text{C}$ charge is surrounded by an uncharged conducting spherical shell (in yellow)

Compare the electric field at point X to the one you would find if the conducting shell was removed.



(a) $E_{\text{shell}} < E_{\text{NoShell}}$

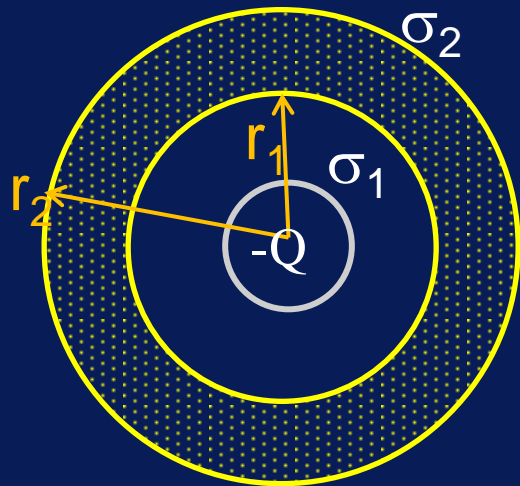
(b) $E_{\text{shell}} = E_{\text{NoShell}}$

(c) $E_{\text{shell}} > E_{\text{NoShell}}$

Clicker 5-1

A $Q = -3 \mu\text{C}$ charge is surrounded by an uncharged conducting spherical shell (in yellow)

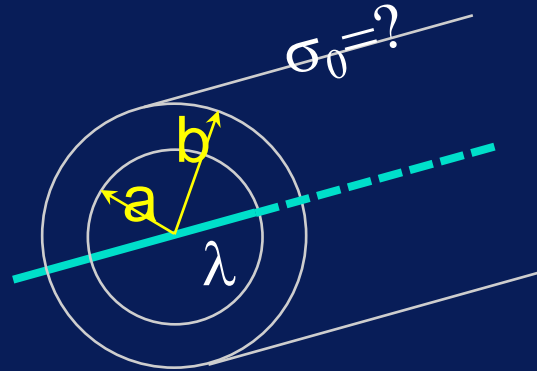
What is the value of the surface charge density σ_1 on the inner surface of the conducting shell?



- (a) $\sigma_1 = -Q$ (b) $\sigma_1 = +Q$ (c) $\sigma_1 = 0$ (d) $\sigma_1 = \frac{-Q}{4\pi\epsilon_0 r_1^2}$ (e) $\sigma_1 = \frac{+Q}{4\pi\epsilon_0 r_1^2}$

A line charge λ C/m is placed along the axis of an uncharged conducting cylinder of inner radius $r_i = a$, and outer radius $r_o = b$ as shown.

What is the value of the charge density σ_o (C/m²) on the outer surface of the cylinder?



(a) $\sigma_o = -\frac{\lambda}{2\pi b}$

(b) $\sigma_o = 0$

(c) $\sigma_o = +\frac{\lambda}{2\pi b}$

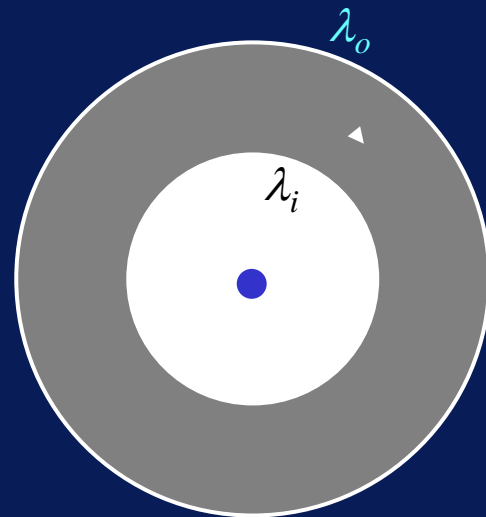
Lecture 6

Clicker 6-1

A long thin wire has a uniform positive charge density of 2.5 C/m . Concentric with the wire is a long thick conducting cylinder, with inner radius 3 cm , and outer radius 5 cm . The conducting cylinder has a net linear charge density of -4 C/m .

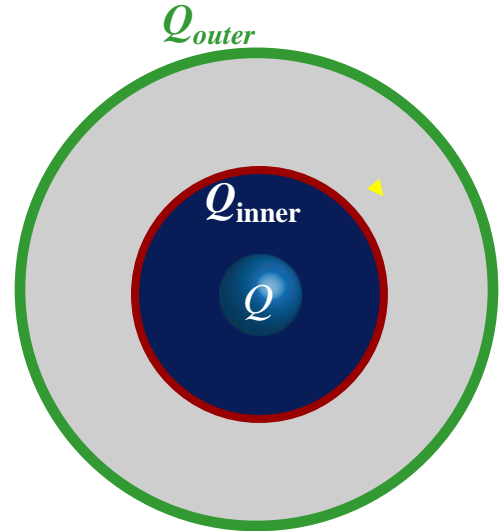
What is the linear charge density of the induced charge on the inner surface of the conducting cylinder (λ_i) and on the outer surface (λ_o)?

λ_i :	$+2.5 \text{ C/m}$	-4 C/m	-2.5 C/m	-2.5 C/m	0
λ_o :	-6.5 C/m	0	$+2.5 \text{ C/m}$	-1.5 C/m	-4 C/m
	A	B	C	D	E



A particle with charge $+Q$ is placed in the center of an uncharged conducting hollow sphere. How much charge will be induced on the inner and outer surfaces of the sphere?

- A) inner = $-Q$, outer = $+Q$
- B) inner = $-Q/2$, outer = $+Q/2$
- C) inner = 0, outer = 0
- D) inner = $+Q/2$, outer = $-Q/2$
- E) inner = $+Q$, outer = $-Q$



You hold a positively charged ball and walk to the right in a region that contains an electric field directed to the left.

Clicker 6-3

W_H is the work done by the hand on the ball

W_E is the work done by the electric field on the ball

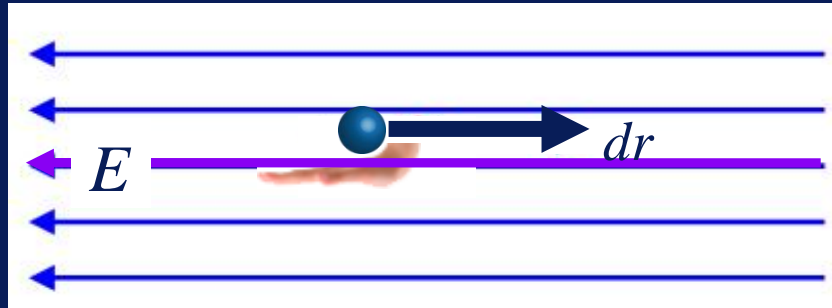
Which of the following statements is true:

A) $W_H > 0$ and $W_E > 0$

B) $W_H > 0$ and $W_E < 0$

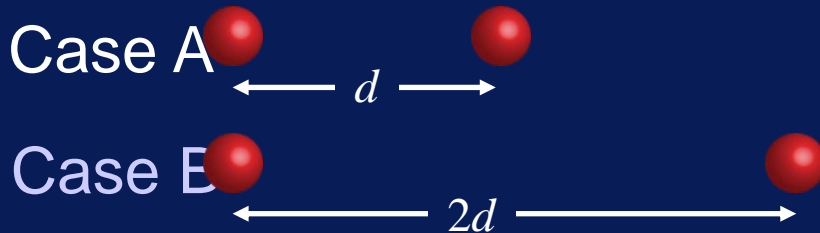
C) $W_H < 0$ and $W_E < 0$

D) $W_H < 0$ and $W_E > 0$

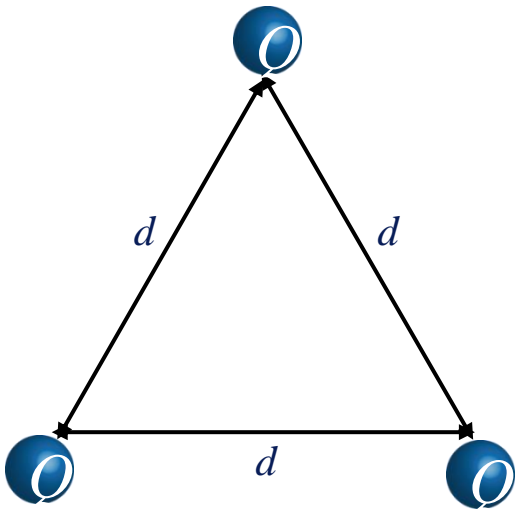


In Case A two negative charges which are equal in magnitude are separated by a distance d . In Case B the same charges are separated by a distance $2d$. Which configuration has the highest potential energy?

- A) Case A
- B) Case B



What is the total energy required to bring in three identical charges, from infinitely far away to the points on an equilateral triangle shown.



A) 0

B) $\Delta U = \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

C) $\Delta U = 2 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

D) $\Delta U = 3 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

E) $\Delta U = 6 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

Lecture 7

Suppose one of the charges is negative. Now what is the total energy required to bring the three charges in infinitely far away?

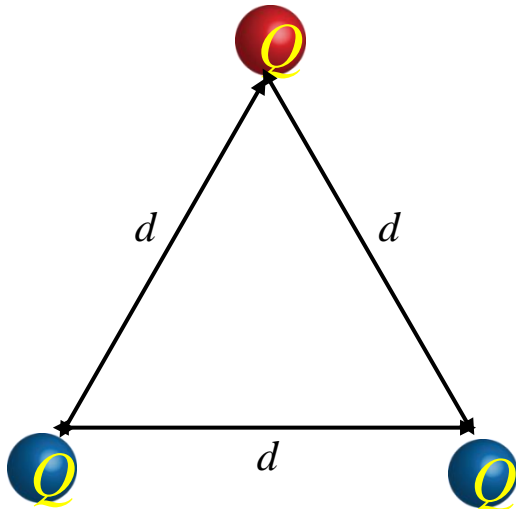
A) 0

B) $\Delta U = +1 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

C) $\Delta U = -1 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

D) $\Delta U = +2 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

E) $\Delta U = -2 \frac{Q^2}{4\pi\epsilon_0} \frac{1}{d}$

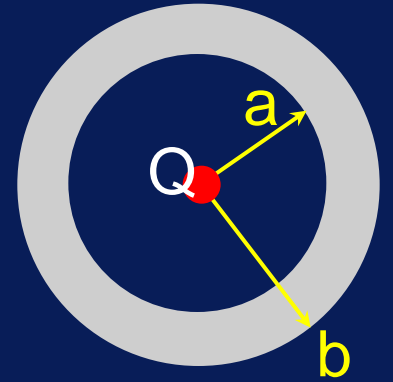


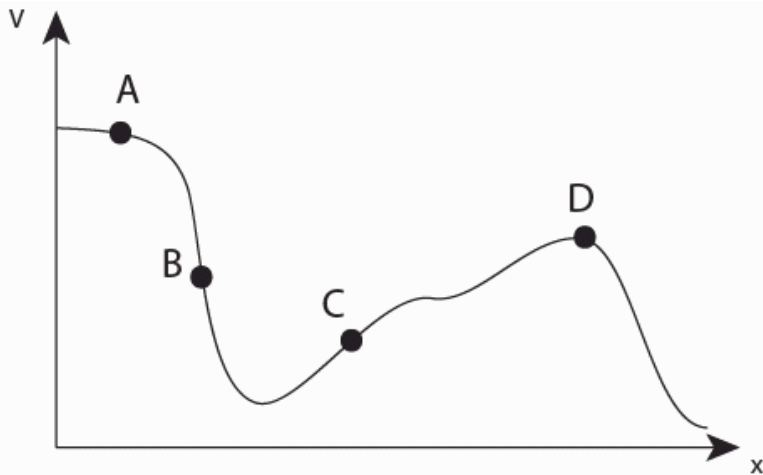
Lecture 8

A point charge Q is fixed at the center of an uncharged conducting spherical shell of inner radius a and outer radius b .

- What is the value of the potential V_a at the inner surface of the spherical shell?

(a) $V_a = 0$ (b) $V_a = \frac{1}{4\pi\epsilon_0} \frac{Q}{a}$ (c) $V_a = \frac{1}{4\pi\epsilon_0} \frac{Q}{b}$





At which point is the direction of the E field along the negative x axis ?

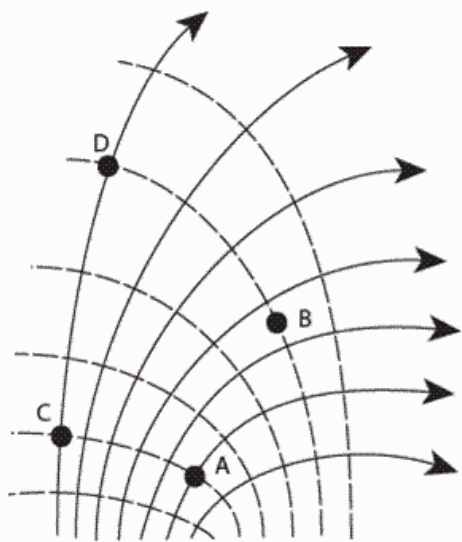
A

B

C

D

E = none of these



What is the sign of W_{AC} = work done by E field to move negative charge from A to C?

A) $W_{AC} < 0$

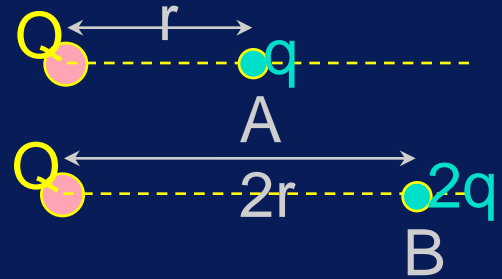
B) $W_{AC} = 0$

C) $W_{AC} > 0$

Lecture 9

Two test charges are brought separately to the vicinity of positive charge Q .

- Charge $+q$ is brought to A, a distance r from Q .
- Charge $+2q$ is brought to B, a distance $2r$ from Q .
- Compare the potential at A (V_A) to that at B:



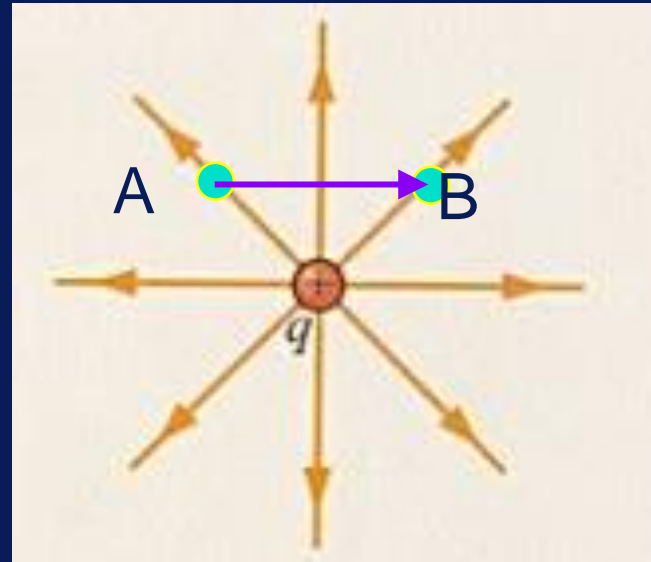
(a) $V_A < V_B$

(b) $V_A = V_B$

(c) $V_A > V_B$

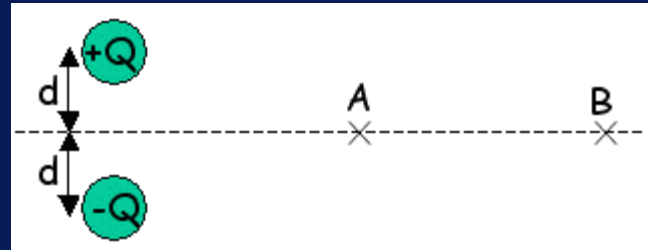
A positive charge Q is moved from A to B along the path shown. What is the sign of the work done to move the charge from A to B?

- (a) $W_{AB} < 0$ (b) $W_{AB} = 0$ (c) $W_{AB} > 0$



Clicker 9-3

An electric dipole with charge magnitude Q and separation $2d$ is oriented as shown below. Compare V_A , the electric potential at point A, with V_B , the electric potential at point B.

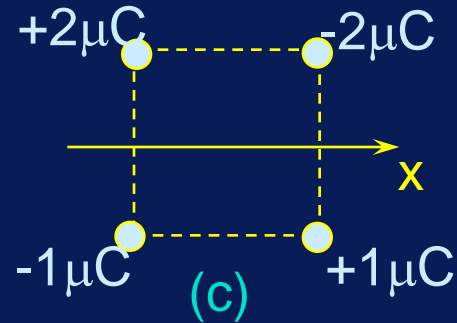
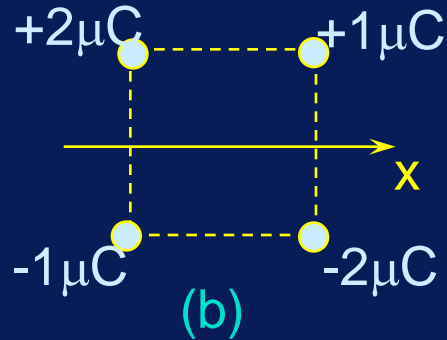
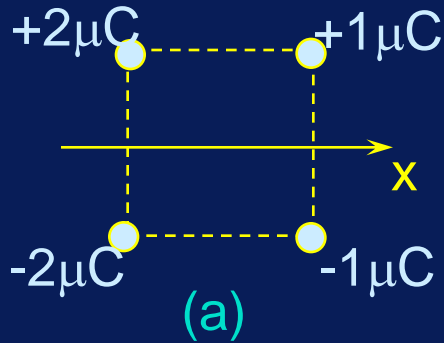


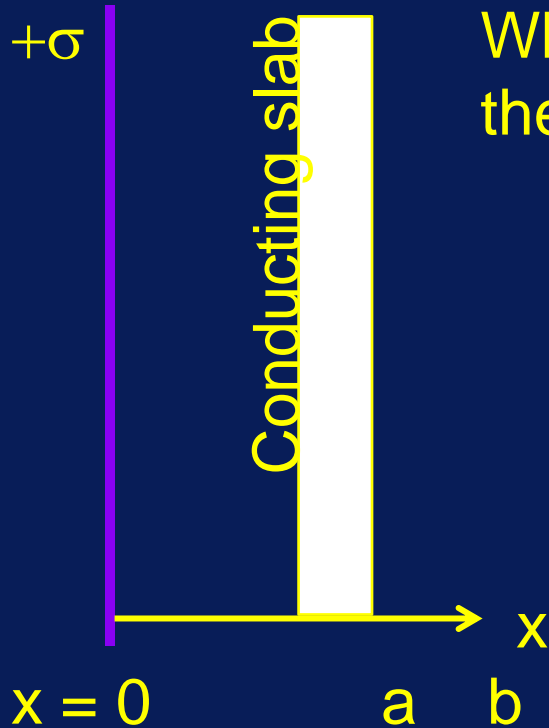
(a) $V_A < V_B$

(b) $V_A = V_B$

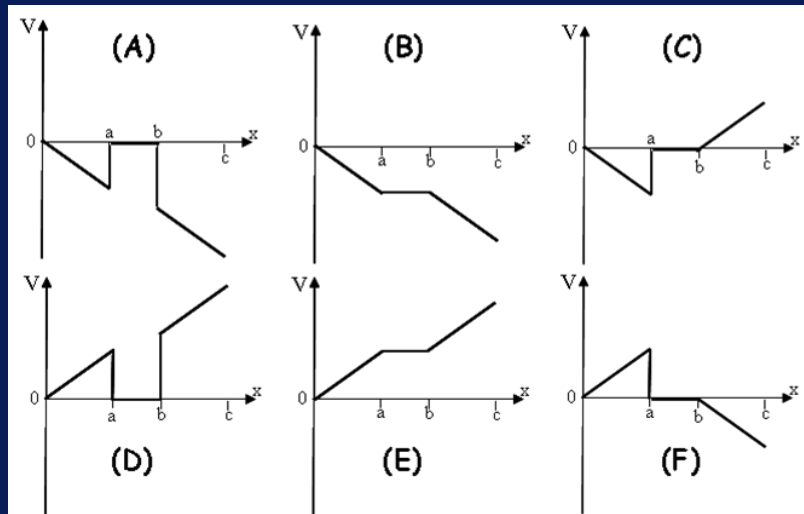
(c) $V_A > V_B$

Which of the following charge distributions produces $V(x) = 0$ for all points on the x axis? (we are defining $V(x) \equiv 0$ at $x = \infty$)





Which curve best represents the Potential in the positive x direction?

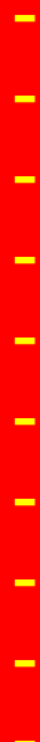


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Lecture 10

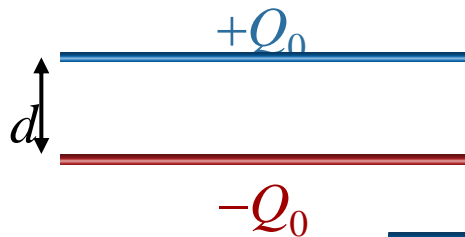
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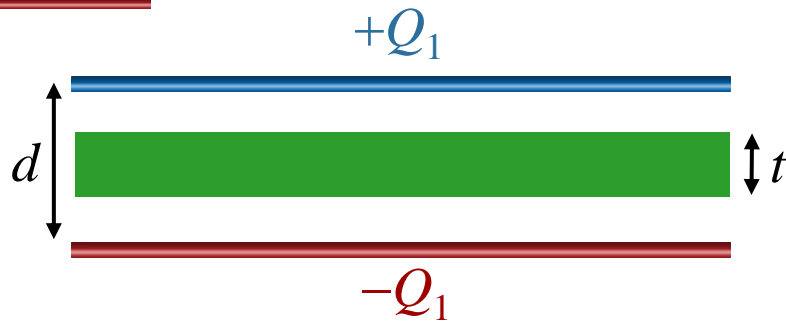
Clicker 10-1

Initial charge on capacitor = Q_0



Insert uncharged conductor

Charge on capacitor now = Q_1



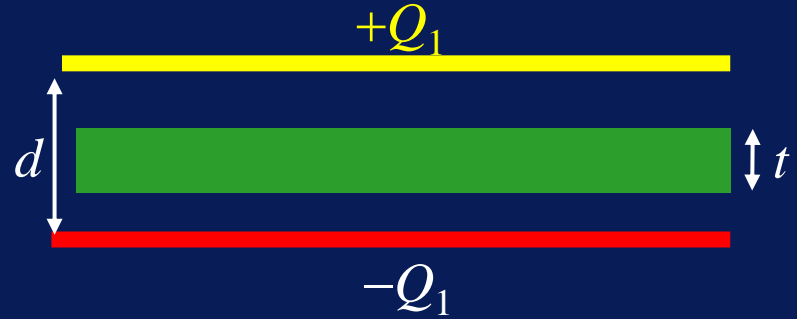
How is Q_1 related to Q_0 ?

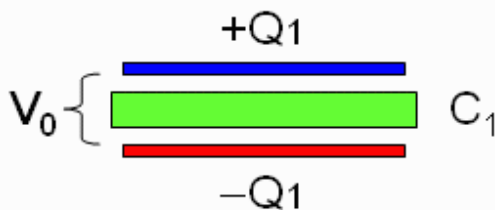
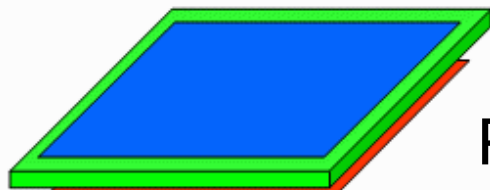
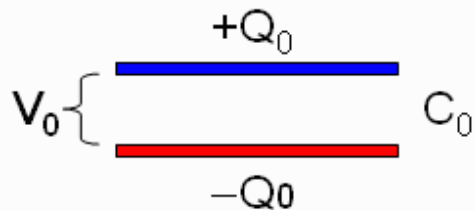
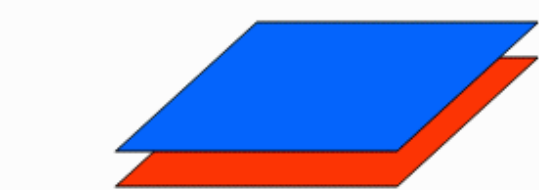
- A) $Q_1 < Q_0$
- B) $Q_1 = Q_0$
- C) $Q_1 > Q_0$

What is the total charge induced on the bottom surface of the conductor?

(Initial charge on capacitor = Q_0)

- A) $+Q_0$
- B) $-Q_0$
- C) 0
- D) Positive but the magnitude is unknown
- E) Negative but the magnitude is unknown





Potential difference is
the **SAME** as before.
(we adjusted it)

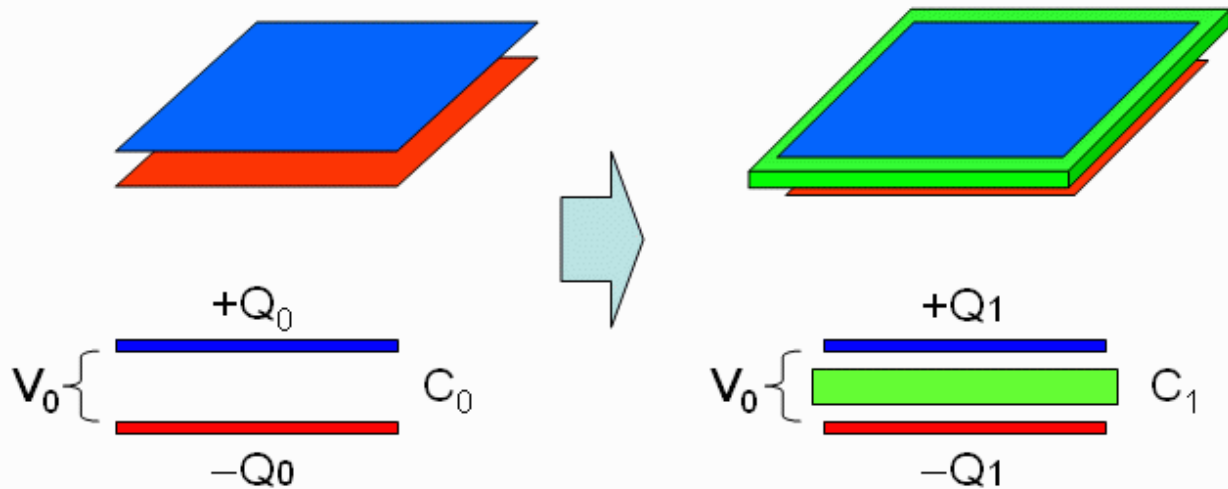
How is charge Q_1 related to the original Q_0 ?

A) $Q_1 < Q_0$

B) $Q_1 = Q_0$

C) $Q_1 > Q_0$

Clicker 10-3



We adjusted Q_1 to make the Potential Difference the Same

How did the Capacitance of the object change?

- A) $C_1 > C_0$ B) $C_1 = C_0$ C) $C_1 < C_0$

Clicker 10-4

Lecture 11

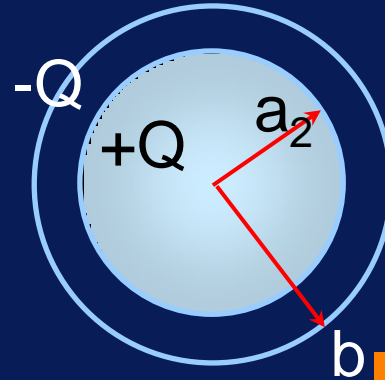
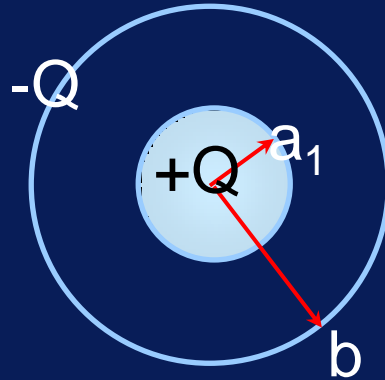
In each case below, a charge of $+Q$ is placed on a solid spherical conductor and a charge of $-Q$ is placed on a concentric conducting spherical shell.

- Let V_1 be the potential difference between the spheres with (a_1, b) .
- Let V_2 be the potential difference between the spheres with (a_2, b) .
- What is the relationship between V_1 and V_2 ?

(a) $V_1 < V_2$

(b) $V_1 = V_2$

(c) $V_1 > V_2$

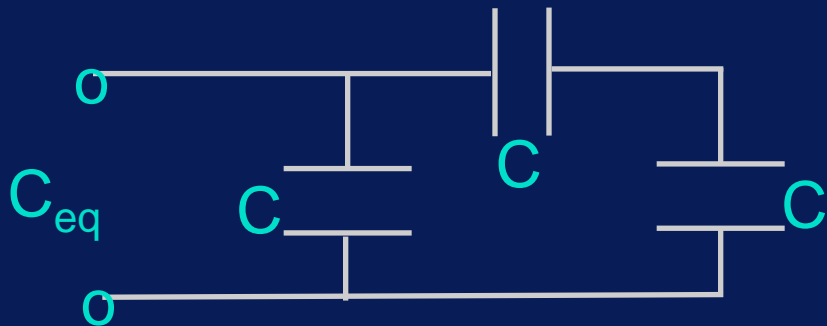


Suppose you have two identical capacitors, each having capacitance C . C_{\max} is the biggest possible equivalent capacitance that can be made by combining these two, and C_{\min} is the smallest.

How does C_{\max} compare to C_{\min} ?

- A. $C_{\max} = 4C_{\min}$
- B. $C_{\max} = 3C_{\min}$
- C. $C_{\max} = 2C_{\min}$
- D. $C_{\max} = (3/2)C_{\min}$
- E. $C_{\max} = C_{\min}$

What is the equivalent capacitance, C_{eq} , of the combination shown?



(a) $C_{eq} = (3/2)C$

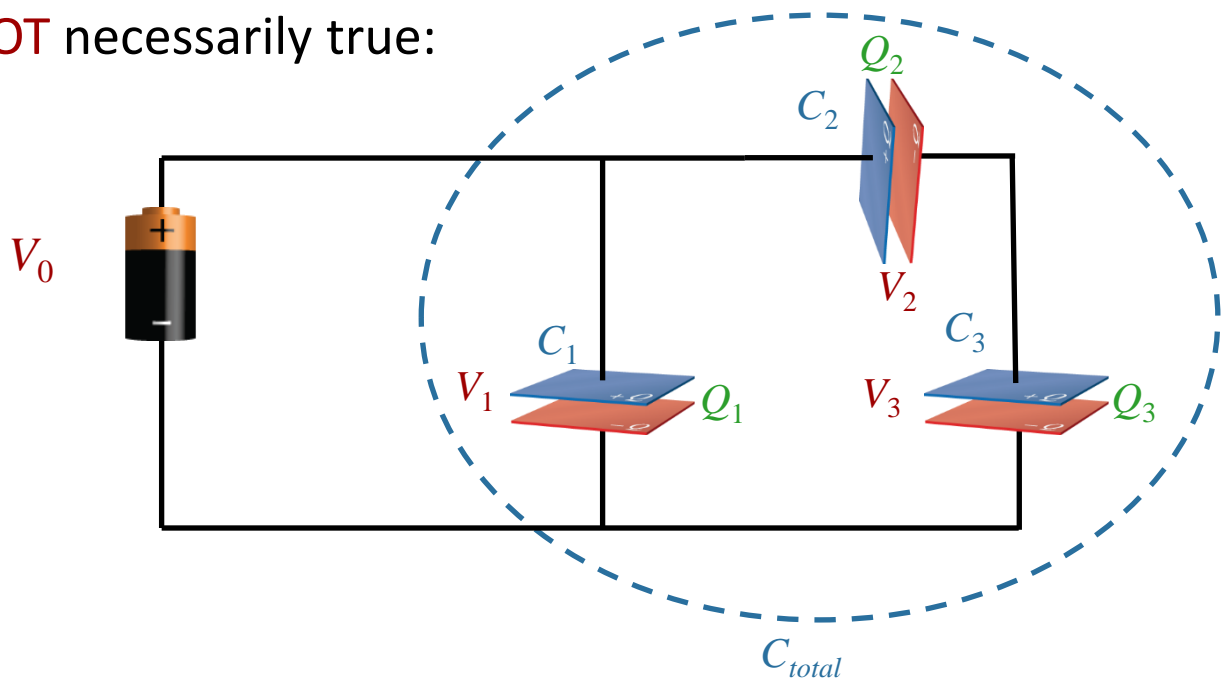
(b) $C_{eq} = (2/3)C$

(c) $C_{eq} = 3C$

Clicker 11-3

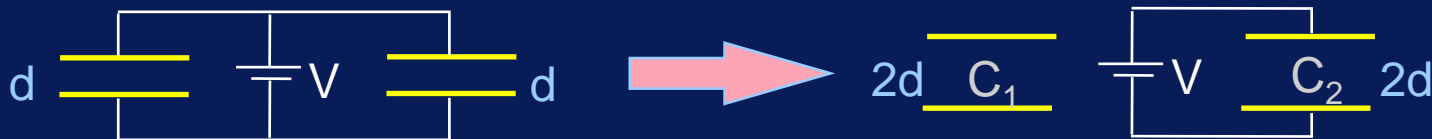
Which of the following is **NOT** necessarily true:

- A) $V_0 = V_1$
- B) $C_{total} > C_1$
- C) $V_2 = V_3$
- D) $Q_2 = Q_3$
- E) $V_1 = V_2 + V_3$



Lecture 12

- Two identical parallel plate capacitors are connected to a battery.
 - C_1 is then disconnected from the battery and the separation between the plates of both capacitors is doubled.



- What is the relation between U_1 , the energy stored in C_1 , and U_2 , the energy stored in C_2 ?

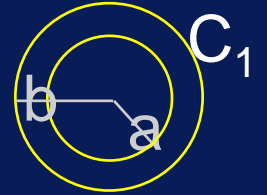
(a) $U_1 < U_2$ (b) $U_1 = U_2$ (c) $U_1 > U_2$ (d) I don't know

Clicker 12-1

Consider two cylindrical capacitors, each of length L .

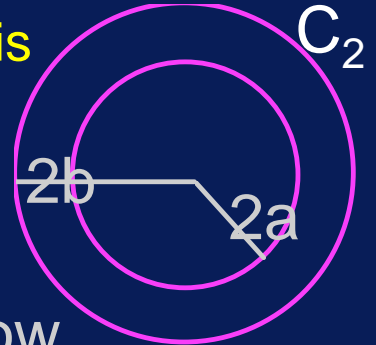
C_1 has inner radius a and outer radius b .

C_2 has inner radius $2a$ and outer radius $2b$.



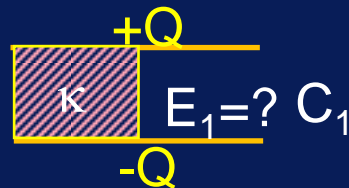
If both capacitors are given the same amount of charge, what is the relation between U_1 , the energy stored in C_1 , and U_2 , the energy stored in C_2 ?

$$C_{\text{Cylinder}} = \frac{2\pi\epsilon_0 L}{\ln\left(\frac{b}{a}\right)}$$

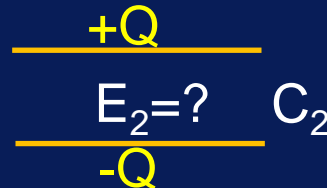


(a) $U_2 < U_1$ (b) $U_2 = U_1$ (c) $U_2 > U_1$ (d) I don't know

- Two parallel plate capacitors are identical except C_1 has half of the space between the plates filled with a material of dielectric constant κ .

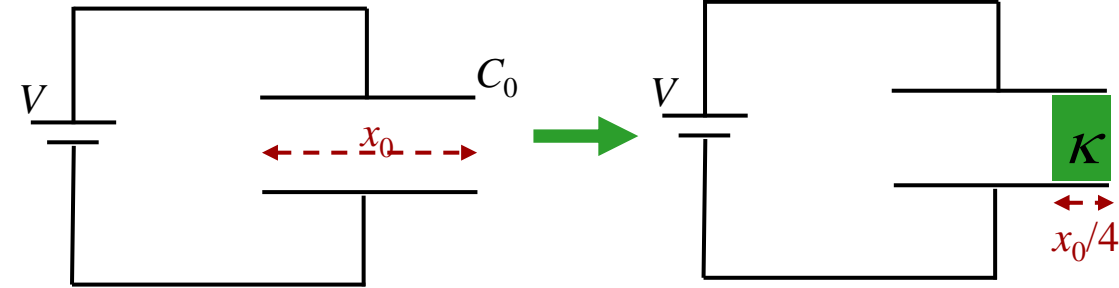


- Both capacitors have charge Q
- Compare E_1 , the electric field in the air of C_1 , to E_2 , the electric field in the air of C_2



(a) $E_1 < E_2$ (b) $E_1 = E_2$ (c) $E_1 > E_2$ (d) I don't know

Lecture 13



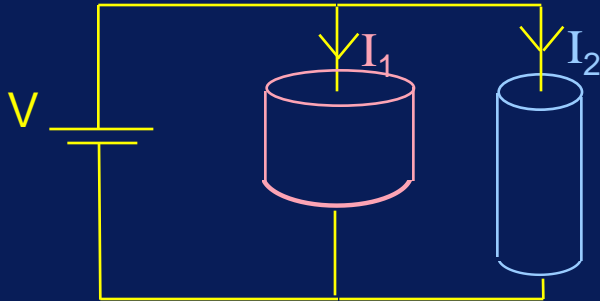
- An air-gap capacitor, having capacitance C_0 and width x_0 is connected to a battery of voltage V .

- A dielectric (κ) of width $x_0/4$ is inserted into the gap as shown.

What changes when the dielectric added?

- A) Only C B) only Q C) only V D) C and Q E) V and Q F) I Don't Know

- Two cylindrical resistors, R_1 and R_2 , are made of identical material. R_2 has twice the length of R_1 but half the radius of R_1 .
 - These resistors are then connected to a battery V as shown:



- What is the relation between I_1 , the current flowing in R_1 , and I_2 , the current flowing in R_2 ?

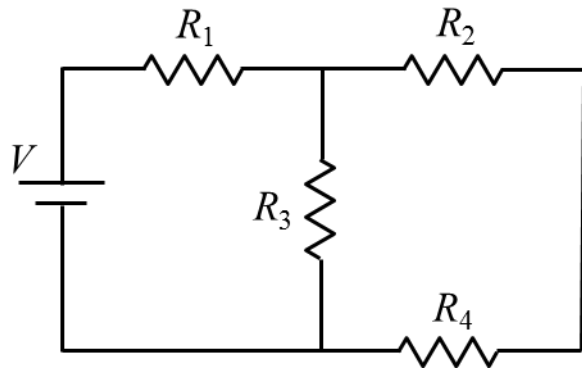
(a) $I_1 = I_2$

(b) $I_1 = 2I_2$

(c) $I_1 = 4I_2$

(d) $I_1 = 8I_2$

Clicker 13-2



30 second clicker

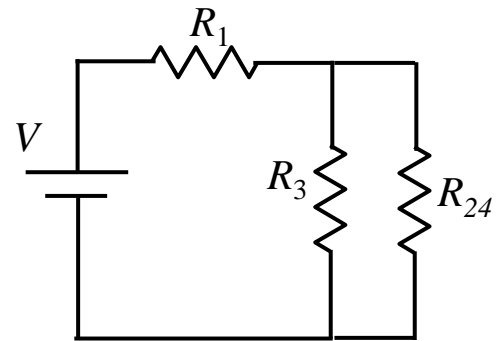
Combine Resistances: R_1 and R_2 are connected:

A) in series

B) in parallel

C) neither in series nor in parallel

Clicker 13-3



In the circuit shown: $V = 18\text{V}$,
 $R_1 = 1\Omega$, $R_2 = 2\Omega$, $R_3 = 3\Omega$, and $R_4 = 4\Omega$.

What is V_2 , the voltage across R_2 ?

Combine Resistances: R_2 and R_4 are connected in series $= R_{24}$
 R_3 and R_{24} are connected in parallel $= R_{234}$

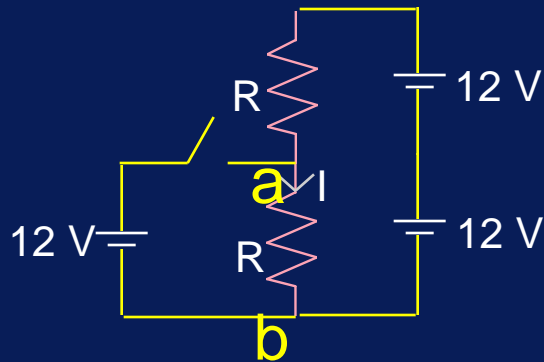
What is the value of R_{234} ?

A) $R_{234} = 1\Omega$ B) $R_{234} = 2\Omega$ C) $R_{234} = 4\Omega$ D) $R_{234} = 6\Omega$

Clicker 13-4

Lecture 14

- **Consider the circuit shown.**
 - The switch is initially open and the current flowing through the bottom resistor is I_0 .
 - After the switch is closed, the current flowing through the bottom resistor is I_1 .
 - What is the relation between I_0 and I_1 ?



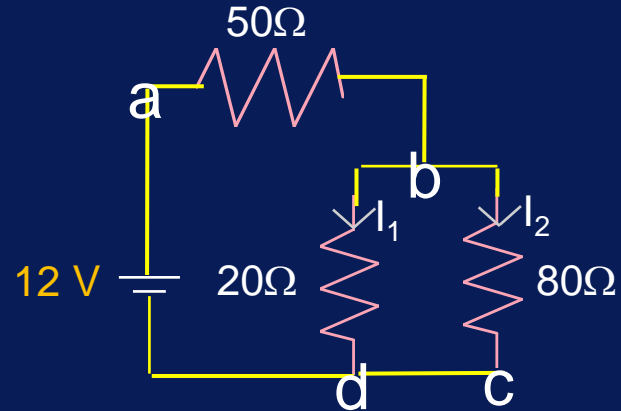
(a) $I_1 < I_0$

(b) $I_1 = I_0$

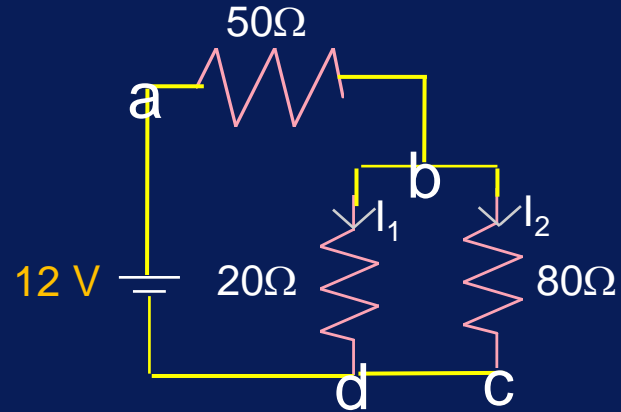
(c) $I_1 > I_0$

- Consider the circuit shown:
 - What is the relation between $V_a - V_d$ and $V_a - V_c$?

- (a) $(V_a - V_d) < (V_a - V_c)$
- (b) $(V_a - V_d) = (V_a - V_c)$
- (c) $(V_a - V_d) > (V_a - V_c)$



- Consider the circuit shown:
- What is the relation between I_1 and I_2 ?



(a) $I_1 < I_2$

(b) $I_1 = I_2$

(c) $I_1 > I_2$

Lecture 15

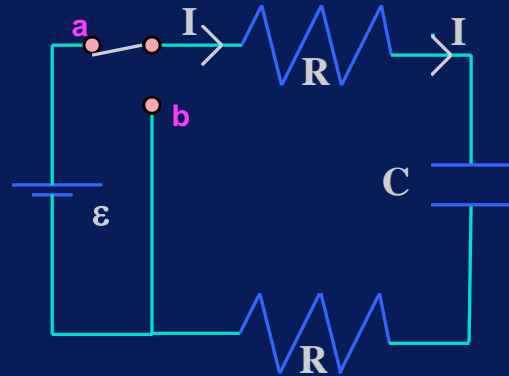
At $t = 0$ the switch is thrown from position b to position a in the circuit shown: The capacitor is initially uncharged.

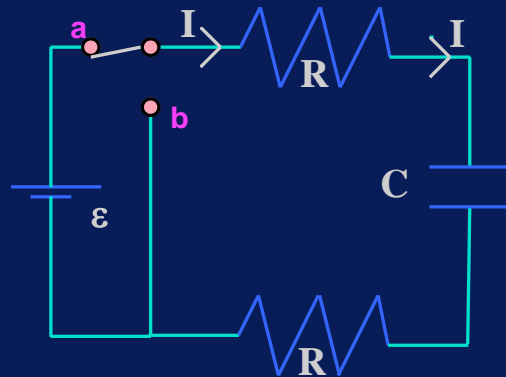
– What is the value of the current I_0 just after the switch is thrown?

(a) $I_0 = 0$

(b) $I_0 = \varepsilon/2R$

(c) $I_0 = 2\varepsilon/R$





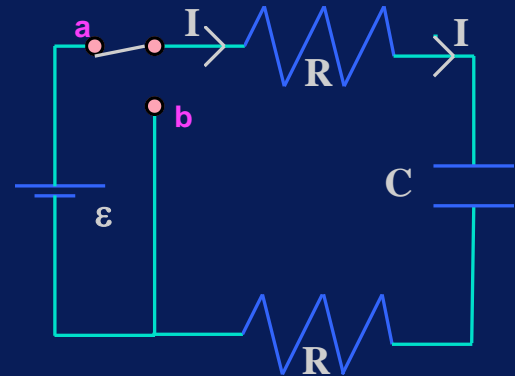
What is the value of the current I_∞ after a very long time?

(a) $I_\infty = 0$

(b) $I_\infty = \varepsilon/2R$

(c) $I_\infty > 2\varepsilon/R$

- At $t = 0$ the switch is thrown from position b to position a in the circuit shown: The capacitor is initially uncharged.
 - At time $t = t_1 = \tau$, the charge Q_1 on the capacitor is $(1-1/e)$ of its asymptotic charge $Q_f = C\varepsilon$.
 - What is the relation between Q_1 and Q_2 , the charge on the capacitor at time $t = t_2 = 2\tau$?

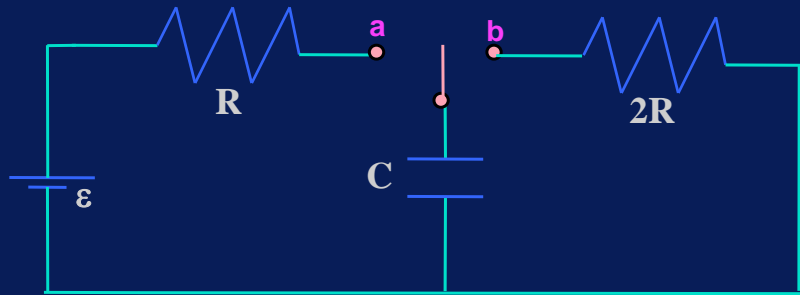


(a) $Q_2 < 2 Q_1$

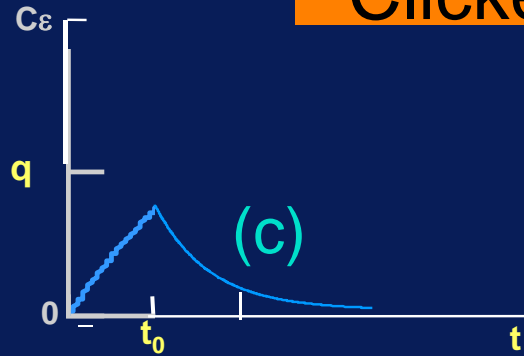
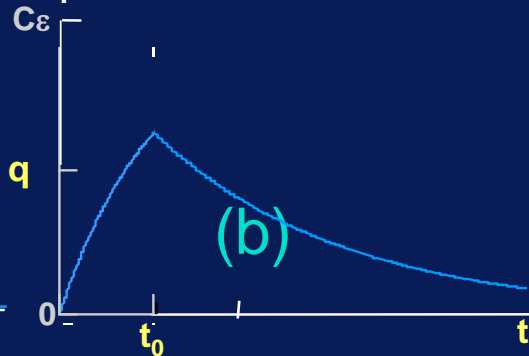
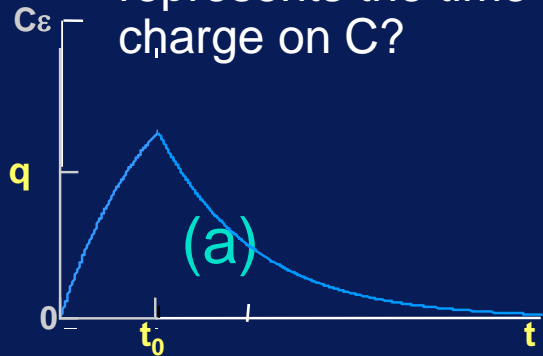
(b) $Q_2 = 2 Q_1$

(c) $Q_2 > 2 Q_1$

- At $t = 0$ the switch is connected to position **a** in the circuit shown: The capacitor is initially uncharged.
 - At $t = t_0$, the switch is thrown from position **a** to position **b**.
 - Which of the following graphs best represents the time dependence of the charge on C ?



Clicker 15-4



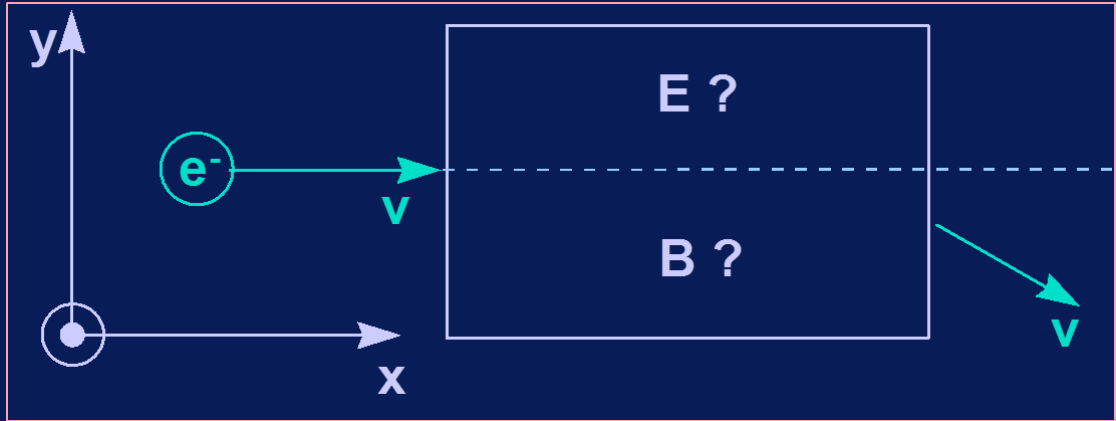
Lecture 16 - Review

Lecture 17

An electron enters a region of space with speed v and exits the region as shown with the same speed (magnitude) v .

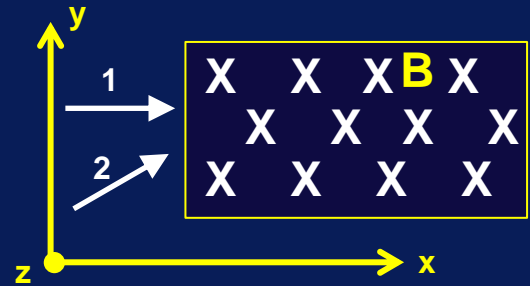
From this information, what can we infer about the E_y and B_z fields in the region?

- A. Only E_y exists
- B. Only B_z exists
- C. Both E_y & B_z can exist



Two protons each move at speed v toward a region of space which contains a constant B field in the $-z$ direction.

- *What is the relation between the magnitudes of the forces on the two protons in the magnetic field region?*

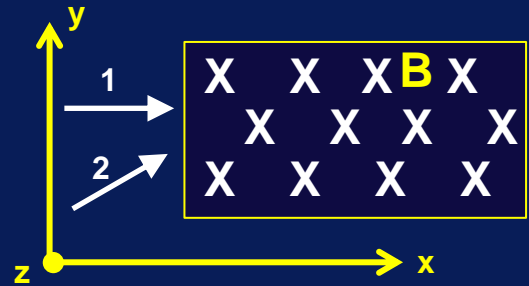


(a) $F_1 < F_2$

(b) $F_1 = F_2$

(c) $F_1 > F_2$

Two protons each move at speed v toward a region of space which contains a constant B field in the $-z$ direction.



What is F_{2x} , the x -component of the force on the second proton?

(a) $F_{2x} < 0$

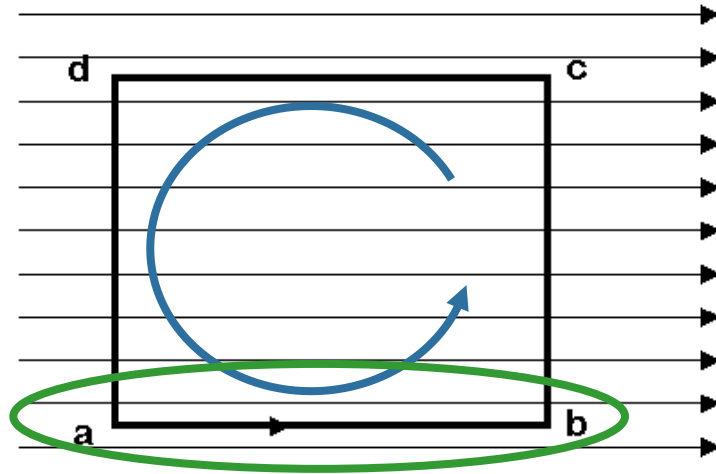
(b) $F_{2x} = 0$

(c) $F_{2x} > 0$

Question about work; Answer = no work,
B

Lecture 18

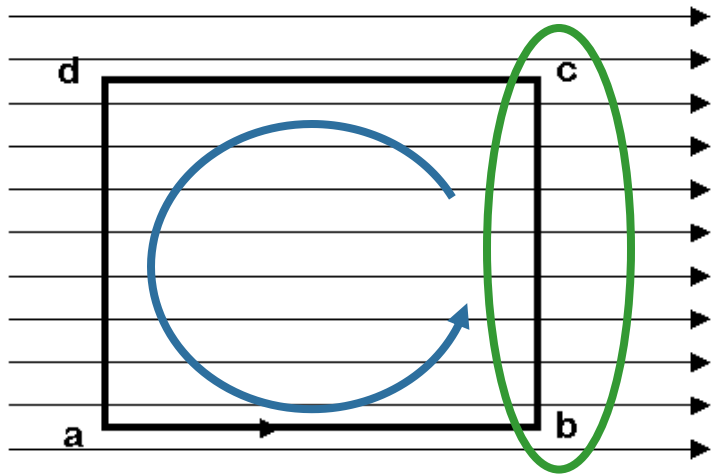
A square loop of wire is carrying current in the counterclockwise direction. A horizontal uniform magnetic field points to the right



What is the force on section **a-b** of the loop ?

- A) zero B) out of the page C) into the page D) Up E) Down

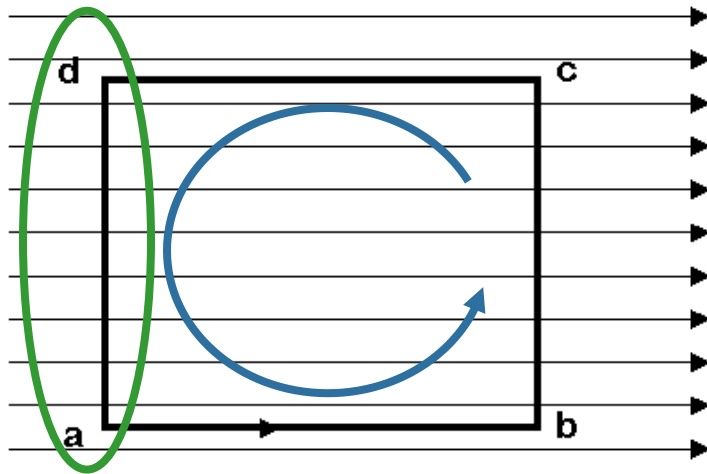
A square loop of wire is carrying current in the counterclockwise direction. A horizontal uniform magnetic field points to the right



What is the force on section **b-c** of the loop ?

- A) zero B) out of the page C) into the page D) Up E) Down

A square loop of wire is carrying current in the counterclockwise direction. A horizontal uniform magnetic field points to the right



What is the force on section **d-a** of the loop ?

- A) zero B) out of the page C) into the page D) Up E) Down

A **current I** flows in a wire which is formed in the shape of an isosceles triangle as shown. A constant magnetic field exists in the $-z$ direction.

What is F_y , net force on the wire in the y -direction?

(a) $F_y < 0$

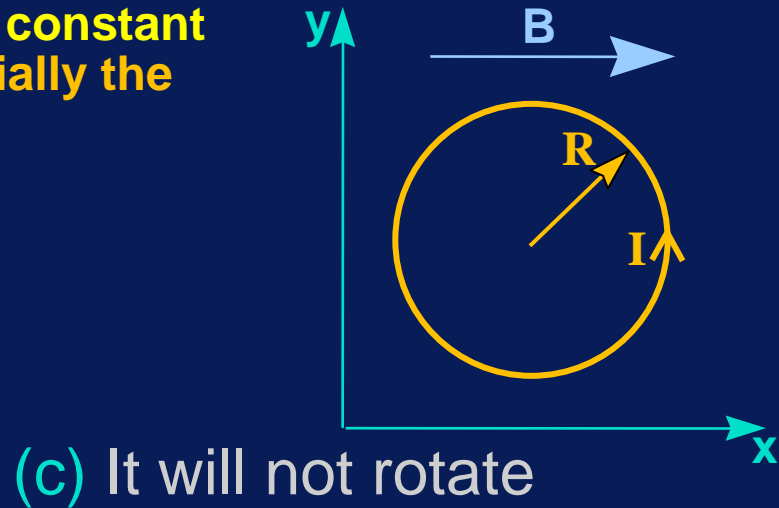
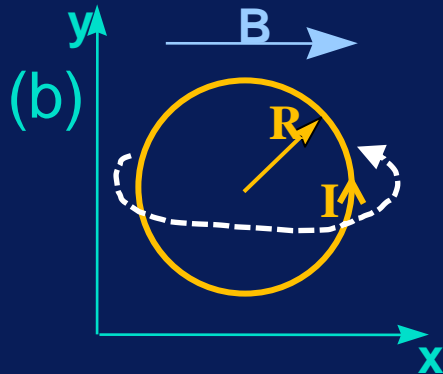
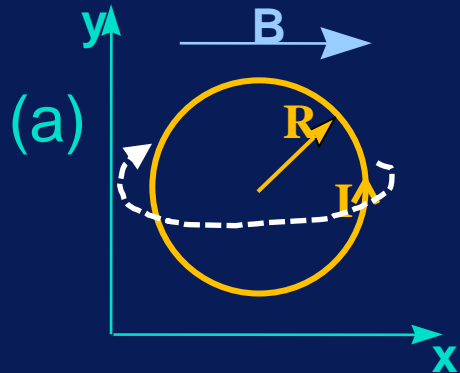
(b) $F_y = 0$

(c) $F_y > 0$



A circular loop of radius R carries current I . A constant magnetic field B exists in the $+x$ direction. Initially the loop is in the x - y plane.

– How will the coil rotate?



Lecture 19

A long straight wire is carrying current from left to right. Two identical charges are moving with equal speed. Compare the magnitude of the force on charge *a* moving directly to the right, to the magnitude of the force on charge *b* moving up and to the right at the instant shown (i.e. same distance from the wire).



A) $|F_a| > |F_b|$

B) $|F_a| = |F_b|$

C) $|F_a| < |F_b|$

Two long wires carry opposite current

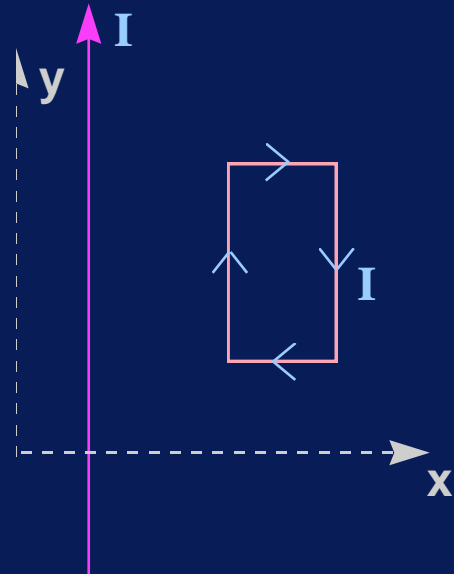
X

What is the direction of the magnetic field above, and midway between the two wires carrying current – at the point marked “X”?



- A) Left B) Right C) Up D) Down E) Zero

- A current I flows in the positive y direction in an infinite wire; a current I also flows in the loop as shown in the diagram.
 - What is F_x , net force on the loop in the x -direction?

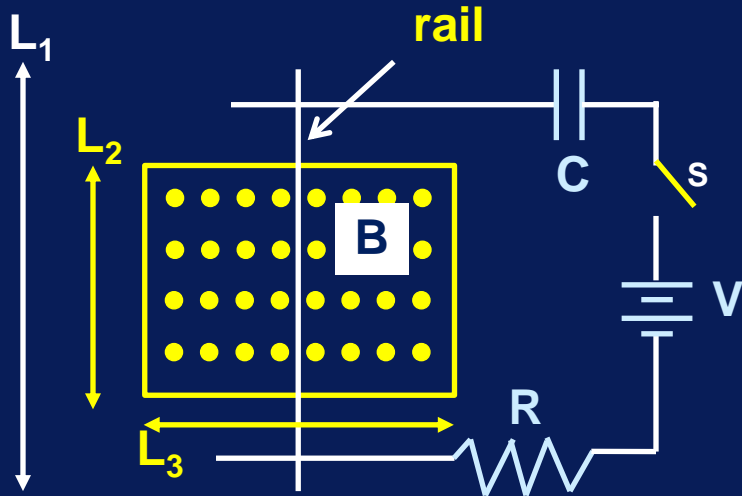


(a) $F_x < 0$

(b) $F_x = 0$

(c) $F_x > 0$

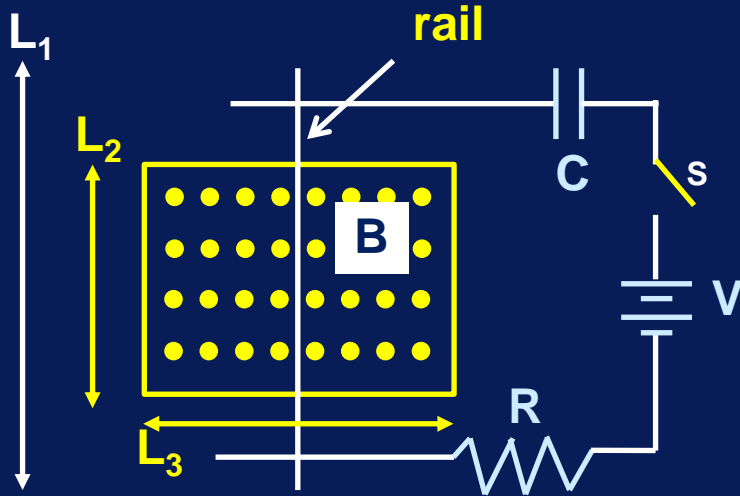
Lecture 20



A conducting rail of length L_1 rests on the top of the circuit loop as shown. It is free to move. A uniform magnetic field exists in the box of dimension L_2 by L_3 .

When switch s is closed, which way does the rail move (if at all) ?

- A) Left
- B) Right
- C) Rotates clockwise
- D) Rotates counterclockwise
- E) Does not move

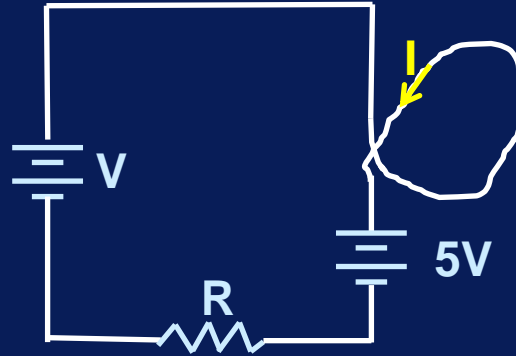


A conducting rail of length L_1 rests on the top of the circuit loop as shown. It is free to move. A uniform magnetic field exists in the box of dimension L_2 by L_3 .

What is the magnitude of the force on the rail RC seconds after the switch has been closed?

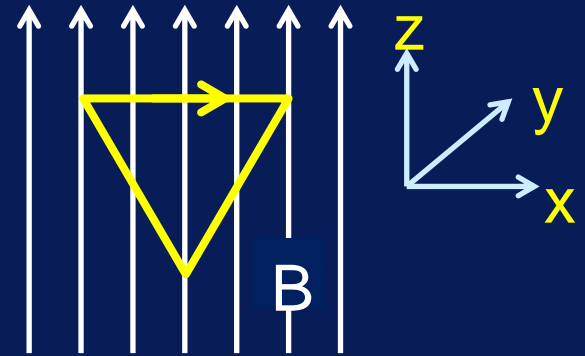
- A) $0.37(V/R)$
- B) $0.63(VL_1B)/R$
- C) $0.37(VL_1B)/R$
- D) $(V/R) L_1L_2B$
- E) $0.37(VL_2B)/R$
- F) My answer wasn't listed ☹

- A loop of wire is formed in this circuit as shown on the right of the drawing.
- We define the direction of positive current through the loop, $+I$, as shown
- What is the direction of the magnetic moment and current?



- | | |
|-----------------|----------------------------|
| A) I is > 0 | & μ is out of the page |
| B) I is < 0 | & μ is out of the page |
| C) I is > 0 | & μ is into the page |
| D) I is < 0 | & μ is into the page |

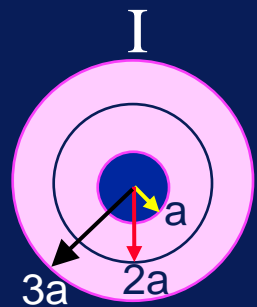
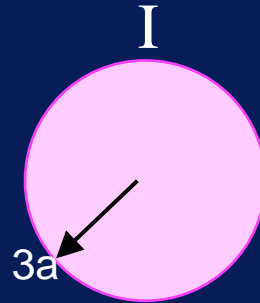
- Consider the loop of current shown, which is located in a uniform vertical magnetic field.
- About which axis might this loop rotate?



- A) x
- B) y
- C) z
- D) It will not rotate

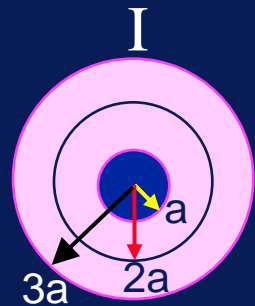
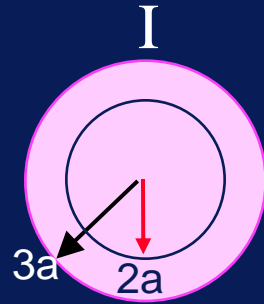
Two cylindrical conductors each carry current I into the screen as shown. The conductor on the left is solid and has radius $R = 3a$. The conductor on the right has a hole in the middle and carries current only between $R = a$ and $R = 3a$.

- What is the relation between the magnetic fields at $R = 6a$ for the two cases (L=left, R=right)?



- (a) $B_L(6a) < B_R(6a)$ (b) $B_L(6a) = B_R(6a)$ (c) $B_L(6a) > B_R(6a)$

Two cylindrical conductors each carry current I into the screen as shown. The conductor on the left is solid and has radius $R = 3a$. The conductor on the right has a hole in the middle and carries current only between $R = a$ and $R = 3a$.



What is the relation between the magnetic field at $R = 2a$ for the two cases (L=left, R=right)? (do the calculation)

- (a) $B_L(2a) < B_R(2a)$ (b) $B_L(2a) = B_R(2a)$ (c) $B_L(2a) > B_R(2a)$

Lecture 21

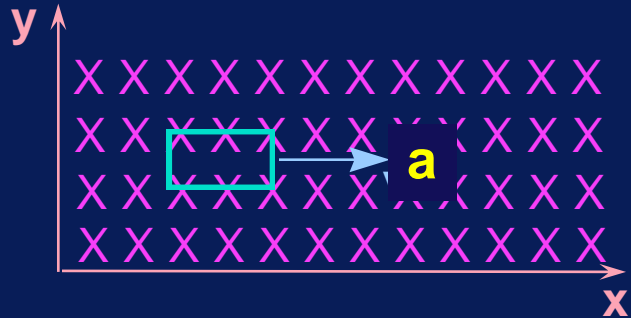
- A conducting rectangular loop is accelerated in the $+x$ direction through a region of constant magnetic field B in the $-z$ direction as shown.

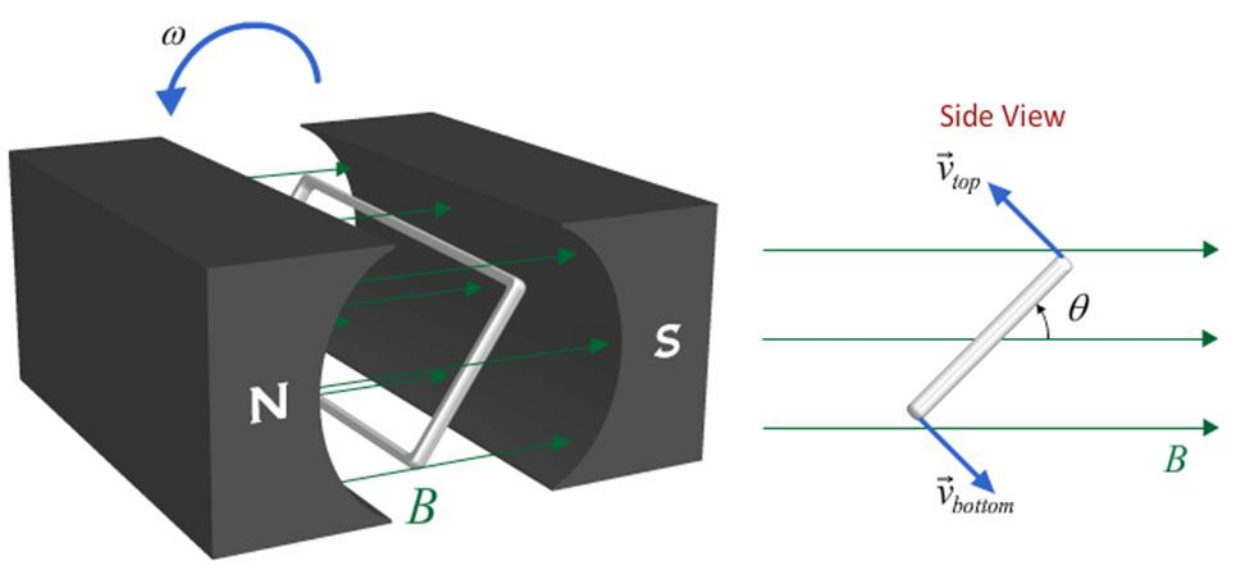
– What is the direction of the induced current in the loop?

(a) ccw

(b) cw

(c) no induced current





At what angle θ is *emf* the largest?

- A)** $\theta = 0$ **B)** $\theta = 45^\circ$ **C)** $\theta = 90^\circ$ **D)** *emf* is same at all angles

Lecture 22

Suppose you double the magnetic field in a given region and quadruple the area through which this magnetic field exists. The effect on the flux through this area would be to

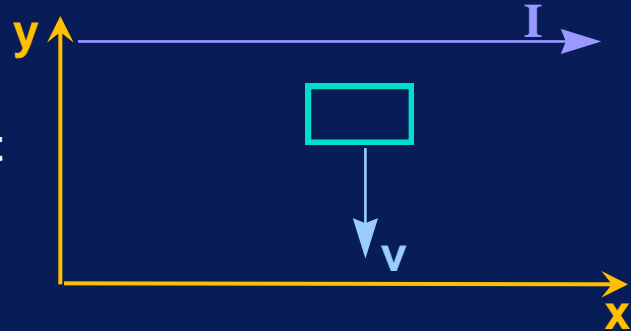
- A. Leave it unchanged
- B. Double it
- C. Quadruple it
- D. Increase by factor of 6
- E. Increase it by factor of 8

A 3.0-cm by 5.0-cm rectangular coil has 100 turns. Its axis makes an angle of 55° with a uniform magnetic field of 0.35 T. What is the magnetic flux through this coil?

- A. 3.0×10^{-4} Wb
- B. 4.3×10^{-4} Wb
- C. 3.0×10^{-2} Wb
- D. 4.3×10^{-2} Wb
- E. 5.3×10^{-2} Wb

A conducting rectangular loop moves with constant velocity \mathbf{v} in the $-y$ direction and a constant current I flows in the $+x$ direction as shown.

What is the direction of the induced current in the loop?

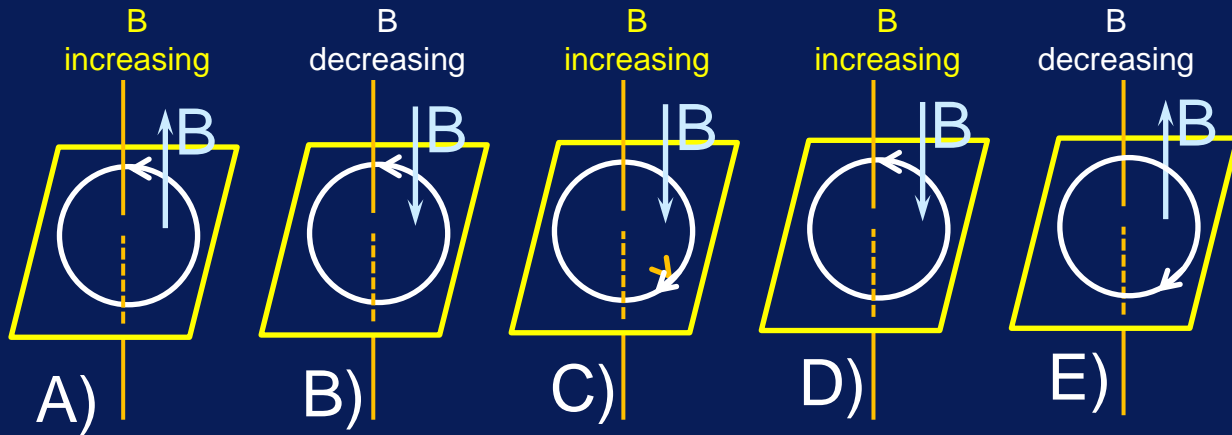


(a) ccw

(b) cw

(c) no induced current

A loop rests in the xy plane. The z axis is normal to the plane. The direction of the changing flux is indicated by the arrow on the z axis. The diagram that correctly shows the direction of the resultant induced current in the loop is

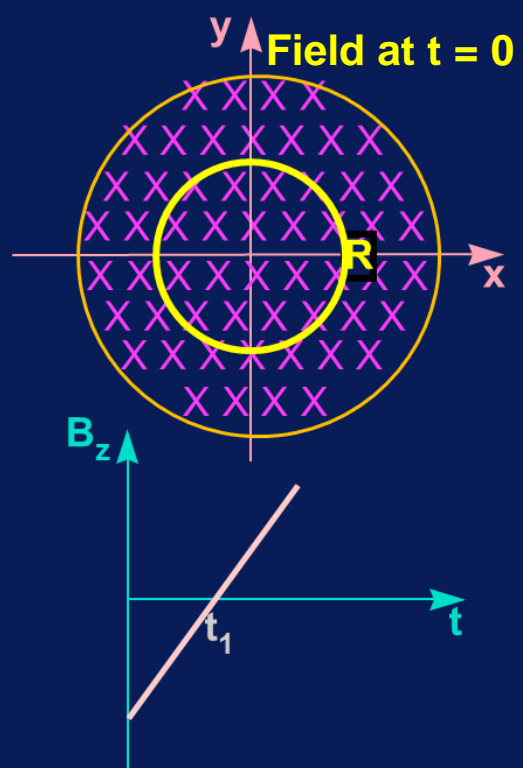


Lecture 23

The magnetic field in a region of space of radius $2R$ is aligned with the z -direction and changes in time as shown in the plot.

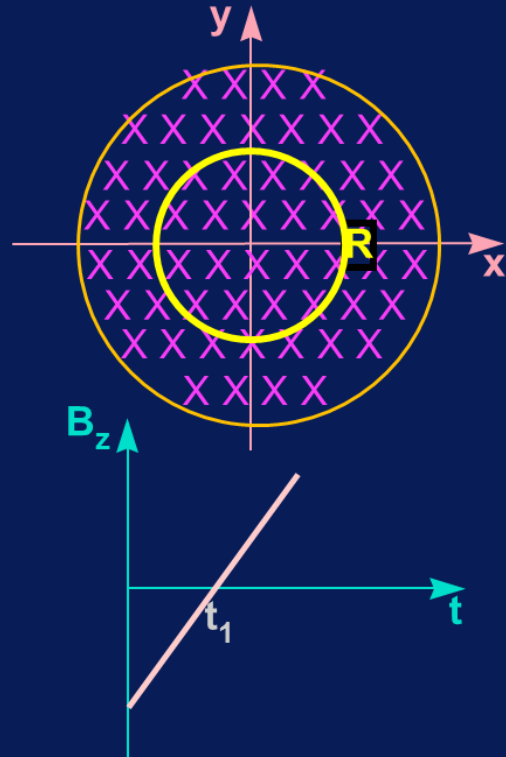
Which way would the induced current flow in yellow loop at time $t=t_1$?

- (a) ccw (b) cw (c) No current

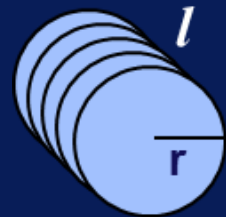


What is the relation between the magnitudes of the induced electric fields E_R at radius R and E_{2R} at radius $2R$?

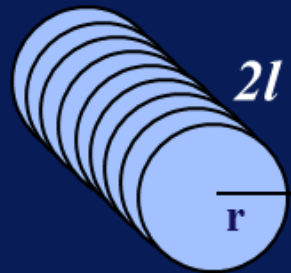
- (a) $E_{2R} = E_R$ (b) $E_{2R} = 2E_R$ (c) $E_{2R} = 4E_R$



- Consider the two inductors shown:
 - Inductor 1 has length l , N total turns and has inductance L_1 .
 - Inductor 2 has length $2l$, $2N$ total turns and has inductance L_2 .
 - What is the relation between L_1 and L_2 ?



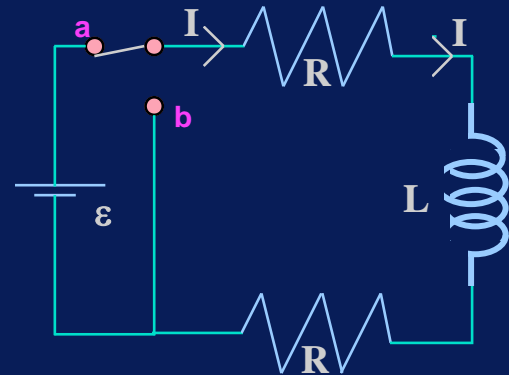
N turns



$2N$ turns

- (a) $L_2 < L_1$ (b) $L_2 = L_1$ (c) $L_2 > L_1$

- At $t = 0$ the switch is thrown from position b to position a in the circuit shown:
 - What is the value of the current I_{∞} a long time after the switch is thrown?

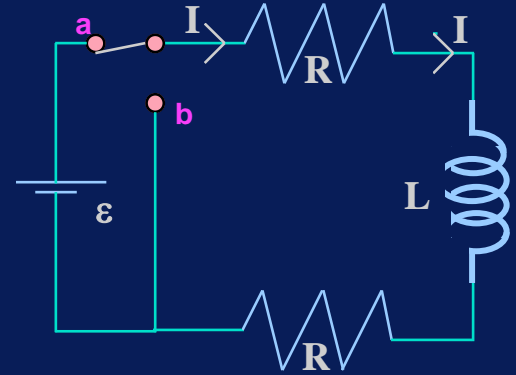


(a) $I_{\infty} = 0$

(b) $I_{\infty} = \epsilon / 2R$

(c) $I_{\infty} = 2\epsilon / R$

What is the value of the current I_0 immediately after the switch is thrown?



(a) $I_0 = 0$

(b) $I_0 = \epsilon / 2R$

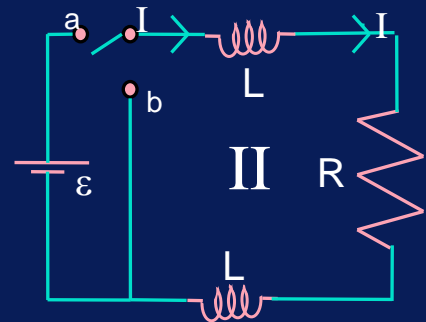
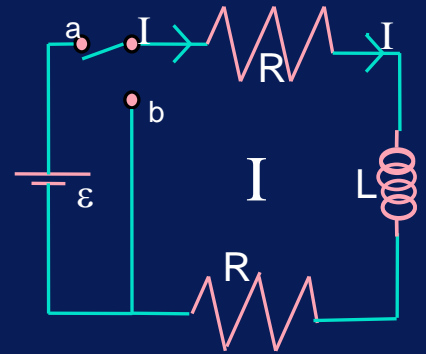
(c) $I_0 = 2\epsilon / R$

Lecture 24

At $t=0$, the switch is thrown from position b to position a as shown:

- Let t_I be the time for circuit I to reach $1/2$ of its asymptotic current.
- Let t_{II} be the time for circuit II to reach $1/2$ of its asymptotic current.
- What is the relation between t_I and t_{II} ?

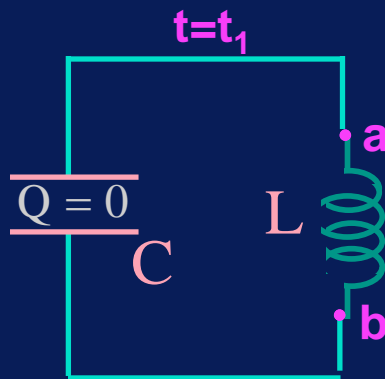
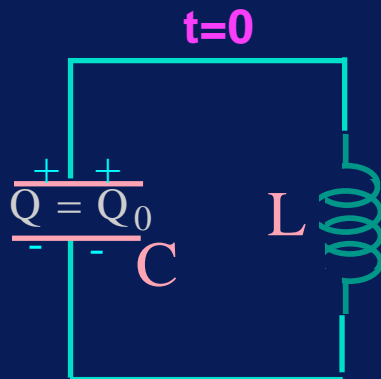
(a) $t_{II} < t_I$ (b) $t_{II} = t_I$ (c) $t_{II} > t_I$



Lecture 25

At $t=0$, the capacitor in the LC circuit shown has a total charge Q_0 . At $t = t_1$, the capacitor is uncharged.

- What is the value of V_{ab} , the voltage across the inductor at time t_1 ?

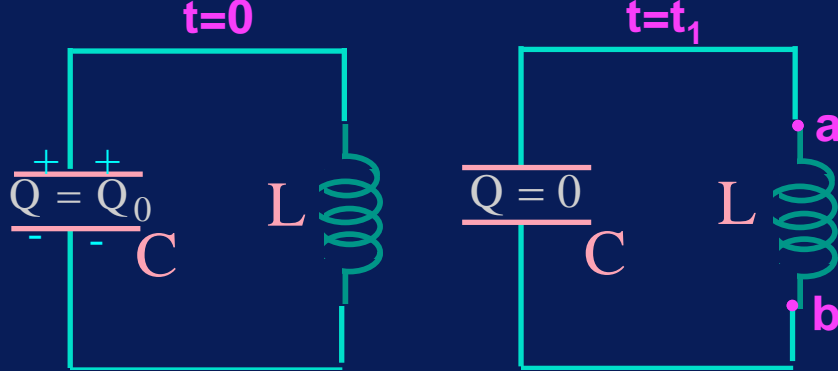


(a) $V_{ab} < 0$

(b) $V_{ab} = 0$

(c) $V_{ab} > 0$

At $t=0$, the capacitor in the LC circuit shown has a total charge Q_0 . At $t = t_1$, the capacitor is uncharged.



What is the relation between U_{L1} , the energy stored in the inductor at $t = t_1$, and U_{C1} , the energy stored in the capacitor at $t = t_1$?

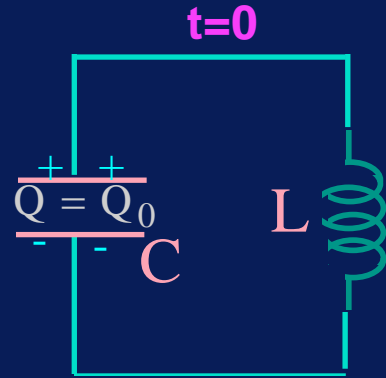
(a) $U_{L1} < U_{C1}$

(b) $U_{L1} = U_{C1}$

(c) $U_{L1} > U_{C1}$

At $t = 0$ the capacitor has charge Q_0 ; the resulting oscillations have frequency ω_0 . The maximum current in the circuit during these oscillations has value I_0 .

- What is the relation between ω_0 and ω_2 , the frequency of oscillations when the initial charge = $2Q_0$?



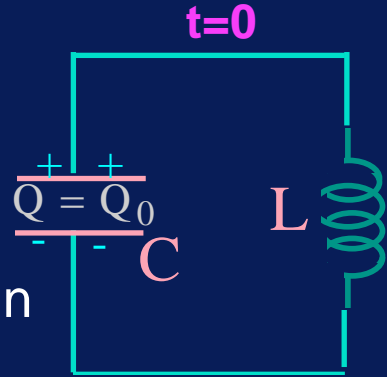
(a) $\omega_2 = 1/2 \omega_0$

(b) $\omega_2 = \omega_0$

(c) $\omega_2 = 2 \omega_0$

- At $t = 0$ the capacitor has charge Q_0 ; the resulting oscillations have frequency ω_0 . The maximum current in the circuit during these oscillations has value I_0 .

What is the relation between I_0 and I_2 , the maximum current in the circuit when the initial charge = $2Q_0$?



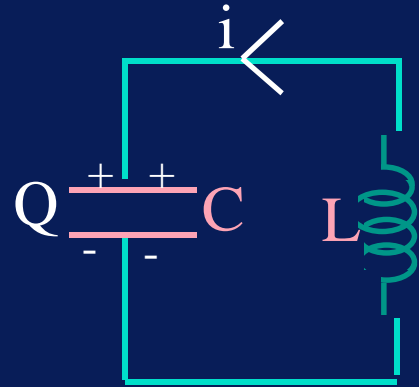
(a) $I_2 = I_0$

(b) $I_2 = 2 I_0$

(c) $I_2 = 4 I_0$

At $t = 0$ the current flowing through the circuit is $1/2$ of its maximum value.

- Which of the following is a possible value for the phase ϕ , when the charge on the capacitor is described by: $Q(t) = Q_0 \cos(\omega t + \phi)$.



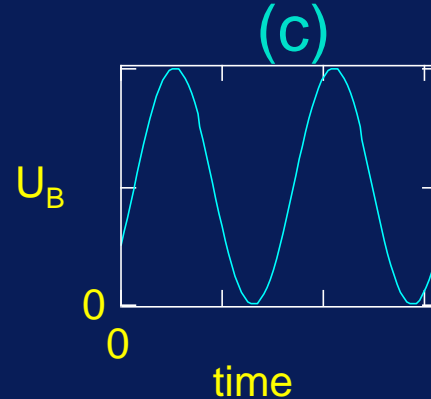
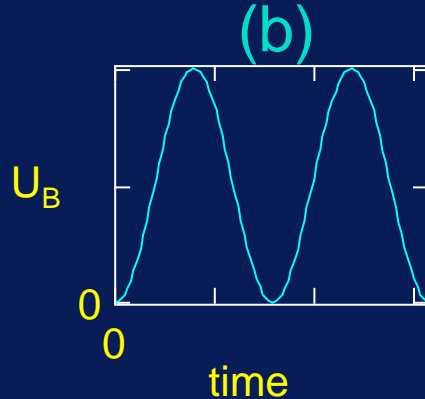
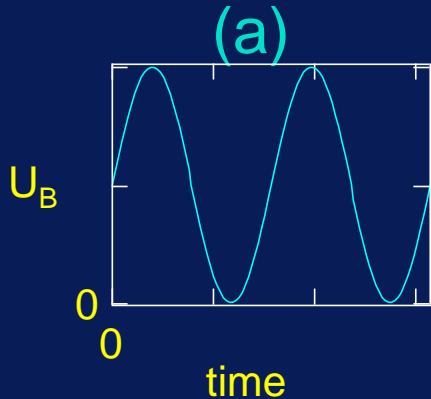
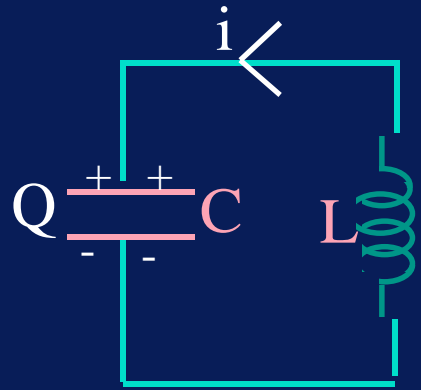
(a) $\phi = 30^\circ$

(b) $\phi = 45^\circ$

(c) $\phi = 60^\circ$

Lecture 26

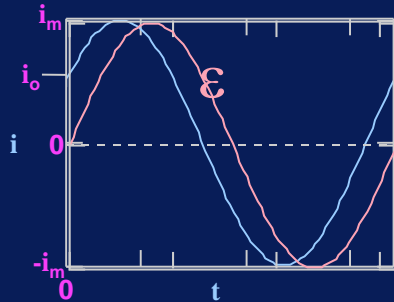
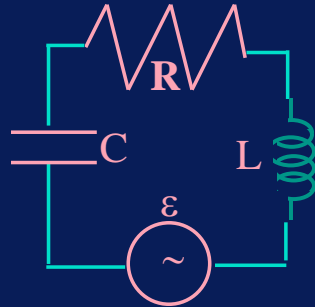
- At $t = 0$ the current flowing through the circuit is $1/2$ of its maximum value.
 - Which of the following plots best represents U_B , the energy stored in the inductor as a function of time ?



Series LCR circuit is driven by a generator with $\varepsilon = \varepsilon_m \sin \omega t$. The time dependence of the current i which flows in the circuit is shown in the plot.

- How should ω be changed to bring the current and driving voltage into phase?

$$X_L \equiv \omega L \quad X_C \equiv \frac{1}{\omega C}$$



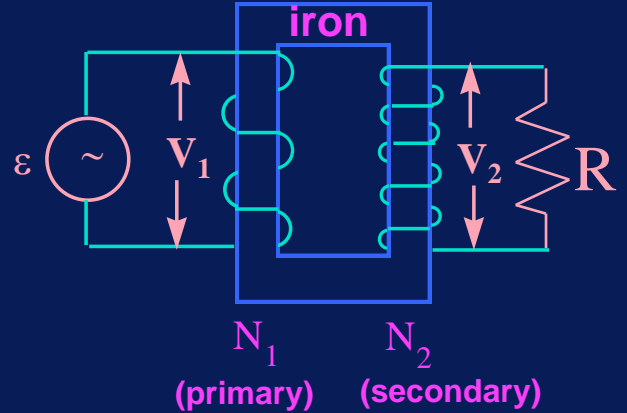
(a) increase ω

(b) decrease ω

(c) impossible

- The primary coil of an ideal transformer is connected to an AC voltage source as shown. There are 50 turns in the primary and 200 turns in the secondary.

– If $V_1 = 120\text{ V}$, what is the potential drop across the resistor R ?

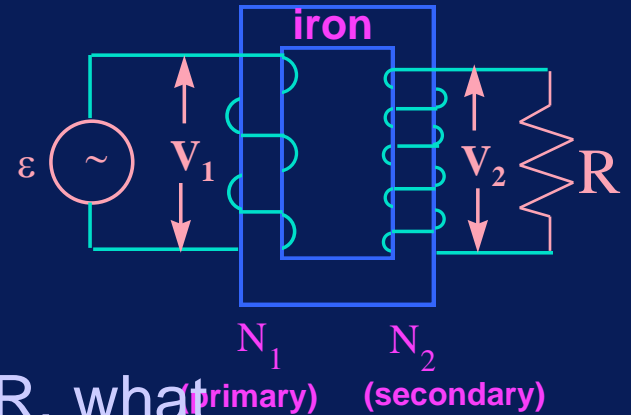


(a) 30 V

(b) 120 V

(c) 480 V

- The primary coil of an ideal transformer is connected to an AC voltage source as shown. There are 50 turns in the primary and 200 turns in the secondary.



– If 960 W are dissipated in the resistor R , what is the current in the primary ?

(a) 8 A

(b) 16 A

(c) 32 A