

Review of Concepts with Examples

PHYS 1004

by

Alain Bellerive



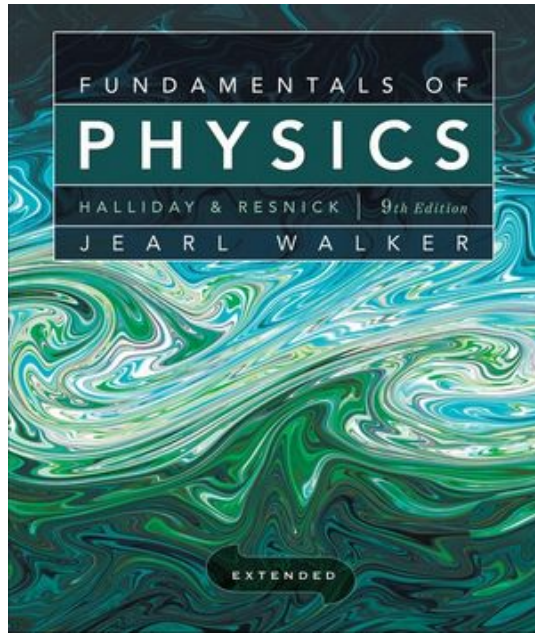
Review Tutorial

A non-obligatory review tutorial will take place Thursday April 11 at 11:30am in the River Building auditorium. It will be given by A. Bellerive (me).

Chapters

- The final exam covers Chapters 21- 34
- Sections **not** covered
 - Section 30-12
 - Sections 32-6 to 32-11
 - Section 33-6
 - Sections 34-8 to 34-9
- Review your lecture notes and examples.
Understand the problem sets of the mini-tests. Focus on the concepts. Learn to use the formula sheet.

Copyrights



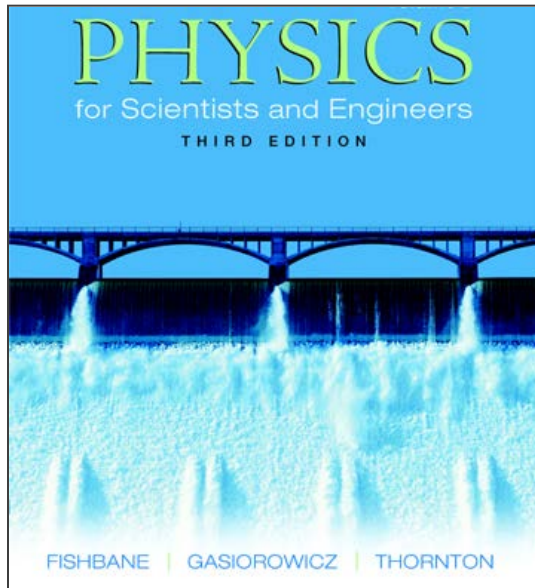
Lecture PowerPoint Provided by

© 2011 John Wiley & Sons, Inc

Fundamentals of Physics,

9th edition

Halliday
Resnick
Walker



Lecture PowerPoint Provided by

© 2005 Pearson Prentice Hall

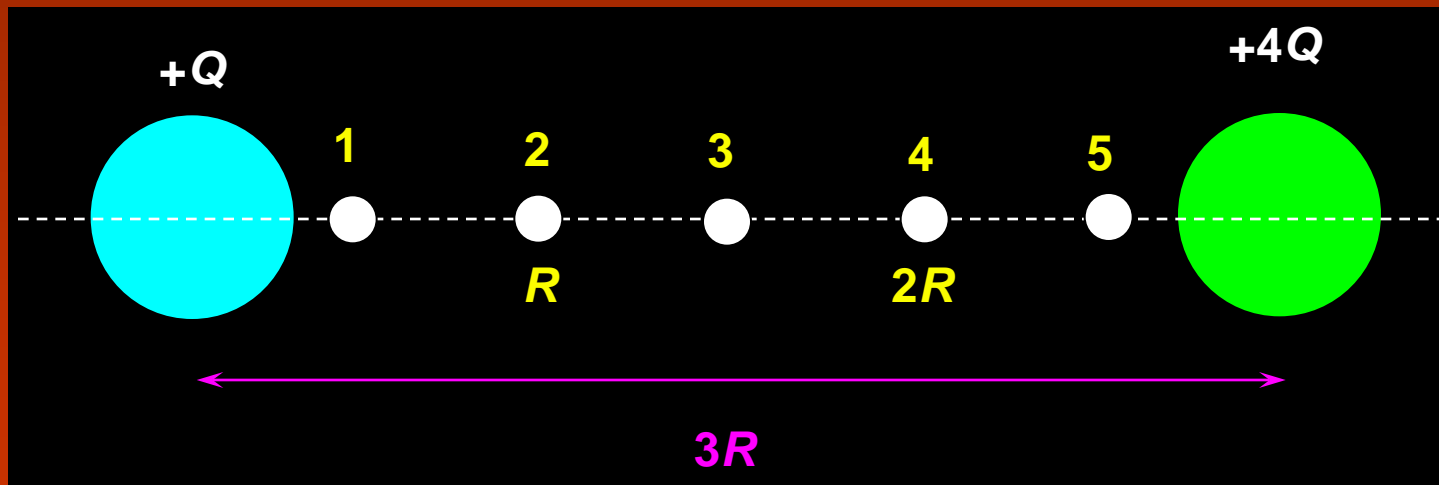
Physics for Scientists and Engineers,

3rd edition

Fishbane
Gasiorowicz
Thornton

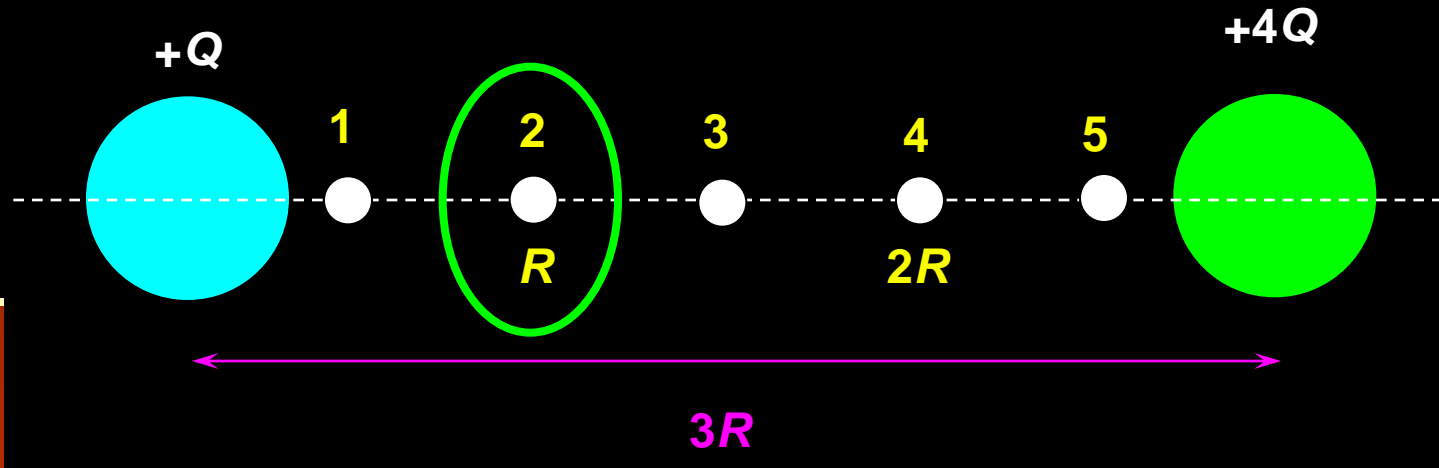
Question 1: Electric Charge [Chap 21]

Two balls with charges $+Q$ and $+4Q$ are separated by $3R$. Where should you place another charged ball Q_0 on the line between the two charges such that the net force on Q_0 will be zero?



Question 1: Electric Charge [Chap 21]

Two balls with charges $+Q$ and $+4Q$ are separated by $3R$. Where should you place another charged ball Q_0 on the line between the two charges such that the net force on Q_0 will be zero?



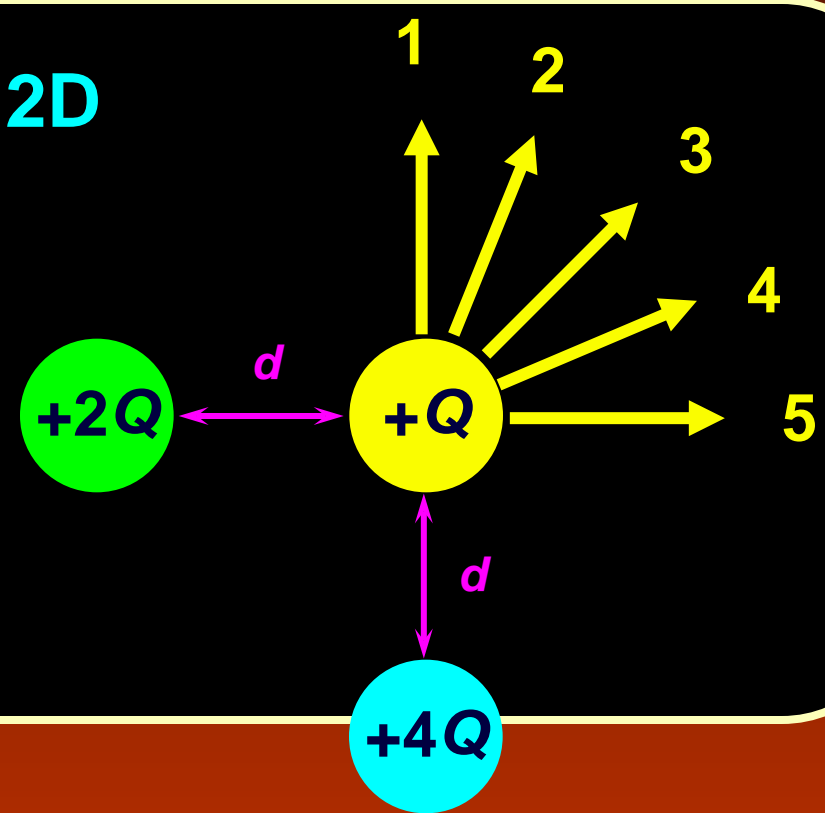
The force on Q_0 due to $+Q$ is: $F = k(Q_0)(Q)/R^2$

The force on Q_0 due to $+4Q$ is: $F = k(Q_0)(4Q)/(2R)^2$

Since $+4Q$ is 4 times bigger than $+Q$, then Q_0 needs to be farther from $+4Q$. In fact, Q_0 must be twice as far from $+4Q$, since the distance is squared in Coulomb's Law.

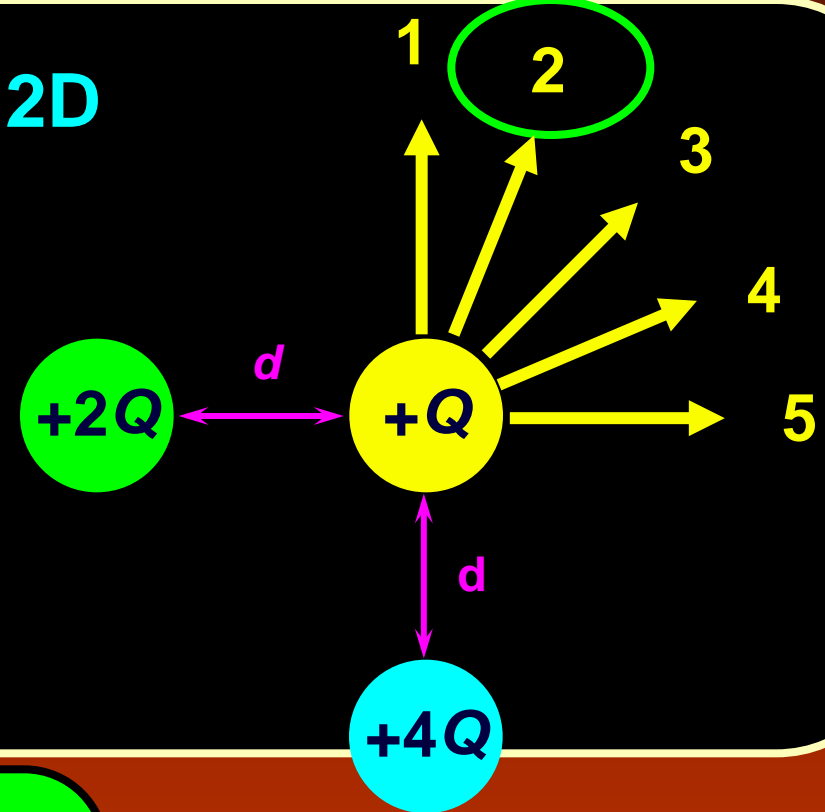
Question 2: Forces in 2D

Which of the arrows best represents the direction of the net force on charge $+Q$ due to the other two charges?



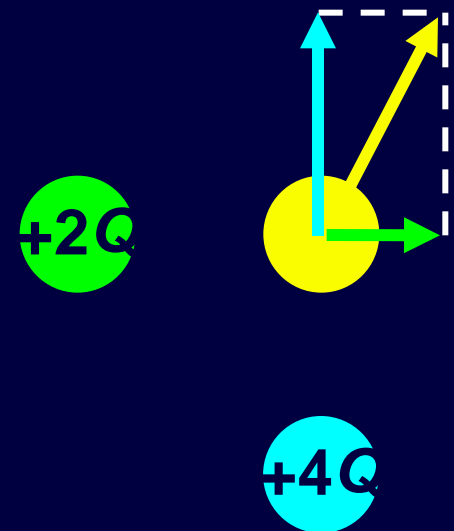
Question 2: Forces in 2D

Which of the arrows best represents the direction of the net force on charge $+Q$ due to the other two charges?



The charge $+2Q$ repels $+Q$ towards the right. The charge $+4Q$ repels $+Q$ upwards, but with a stronger force. Therefore, the **net force is up and to the right, but mostly up**. Add vectors!

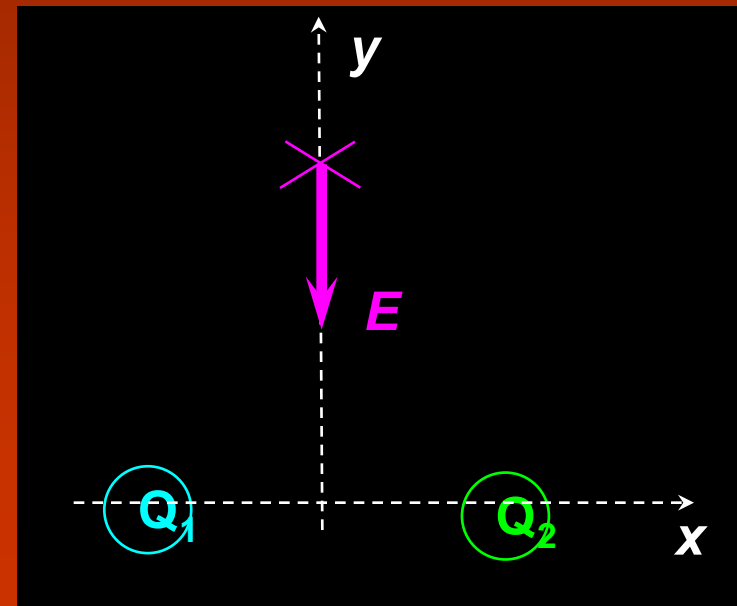
Follow-up: $\tan \theta = F_y / F_x = 2$;
 $\theta = \tan^{-1} 2 = 63.43^\circ$



Question 3: Find the Charges [Chap 22]

Two charges are fixed along the x -axis. They produce an electric field E directed along the negative y -axis at the indicated point. Which of the following is true?

- 1) charges are equal and positive
- 2) charges are equal and negative
- 3) charges are equal and opposite
- 4) charges are equal, but sign is undetermined
- 5) charges cannot be equal

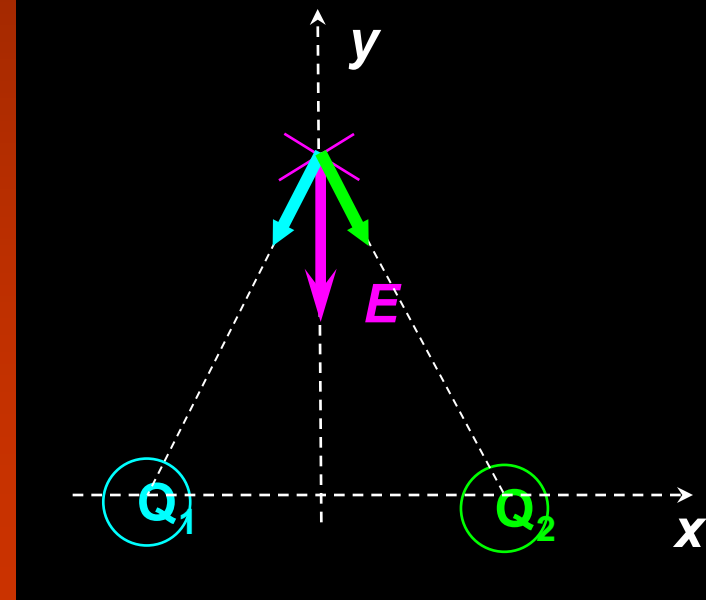


Question 3: Find the Charges [Chap 22]

Two charges are fixed along the x -axis. They produce an electric field E directed along the negative y -axis at the indicated point. Which of the following is true?

- 1) charges are equal and positive
- 2) charges are equal and negative
- 3) charges are equal and opposite
- 4) charges are equal, but sign is undetermined
- 5) charges cannot be equal

The way to get the resultant PINK vector is to use the GREEN and BLUE vectors. These E vectors correspond to **equal charges** (because the lengths are equal) that are **both negative** (because their directions are toward the charges).

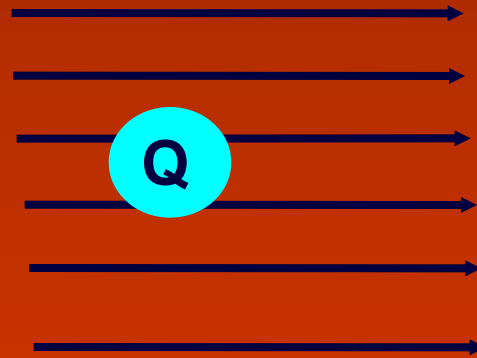


Follow-up: How would you get the E field to point toward the right?

Question 4: Uniform Electric Field

In a uniform electric field in empty space, a 4 C charge is placed and it feels an electrical force of 12 N. If this charge is removed and a 6 C charge is placed at that point instead, what force will it feel?

- 1) 12 N
- 2) 8 N
- 3) 24 N
- 4) no force
- 5) 18 N



Question 4: Uniform Electric Field

In a uniform electric field in empty space, a 4 C charge is placed and it feels an electrical force of 12 N. If this charge is removed and a 6 C charge is placed at that point instead, what force will it feel?

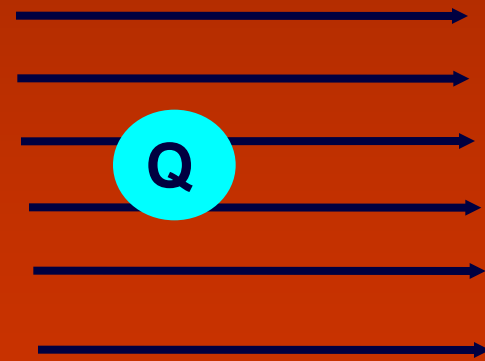
- 1) 12 N
- 2) 8 N
- 3) 24 N
- 4) no force
- 5) 18 N

Since the 4 C charge feels a force, there must be an electric field present, with magnitude:

$$E = F/q = 12 \text{ N} / 4 \text{ C} = 3 \text{ N/C}$$

Once the 4 C charge is replaced with a 6 C charge, this new charge will feel a force of:

$$F = qE = (6 \text{ C})(3 \text{ N/C}) = 18 \text{ N}$$

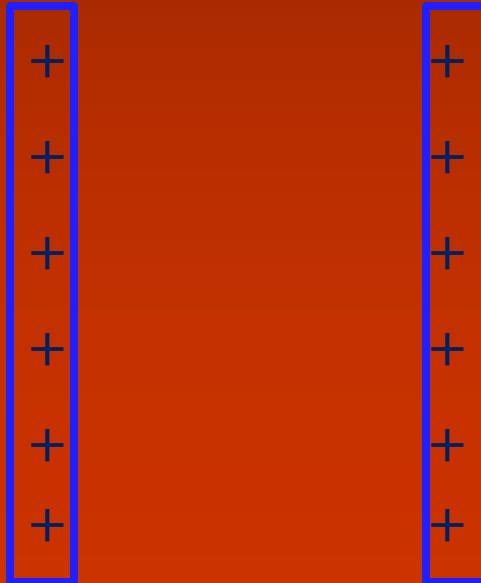


Follow-up: Difference of potential if Q is moved by -1 m? $\Delta V = -E d = +3 \text{ V}$

Question 5: Electric Field [Chap 23]

Two positively infinite conductive plates charge with surface charged density $+\sigma$ are placed parallel next to each other. What is the electric field vector in the middle of the two plates?

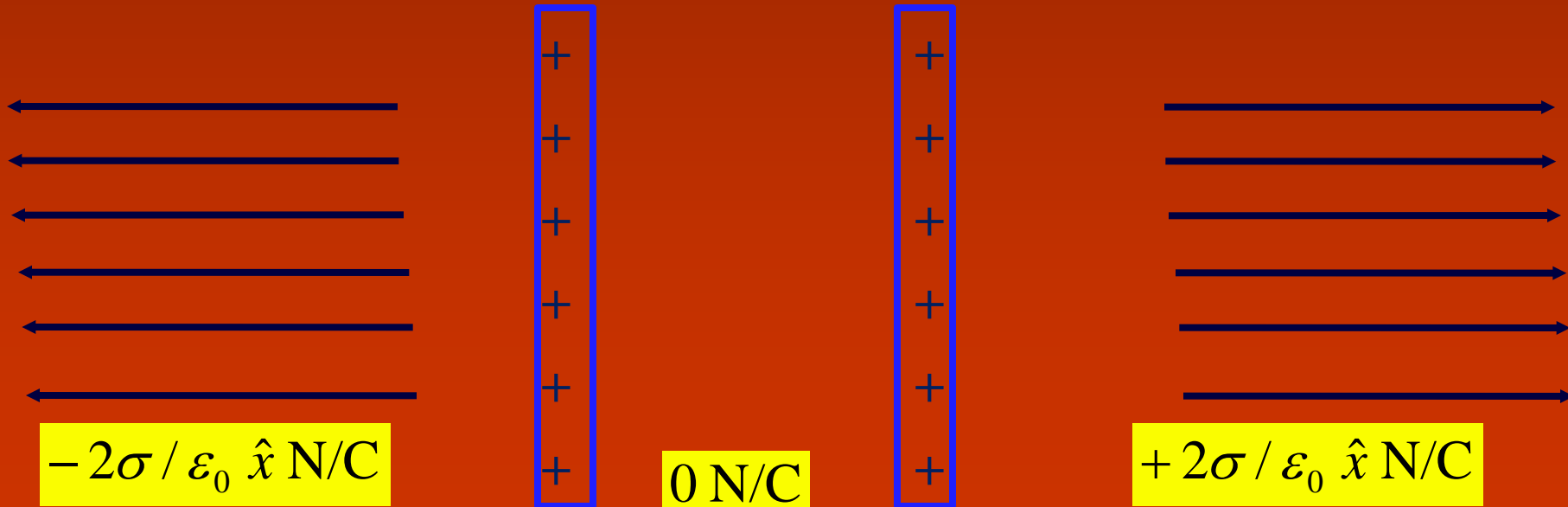
- 1) $+\sigma / \epsilon_0 \hat{x}$ N/C
- 2) $-\sigma / \epsilon_0 \hat{x}$ N/C
- 3) $+2\sigma / \epsilon_0 \hat{x}$ N/C
- 4) $-2\sigma / \epsilon_0 \hat{x}$ N/C
- 5) 0 N/C



Question 5: Electric Field [Chap 23]

Two positively infinite conductive plates charge with surface charged density $+\sigma$ are placed parallel next to each other. What is the electric field vector in the middle of the two plates?

- 1) $+\sigma / \epsilon_0 \hat{x}$ N/C
- 2) $-\sigma / \epsilon_0 \hat{x}$ N/C
- 3) $+2\sigma / \epsilon_0 \hat{x}$ N/C
- 4) $-2\sigma / \epsilon_0 \hat{x}$ N/C
- 5) 0 N/C



Question 6a: Gauss's law

The net electric flux through a Gaussian sphere centered outside a charged volume is $-2.0 \times 10^5 \text{ N m}^2 / \text{C}$. What is the total charge of the volume?

- 1) $2.0 \times 10^{-5} \text{ C}$
- 2) $0.5 \times 10^{-6} \text{ C}$
- 3) $-0.5 \times 10^{-6} \text{ C}$
- 4) $-1.8 \times 10^{-6} \text{ C}$
- 5) $2 \pi \text{ C}$

Question 6a: Gauss's law

The net electric flux through a Gaussian sphere centered outside a charged volume is $-2.0 \times 10^5 \text{ N m}^2 / \text{C}$. What is the total charge of the volume?

1) $2.0 \times 10^{-5} \text{ C}$

2) $0.5 \times 10^{-6} \text{ C}$

3) $-0.5 \times 10^{-6} \text{ C}$

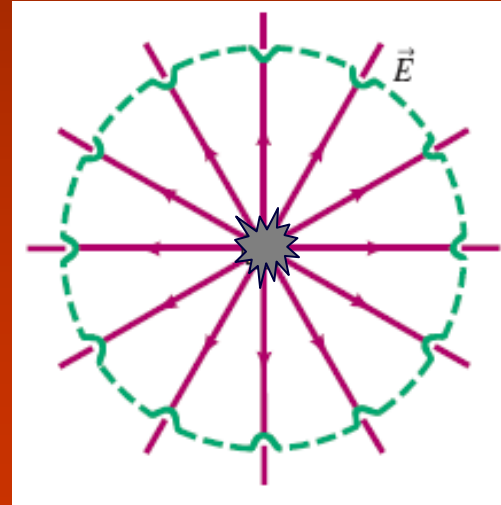
4) $-1.8 \times 10^{-6} \text{ C}$

5) $2 \pi \text{ C}$

$$\epsilon_0 \Phi = q_{\text{enc}} \quad (\text{Gauss' law}).$$

$$\epsilon_0 \oint \vec{E} \cdot d\vec{A} = q_{\text{enc}} \quad (\text{Gauss' law}).$$

$$\begin{aligned} Q(\text{volume}) &= -2.0 \times 10^5 \text{ N m}^2 / \text{C} \times 8.85 \times 10^{-12} \text{ C}^2 / \text{N m}^2 \\ &= -1.77 \times 10^{-6} \text{ C} \cong 1.8 \times 10^{-6} \text{ C} \end{aligned}$$



Follow-up: What is the shape of the volume? Unknown!

Question 6b: Gauss's law

A negative point charge $-2Q$ is located within a spherical metal shell that is electrically neutral. What is the surface charge on the inner wall of the shell?

- 1) $2Q$
- 2) Q
- 3) zero
- 4) $-2Q$
- 5) $-Q$

Question 6b: Gauss's law

A negative point charge $-2Q$ is located within a spherical metal shell that is electrically neutral. What is the surface charge on the inner wall of the shell?

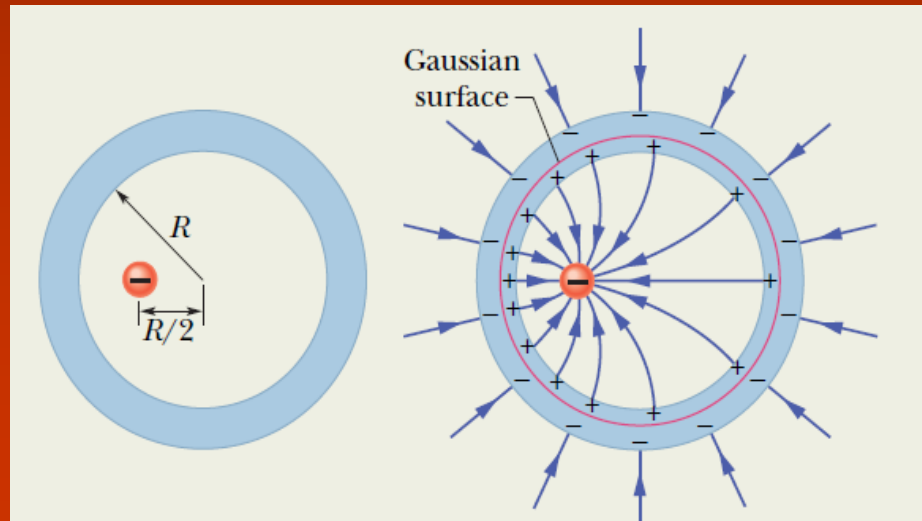
1) $2Q$

2) Q

3) zero

4) $-2Q$

5) $-Q$

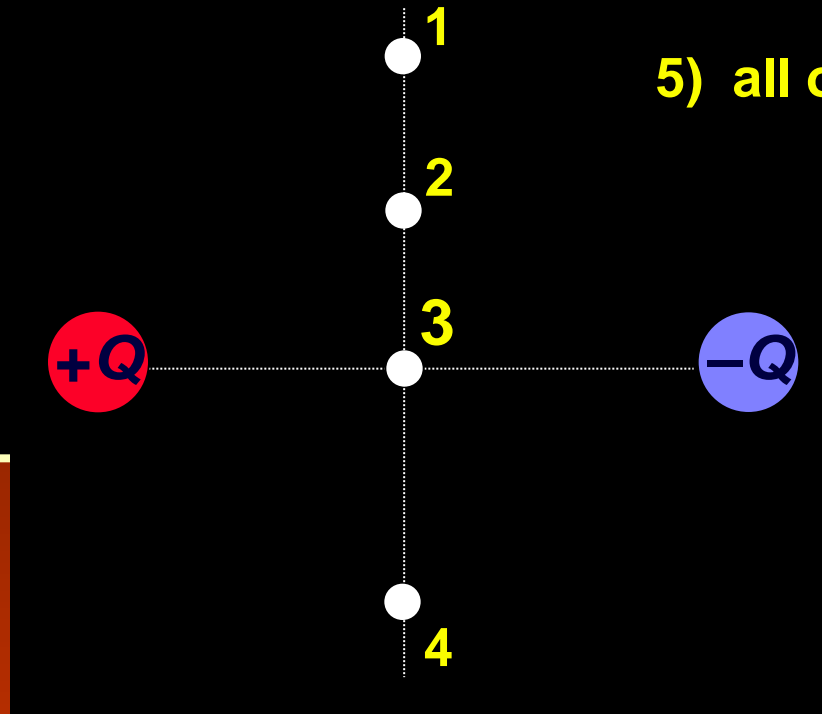


Follow-up: Is the charge on the inner wall uniformly distributed? No!

Question 7: Equipotential Surfaces [Chap 24]

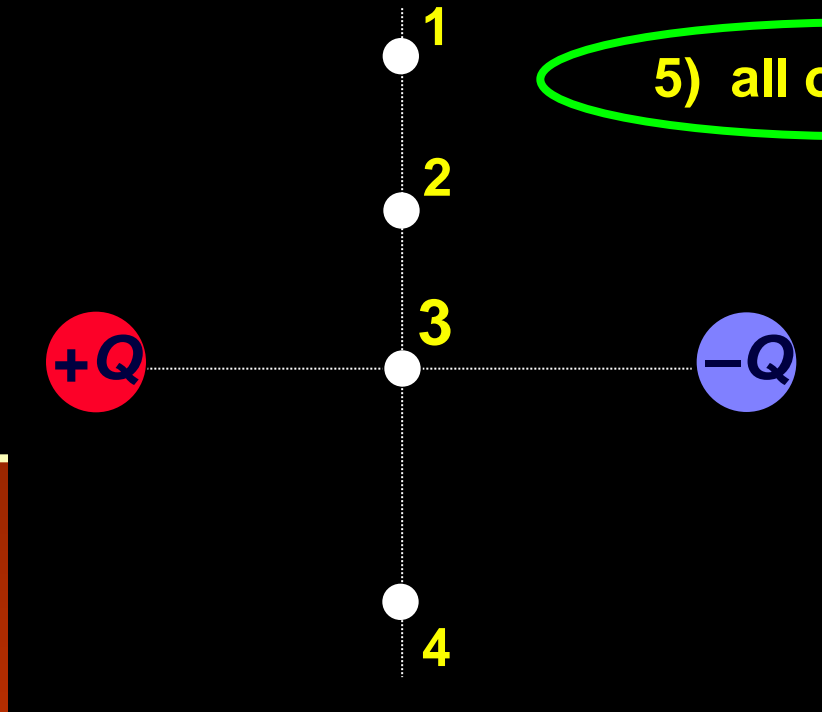
At which point
does $V = 0$?

5) all of them



Question 7: Equipotential Surfaces [Chap 24]

At which point
does $V = 0$?



5) all of them

All of the points are equidistant from both charges. Since the charges are equal and opposite, their contributions to the potential **cancel out everywhere** along the mid-plane between the charges.

Follow-up: What is the direction of the electric field at all 4 points? Right.

Question 8: Square

Four point charges are arranged at the corners of a square. Find the **electric field E** and the **potential V** at the **center of the square**.

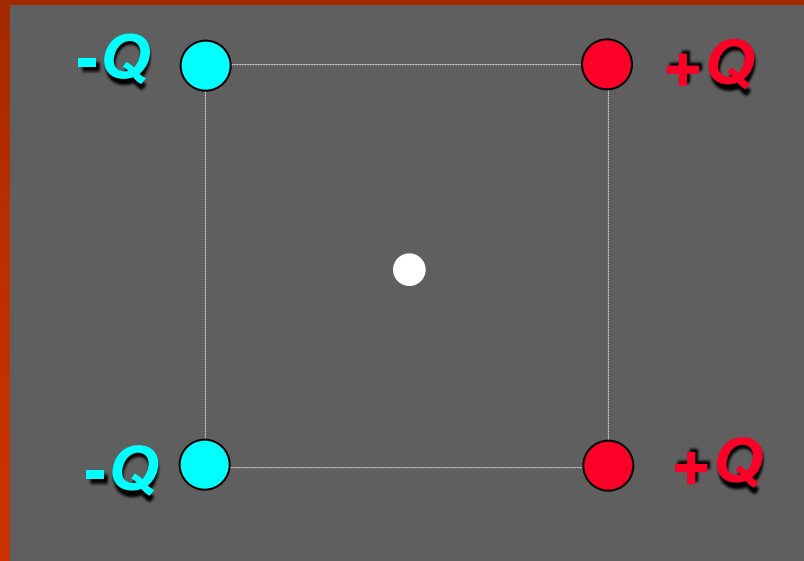
1) $E = 0$ $V = 0$

2) $E = 0$ $V \neq 0$

3) $E \neq 0$ $V \neq 0$

4) $E \neq 0$ $V = 0$

5) $E = V$ regardless of the value



Question 8: Square

Four point charges are arranged at the corners of a square. Find the **electric field E** and the **potential V** at the **center of the square**.

1) $E = 0$ $V = 0$

2) $E = 0$ $V \neq 0$

3) $E \neq 0$ $V \neq 0$

4) $E \neq 0$ $V = 0$

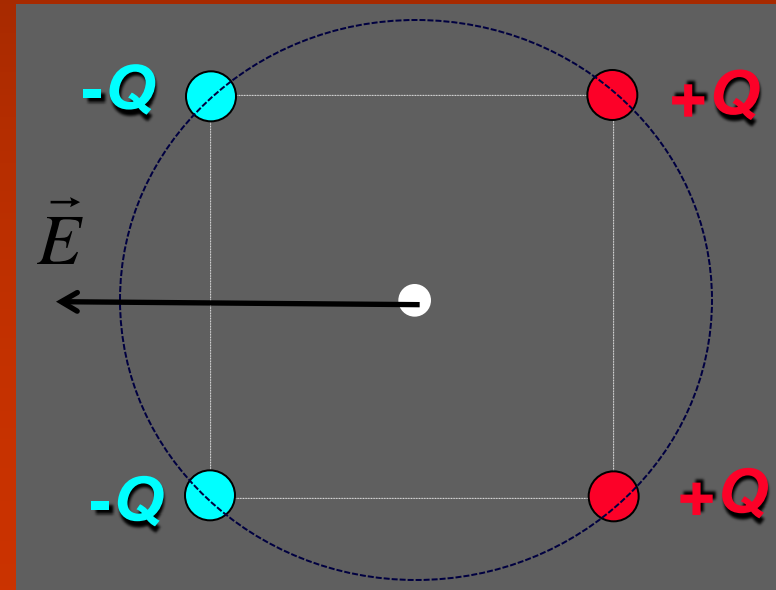
5) $E = V$ regardless of the value

The **potential is zero**: the scalar contributions from the two positive charges cancel the two minus charges.

However, the contributions from the electric field add up as vectors, and they do not cancel (so **it is non-zero**).

Remark: Circular arc:

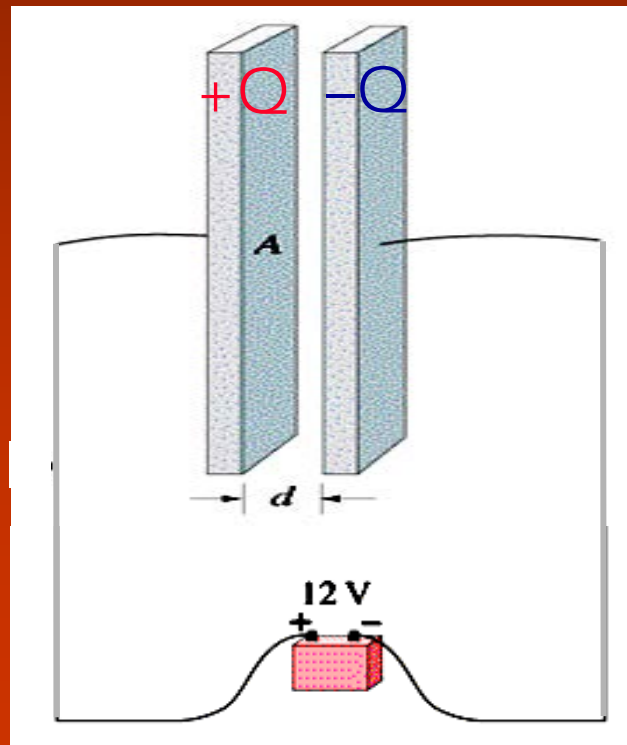
$$V = k_e/R \sum q_i$$



Question 9: Plate Capacitance [Chap 25]

What must be done to a capacitor in order to increase the amount of charge it can hold (for a constant voltage)?

- 1) increase the area of the plates
- 2) decrease separation between the plates
- 3) decrease the area of the plates
- 4) either (1) or (2)
- 5) either (2) or (3)

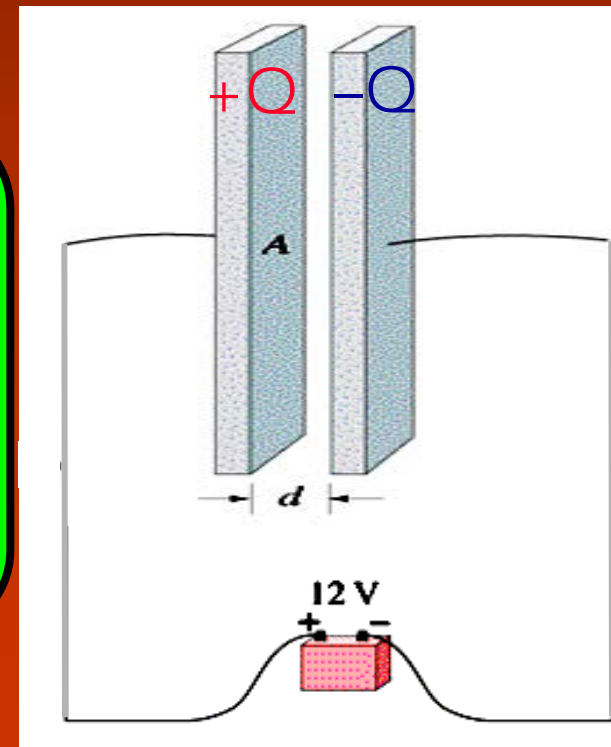


Question 9: Plate Capacitance [Chap 25]

What must be done to a capacitor in order to increase the amount of charge it can hold (for a constant voltage)?

- 1) increase the area of the plates
- 2) decrease separation between the plates
- 3) decrease the area of the plates
- 4) either (1) or (2)
- 5) either (2) or (3)

Since $Q = CV$, in order to increase the charge that a capacitor can hold at constant voltage, one has to **increase its capacitance**. Since the capacitance is given by $C = \epsilon_0 \frac{A}{d}$, that can be done by either **increasing A** or **decreasing d** .

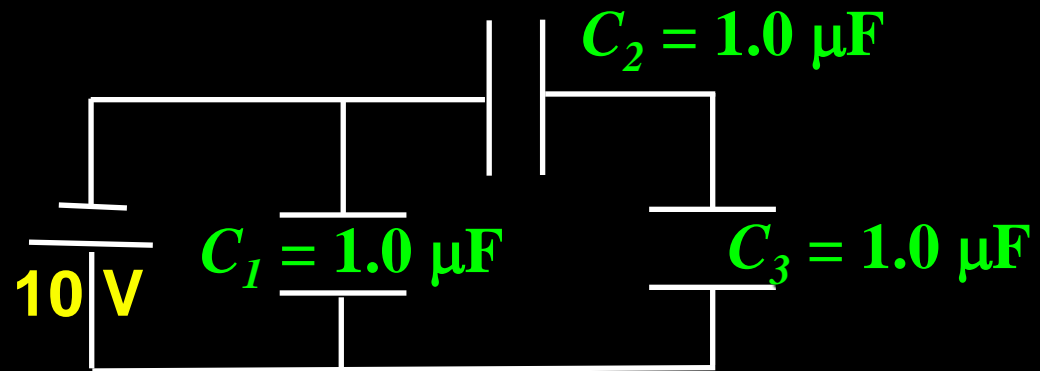


Question 10:

Capacitors

How does the charge Q_1 on the first capacitor (C_1) compare to the charge Q_2 on the second capacitor (C_2)?

- 1) $Q_1 = Q_2$
- 2) $Q_1 > Q_2$
- 3) $Q_1 < Q_2$
- 4) all charges are zero



Question 10:

Capacitors

How does the charge Q_1 on the first capacitor (C_1) compare to the charge Q_2 on the second capacitor (C_2)?

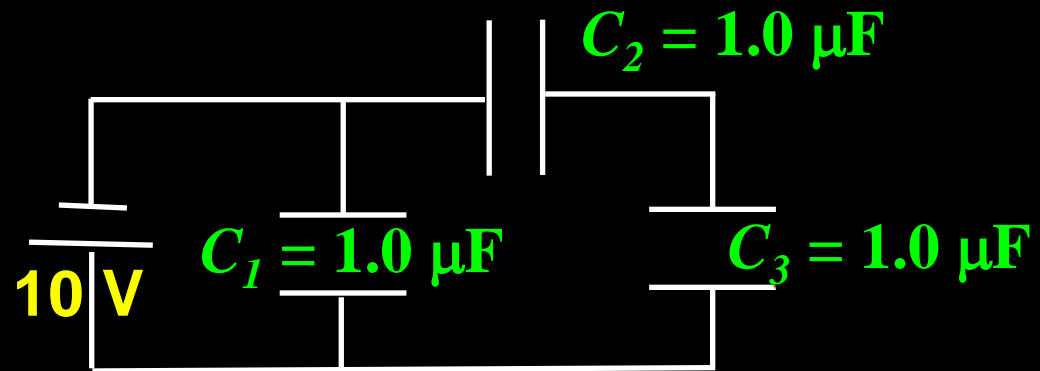
1) $Q_1 = Q_2$

2) $Q_1 > Q_2$

3) $Q_1 < Q_2$

4) all charges are zero

ΔV across C_1 is 10 V. The combined capacitors $C_2 + C_3$ are parallel to C_1 . ΔV across $C_2 + C_3$ is 10 V. C_2 and C_3 are in series, their voltages add. ΔV across C_2 and C_3 is each 5 V. $Q = CV$ and C is the same for all the capacitors, then $V_1 > V_2$ leads to $Q_1 > Q_2$.



Question 11: Wires [Chap 26]

Two wires, **A** and **B**, are made of the same metal and have equal length, but the resistance of wire **A** is four times the resistance of wire **B**. How do their diameters compare?

1) $d_A = 4 d_B$

2) $d_A = 2 d_B$

3) $d_A = d_B$

4) $d_A = 1/2 d_B$

5) $d_A = 1/4 d_B$

Question 11: Wires [Chap 26]

Two wires, **A** and **B**, are made of the same metal and have equal length, but the resistance of wire **A** is four times the resistance of wire **B**. How do their diameters compare?

1) $d_A = 4 d_B$

2) $d_A = 2 d_B$

3) $d_A = d_B$

4) $d_A = 1/2 d_B$

5) $d_A = 1/4 d_B$

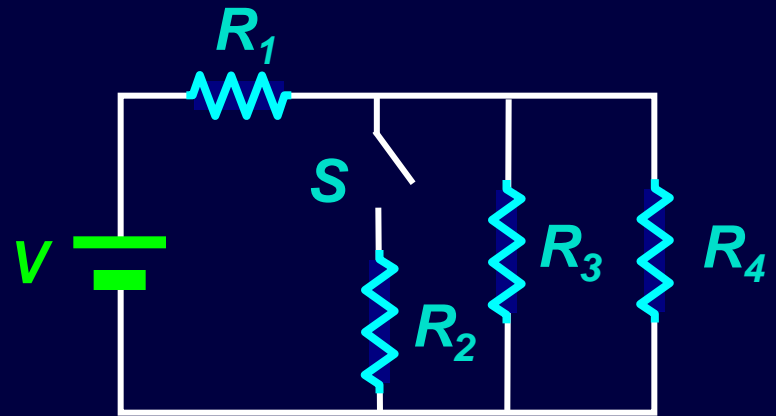
The resistance of wire **A** is greater because its area is less than wire **B**. Since area is related to radius (or diameter) squared, the diameter of **A** must be two times less than **B**.

$$R = \rho \frac{L}{A}$$

Question 12: Resistances [Chap 27]

What happens to the voltage across the resistor R_4 when the switch is closed?

- 1) increases
- 2) decreases
- 3) stays the same



Question 12: Resistances [Chap 27]

What happens to the voltage across the resistor R_4 when the switch is closed?

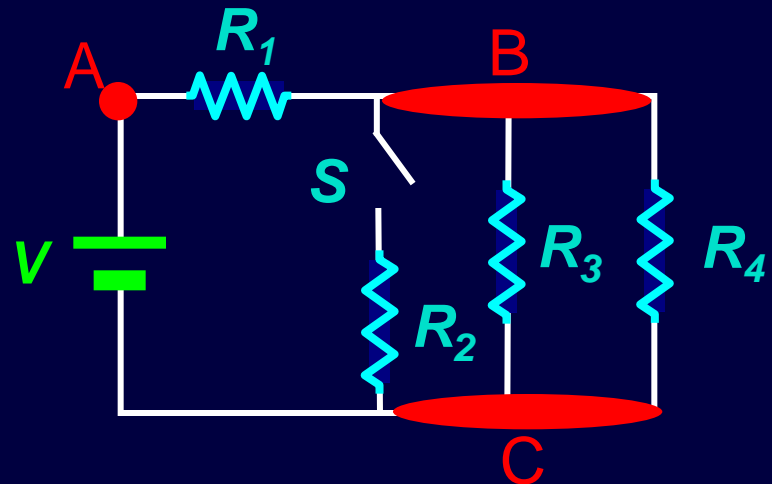
1) increases

2) decreases

3) stays the same

$$\frac{1}{R_3} + \frac{1}{R_4} < \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \text{ so } \left(\frac{1}{R_3} + \frac{1}{R_4}\right)^{-1} > \left(\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right)^{-1}$$

With the switch closed, the addition of R_2 decreases the equivalent resistance, so the current from the battery increases ($V = R_{\text{eq}} I$). This will cause an increase in the voltage across R_1 (which is V_{AB}). The voltage of the battery is constant, so if V_{AB} increases, then V_{BC} must decrease!



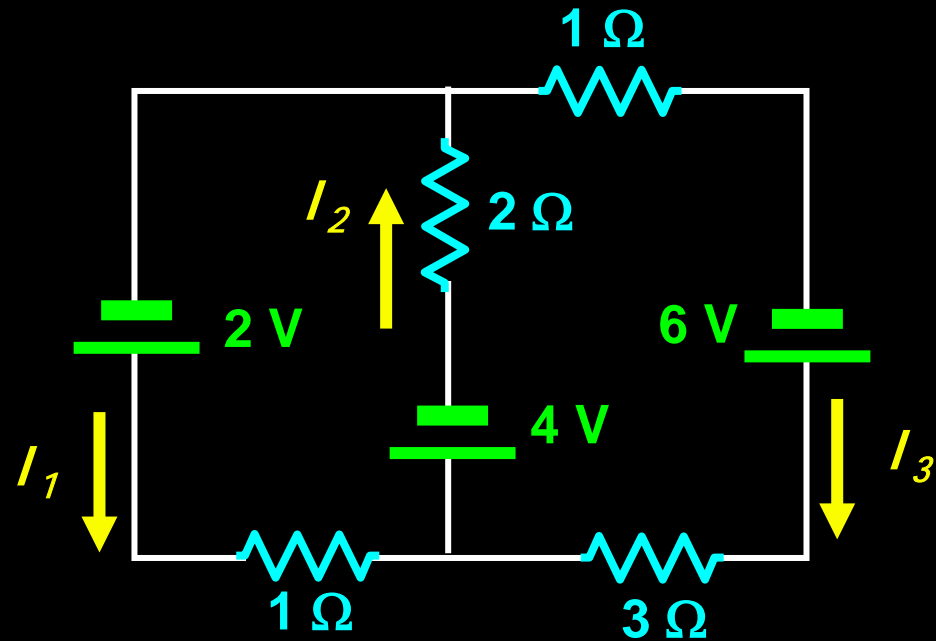
Follow-up: What happens to the current through R_4 ? Decreases $V_{BC} = R_4 I_4$

Question 13:

Which of the equations is valid for the circuit below?

Kirchhoff's Rules

- 1) $2 - I_1 - 2I_2 = 0$
- 2) $2 - 2I_1 - 2I_2 - 4I_3 = 0$
- 3) $2 - I_1 - 4 - 2I_2 = 0$
- 4) $I_3 - 4 - 2I_2 + 6 = 0$
- 5) $2 - I_1 - 3I_3 - 6 = 0$



Question 13:

Which of the equations is valid for the circuit below?

Kirchhoff's Rules

1) $2 - I_1 - 2I_2 = 0$

2) $2 - 2I_1 - 2I_2 - 4I_3 = 0$

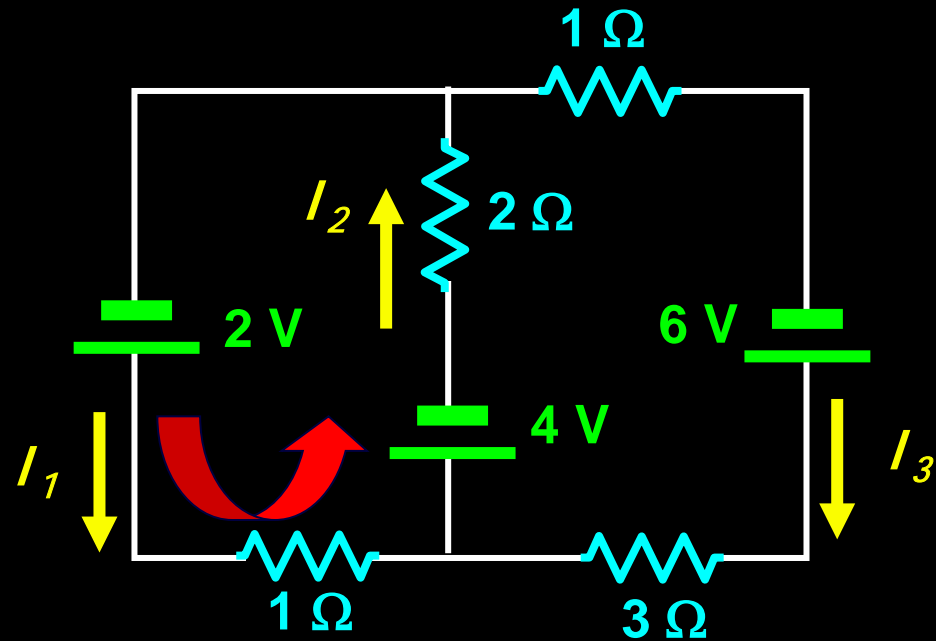
3) $2 - I_1 - 4 - 2I_2 = 0$

4) $I_3 - 4 - 2I_2 + 6 = 0$

5) $2 - I_1 - 3I_3 - 6 = 0$

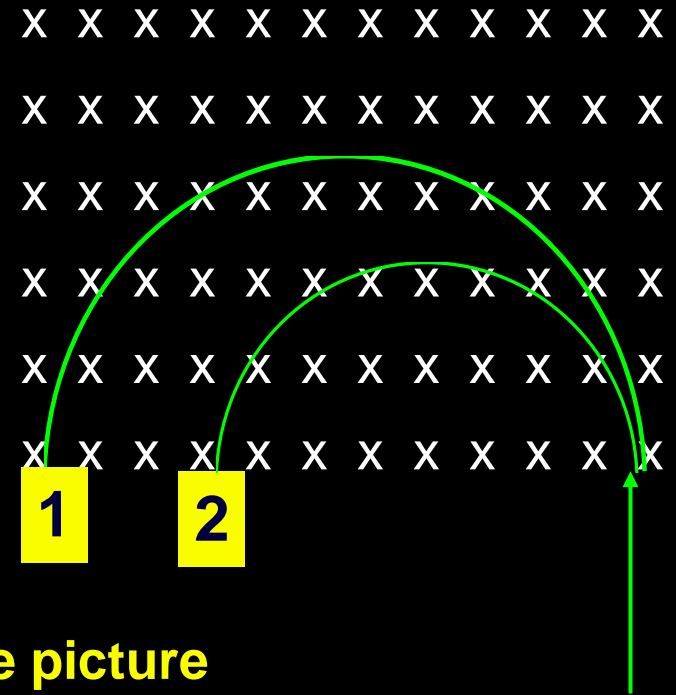
Eqn. 3 is valid for the left loop:

The left battery gives +2V, then there is a drop through a 1Ω resistor with current I_1 flowing. Then we go through the middle battery (but from + to -!), which gives -4V. Finally, there is a drop through a 2Ω resistor with current I_2 .



Question 14: Mass Spectrometer [Chap 28]

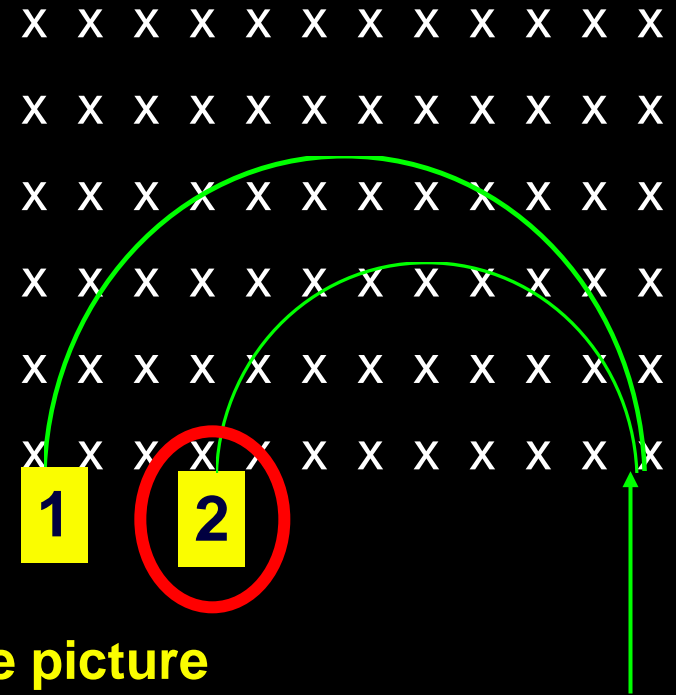
Two particles of the *same mass* enter a magnetic field with the *same speed* and follow the paths shown. Which particle has the *bigger charge*?



- 3) both charges are equal
- 4) impossible to tell from the picture

Question 14: Mass Spectrometer [Chap 28]

Two particles of the *same mass* enter a magnetic field with the *same speed* and follow the paths shown. Which particle has the *bigger charge*?



- 3) both charges are equal
- 4) impossible to tell from the picture

$$F = mv^2/R = qvB$$

The relevant equation for us is:
According to this equation, the
bigger the charge, the smaller the radius.

$$R = \frac{mv}{qB}$$

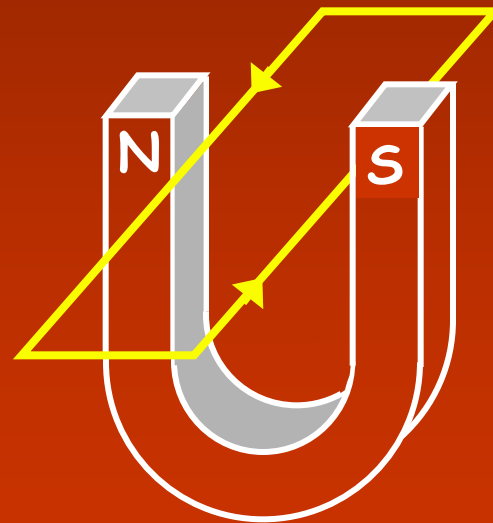
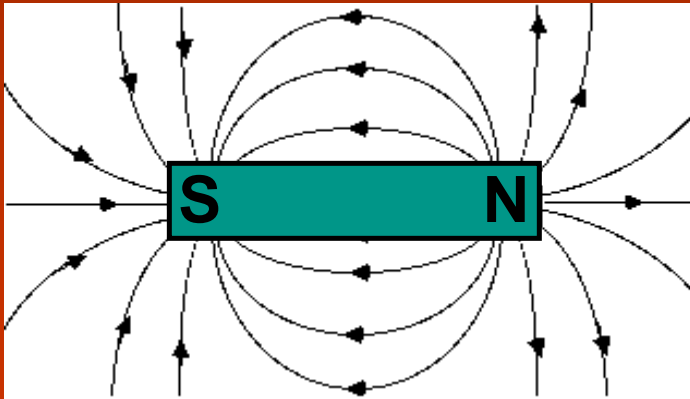
Follow-up: What is the sign of the charges in the picture? +Q

Question 15: Magnetic Force on a Loop

If there is a current in the loop in the direction shown, the loop will:

- 1) move up
- 2) move down
- 3) rotate clockwise
- 4) rotate counterclockwise
- 5) both rotate and move

B field out of North
B field into South

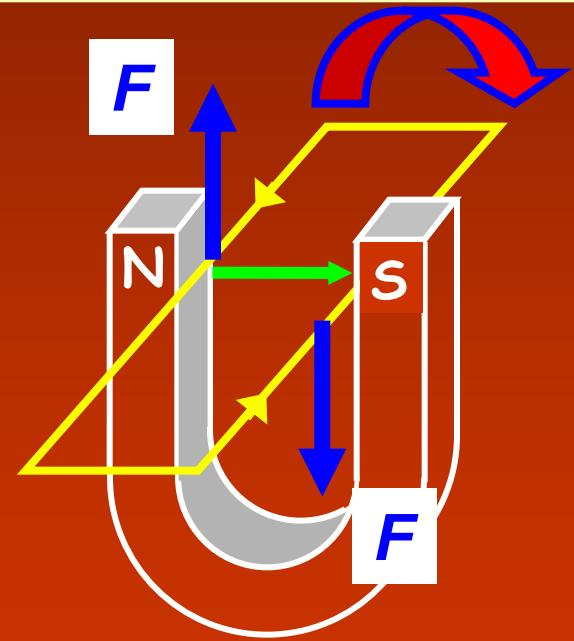


Question 15: Magnetic Force on a Loop

If there is a current in the loop in the direction shown, the loop will:

- 1) move up
- 2) move down
- 3) rotate clockwise
- 4) rotate counterclockwise
- 5) both rotate and move

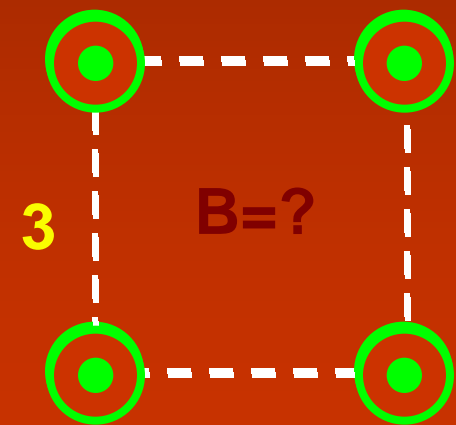
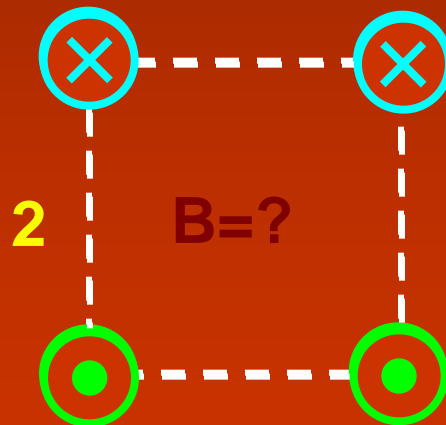
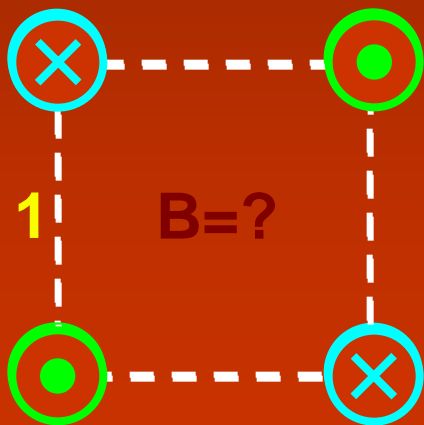
Look at the North Pole: here the magnetic field points to the **right** and the current points **out of the page**. The right-hand rule says that the force must point **up**. At the south pole, the same logic leads to a **downward** force. Thus the loop rotates **clockwise**.



Question 16: Magnetic Field [Chap 29]

Each of the wires in the figures below carry the same current, either into or out of the page. In which case is the magnetic field at the center of the square greatest?

- 1) arrangement 1
- 2) arrangement 2
- 3) arrangement 3
- 4) same for all



Question 16: Magnetic Field [Chap 29]

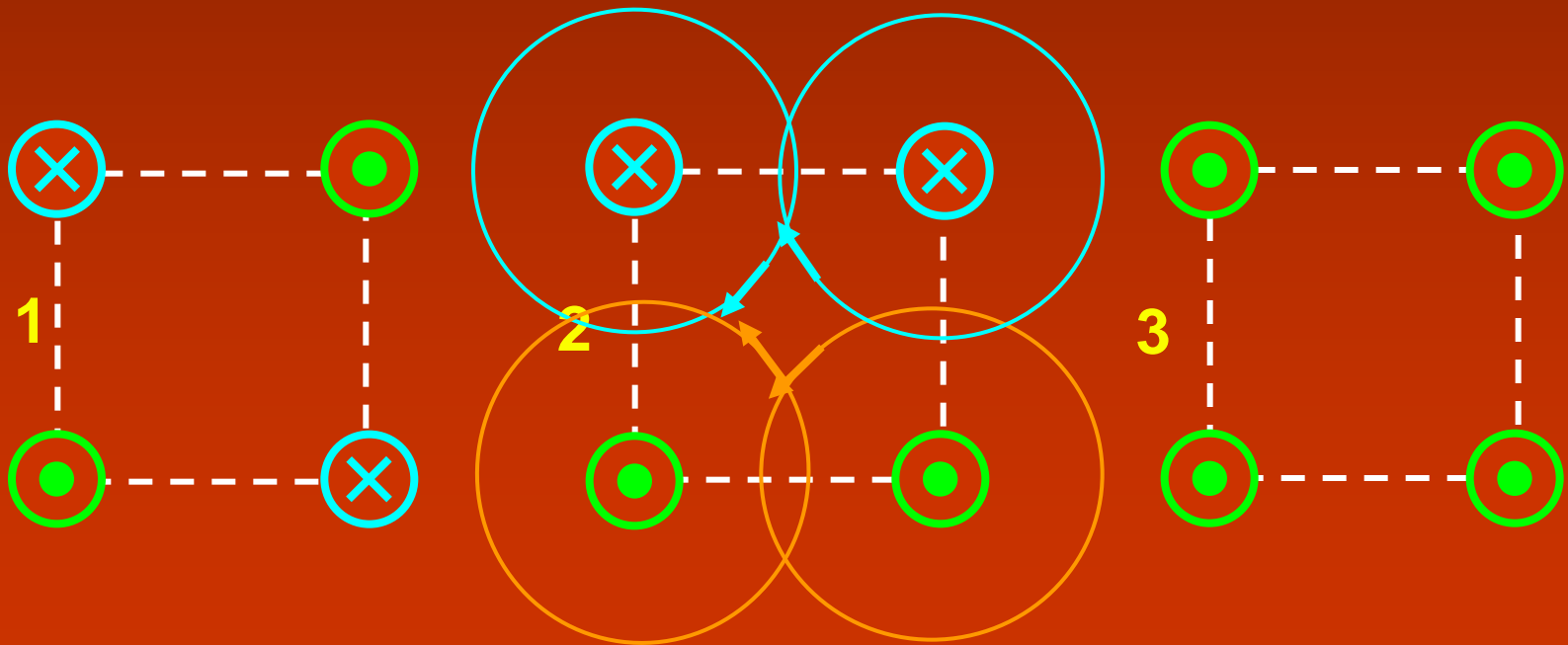
Each of the wires in the figures below carry the same current, either into or out of the page. In which case is the magnetic field at the center of the square greatest?

1) arrangement 1

2) arrangement 2

3) arrangement 3

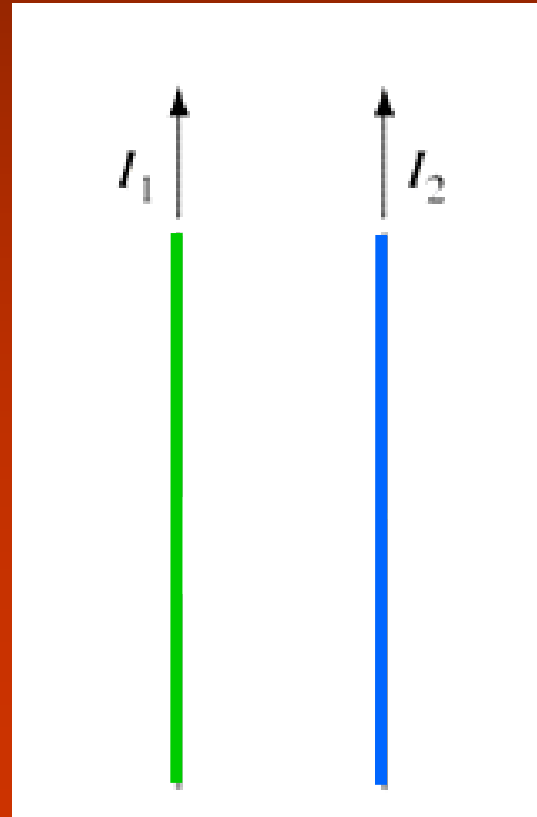
4) same for all



Question 17: Field and Force

Two straight wires run parallel to each other, each carrying a current in the direction shown below. The two wires experience a force in which direction?

- 1) toward each other
- 2) away from each other
- 3) there is no force



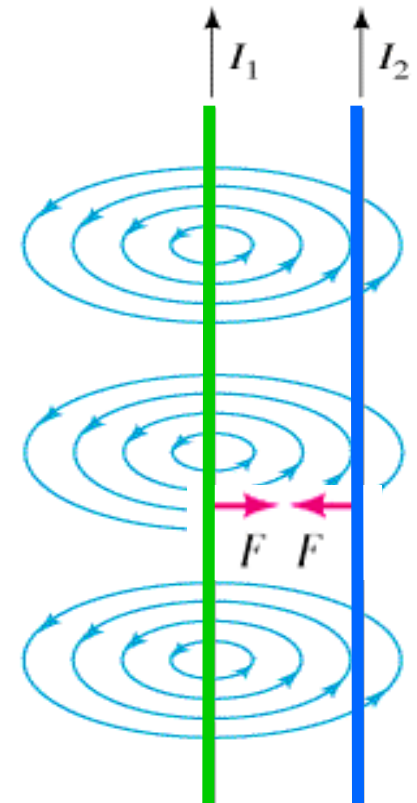
Question 17: Field and Force

Two straight wires run parallel to each other, each carrying a current in the direction shown below. The two wires experience a force in which direction?

- 1) toward each other
- 2) away from each other
- 3) there is no force

The current in each wire produces a magnetic field that is felt by the current of the other wire. Using the right-hand rule, we find that each wire experiences a force toward the other wire (i.e., an **attractive force**) when the currents are parallel (as shown).

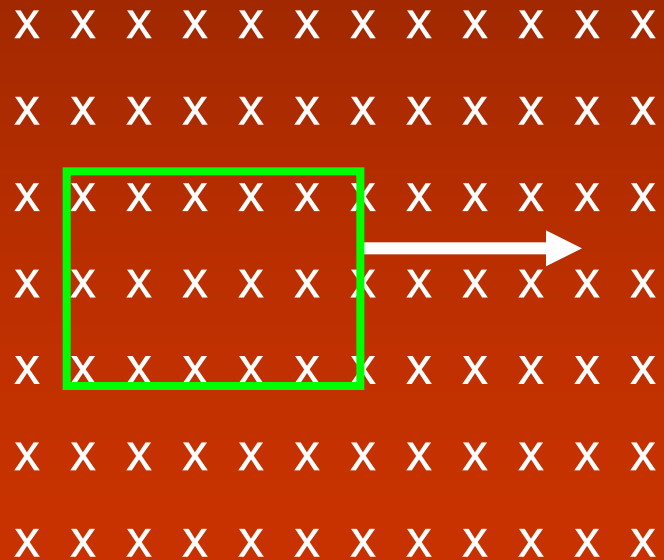
Follow-up: What happens when one of the currents is turned off?
Both forces are zeroed!



Question 18a: Moving Wire Loop I [Chap 30]

A wire loop is being pulled through a uniform magnetic field. What is the direction of the induced current?

- 1) clockwise
- 2) counterclockwise
- 3) no induced current

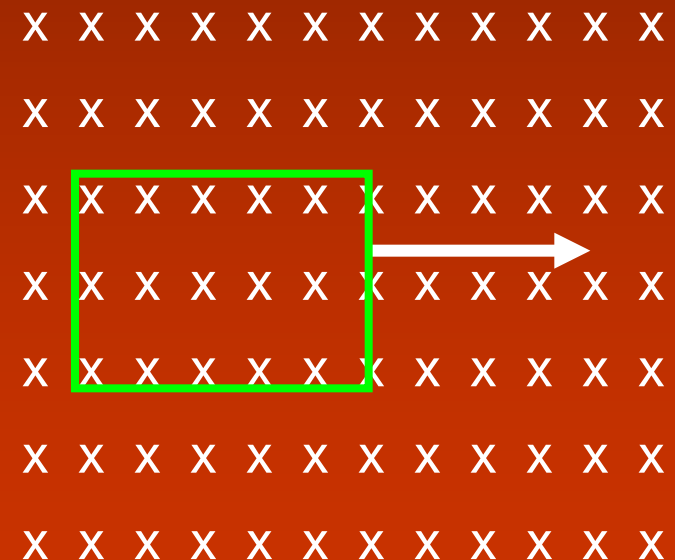


Question 18a: Moving Wire Loop I [Chap 30]

A wire loop is being pulled through a uniform magnetic field. What is the direction of the induced current?

- 1) clockwise
- 2) counterclockwise
- 3) no induced current

Since the magnetic field is uniform, the magnetic flux through the loop is not changing. Thus **no current is induced**.



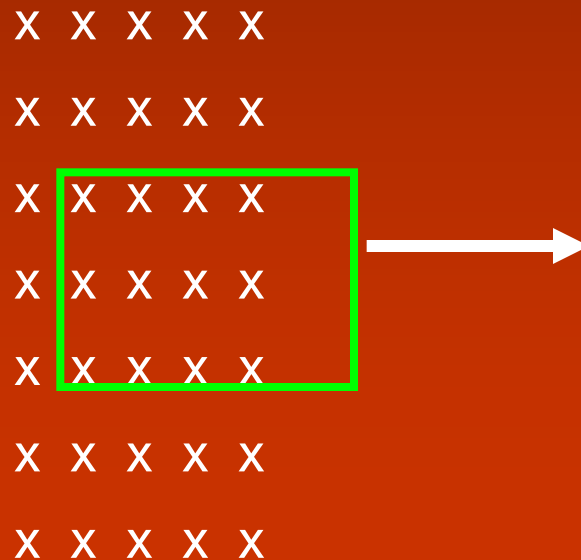
Follow-up: What happens if the loop moves out of the page? Nothing! The B-field inside the loop is still constant but **induced emf** = $-\frac{d\Phi_B}{dt}$

Question 18b: Moving Wire Loop II

A wire loop is being pulled through a **uniform magnetic field that suddenly ends.**

What is the direction of the induced current?

- 1) clockwise
- 2) counterclockwise
- 3) no induced current



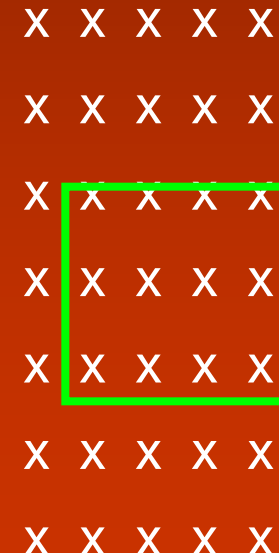
Question 18b: Moving Wire Loop II

A wire loop is being pulled through a **uniform magnetic field that suddenly ends**.

What is the direction of the induced current?

- 1) clockwise
- 2) counterclockwise
- 3) no induced current

The **B field into the page** is disappearing in the loop, so it must be compensated by an **induced flux also into the page**. This can be accomplished by an **induced current in the clockwise direction** in the wire loop.



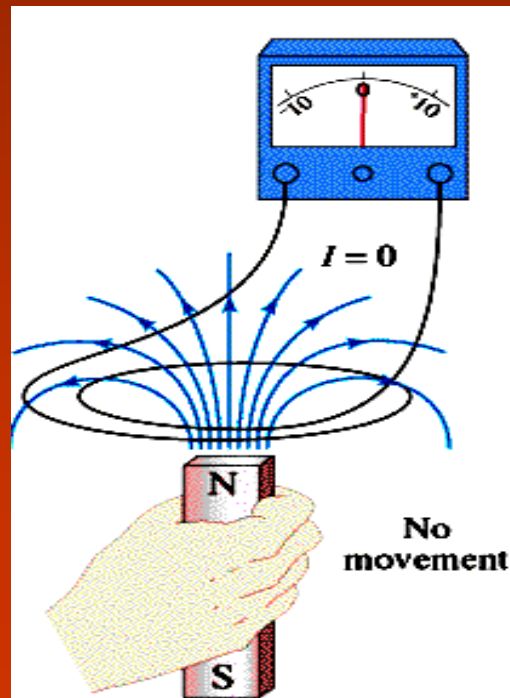
A diagram showing a uniform magnetic field represented by a grid of 'X' marks. A rectangular wire loop, outlined in green, is positioned on the right side of the field, partially overlapping the boundary. A white arrow points to the right from the right side of the loop, indicating its direction of motion.

Follow-up: What happens when the loop is completely out of the field? Induced current is zero. No more variation of the B-field.

Question 19a Magnetic Flux I

In order to change the magnetic flux through the loop, what would you have to do?

- 1) drop the magnet
- 2) move the magnet upwards
- 3) move the magnet sideways
- 4) only (1) and (2)
- 5) all of the above

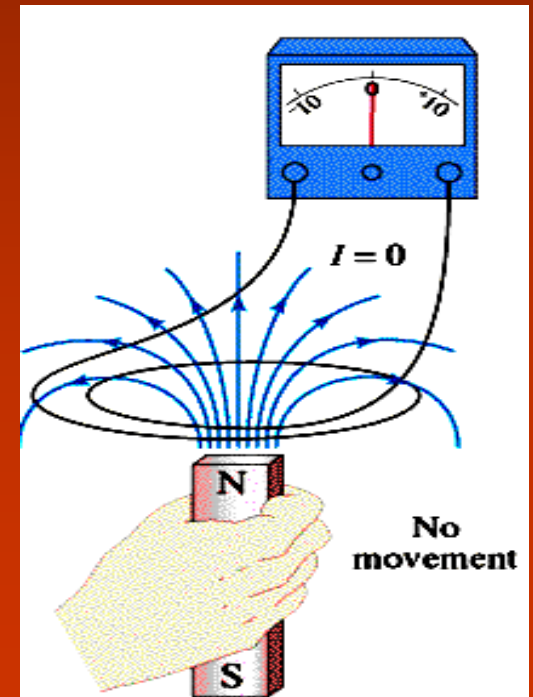


Question 19a Magnetic Flux I

In order to change the magnetic flux through the loop, what would you have to do?

- 1) drop the magnet
- 2) move the magnet upwards
- 3) move the magnet sideways
- 4) only (1) and (2)
- 5) all of the above

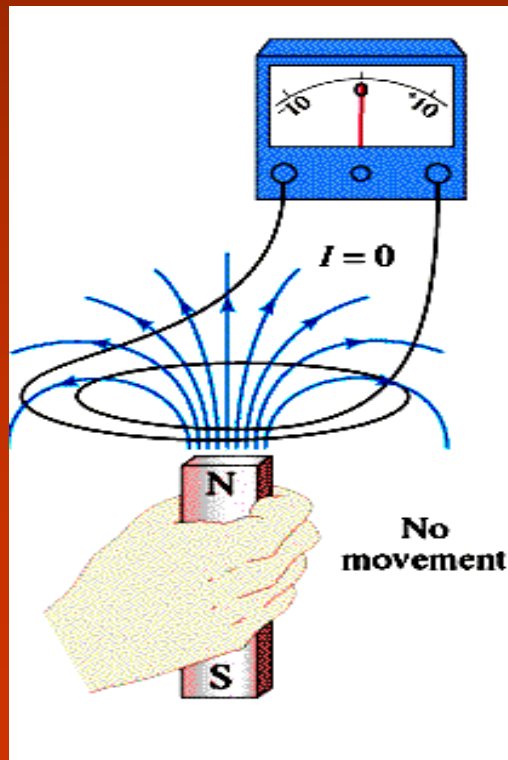
Moving the magnet in **any direction** would change the magnetic field through the loop and thus the magnetic flux.



Question 19b Magnetic Flux II

In order to change the magnetic flux through the loop, what would you have to do?

- 1) tilt the loop
- 2) change the loop area
- 3) use thicker wires
- 4) only (1) and (2)
- 5) all of the above

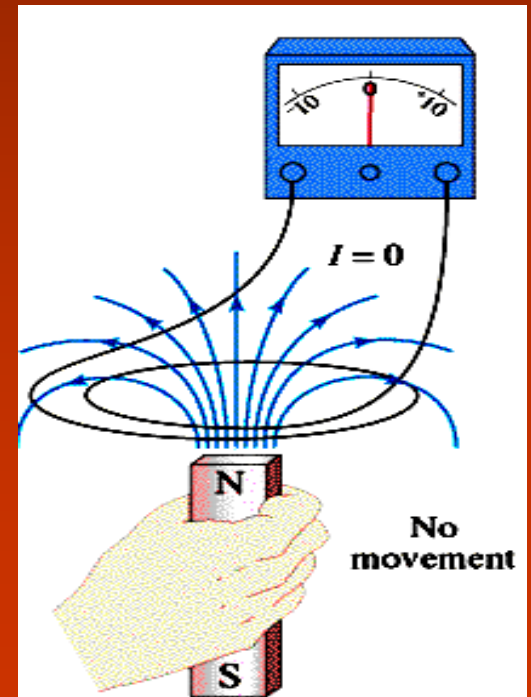


Question 19b Magnetic Flux II

In order to change the magnetic flux through the loop, what would you have to do?

- 1) tilt the loop
- 2) change the loop area
- 3) use thicker wires
- 4) only (1) and (2)
- 5) all of the above

Since $\Phi = B A \cos\theta$, changing the area or tilting the loop (which varies the projected area) would change the magnetic flux through the loop.



Question 20a Transformers [Chap 31]

What is the voltage
across the lightbulb?

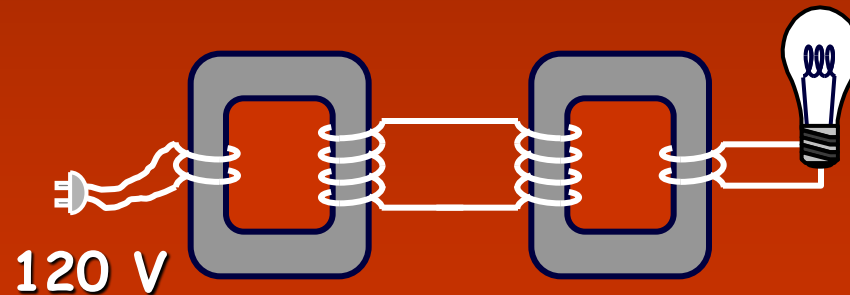
1) 30 V

2) 60 V

3) 120 V

4) 240 V

5) 480 V



Question 20a Transformers [Chap 31]

What is the voltage across the lightbulb?

1) 30 V

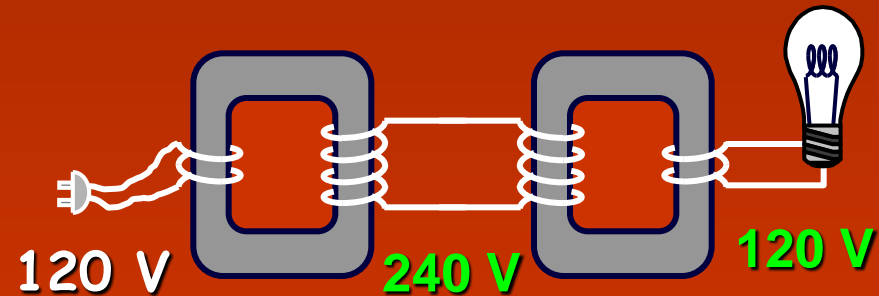
2) 60 V

3) 120 V

4) 240 V

5) 480 V

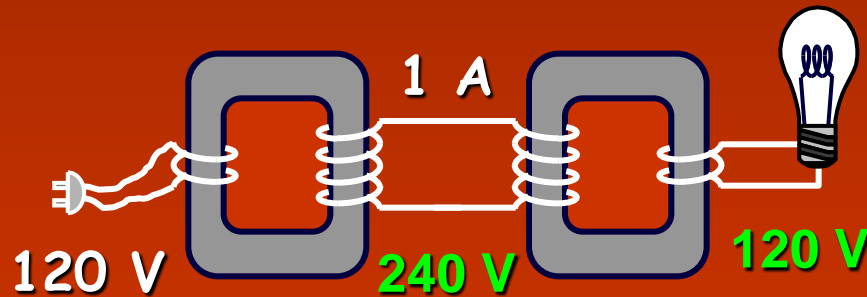
The first transformer has a 2:1 ratio of turns, so the voltage doubles. But the second transformer has a 1:2 ratio, so the voltage is halved again. Therefore, the end result is the same as the original voltage.



Question 20b Transformers II

Given that the intermediate current is 1 A, what is the current through the lightbulb?

- 1) $1/4$ A
- 2) $1/2$ A
- 3) 1 A
- 4) 2 A
- 5) 5 A



Question 20b Transformers II

Given that the intermediate current is 1 A, what is the current through the lightbulb?

1) 1/4 A

2) 1/2 A

3) 1 A

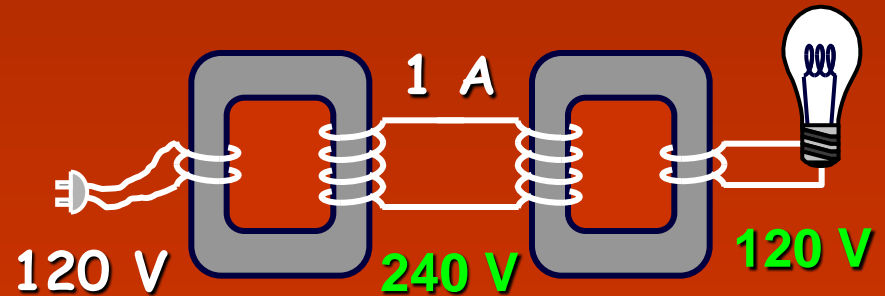
4) 2 A

5) 5 A

Power in = Power out

$$240 \text{ V} \times 1 \text{ A} = 120 \text{ V} \times ???$$

The unknown current is 2 A.

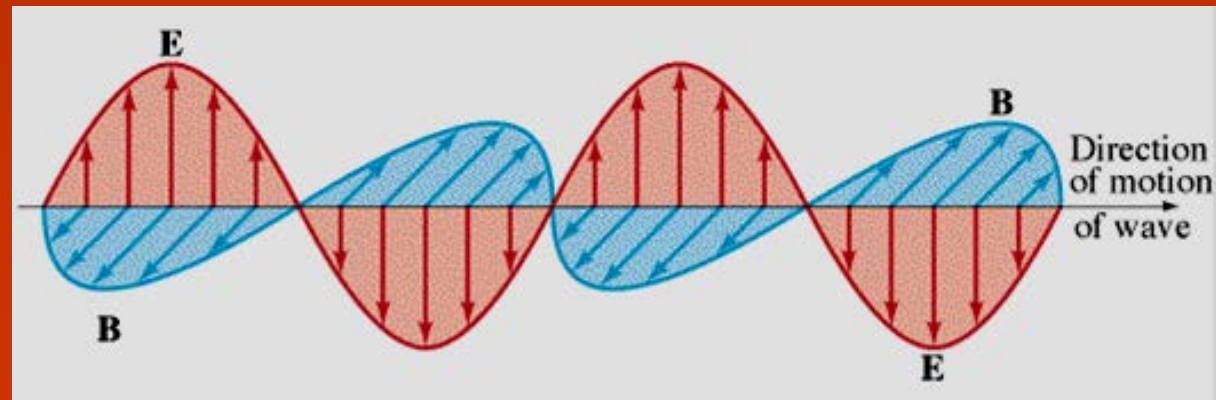


Question 21

Oscillations [Chap 32]

The electric field in an EM wave traveling northeast oscillates up and down. In what plane does the magnetic field oscillate?

- 1) In the north-south plane.
- 2) In the up-down plane.
- 3) In the NE-SW plane.
- 4) In the NW-SE plane.
- 5) In the east-west plane.



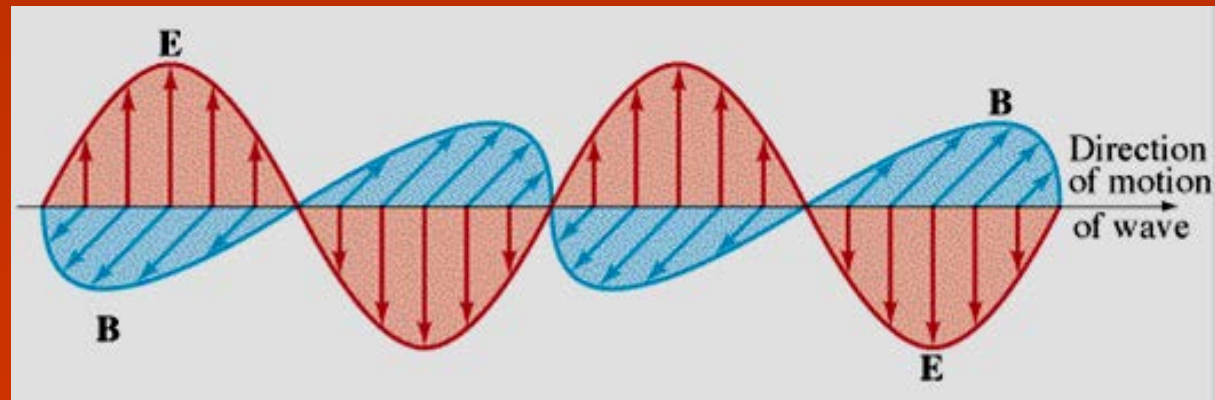
Question 21

Oscillations [Chap 32]

The electric field in an EM wave traveling northeast oscillates up and down. In what plane does the magnetic field oscillate?

- 1) In the north-south plane.
- 2) In the up-down plane.
- 3) In the NE-SW plane.
- 4) In the NW-SE plane.
- 5) In the east-west plane.

The magnetic field oscillates perpendicular to **BOTH** the electric field and the direction of the wave. Therefore the magnetic field must oscillate in the NW-SE plane.

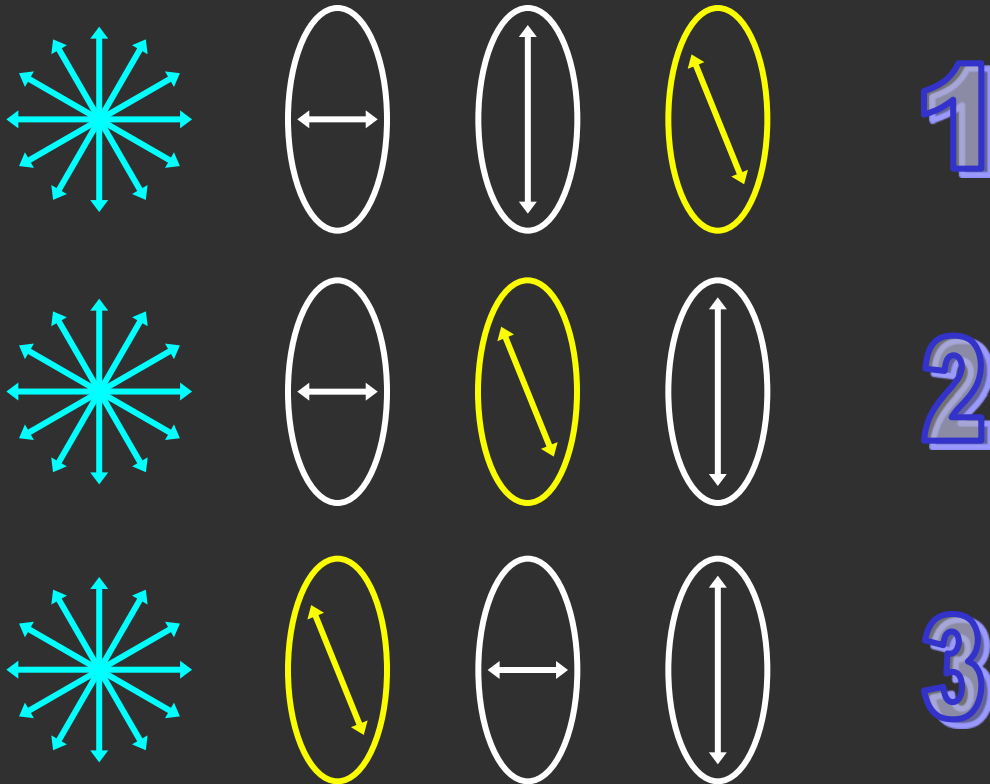


Question 22

Polarization

If unpolarized light is incident from the left, in which case will some light get through?

- 1) only case 1
- 2) only case 2
- 3) only case 3
- 4) cases 1 and 3
- 5) all three cases



Question 22

Polarization

If unpolarized light is incident from the left, in which case will some light get through?

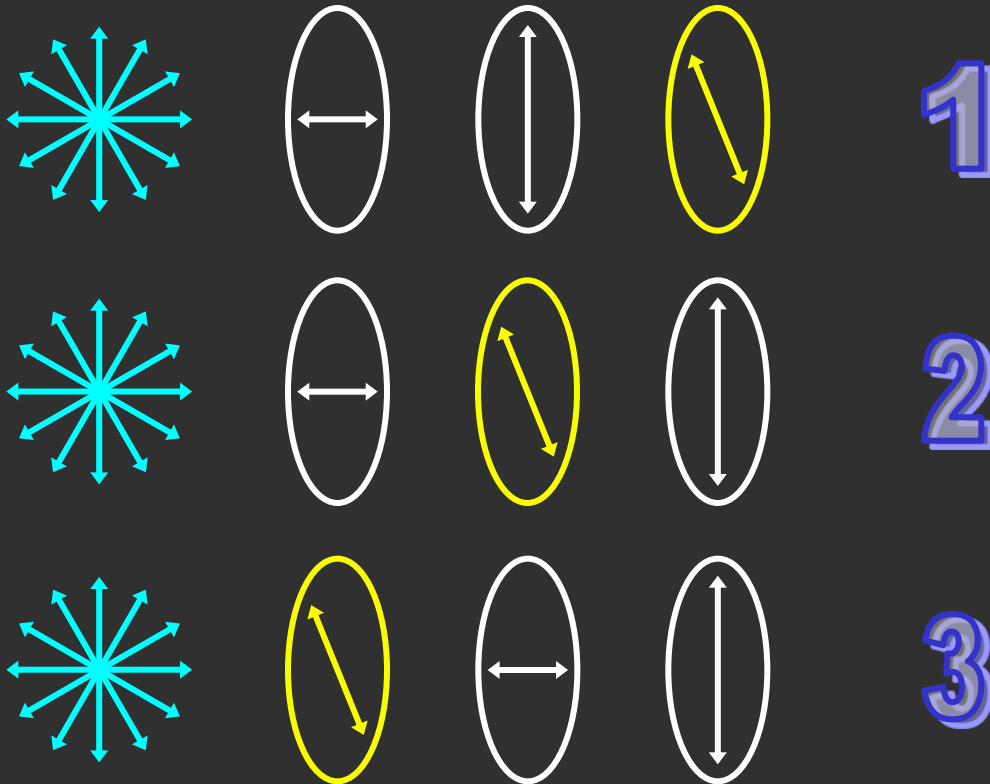
1) only case 1

2) only case 2

3) only case 3

4) cases 1 and 3

5) all three cases



In cases 1 and 3, light is blocked by the adjacent horizontal and vertical polarizers. However, in case 2, the **intermediate 45° polarizer allows some light to get through** the last vertical polarizer.

Question 23

Refraction I [Chap 33]

Parallel light rays cross interfaces from medium 1 into medium 2 and then into medium 3. What can we say about the relative sizes of the index of refraction of these media?

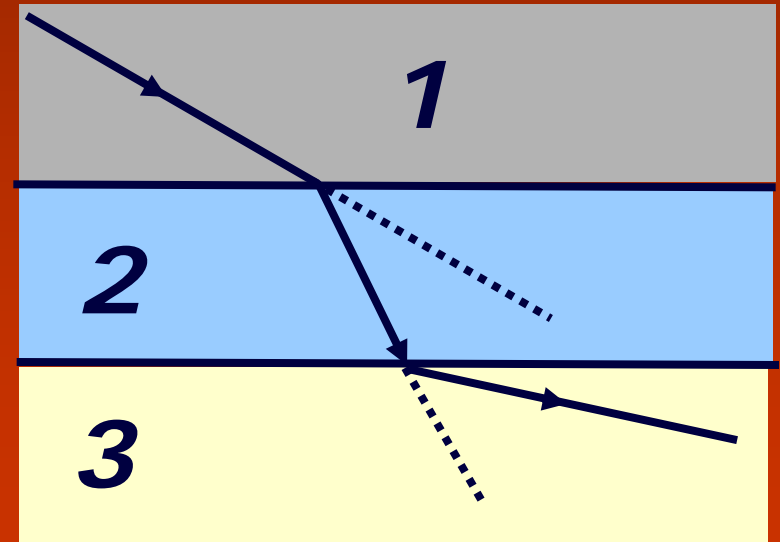
1) $n_1 > n_2 > n_3$

2) $n_3 > n_2 > n_1$

3) $n_2 > n_3 > n_1$

4) $n_1 > n_3 > n_2$

5) none of the above



Question 23

Refraction I [Chap 33]

Parallel light rays cross interfaces from medium 1 into medium 2 and then into medium 3. What can we say about the relative sizes of the index of refraction of these media?

1) $n_1 > n_2 > n_3$

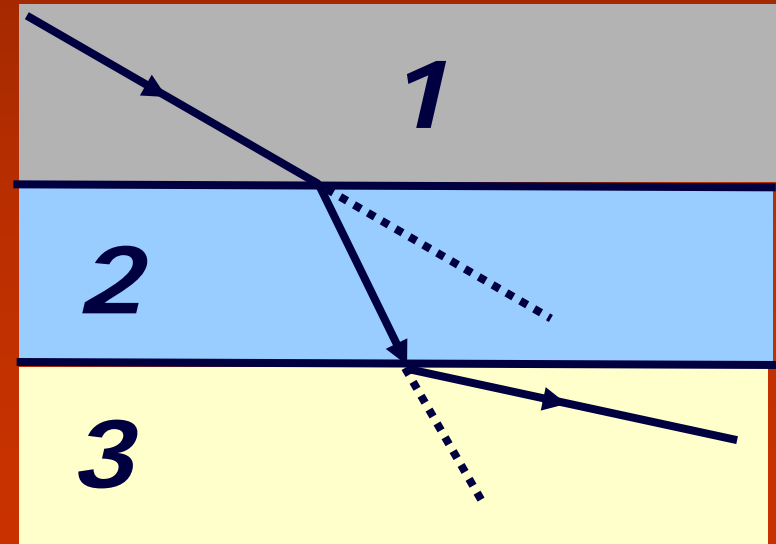
2) $n_3 > n_2 > n_1$

3) $n_2 > n_3 > n_1$

4) $n_1 > n_3 > n_2$

5) none of the above

The rays are bent toward the normal when crossing into #2, so $n_2 > n_1$. But rays are bent away from the normal when going into #3, so $n_3 < n_2$. How to find the relationship between #1 and #3? Ignore medium #2! So the rays are bent away from the normal if they would pass from #1 directly into #3. Thus, we have: $n_2 > n_1 > n_3$.



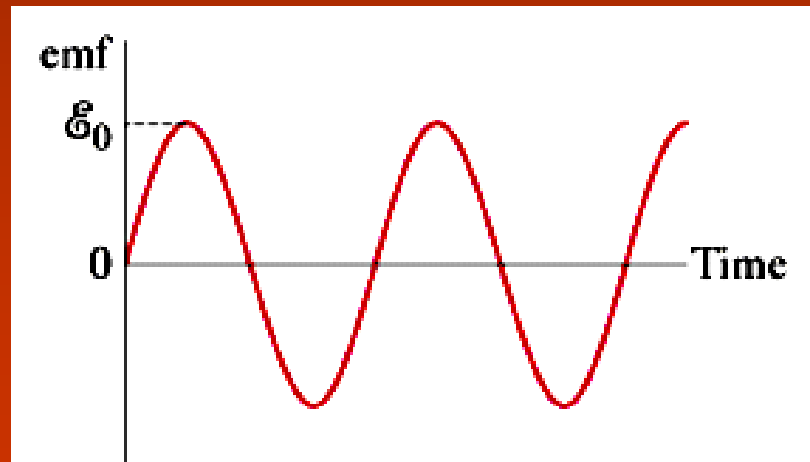
$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Question 19: Generators

A generator has a coil of wire rotating in a magnetic field.

If the *rotation rate increases*, how is the *maximum output voltage* of the generator affected?

- 1) increases
- 2) decreases
- 3) stays the same
- 4) varies sinusoidally



Question 19: Generators

A generator has a coil of wire rotating in a magnetic field.

If the **rotation rate increases**, how is the **maximum output voltage** of the generator affected?

- 1) increases
- 2) decreases
- 3) stays the same
- 4) varies sinusoidally

The maximum voltage is the leading term that multiplies $\sin(\omega t)$ and is given by $\varepsilon_0 = NBA\omega$. Therefore, if ω increases, then ε_0 must increase as well.

$$|\varepsilon| = NBA\omega \sin(\omega t)$$

