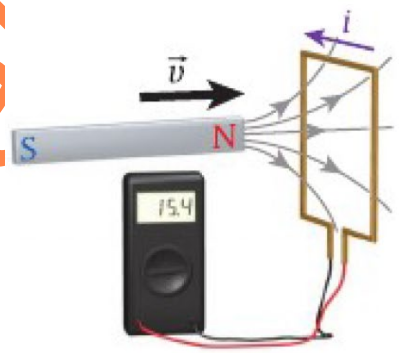
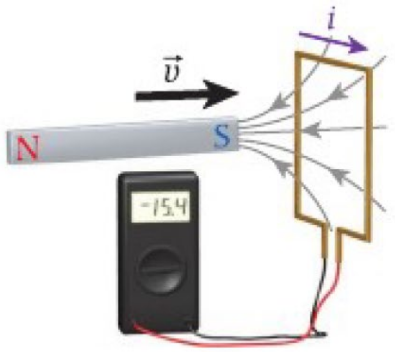
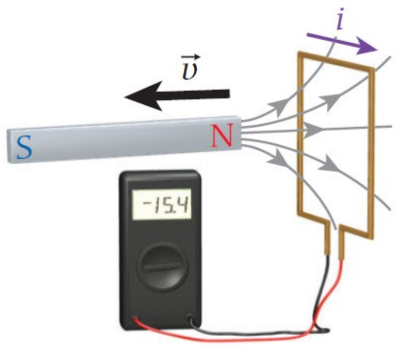
Faraday's Experiments (lesson 9.1)

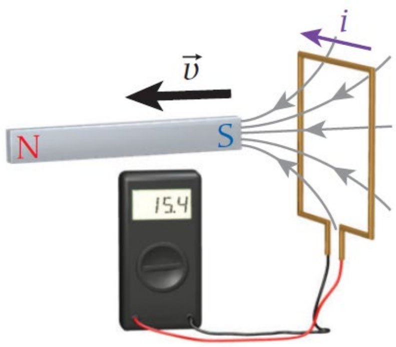
It is a set of experiments by which Faraday proved that :
A changing magnetic field through a loop induces a potential difference and electric current in the loop .

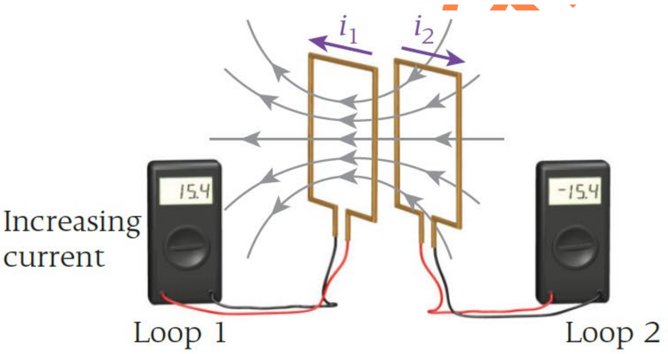
* The potential difference generated by this way is called an induced potential difference (ΔV_{ind}) or a motional emf (V_{emf}).
* The electric current generated by this way is called an induced current (i_{ind}) .
* The following figures show some ways of changing the magnetic field through a loop:

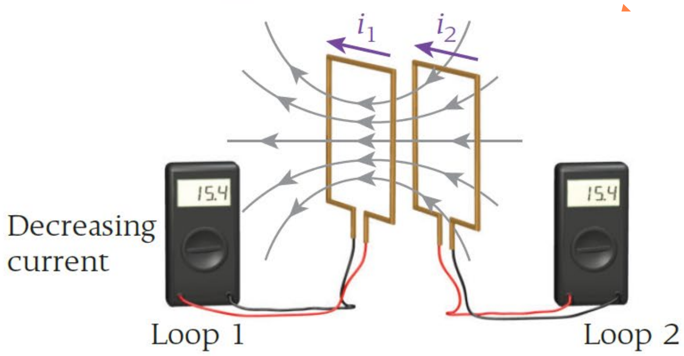






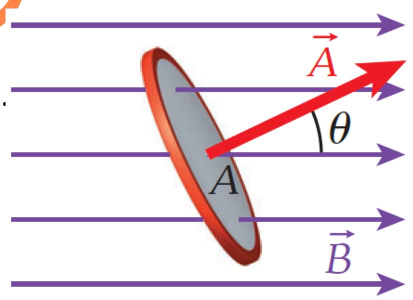






Faraday's Law of Induction (lesson 9.2)

Faraday's Law of Induction in its qualitative form states :
A potential difference is induced in a loop when the **magnetic flux** through the loop changes with time .
OR : A potential difference is induced in a loop when the number of magnetic field lines passing through the loop changes with time .



Magnetic flux ϕ_B

It is a quantity that expresses the number of magnetic field lines that pass through a surface area .

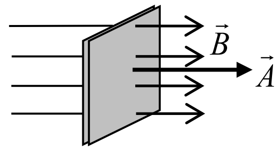
In the case of a uniform magnetic field :

$$\phi_B = A\,B\cos\theta$$

A : The surface area .

θ: the angle between $(\vec{B})$ and the area normal vector to the plane of the loop $(\vec{A})$.

The unit of flux is : $(T.m^2)$ and it is called Weber (Wb) .

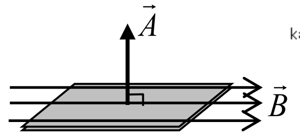


If the magnetic field is perpindecular to the plane of the loop $(\theta = 0)$:

$$\phi_{\max} = A B$$

If the magnetic field $\vec{B}$ is paralle to the plane of the loop $(\theta = 90^o)$:

$$\phi_{\min} = 0$$



In the case of a nonuniform magnetic field ,
the magnetic flux is the surface integral of the magnetic field passing through a differential element of area .

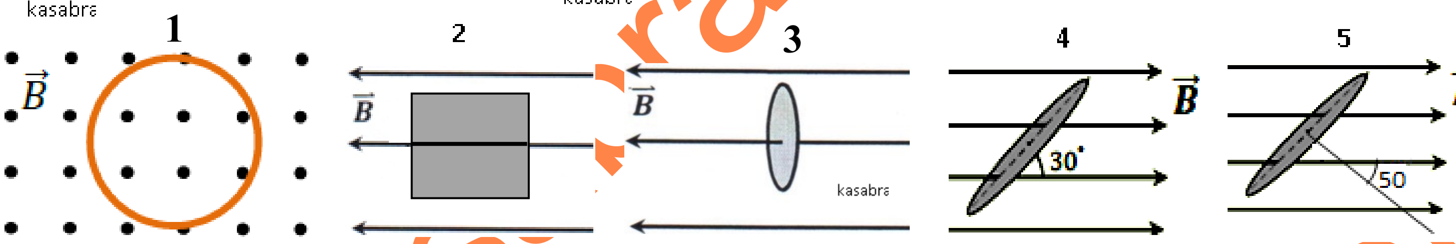
$$\phi_B = \iint \vec{B}.d\vec{A}$$

Gauss's law for magnetic field
Through any closed surface :

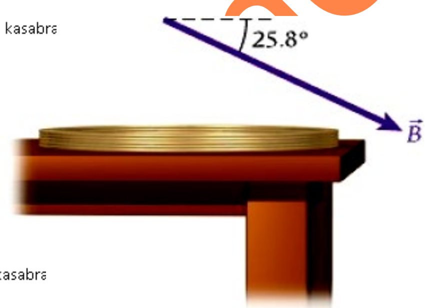
$$\oiint \vec{B}.d\vec{A} = 0$$

The reson : because no magnet monopole , no separate north pole or separate south pole)

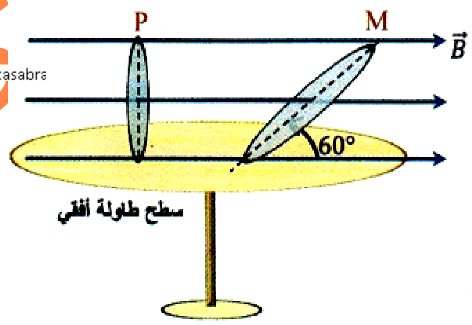
Q1) A circular conductor loop with an area $(0.2\,m^2)$ is placed in a uniform magnetic field of magnitude $(0.4\,T)$. Calculate the flux through the loop in the following cases ?



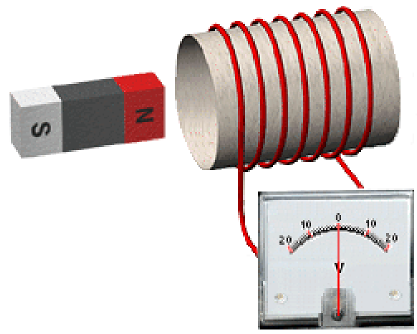
Q2) A circular coil with (20) turns and a radius of $(40\,cm)$ is laying flat on a horizontal tabletop as shown in the figure . There is a uniform magnetic field extending over the entire with a magnitude of $(5.0\,T)$ and makes an angle of (25.8^o) below the horizontal surface as in the figure . Calculate the magnitude flux through the coil?



Q3) In the figure shown if the area of loop (M) is double the area of loop (P) . Calculate the ratio of flux through loop (M) to the flux through loop (P) ?



Faraday's law in its quantitatively form states :
The magnitude of the potential difference induced in a loop is equal to the time rate of change of magnetic flux through the loop.



For one loop : $\Delta V_{ind} = -\dfrac{d\phi_B}{dt}$

For a coil of (N) loops : $\Delta V_{ind} = -N\dfrac{d\phi_B}{dt}$

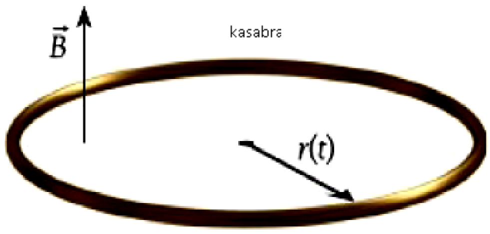
$\dfrac{d\phi}{dt}$ **:** the time rate of change of magnetic flux

The negative sign means: the induced potential difference establishes an induced current whose magnetic field tends to oppose the flux change .

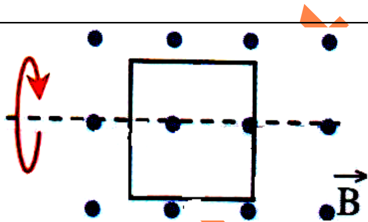
Q4) A circular loop of area $(0.4m^2)$ **is placed so that its plane is perpendicular to a variable magnetic field changed by the equation** $(B = 0.2t^3 - 0.5t + 2.0)$
Calculate the potential difference induced in the loop at $(t = 3.0s)$ **.**

Q5) A coil consisting of (8) square turns have a side length of $(0.20m)$ **and resistance** (3.0Ω) **are placed in a magnetic field that makes an angle** $(40°)$ **with the plane of the coil . The magnetic field varies according to the equation** $(B=1.5t^3)$**, where (t) is measured in seconds and (B) in Tesla .**
Calculate the current induced in the coil at $(t = 2.0s)$ **.**

Q6) An elastic circular conducting loop expands at a constant rate over time such that its radius is given by $(r = 0.1 + 0.015t)$ **, The loop has a constant resistance of** (12Ω) **and is placed in a uniform magnetic field of magnitude** $(0.75T)$ **perpendicular to the plane of the loop, as shown in the figure .**
Find the magnitude of the current induced in the loop at $(t = 5.0s)$**.**

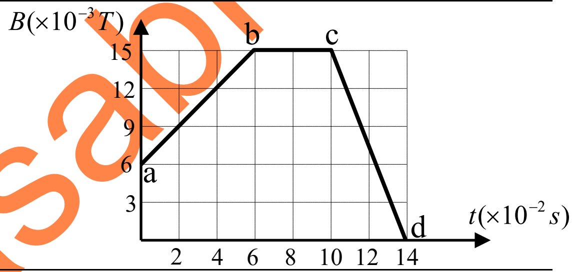


Q7) A square conducting loop with sides of length (L) **is rotating at a constant angular speed** (ω) **in a uniform magnetic field** (B) **. Find an expression for the potential difference induced in the loop as a function of time .**



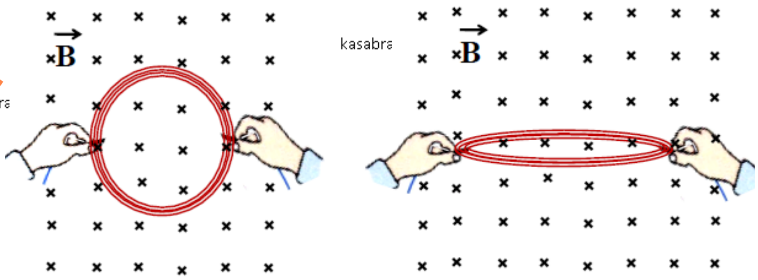
Q8) A (40) turns coil with area of $(0.03m^2)$ **is placed in the magnetic field perpendicular to its plane , if the magnetic field decreases by a rate of** $(0.05T/s)$ **, what is the potential difference induced in the coil ?**

Q9) A (150) turns coil with area of $(0.04m^2)$ **is placed where its plane is perpendicular to a magnetic field varies with time as shown in the figure .**
What is the average potential difference induced in the coil each stage ?



Q10) A circular loop with radius $(4.0cm)$ **consist of (80) turns , its plane is perpendicular to a uniform magnetic field** $(0.18T)$**. Calculate is the induced potential difference in following cases :**
a) If the magnetic field varies from $(0.18T)$ **to** $(0.12T)$ **in** $(0.1s)$ **?**
b) If the magnetic field decreases to zero in $(0.15s)$
c) If the direction of the magnetic field is revered during a period of $(0.4s)$ **.**

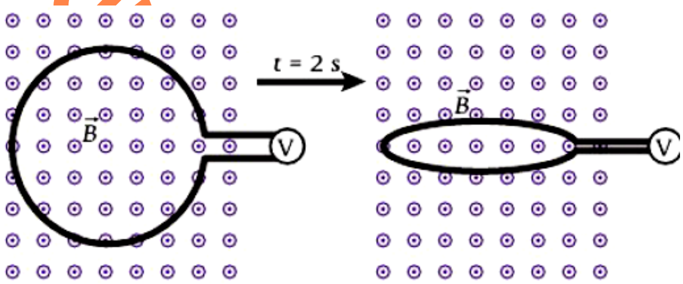
Q11) The figure shows an elastic circular coil of (10) **turns and** $(0.5\,m^2)$ **area is placed in a uniform magnetic field of** $(0.6\,T)$ **.**
If the coil is pulled from its sides in order to decrease its area to quarter during a period of $(0.4\,s)$ **, what is the induced potential difference in the coil ?**



Q12) A (500) turns coil with area of $(0.01\,m^2)$ **rotates in a uniform magnetic field** (B) **) with a constant speed , the coil rotates from a perpendicular position to a parallel position to the field lines in** $(0.2\,s)$ **. Calculate the magnetic field** (B) **if the average potential difference induced in the coil equals** $(2.0\,V)$ **?**

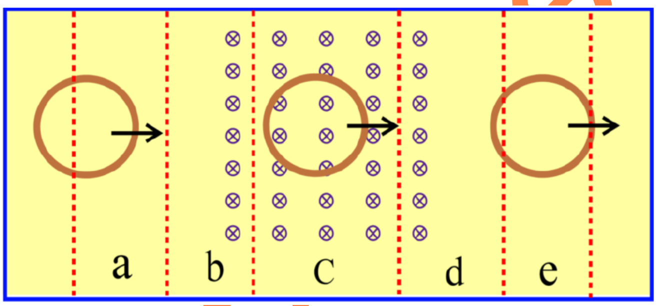
Q13) Choose the correct answer :

1) A wire loop is placed in a uniform magnetic field . Over a period of $(2\,s)$ **, the loop is shrunk . Which statement about the induced potential difference is correct ?**



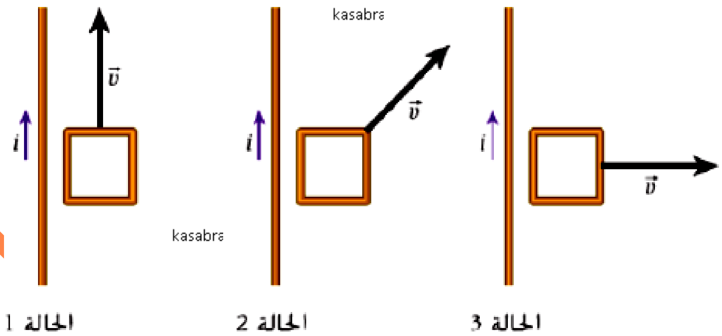
a) There will be some induced potential difference
b) There will be no induced potential difference because the magnetic flux does not change .
c) There will be no induced potential difference because the loop is not closed .
d) There will be no induced potential difference because the loop is shrinking .

2) A conducting ring is moving from left to right through a uniform magnetic field, as shown in the figure. In which region (s) there is an induced current in the ring ?



a) Regions b and d
b) Regions c and e
c) Regions e and a
d) Regions c and a

3) A long wire carries a current, as shown in the figure. A square loop moves in the same plane as the wire, as indicated. In which cases will the loop have an induced current ?



a) Cases 1 and 2
b) Cases 1 and 3
c) Cases 2 and 3
d) All the loops will have an induced current .

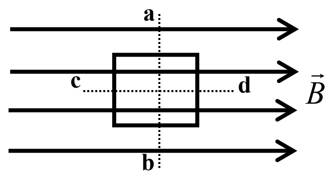
4) In which of the following , a current will be induced in the loop shown below .

a) When it moves to the right

b) When it rotates around the axis (ab)

c) When it rotates around the axis (cd)

d) When the magnetic field increases



5) Which of the following will induce a current in a loop its plane perpendicular to a uniform magnetic field ?

a) Decreasing the magnetic field .

b) Rotating the loop about an axis parallel to the field

c) Moving the loop within the field

d) All of the above

6) Faraday's law of induction states that :

a) A potential difference is induced in a loop when the magnetic flux changes through the loop.

b) The current induced in a loop by a changing magnetic field produces a magnetic field that opposes this change in magnetic field .

c) A changing magnetic field induces an electric field

d) Magnetic flux is the product of the average magnetic field and the area perpendicular to it that it penetrates

7) A rectangular wire loop of $(4.0\,cm)$ **length and** $(2.0\,cm)$ **width is placed in a magnetic field varies by the equation** $B(t)=7.0t^2$ **and perpendicular to plane of the loop , What is the induced potential difference in the loop at** $(t=5.0\,s)$ **?**

a) $0.60\,V$ b) $0.06\,V$

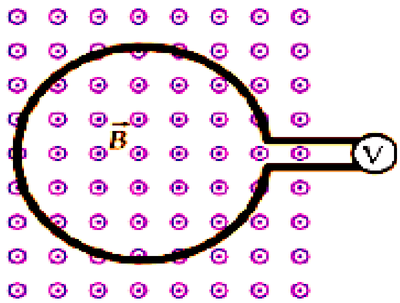
c) $0.14\,V$ c) $1.4\,V$

8) A circular loop with radius of $(1.0\,cm)$ **is placed perpendicular to a uniform magnetic field of** $(1.2\,T)$**. If the field disappeared in** $(20\,s)$ **. What is the average potential difference induced in the loop ?**

a) $5.36\times10^{-5}\,V$ b) $8.21\times10^{-5}\,V$

c) $1.88\times10^{-5}\,V$ d) $3.95\times10^{-5}\,V$

9) A respiration monitor has a flexible loop of copper wire, which wraps around the chest. As the wearer breathes the radius of the loop of wire increases and decreases when a person in the earth's magnetic field of magnitude $(4.26\times10^{-5}\,T)$**. What is the average current in the loop, assuming it has a resistance of** $(30\,\Omega)$ **and increases in radius from** $(20\,cm)$ **to** $(25\,cm)$ **over** $(1.0\,s)$ **? Assume that the magnetic field is perpendicular to the plane of the loop .**



a) $1.0\times10^{-3}\,A$ b) $1.0\times10^{-7}\,A$

c) $1.0\times10^{-5}\,A$ d) $1.0\times10^{-6}\,A$

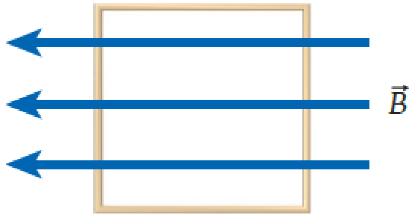
10) A wire loop is placed in a uniform magnetic field $(0.5\,T)$ **,the magnetic field decreased to be zero with a constant rate during a period of** $(0.25\,s)$ **, if the average potential difference induced in the loop is** $(1.24\,V)$ **what is the radius of the loop ?**

a) $0.19\,m$ b) $0.28\,m$

c) $0.88\,m$ d) $0.44\,m$

11) A metal loop has an area of $(0.1m^2)$ and is placed flat on the ground . There is a uniform magnetic field pointing due west, as shown in the figure . This magnetic field initially has a magnitude of $(0.123T)$, which decreased steadily to $(0.075T)$ during a period of $(0.58s)$.

Find the potential difference induced in the loop during this time ?



a) $0.002V$

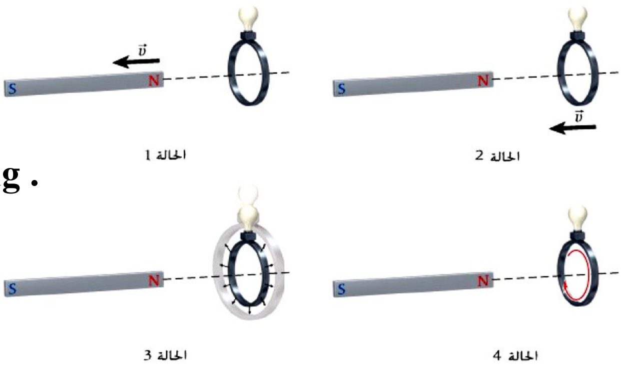
b) $0.008V$

c) $0.02V$

d) zero

12) The figure shows a bar magnet and a light bulb connected to the ends of a conducting loop . The plane of the loop is perpendicular to the dashed line .

In case 1, the loop is stationary, and the magnet is moving away from the loop. In case 2, the magnet is stationary, and the loop is moving towards the magnet . In case 3, both the magnet and the loop are stationary, but the area of the loop is increasing . In case 4, the magnet is stationary, and the loop is rotating about its center. In which of these situations will the bulb light up .



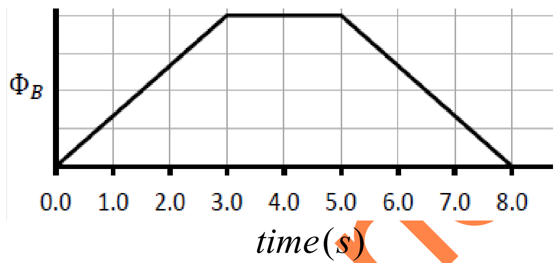
a) Case 1

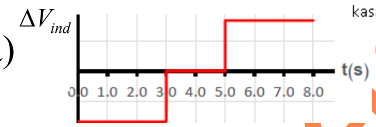
b) Cases 1 , 2 and 3

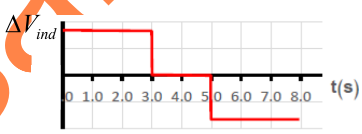
c) Cases 1 and 2

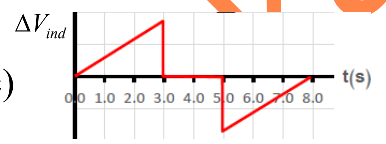
d) All 4 case

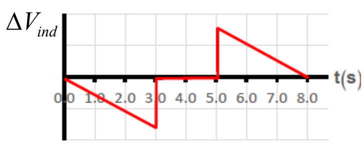
13) The figure shows how the magnetic flux in a loop varies with time, which figure explains the changes. of the induced potential difference in the loop?



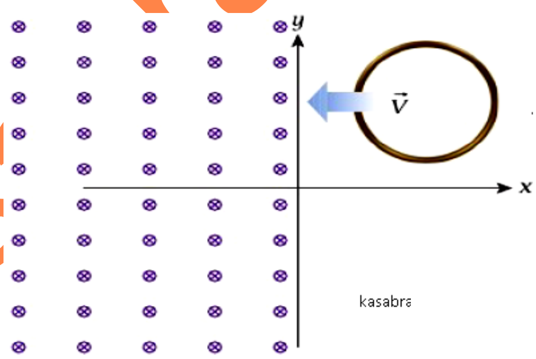
a) 

b) 

c) 

d) 

14) A circular loop of wire moves in the xy-plane with a constant velocity in the negative x-direction enters a uniform magnetic field, as shown in the figure . Which of the following statements is correct ?



a) The induced potential difference in the loop is at a maximum as the edge of the loop just enters the region with the magnetic field.

b) The induced potential difference in the loop is at a maximum when one fourth of the loop is in the region with the magnetic field

c) The induced potential difference in the loop is at a maximum when the loop is halfway into the region with the magnetic field

d) The induced potential difference in the loop is constant from the instant the loop starts to enter the region with the magnetic field .

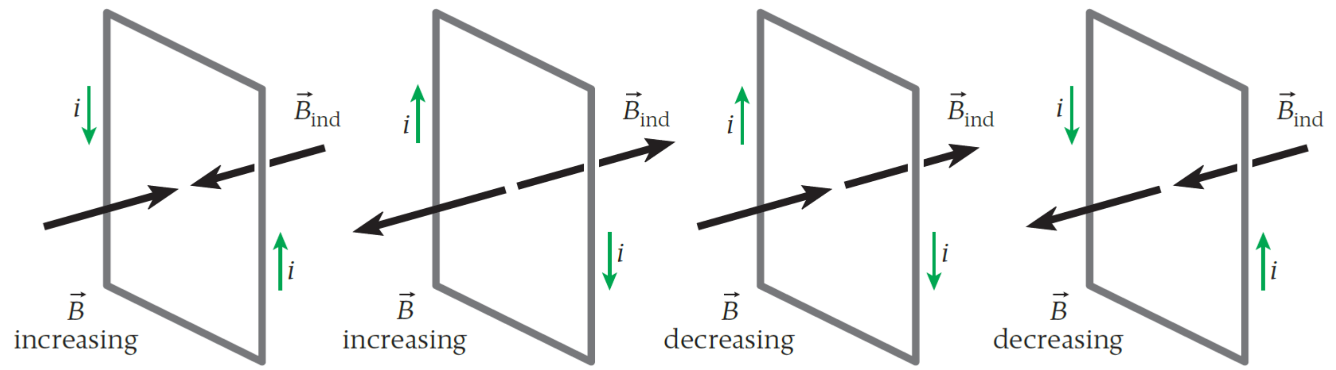
Lenz's law (lesson 9.3)

* The current induced in a loop tends to oppose the change in magnetic flux .

* When the magnetic flux increases by any way :
$\vec{B}_{ind}$ will be opposite to the direction of the original field . (see the figure a and b)

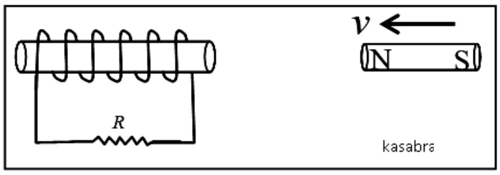
* When the flux decreases by any way :
$\vec{B}_{ind}$ will be in the same direction of the original field . (see the figure a and b)

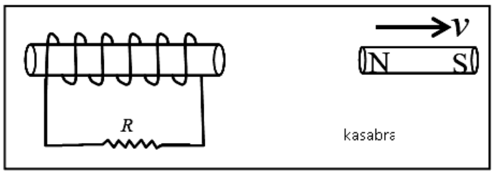
* When the flux doesn't change : no current is induced .
* After determining the direction of $\vec{B}_{ind}$, we use the right hand rule 3 . (Thumbs are directed toward the induced magnetic field and the fingers are rotated with the current)

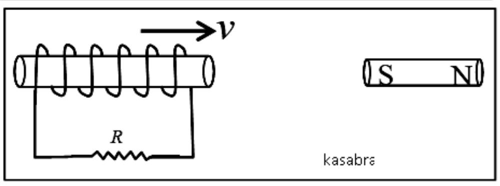


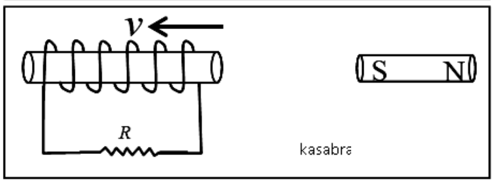
(a) (b) (c) (d)

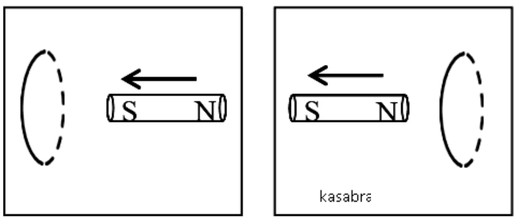
Q14) Determine the direction of the induced current in the coil and in the resistor (R) in the following situations ?

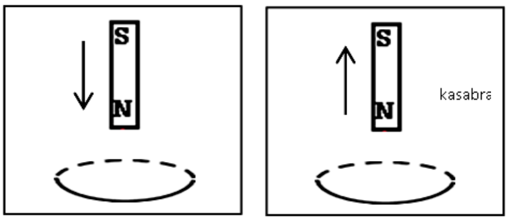
1) 

2) 

3) 

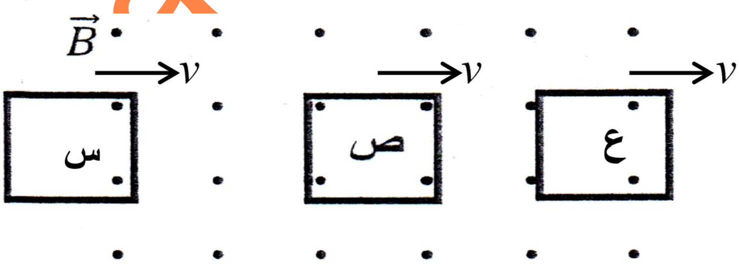
4) 

5) 

6) 

Q15) The figure shows three loops (س , ص , ع) move to the right in a uniform magnetic field . What is the direction of the induced current in each case ?

1) In loop س
2) In loop ص
3) In loop ع



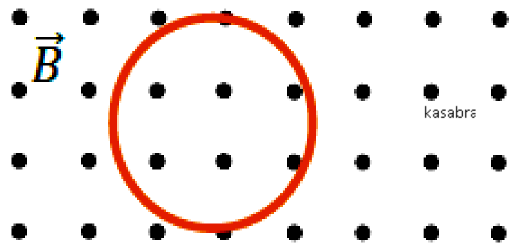
Q16) What is the direction of the induced current in the elastic loop in the figure in the following cases ?

a) When the magnetic field cross the loop increases .

b) When the diameter of the loop decreases .

c) When the loop moves to the right inside the field

d) When the loop rotates around one of its diameters

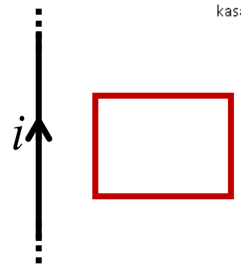


Q17) What is the direction of the induced current in the loop shown in the figure in the following cases .

a) When the loop moves to right

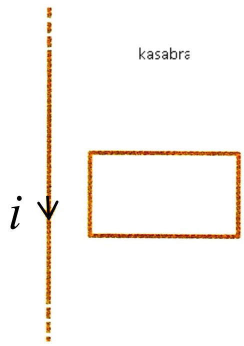
b) When the loop moves to the left

c) When the loop moves upward parallel to the wire



Q18) The figure shows an elastic copper loop . Write in the first column what you should do to get the needed .

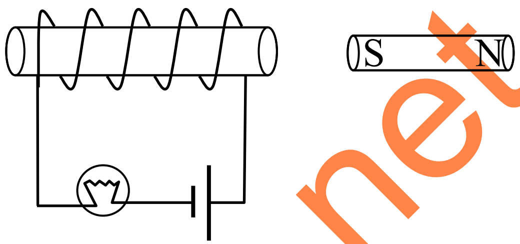
First column	Needed
	No current induced in the loop when it is moving
	Current induced in a counterclockwise direction
	Current induced in a clockwise direction



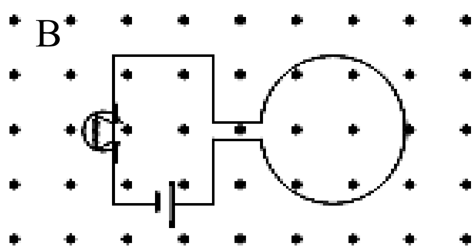
Q19) what happens to the bulb lighting in the following ?

1) When the magnet moves towards the coil .

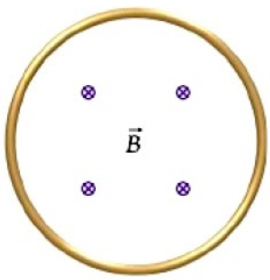
2) When the magnet moves away from the coil



Q20) an elastic circular loop is connected to a lamp as shown in the figure, what happens to the lighting when the loop shrinks?



Q21) A loop of wire with an area of $(5.0\,m^2)$ is located in the plane of the page, as shown in the figure. A time-varying magnetic field in the region of the loop is directed into the page, and its magnitude is given by $[\,B = 3.0 + 2.0\,t\,]$. what is the potential difference induced in the loop at $(t = 4.0\,s)$, and the determine the direction of the induced current ?



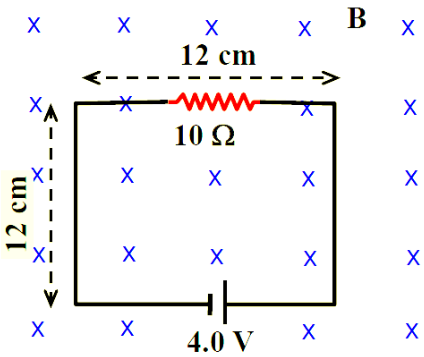
Q22) A rectangular conducting loop with area (A) and resistance (R) is placed in the $(x\,y)$ plane. A magnetic field of magnitude (B) passes through the loop. The magnetic field is in the positive (z) direction and varies in time according to $B = B_o(1 + c\,t^3)$, where c and B_o are positive constants .

1) Calculate the magnetic flux through the loop at $(t = 0)$.

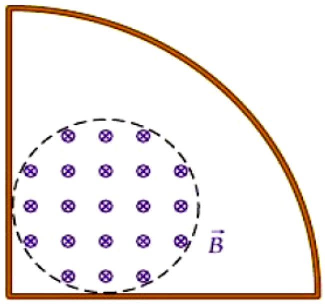
2) Derive an equation for the induced current in the loop as a function of time .

3) What is the direction of the current induced in the loop at any time .

Q23) In the figure shown , the magnetic field through the loop decreases at a rate of $(150\,T/s)$.
Calculate the electric current passing through the resistor .



Q24) The conducting loop in the shape of a quarter-circle shown in the figure has a radius of $(10\,cm)$ and the resistance of (0.2Ω) .
The magnetic field strength within the dotted circle of radius $(3\,cm)$ is initially $(2\,T)$. The magnetic field strength then decreases from $(2.0\,T)$ to $(1.0\,T)$ in $(2\,s)$. Calculate the magnitude and the direction of the induced current in the loop .

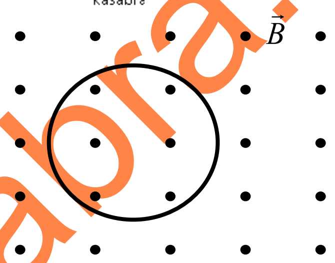


Q25) Choose the correct answer in the following :

1) According to the Lenz law the induced current in the loop

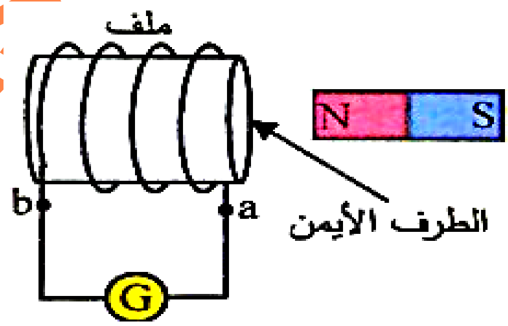
a) Increases the external field
b) Oppose the flux
c) Oppose the external magnetic field
d) Oppose the change in the magnetic flux

2) Which of the following induce a current in a clockwise direction in the loop shown in the figure :



a) Decreasing the magnetic field
b) Moving the loop to the right
c) Increasing the magnetic field
d) Moving the loop to the left

3) What will happen when the magnet moves towards the solenoid coil in the figure shown



a) Right side of the loop becomes north pole
b) Right side of the loop becomes south pole
c) Potential of point (a) is greater than potential of (b)
d) A current passes from (a) to (b) through a galvanometer

Eddy current

It is a current induced in any piece of metal when the magnetic flux varies through it .

* Eddy currents cause a slowdown in the movement of any metal in which the magnetic flux changes, and this was explained by the pendulum experiment shown in the figure .

Two pendulums, one consisting of an arm and a solid metal plate and a second consisting of an arm and a slotted metal plate. The five frames are in time sequence from left to right, with the two pendulums starting their motion together in the second frame from the left. The pendulum with the solid plate stops in the gap, while the pendulum with the slotted plate passes through the gap.

* Eddy currents generate a heat in the devices and equipment, so they are often undesirable , forcing equipment designers to minimize them by segment or laminating electrical devises that must operate in an environment of changing magnetic fields .

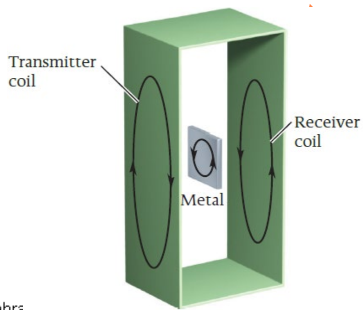
* Eddy current can also be useful and are employed in certain practical applications , such as the brakes of train cars .

Q26) A cylindrical permanent magnet is dropped down along an aluminum tube as shown in the figure .
1) Does the magnet fall with the same, less, or greater than free-fall acceleration (g) ?
2) Does it matter if the North Pole or South Pole of the magnet is on the lower side ?

Metal Detector

* It consists of a transmitter coil in which an alternating current passes, and a receiver coil in which an induced current is generated due to the change of flux through it .

* When a metal passes between the two coils, eddy currents are generated in the metal, and these currents work to reduce the induced current in the receiver coil .

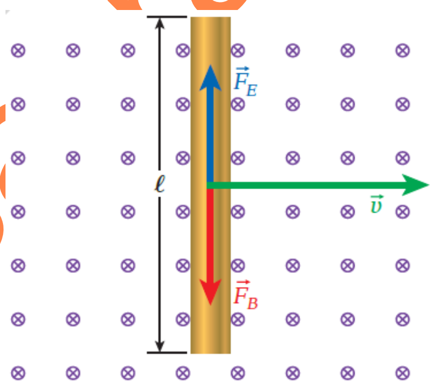


Induced potential difference in a straight wire

$$F_B = F_E \quad \Rightarrow \quad E_{ind} = vB$$

$$E_{ind} = \frac{\Delta V_{ind}}{\ell}$$

$$\boxed{\Delta V_{ind} = v\ell B}$$



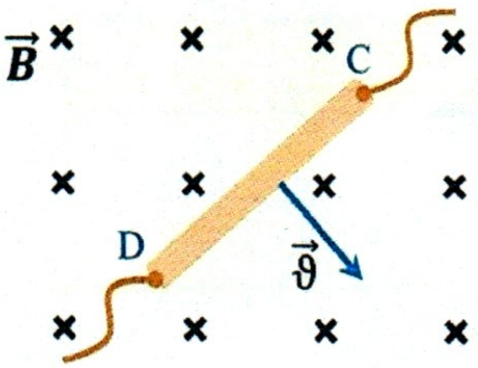
v : speed of the wire ℓ : length of the wire

Explanation why ΔV_{ind} is generated in the wire :

When the wire moves its free electrons will be affected by a magnetic force making it group at the bottom while the positive charges groups at the top , because of this an induced potential difference is generated .

Q27) A straight wire of $(10\,cm)$ length is placed in a uniform magnetic field $(1.0\,T)$. When the wire moves with a constant speed as in the figure , a $(2.0\,V)$ potential difference is induced in it .

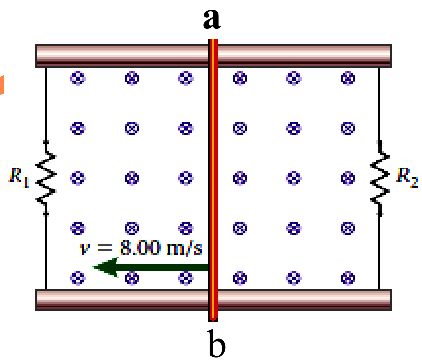
1) Determine the direction of the current induced in the wire .



2) Calculate the speed of wire .

Q28) A conducting rod (ab) of length $(50\,cm)$ slides over 2 parallel metal bars placed in a magnetic field with a magnitude of $(0.1\,T)$ as shown in the figure . The ends of the rods are connected by two resistors $(R_1 = 100\Omega\ ,\ R_2 = 200\Omega)$, the conducting rod (ab) moves with constant speed of $(8.0\,m/s)$.

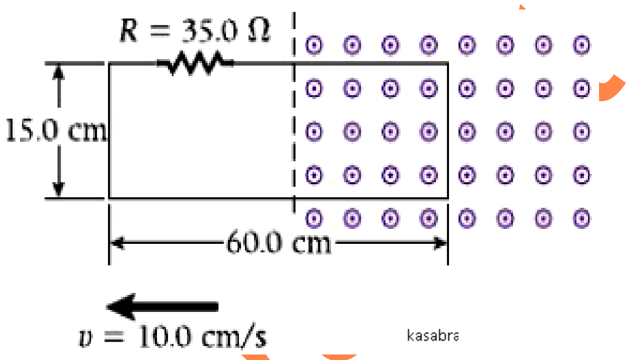
1) Calculate the currents flowing through the rod (ab) ?



2) Calculate the force is needed to keep the rod moving with constant velocity ?

Q29) A rectangular (60 cm long by 15 cm wide) circuit loop with resistance (35Ω) is held parallel to the xy-plane and moves at constant speed of $(10\,cm/s)$ to the left in a uniform magnetic field given by $(2.0\ T)$ is directed along the positive z-axis to the right of the dashed line , as shown in the figure :

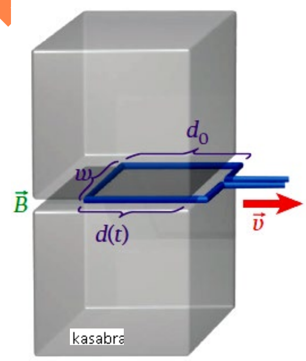
1) What is the current flowing through the loop ?



2) What is the power dissipated in the resistance (R) ?

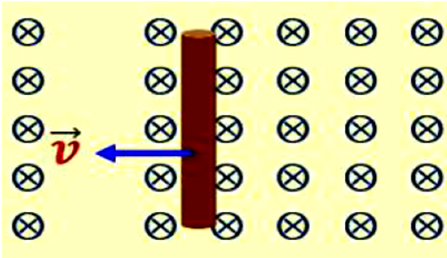
Q30) A rectangular wire loop of width $(w = 3.1\,cm)$ and depth $(d_o = 4.8\,cm)$ is pulled out of the gap between two permanent magnets . A magnetic field of magnitude $(B = 0.073\,T)$ is present throughout the gap .

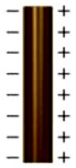
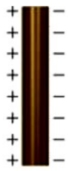
If the loop is removed at a constant speed of (1.6 cm/s) , calculate the induced potential difference in the loop .



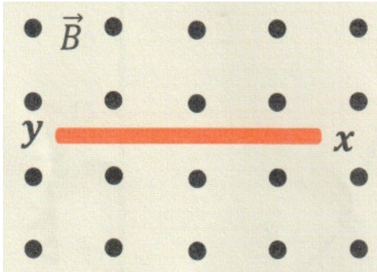
Q31) Choose the correct answer in the following :

1) A metal bar is moving with constant velocity $(\vec{v})$ through a uniform magnetic field pointing into the page, as shown in the figure. Which of the following most accurately represents the charge distribution on the surface of the bar ?



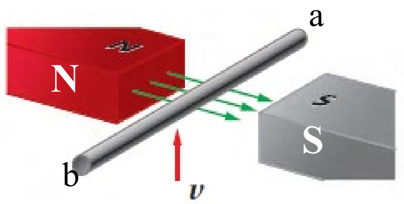
a)  **b)**  **c)**  **d)** 

2) What is the direction of the wire velocity to make x-potential is greater than y-potential ?



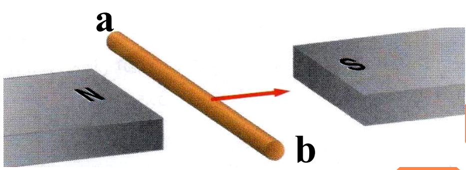
a) Upward
b) Downward
c) To the right
d) To the left

3) In the figure shown a conductor wire (ab) is a part of a closed circuit . What is the direction of the induced current in the wire ?



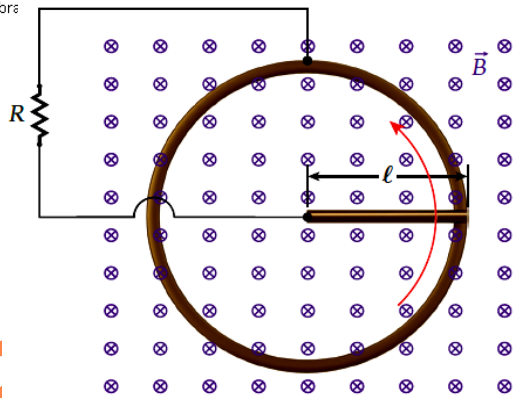
a) From (a) to (b)
b) Cannot be determined
c) From (b) to (a)
d) No current induced

4) In the figure shown a conductor wire (ab) is a part of a closed circuit . What is the direction of the induced current in the wire ?



a) From (a) to (b)
b) From (b) to (a)
c) Cannot be determined
d) No current induced

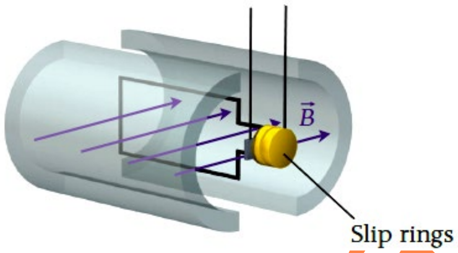
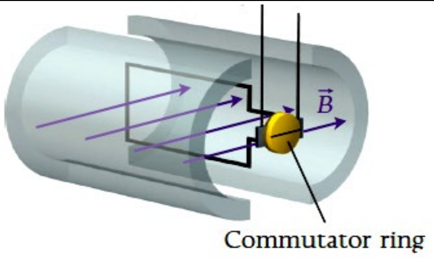
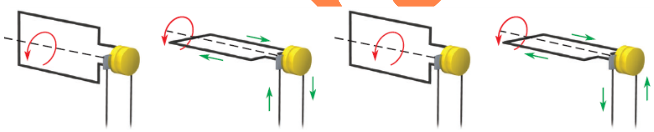
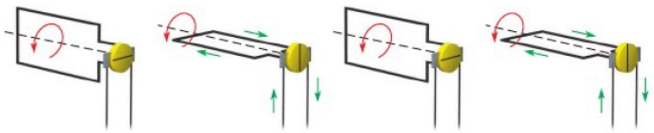
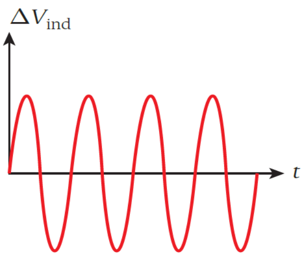
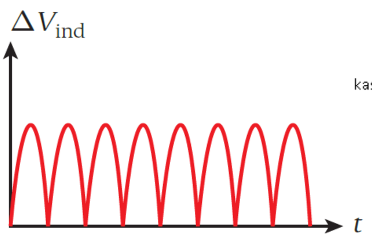
Q32) A conducting rod with length $(\ell = 8.2\,cm)$ rotates around one of its ends in a uniform magnetic field that has a magnitude of $(1.53T)$. The rod makes (6) revolutions per second . A resistor $(R = 1.63\,m\Omega)$, is connected between the rotating rod and the conducting ring .



1) Calculate the potential difference induced in the rod .
2) Calculate the dissipated power in the resister .
3) By what factor does the power dissipated in the resistor change in these cases .
a) If the rod's length increases by factor of 2
b) If the resistance increases by a factor of 2

Generators and Motors (lesson 9.4)

The Generator : is a device produces an electric current from mechanical motion .
The Motor : is a device produces mechanical motion from electric current .
How does the Generator work :
when the loop rotates in the fixed magnetic field the angle changes, so the flux changes and a potential difference is induced .

Alternating-Current generator (AC)	Direct-Current generator (DC)
	
Its direction and magnitude varies with time 	Its direction constant with time 
	

The potential difference Induces in the generator ΔV_{ind} is calculated by :

$$\Delta V_{ind} = NAB\omega \sin\theta$$

$$V_{max} = NAB\omega$$

ω : angular velocity , its unit is $(rad\ /\ s)$ N : number of turns A : loop area

* When the loop parallels the field lines $(\theta = 90^o)$: $\Delta V_{ind} = V_{max}$

* When the loop perpendiculars the field lines $(\theta = 0^o)$: $\Delta V_{ind} = 0$

Q33) A generator consist of a coil with (200) turns , each turn has an $(7.96 \times 10^{-3}\ m^2)$ area , the coil rotates with an angular velocity $(31.4\ rad\ /\ s)$ in a uniform magnetic field of $(0.4T)$:

1) What is the maximum value of induced potential difference ?

2) What is the maximum current that flows in a (5.0Ω) resistor connected with the generator's coil ?

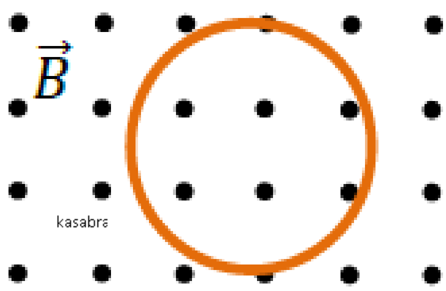
Induced electric field (E_{ind}) (lesson 9.5)

A changing magnetic flux induces an electric field .

$$\Delta V_{ind} = \oint \vec{E}_{ind} \,.\, d\,\vec{s} = -\frac{d\phi_B}{dt}$$

The direction of (E_{ind}) is in the same direction of (i_{ind}) .

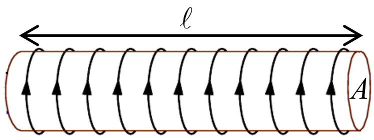
Q34) A single loop of wire with a radius of $(0.2\,m)$ is located in the plane of page as shown in the figure. A time varying magnet field in the region of the loop is directed out of the page and its magnitude is given by the equation $(B = 3.0t^2)$:



1) Calculate the induced electric field in the loop wire at $(t = 1.2\,s)$.

2) Determine the direction of the induced electric field lines ?

Inductance of a Solenoid (lesson 9.6)



The magnetic flux through one winding or through the cross-sectional area of the solenoid is ϕ_B where :

$$\phi_B = AB\cos 0 = AB$$

The **flux linkage** is the flux through all the windings of the solenoid and is equal to : $N\,\phi_B$

$$N\,\phi_B = Li$$

L : inductance where the inductance is the flux linkage divided by the current **OR** it is the flux linkage per unit of current .

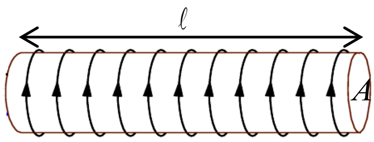
The unit of **L** is (henry H) where $(1H = Wb/A = T.m^2/A)$

$$L = \mu_o n^2 A\ell = \frac{\mu_o N^2 A}{\ell}$$

$$n = \frac{N}{\ell}$$

n : Number of turns per unit length
N : Number of turns
A : cross-sectional area $(A = \pi r^2)$
ℓ : The length of solenoid
The Solenoid is called inductor .

Q35) A solenoid with a length of $(0.2\,m)$ and (10 turns/cm) and a radius of $(3.0\,cm)$. An electric current of $(4.2\,A)$ is passing through it as shown in the figure .



1) Calculate the inductance of the coil ?

2) Calculate the magnetic field inside the coil , and determine its direction?

3) Calculate the magnetic flux through the cross-sectional area of the coil ?

4) Calculate the total flux in the coil ?

Q36) Choose the correct answer :

1) A solenoid of (L) inductance is divided into (2) equal parts in length . What is the inductance of each part ?

a) L b) $2L$
c) $\frac{L}{2}$ d) $\frac{L}{4}$

2) What happens to the inductance of a solenoid if the solenoid is pressed to its half length

a) Halved b) Doubled
c) Stays the same d) Quadruple

3) Which of the following increase the inductance of a solenoid?

a) Put an iron rod in the coil
b) Press the coil
c) Increase the cross-sectional area of the coil
d) All of the above

4) If a solenoid is reformed to have a double diameter than the original . The inductance changed by :

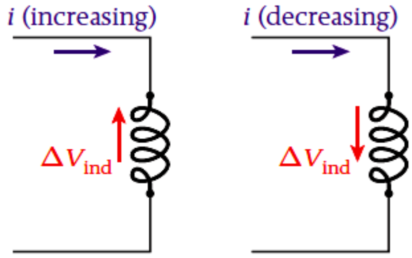
a) $\frac{1}{2}$ b) $\frac{1}{4}$ c) 2 d) 4

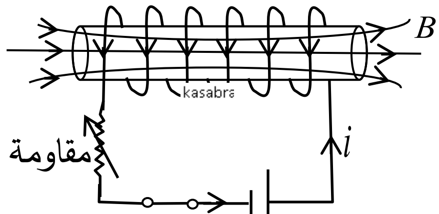
Self-Induction and Mutual Induction (lesson 9.7)

Self-induction

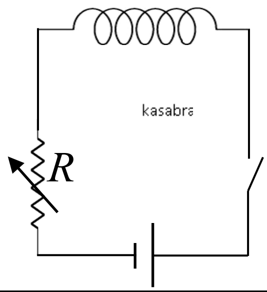
It is a producing of potential difference in a coil by changing the current in the same coil .

* The direction of the induced self-current determine by using the right hand rule .



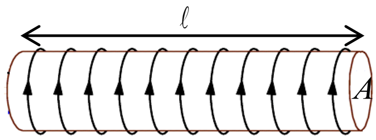


Q37) In the figure shown :
What is the direction of the induced current in the coil in the following cases ?
1) When the switch is closed .
2) When the resistance (R) is increased .
3) When the resistance (R) is decreased .



Self – induced potential difference $\Delta V_{ind,L}$

$$\Delta V_{ind,L} = -L\frac{di}{dt} = -N\frac{d\phi_B}{dt}$$



L : inductance of the solenoid .

$\frac{di}{dt}$: The time rate of change of the current .

The Self – induced potential difference depends on :

1) the time rate of change of the current 2) the inductance of the solenoid .

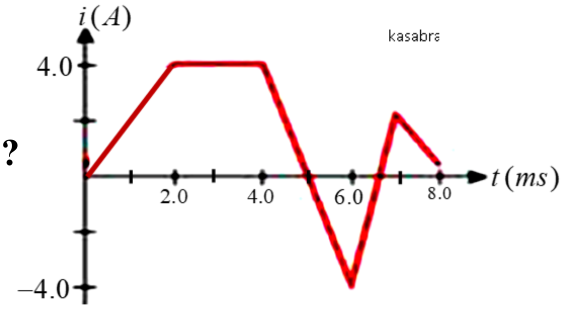
Q38) A (200) turns solenoid with a length of $(0.1\,m)$, a $(4\times10^{-4}\,m^2)$ cross sectional area . The core of the solenoid is iron where $(\mu = 2\times10^{-3}\,T.m/A)$, the solenoid is connected to a closed circuit and a variable current $(i = 8.0 - 3t^2)A$ is passing through it .
1) Calculate the induced potential difference in the coil at $(t = 0.5\,s)$?
2) Calculate the time rate of change of the magnetic flux through the cross sectional area of the solenoid at $(t = 0.5\,s)$?

Q39) A direct current flows through an inductor and its magnitude changes according to the equation $(i = 5 + 7t - 2t^2)$, at time $(t = 3.0\,s)$, the potential difference was induced in the inductor equals $(0.036\,V)$. Calculate the magnitude of coil inductance ?

Q40) A solenoid has (600) turns , a $(0.576\,m)$ length , a $(4\times10^{-4}\,m^2)$ cross-sectional area and has an iron core of $(\mu = 2\times10^{-3}\,T.m/A)$. A current of $(0.4\,A)$ flows in the solenoid, calculate induced potential difference in the coil in the following cases :
1) when the current reverse its direction in $(0.3\,s)$.
2) when the switch is opened, and the current gradually becomes zero in $(0.2\,s)$.

Q41) A solenoid has a current varies with a time rate of $(20\,A/s)$ and so its magnetic flux through each turn varies with a rate of $(0.16\,Wb/s)$, if the turns of the solenoid is (100) :
1) Calculate the self-inductance of the solenoid .
2) Calculate the induced potential difference in the coil ?

Q42) The figure shows the current through a $(10\,mH)$ inductor over a time interval :

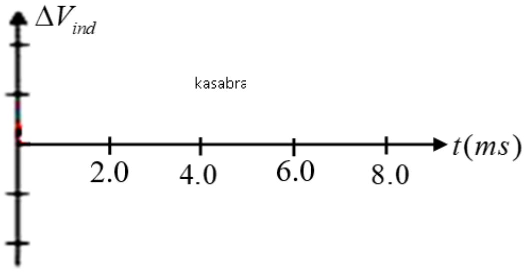


1) Calculate the induced potential difference in the inductor during the first period of the current change ?

2) Calculate the induced potential difference in the inductor at $(t = 5.0\,ms)$?

3) Calculate the maximum potential difference induced in the inductor over the period shown?

4) Draw a graphic showing the self-induced potential difference for the inductor over the same interval ?

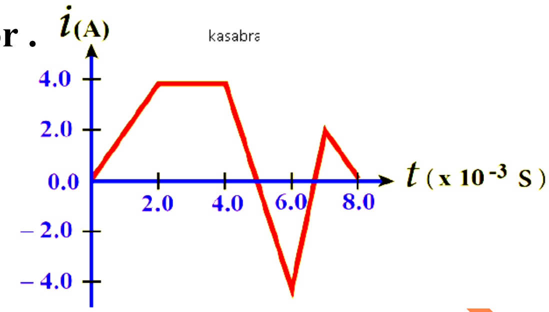


Q43) Choose the correct answer :

1) which of the following statements regarding self-induction is correct :

a) Self-induction occurs only when a direct current is flowing through a circuit .
b) Self-induction occurs only when an alternating current is flowing through a circuit .
c) Self-induction occurs only when either a direct current or an alternating current is flowing through a circuit .
d) Self-induction occurs only when either a direct current or an alternating current is flowing through a circuit as long as the current is varying .

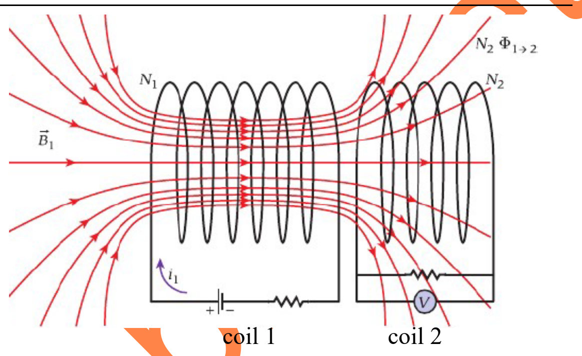
2) The figure shows the current through a $(10\ mH)$ inductor . What is the maximum potential difference induced in the coil over interval shown .



a) $20\,V$
b) $30\,V$
c) $40\,V$
d) $60\,V$

Mutual induction

It is a producing of potential difference in a coil when the current changes in another coil .



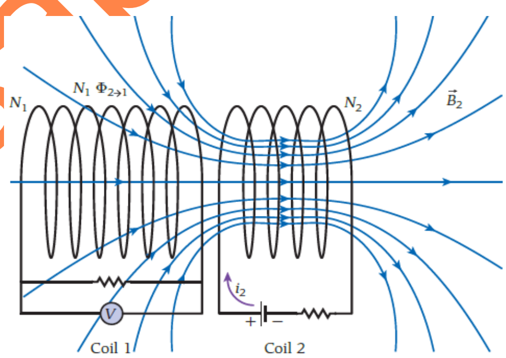
$$\Delta V_{ind,2} = -M\frac{d\,i_1}{d\,t} = -N_2\frac{d\,\phi_{1\to2}}{d\,t}$$

$$\Delta V_{ind,1} = -M\frac{d\,i_2}{d\,t} = -N_1\frac{d\,\phi_{2\to1}}{d\,t}$$

M : Mutual inductance (and its unit is henry)

The mutual inductance of coil 2 due to coil 1 $M_{1\to2} = \dfrac{N_2\,\phi_{1\to2}}{i_1}$

The mutual inductance of coil 1 due to coil 2 $M_{2\to1} = \dfrac{N_1\,\phi_{2\to1}}{i_2}$

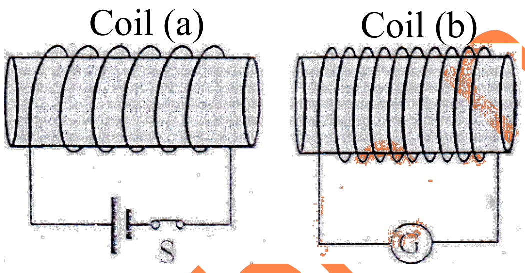


$$M_{1\to2} = M_{2\to1} = M$$

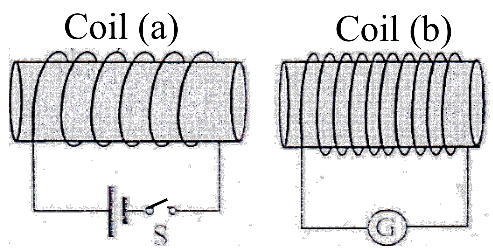
$$M = \mu_o N_1 n_2 A = \mu_o N_2 n_1 A$$

Q44) Determine the direction of the induced current in the coil (b) in the following cases .

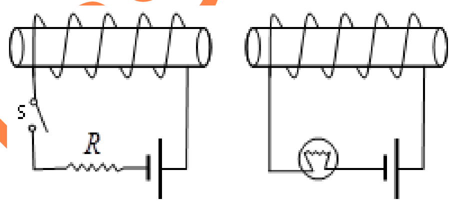
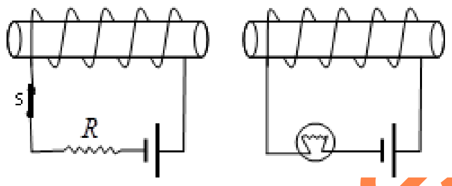
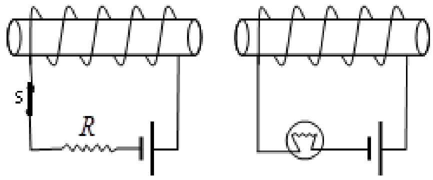
1) When the switch (S) is opened



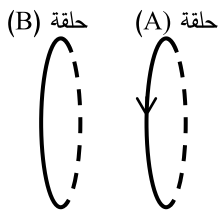
2) When the switch (S) is closed



Q45) what will happen to the bulb's lighting in the following cases :

1) when the switch is closed	2) when the resistance (R) is increased	3) when open the switch
		

Q46) Two adjacent loops as shown in the figure . The current in loop (A) decreases according to the equation $(i = 4.0e^{-2t})$.
At $(t = 0.6\,s)$ a potential difference of $(1.12\,V)$ induced in loop (B) :



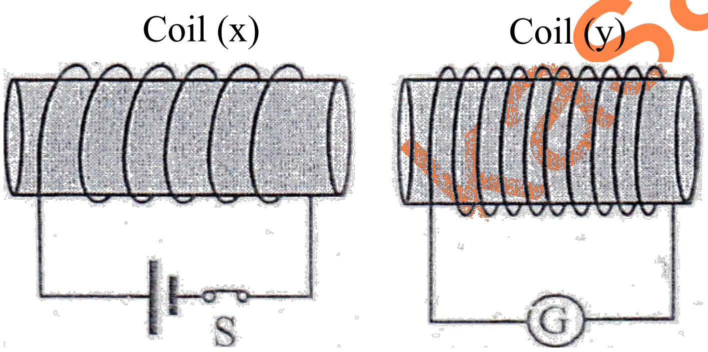
1) Determine the direction of the induced current in loop (B)

2) Calculate the mutual inductance between the loops ?

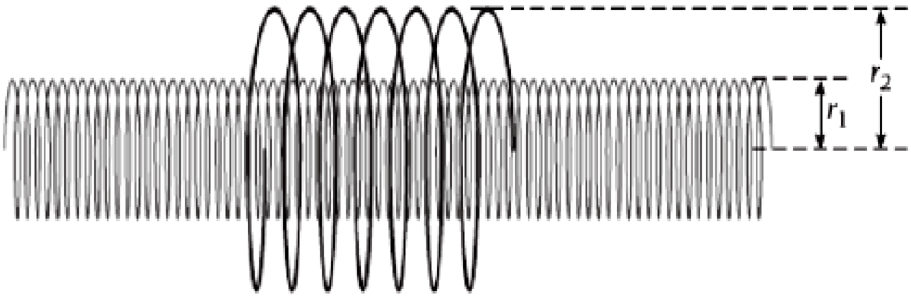
Q47) In the figure shown, when the switch (S) is opened , the current in the coil (x) decreases by a constant rate from $(1.0\,A)$ to zero during $(0.2\,s)$, if the mutual inductance between the two coils is $(0.3\,H)$:

1) Calculate the potential difference induced in the coil (y) through the decreasing of current in coil (x)

2) Calculate the self-induced potential difference in coil (x) which has an inductance of $(0.4\,H)$.



Q48) A long solenoid with a circular cross section of radius $(2.8\,cm)$ and (290 turns/cm) is inside and coaxial with a short coil that has a circular cross-section of radius $(4.9\,cm)$ and (31) turns . The current in the solenoid is increased at a constant rate from zero to $(2.8\,A)$ over a time interval of $(18\,ms)$.
Calculate the potential difference induced in the short coil while the current is changing ?

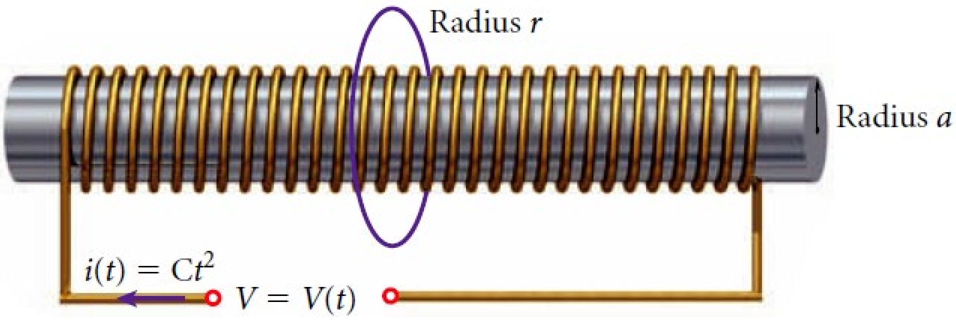


Q49) A solenoid with a circular cross-section of radius $(5.0\,cm)$ and (33150 turn/m), is surrounded by a circular coil of radius $(3.4\,cm)$ and (200) turns . If the current changed in the solenoid according to equation $(i = 0.6 + 1.44\,t^2)$. Calculate the induced potential difference in the circular coil at $(t = 2.0\,s)$?

Q50) A magnetic field inside the solenoid in the figure changes at the rate of $(1.50\ T/s)$. A conducting coil of (200) turns surround the solenoid as shown , the radius of solenoid is $(4.00\,cm)$ and the radius of conducting coil is $(7.00\,cm)$. Calculate the potential difference induced in the conducting coil .

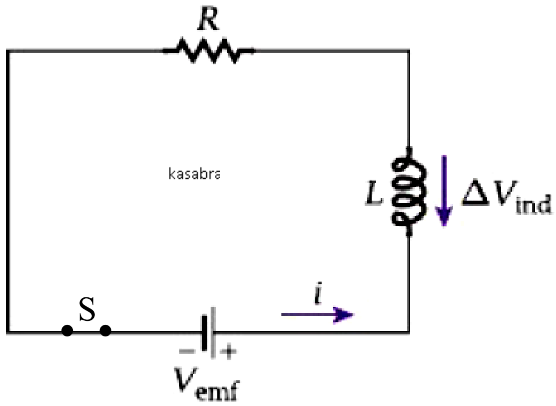
Q51) the current in a very long , tightly solenoid with radius (a) and (n) turns per unit length varies in time according to the equation $(i = C\,t^2)$, where C is a constant with appropriate units . Concentric with the solenoid is a conducting ring of radius (r) , as shown in the figure :
1) Write an expression for the potential difference induced in the ring .

2) Write an expression for the magnitude of the electric field induced at an arbitrary point on the ring .



RL circuits (lesson 9.8)

When the switch is closed, the increasing current flowing through the inductor creates a self-induced potential difference that tends to oppose the increase in current . As time passes the change in current decreases and the opposing self-induced potential difference also decreases . After a long time, the current reaches its final constant value.



$$V_{emf} = iR + L\frac{di}{dt}$$

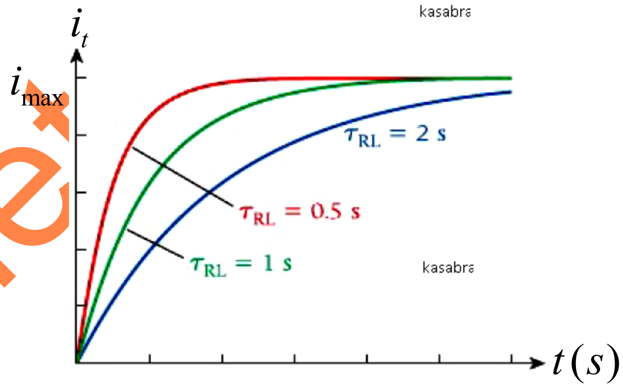
$$i_t = i_{\max}(1 - e^{-t/\tau})$$

Maximum final current : $i_{\max} = \dfrac{V_{emf}}{R}$

Time constant : $\tau = \dfrac{L}{R}$

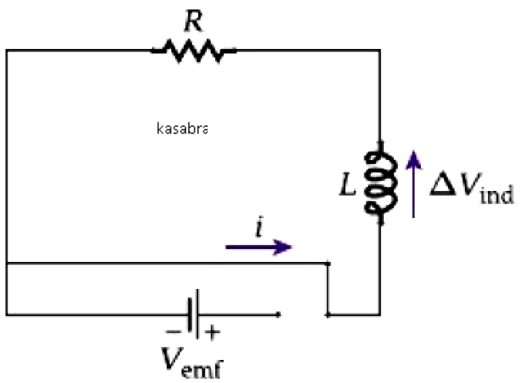
when the switch is closed $(t = 0)$: $i = 0$

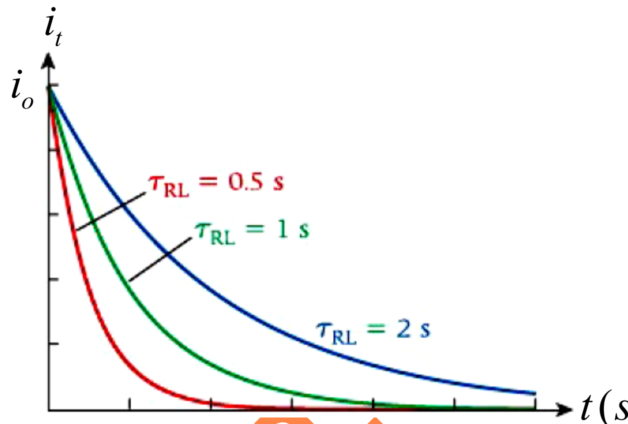
After a long time $(t = \infty)$: $i = i_{\max}$



When the battery suddenly removed as in the circuit shown in the figure :

The current decreases gradually until it reaches zero because the decreasing current in the inductor creates a self- induced potential difference that tends to oppose the decrease in current .



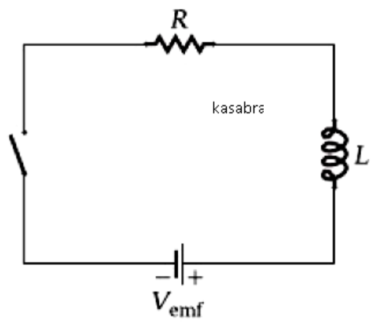


$$iR + L\frac{di}{dt} = 0$$

$$i_t = i_o\, e^{-t/\tau}$$

RL circuits can be used as a timers turn on devices at particular intervals .

Q52) An (RL) circuit with resistance $(1.0\,M\Omega)$ **and inductance** $(1.0\,H$ **which is powered by a** $(10\,V)$ **battery :**



1) What is the current immediately after the switch is closed ?

2) What is the current at $(2.0\,\mu s)$ **after the switch is closed ?**

3) What is the current a long time after the switch is closed ?

4) How long will the current in the circuit take to reach $(8.0\,\mu A)$ **?**

Q53) An (RL) circuit with resistance $(200\ \Omega)$ and inductance $(0.4\,H)$ which is powered by a $(50\,V)$ battery :

1) What is the potential difference across the inductor at $(t = 4.0\,ms)$.

2) What is the rate of current change at the moment when the current in the circuit is $(0.1\,A)$.

Q54) Choose the correct answer in the following :

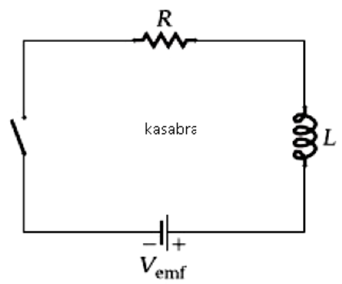
1) For an (RL) circuit with $(R = 21.8\ \Omega)$ and $(L = 55.9\,mH)$, how long does it take the current to reach (75%) of its maximum value ?

a) $1.87\,ms$ b) $5.34\,ms$ c) $2.15\,ms$ d) $3.55\,ms$

2) What is the resistance in an (RL) with $(L = 33\,mH)$ if the time required for the current to reach (75%) of its maximum value is $(3.35\,ms)$?

a) $7.13\ \Omega$ b) $13.7\ \Omega$ c) $17.3\ \Omega$ d) $137\ \Omega$

3) Consider the (RL) circuit shown in the figure . when the switch is closed, the current in the circuit increases exponentially to the maximum value $(i_{\max})$.



If the inductor is replaced with an inductor having three times the number of turns per unit length, what is the time required to reach a current of magnitude $(0.9\ i_{\max})$?

a) increases

b) decreases

c) stays the same

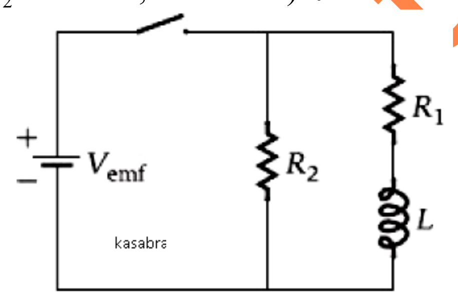
d) cannot be determined

4) An (RL) circuit with $(R = 3.25\ \Omega)$ and $(L = 440\,mH)$, when the current in the circuit is $(3.0\,A)$ the current is increasing at a rate of $(3.6\,A/s)$, what is emf of the battery ?

a) $36.7\,V$ b) $25.6\,V$

c) $11.3\,V$ d) $123\,V$

Q55) In the circuit shown in the figure, $(V_{emf} = 18\,V\ ,\ R_1 = 10\,\Omega\ ,\ R_2 = 6.0\,\Omega\ ,\ L = 5.0\,H)$:



1) Calculate each of the following immediately after the switch is closed :

a) the current through the battery

b) the current through (R_1)

c) the current through (R_2)

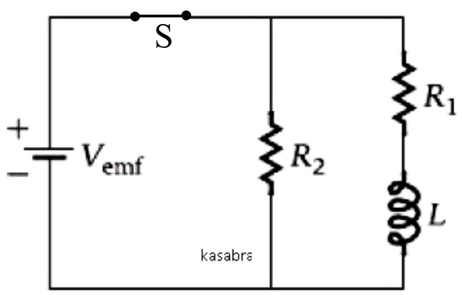
d) the rate of current change across (R_1)

2) Calculate the previous quantities a long time after the switch is closed .

3) Calculate the current in (R_1) and (R_2) at $(0.12\,s)$ after the switch is closed ?

Q56) In the circuit shown in the figure , $(V_{emf} = 9.0\,V\ ,\ R_1 = 60\,\Omega\ ,\ R_2 = 30\ \Omega\ ,\ L = 1.8\,H)$.

Suppose the switch is reopened a long time after it has been closed :



1) Calculate the current in (R_1) and (R_2) immediately after the switch is opened .

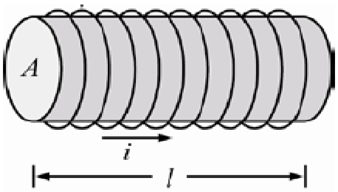
2) Calculate the current in (R_1) and (R_2) at $(0.03\,s)$ after the switch is opened .

3) How long will the current through the resistors take to reach $(0.05\,A)$?

Energy and Energy Density of a Magnetic Field (lesson 9.9)

The inductor is considered as a device that can store energy in a magnetic field .
The energy stored in the magnetic field of the inductor is :

$$U_B = \frac{1}{2}Li^2 = \frac{1}{2}(\mu_o n^2 A\ell)i^2$$



The instantaneous power of the inductor is :

$$P = (L\frac{di}{dt})i$$

Q57) Choose the correct answer in the following :

1) Along solenoid has a circular cross section of radius $(8.1cm)$, a length $(0.54m)$, and $(n = 2\times10^4 \, turns/m)$. The solenoid is carrying a current of magnitude $(4.04\times10^{-3}A)$. How much energy is stored in the magnetic field of the solenoid ?

a) $2.11\times10^{-7}J$ b) $4.57\times10^{-5}J$ c) $6.66\times10^{-3}J$ d) $8.91\times10^{-6}J$

2) If the current in a solenoid is doubled , then the energy stored in the solenoid :

a) decreases by a factor 4 b) increases by a factor of 2
c) increases by a factor of 4 d) remains the same

3) A long solenoid with length $(3m)$ and $(n = 290 \, turns/m)$ carries a current of $(3A)$. It stores $(2.8J)$ of energy . What is the cross-sectional area of the solenoid ?

a) $1.96m^2$ b) $2.3m^2$ c) $0.19m^2$ d) $0.96m^2$

4) A long solenoid with inductance $(1.2H)$ carries a current (i). It stores $(375J)$ of energy . What is current (i) in the solenoid?

a) $5.0A$ b) $25A$ c) $18A$ d) $1.8A$

5) A 100-turn solenoid of length $(8cm)$ and radius $(6mm)$ carries a current of $(0.4A)$ from right to left . The current is then reversed so that it flows from left to right . By how much does the energy stored in the magnetic field inside the solenoid change ?

a) $1.42\times10^{-6}J$ b) $2.84\times10^{-6}J$
c) $1.42\times10^{-2}J$ d) zero

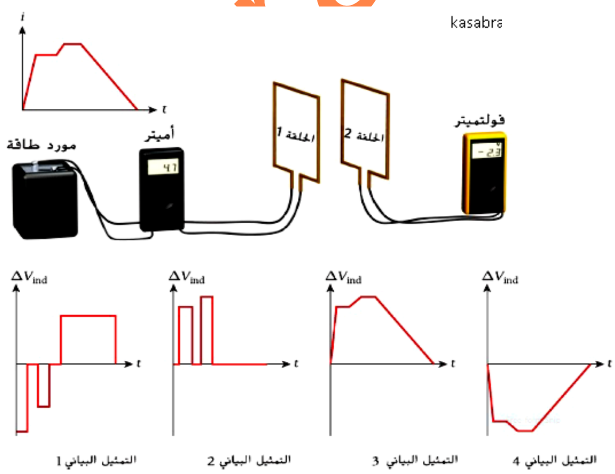
6) An emf of $(20V)$ is applied to a coil with an inductance of $(40mH)$ and resistance of (0.5Ω). What is the energy stored in the magnetic field when the current reaches $(\frac{1}{4})$ of its maximum value .

a) $2J$ b) $20J$ c) $4J$ d) $16J$

Questions from the exams of ministry

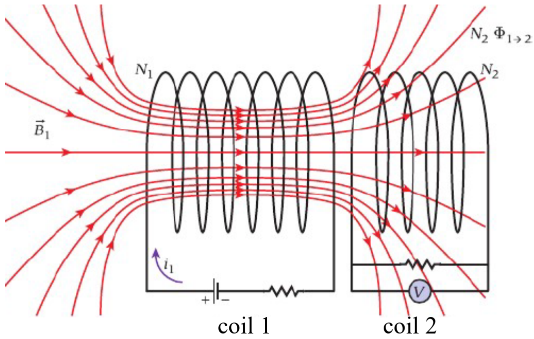
Q58) Choose the correct answer in the following :

1) A power supply is connected to loop (1) and an ammeter as shown in the figure . Loop (2) is close to loop (1) and is connected to a voltmeter . A graph of the current (i) through loop (1) as a function of time t , is also shown in the figure . Which graph best describes the induced potential difference in loop (2) as a function of time .



a) graph 1
b) graph 3
c) graph 2
d) graph 4

2) Depending on the figure What does symbol (z) represent in the equation $\left[\Delta V_{ind,2} = -z\frac{di_1}{dt}\right]$



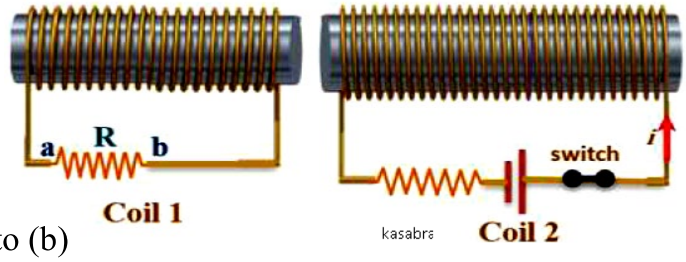
a) Mutual inductance between the two coils (M)

b) The inductance for coil (1) (L_1)

c) The inductance for coil (2) (L_2)

d) The turns for coil (1) (N_1)

3) Two coils are shown in the figure . Coil 2 has a current (i) flowing in the direction shown . When the switch in the circuit containing coil 2 is opened , what happens in coil (1) ?



a) A current is induced in it that flows in (R) from (a) to (b)

b) A current is induced in it that flows in (R) from (b) to (a)

c) No current is induced in coil (1)

d) A current is induced in it that flows in two directions (b) to (a) and (a) to (b)

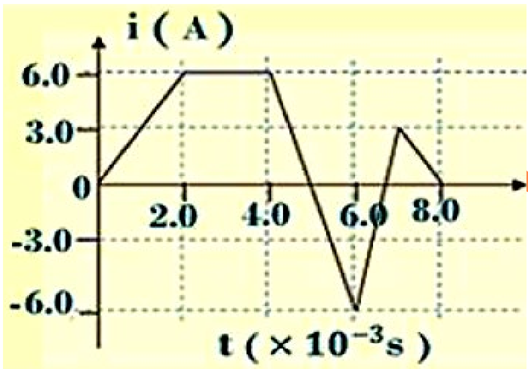
4) Which of the following is equivalent to henry (H) unit ?

a) $T\ m^2\ A$ b) $T\ m^2\ A^2$ c) $T\ m^2\ A^{-2}$ d) $T\ m^2\ A^{-1}$

5) A $(7.2\,mH)$ inductor is connected to a circuit with current passing through the inductor . What is the magnitude of the induced potential difference in the inductor at $(t = 3.0\,s)$, if the current varies with time as $(i = 5 + 7t - 2t^2)$:

a) $22\,mV$ b) $36\,mV$ c) $58\,mV$ d) $90\,mV$

6) The graph shows the current through a $(12\,mH)$ inductor . What is maximum potential difference induced in the inductor over the period shown .



a) $36\,V$

b) $72\,V$

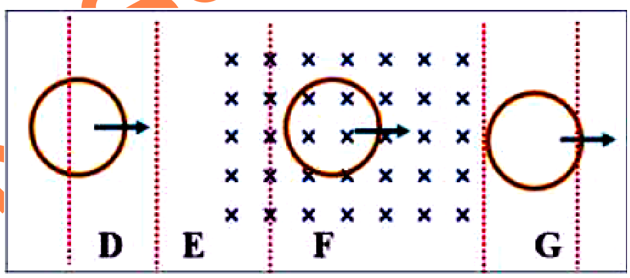
c) $108\,V$

d) $144\,V$

7) A (5) turns square loop whose side length $(0.2\,m)$ is placed in a magnetic field that makes an angle of (30^o) with the normal to the plane of the loop . The magnitude of this field varies with time as $(B = -2.0t^3)$, where (t) is measured in (s) and (B) in (T) . What is the magnitude of the induced potential difference in the loop at $(t = 2.0\,s)$?

a) $4.2\,V$ b) $2.8\,V$ c) $0.84\,V$ d) $2.4\,V$

8) A conducting ring is moving from left to right through a region that contains a constant magnetic field as shown in the figure . In which region there is an induced current in the ring ?



a) D b) E

c) F d) G

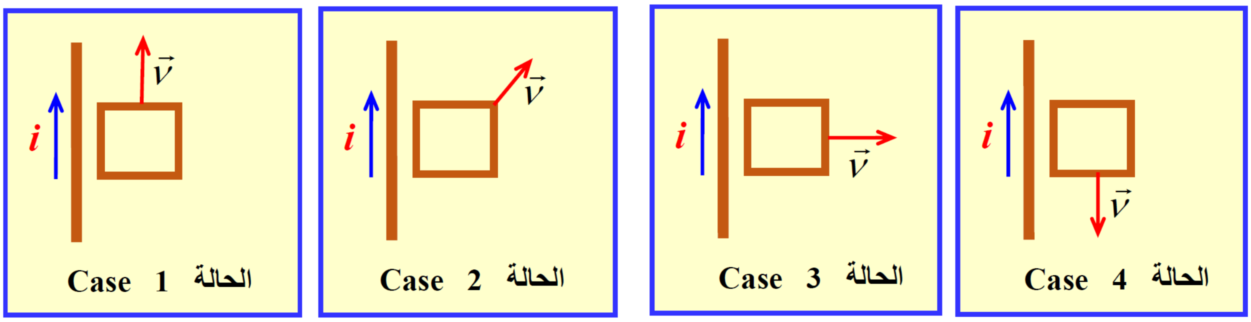
9) In the figure, the straight wire carries current (i) , and the wire moves at constant velocity $(\vec{v})$. In which case the loop will have the largest induced current ?

a) case 4

b) case 3

c) case 2

d) case 1



10) What is the unit for measuring inductance ?

a) Henry b) Volt c) Ohm d) Ampere

11) Which of the following statements is a law in physics that provides a rule for determining the direction of an induced current in a loop ?

a) Lenz's Law b) Newton's Third Law of Motion c) Ohm's Law d) Law of reflection

12) Faraday's law of induction states that a changing magnetic flux induces a potential difference . Which of the following equations best describes this law ?

a) $W = \oint \vec{F} . d\,\vec{s}$ b) $\phi_B = \iint \vec{B} . d\,\vec{A}$

c) $\Delta V_{ind} = -\dfrac{d\,\phi_B}{dt}$ d) $q = q_o e^{-t/\tau}$

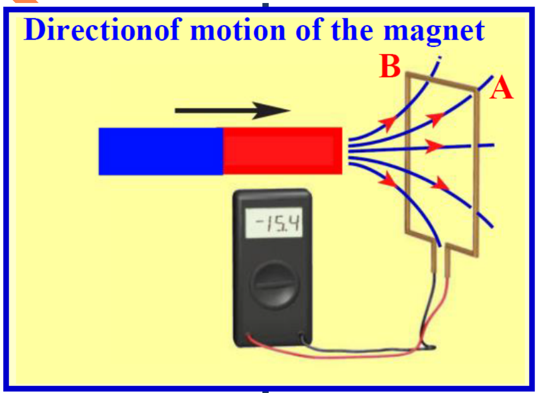
13) In the shown figure , moving the magnet toward the wire loop induces current in the loop . What is the direction of the current in the upper segment of the loop ?

a) Normal to the plane of the loop .

b) Can be in any direction

c) From point (A) to (B)

d) From point (B) to (A)



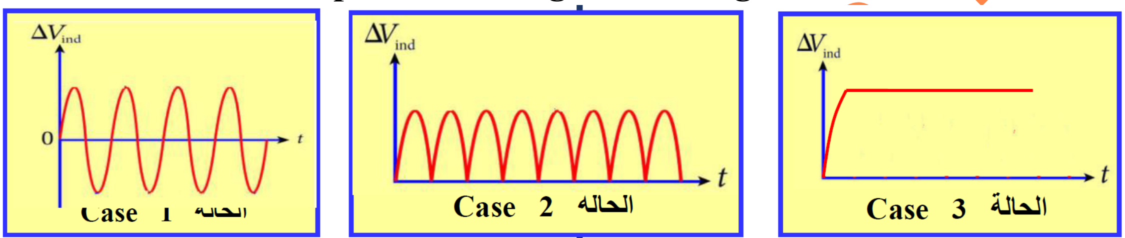
14) A generator is operated when a coil of (N) turns is rotated inside a constant magnetic field (B) at a frequency (f). Which of the following curves shows the induced potential difference as a function of time for a simple alternating – current generator ?

a) case 3

b) case 1

c) case 1 and case 3

d) case 2



15) Consider a current of $(200\,mA)$ passing in a solenoid of length $(30\,cm)$, cross-sectional area $(2\times10^{-4}\,m^2)$, and a number of turns (3000).

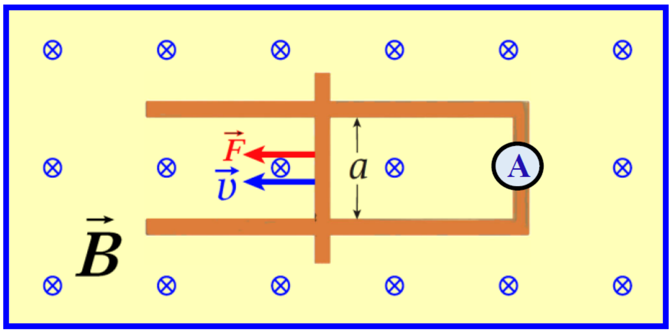
What is the self-inductance of the solenoid ?

a) $7.5\,mH$ b) $6.0\,mH$ c) $3.5\,mH$ d) $20\,mH$

16) The magnetic flux through a wire loop is varying with time according to the equation $(\phi_B = -2t^2)$. what is the induced potential difference in the loop at $(t = 3s)$

a) $12\,V$ b) $-18V$ c) $-12\,V$ d) $18\,V$

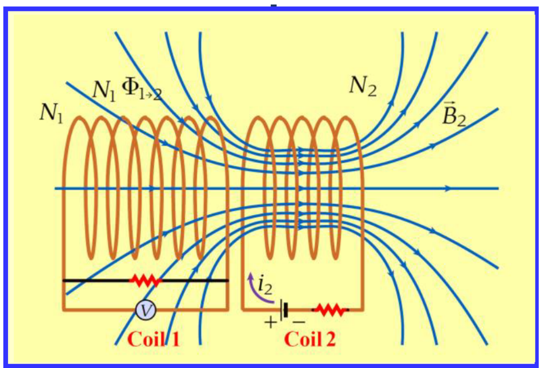
17) In the figure shown , a conducting wire is pulled along a conducting rail with a velocity of $(5\,m/s)$**, if the magnitude of the magnetic field is** $(2T)$ **and the resistance to the passing current is** (20Ω)**. What is the current that the Ammeter reads knowing that the width of the rail** $(20cm)$**?**



a) $1A$ b) $0.5A$

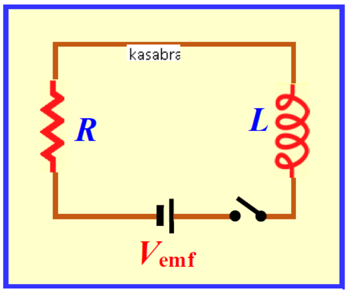
c) $0.1A$ d) $1.2A$

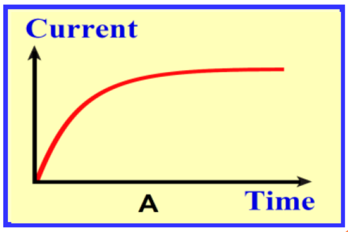
18) In the figure , the current (i_2) **in coil (2) has increased from zero to** $(2A)$ **in a time period of** $(50\,ms)$**. The self-inductance for coil (1) is** $(0.02H)$ **, for coil (2) is** $(0.08H)$ **and the mutual inductance between the two coils is** $(0.04H)$**. What is the induced potential difference in coil (1) ?**

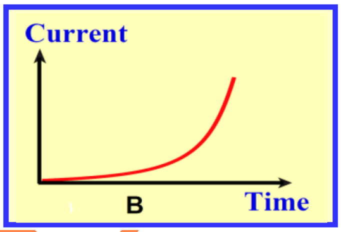


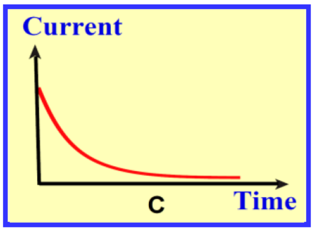
a) $-0.04V$ b) $-0.08V$ c) $1.0V$ d) $-1.6V$

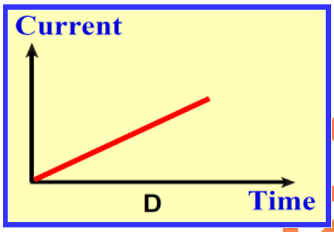
19) A battery , inductor and the resistor are connected in series as shown in the figure . When the switch is closed , the current flows in the circuit . Which one of the following curves represents the current flowing in the circuit as a function of time when the switch is closed ?









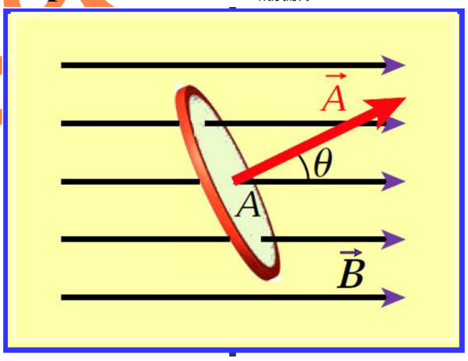


a) A b) B c) C d) D

20) Faraday's law of induction states that a changing magnetic flux induces electric field . Which of the following equations best describes this law ?

a) $F = m\,a$ b) $E = \dfrac{k\,q}{r^2}$ c) $\oint \vec{E}.d\vec{s} = -\dfrac{d\phi_B}{dt}$ d) $F = q\,E$

21) Consider the flat loop of area (A) **placed in a constant magnetic field** $(\vec{B})$ **as shown in the figure . The magnetic field makes an angle** $(\theta = 30^o)$ **with the area normal vector. What can we do to increase the magnetic flux through the loop ?**



a) Rotate the loop such that area normal vector $(\vec{A})$ becomes perpendicular to $(\vec{B})$

b) Rotate the loop such that area normal vector $(\vec{A})$ makes angle $(\theta = 45^o)$ with $(\vec{B})$

c) Reduce the magnitude of the magnetic field $(\vec{B})$

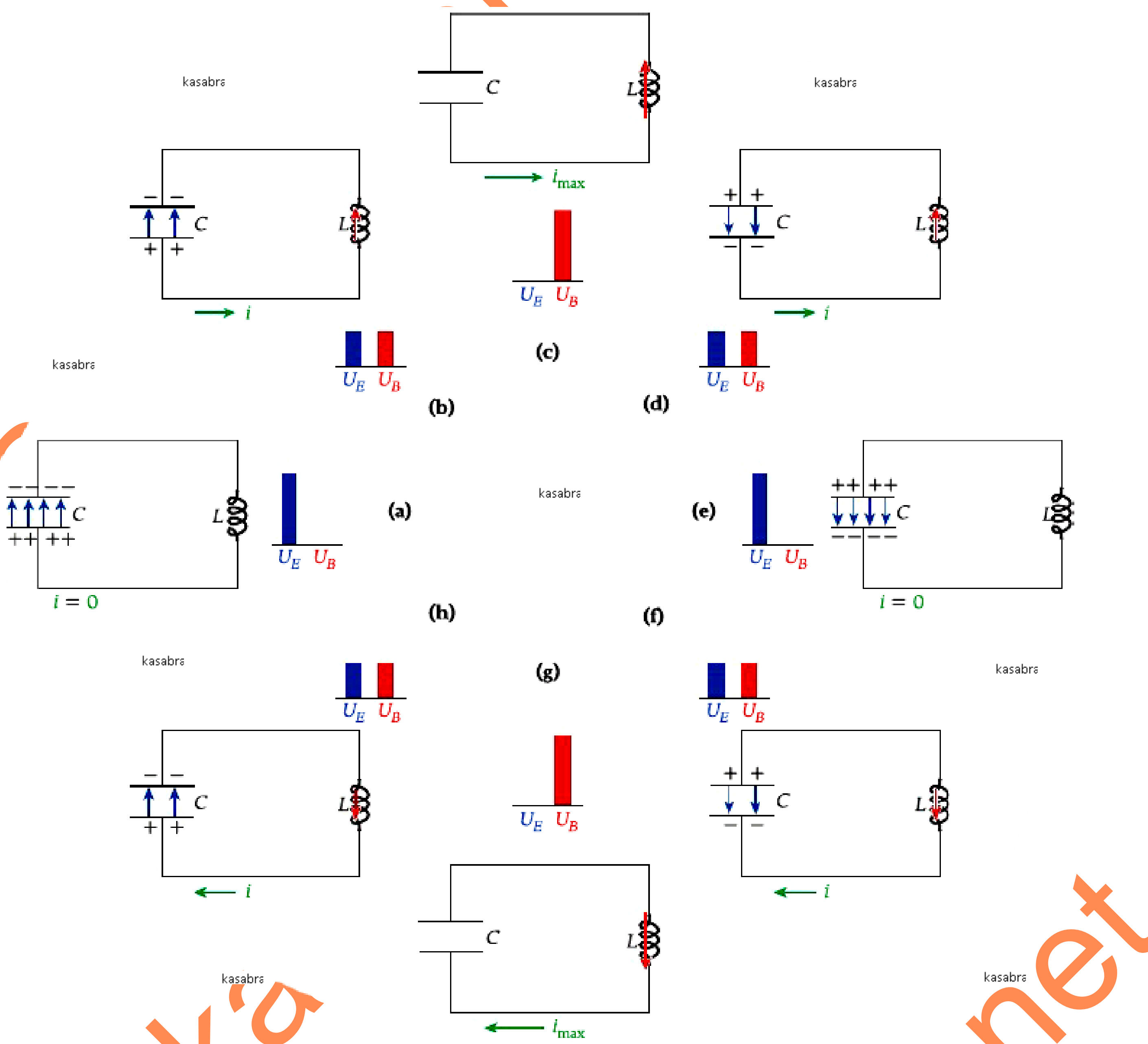
d) Rotate the loop such that area normal vector $(\vec{A})$ becomes parallel to $(\vec{B})$

انتهت الوحدة

نهاية

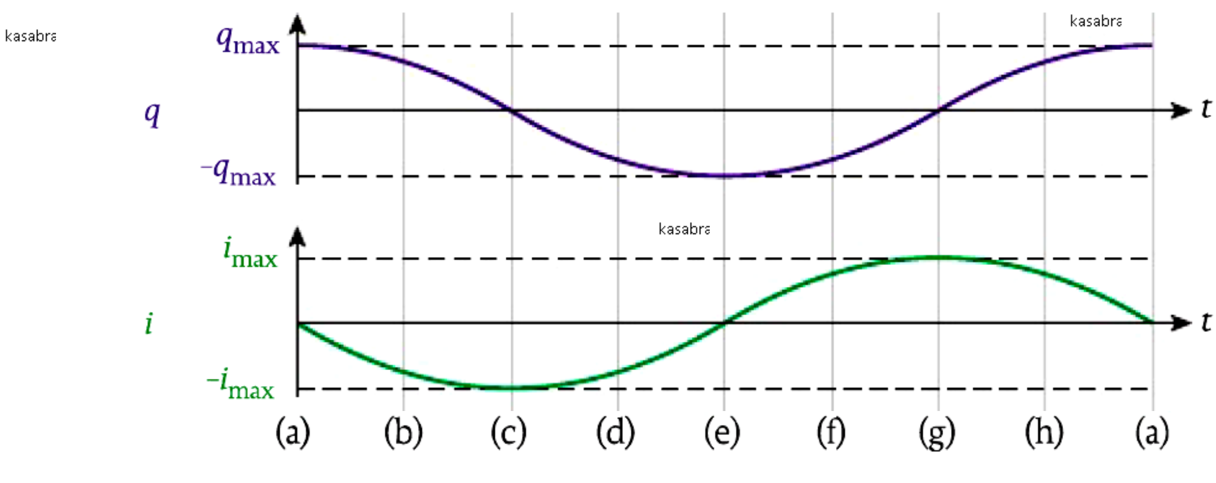
الوحدة

LC circuits (Lesson 10.1)



* The current , voltage , charge , electric field, and magnetic field in (LC) circuits all vary sinusoidally with time .

* The variations of voltage and current in LC circuit are called **electromagnetic Oscillations**



* The energy stored in the electric field of a capacitor (or the electric energy) is :

$$U_E = \frac{1}{2}\frac{q^2}{C}$$

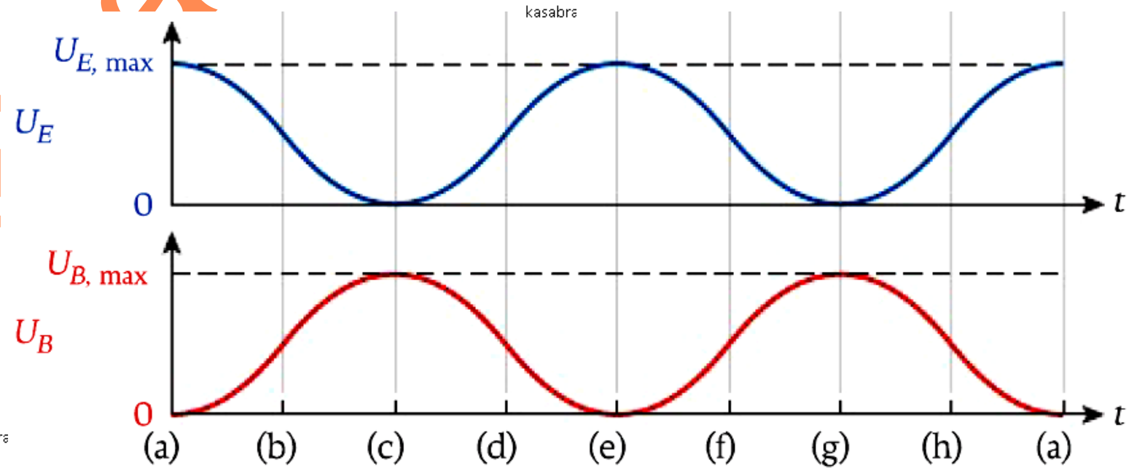
C : the capacitance of the capacitor $\quad$ q : the capacitor's charge

* The energy stored in the magnetic field of an inductor (or the magnetic energy) is :

$$U_B = \frac{1}{2} L i^2$$

L : the inductance

* The electric energy (U_E) and the magnetic energy (U_B) vary between zero and their respective maximum values as a function of time due to the changes in the charge and current .



* The maximum value of the energy stored in the electric field of a capacitor is :

$$U_{E,\max} = \frac{1}{2}\frac{q^2_{\max}}{C}$$

* The maximum value of the energy stored in the magnetic field of an inductor is :

$$U_{B,\max} = \frac{1}{2} L i^2_{\max}$$

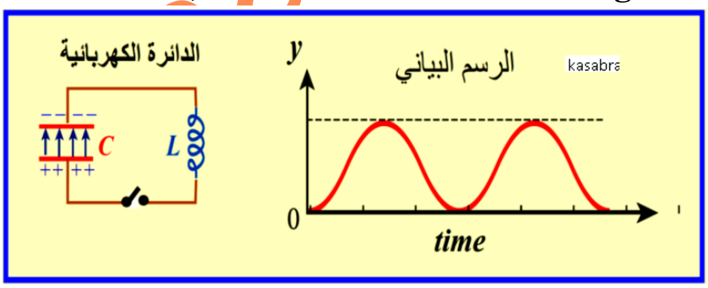
* The total energy stored in the (LC) circuit is :

$$U_T = U_{E,\max} = U_{B,\max}$$

* By neglecting the resistance of the circuit , the total energy stored in the circuit remains constant and the circuit continues to oscillate indefinitely .
* The real (LC) circuits does not oscillate indefinitely , instead the oscillations die away with time because of small resistance in the circuit or electromagnetic radiation .

Q1) Choose the correct answer in the following :

1) When the switch of the circuit in the figure is closed , the current and the voltage in the circuit oscillate over time . What is the physical quantity represented by the y-axis in the graph ?

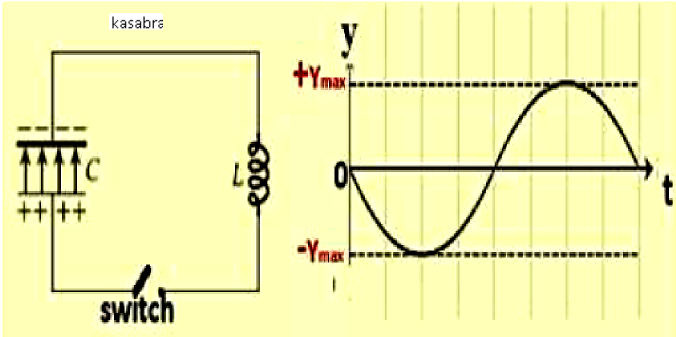


a) the charge
b) the current
c) the energy stored in the electric field
d) the energy stored in the magnetic field

2) In the previous circuit which of the following are true with respect to the capacitor voltage ?

a) Maximum when the current is maximum .
b) Maximum when the magnetic energy is maximum .
c) Maximum when the current is zero .
d) All of above

3) When the switch of the circuit in the figure is closed , the current and the voltage in the circuit oscillate over time . What is the physical quantity represented by the y-axis in the graph ?

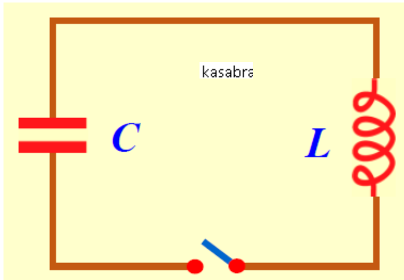


a) the charge
b) the current
c) the energy stored in the electric field
d) the energy stored in the magnetic field

4) Which statement about the phase relation between the electric field and the magnetic field in an (LC) circuit is correct ?

a) When one field is at maximum , the other is also at maximum value .
b) When one field is at maximum , the other is at minimum value (zero) strength .
c) The Phase relation in general depends on the values of L and C
d) None of the above

5) In the figure , the charged capacitor and the inductor are connected through a switch as shown . Initially the charge on the capacitor is $(q_{\max} = 2C)$ **.**
As the switch is closed, current flows in the circuit and the charge on the capacitor changes with time . Which of the following equations represents charge on the capacitor as a function of time $q_{(t)}$ **?**

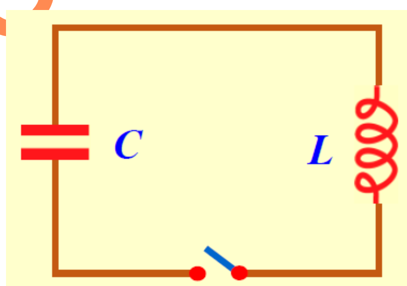


a) $q_{(t)} = q_{\max}$ b) $q_{(t)} = 5q_{\max}$
c) $q_{(t)} = q_{\max} \times t$ d) $q_{(t)} = q_{\max}\cos(3t)$

6) In the circuit shown in the previous question . As the switch is closed, current flows in the circuit . Which of the following statement is correct about the current in the circuit ?

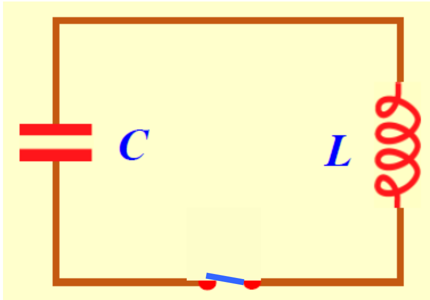
a) Current is maximum when the capacitor is fully charged
b) Current is maximum when the magnetic energy is minimum
c) Current is minimum when the magnetic energy is maximum
d) Current is maximum when the capacitor is empty of charge

7) A circuit contains a capacitor with $(C = 1.5\,\mu F)$ **and an inductor with** $(L = 3.5\,mH)$ **as shown in the figure . the capacitor is fully charged using a (12 V) battery and then connected to the circuit .**
What is the total energy stored in the circuit ?



a) $1.08\times10^{-4}\,J$
b) $2.1\times10^{-4}\,J$
c) $1.1\times10^{-2}\,J$
d) $8.1\times10^{-4}\,J$

Q2) The LC circuit shown in the figure has a $(4.0\,\mu F)$ capacitance , a $(7.0\,mH)$ inductance and a $(3.0\,A)$ maximum current :



1) What is the maximum charge on the capacitor ?
2) What is the total energy stored in the circuit ?
3) What is the energy stored in the electric field of the capacitor when the current in the circuit equals $(1.0\,A)$
4) What is the current in the circuit when the charge on the capacitor is $(3\times10^{-4}\,C)$

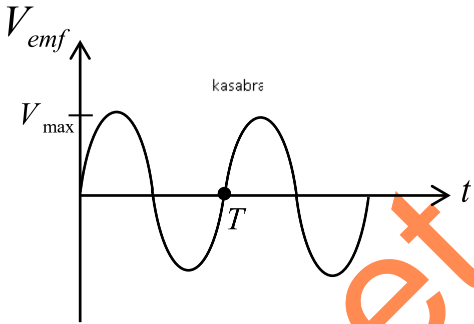
Q3) The total amount of energy stored in an (LC) series circuit is $(8.0\,J)$.
1) How much energy is stored in the magnetic field when the current through the inductor is equal to half its maximum value $(\frac{I_m}{2})$?
2) How much energy is stored in the magnetic field when the charge on the capacitor is equal to half its maximum value $(\frac{q_{max}}{2})$?
3) How much energy is stored in the electric field when the current through the inductor is equal to one fourth its maximum value $(\frac{I_m}{4})$?

درس 10.2 و درس 10.3 محذوفان

Driven AC Circuits (Lesson 10.4)

Alternating Driven emf

It is an emf varies with time as a sinusoidal function .



$$V_{emf} = V_{max} \sin \omega t$$

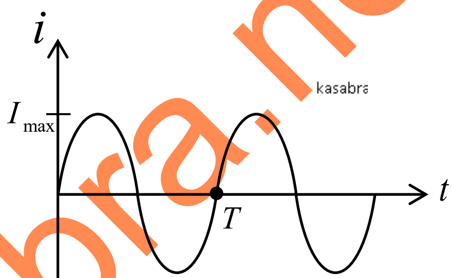
V_{max} : The maximum value of emf (Peak or Amplitude)
ω : angular frequency or angular velocity (The unit is rad/s)

$$\omega = 2\pi f = \frac{2\pi}{T}$$

f : The frequency (The unit is Hz) T : the period

Alternating current (AC) :

It is a current varies with time as a sinusoidal function .



$$i = I_{max} \sin(\omega t - \phi)$$

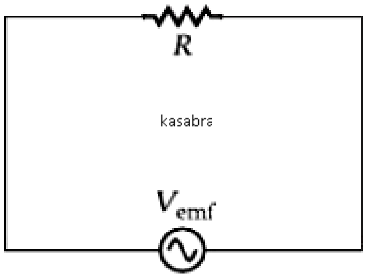
I_{max} : The maximum current (Amplitude) ϕ : phase constant .

Q4) If the equation for alternating current in an electric circuit is given by the equation

$$i = 5\sin(10\pi t + \frac{\pi}{2})$$

1) What is maximum value of the current passing through the circuit ?
2) What is the current's frequency ?
3) What is the period ?
4) What is the phase constant between the voltage and the current ?
5) What is the value of the current at the moment $(t = 0.14\,s)$?

Circuit with a Resistor

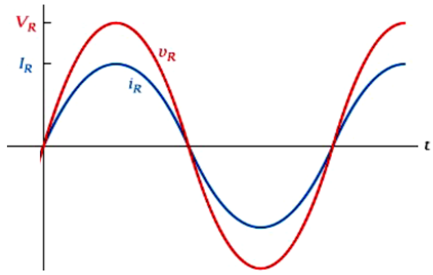


* The current and the voltage in the circuit vary sinusoidally with time .
* The current and the voltage across the resistor are in phase . $\phi = 0$
* The phase difference between the current and the voltage across the resistor is zero

$$i_R = I_R \sin \omega t$$

i_R : The current value at any instant of time

I_R : The maximum current in the resistor .



$$v_R = V_R \sin \omega t$$

v_R : The voltage drop across the resistor at any instant of time .

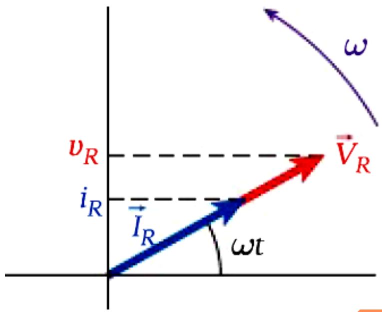
V_R : The maximum voltage drop across the resistor .

$$I_R = \frac{V_R}{R}$$

R : does not depend on the current's frequency .

The phaser

It is a counterclockwise – rotating vector (with its tail fixed at the origin) whose projection on vertical axis represents the sinusoidal variation of the particular quantity in time .

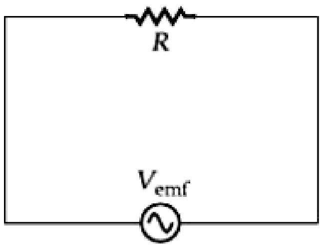


* The phaser of the time - varying current is : $\vec{I}_R$
* The phaser of the time - varying voltage is : $\vec{V}_R$
* The shown figure represents the phasers of the current and the voltage across the resistor .

Q5) A (20Ω) resistor is connected with a time-varying emf has a maximum voltage of $(50V)$ and frequency of $(30Hz)$:

1) Calculate the maximum value of the current in the circuit .

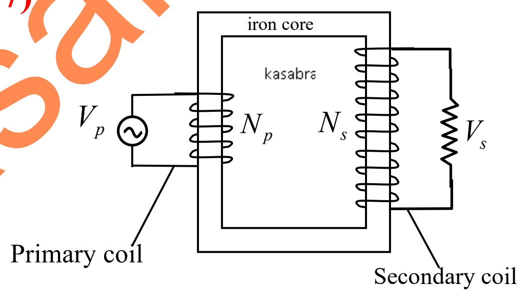
2) Write the equation of current as a function of time .



في درس 10.4 موضوع (دائرة مكثف) وموضوع (دائرة محث نقي) + درس 10.5 + درس 10.6 كلها محذوفة

Transformers (Lesson 10.7)

It is a device used to raise or lower the alternating voltage .



Its components

1) Iron core (make both the primary and secondary coils experience the same changing magnetic flux)

2) * Primary coil (P) . It is connected to the source of emf .

* Secondary coil (S) . It is connected to the resistor .

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

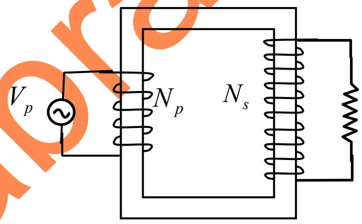
The transformer only works on AC current and doesn't work on direct current . Why ?

The alternating current in the primary coil creates a change in magnetic flux in the secondary and so it generates an induced voltage, but the direct current creates a constant magnetic flux in the secondary, so that no induced voltage is generated .

Types of Transformer

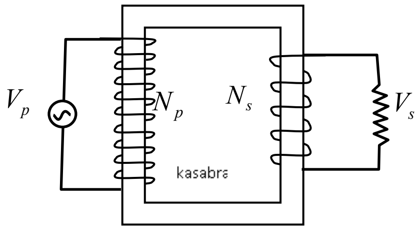
1) Step-up Transformer :

It changes the voltage from lower to higher values . $(V_s \succ V_p \ , N_s \succ N_p)$



2) Step-down Transformer :

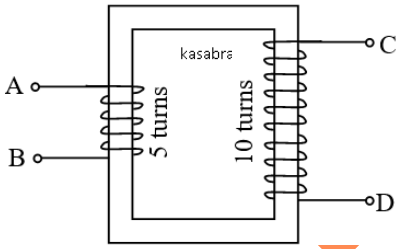
It changes the voltage from higher to lower values . $(V_s \prec V_p \ , N_s \prec N_p)$



Q6) The figure shows a schematic diagram of a transformer .

1) If you want to use this transformer to operate a $(20V)$ **AC electrical appliance by using a** $(10V)$ **AC voltage source , which two terminals of the transformer connect the device to ?**

2) If a $(10V)$ **battery is connected between terminals (C) and (D) then a voltmeter is connected between the two terminals (A) and (B) , how much will be the voltmeter reading ?**



The power in the primary coil : $P_p = I_P V_P$

The power in the secondary coil : $P_S = I_S V_S$

By neglecting the loss of energy : $P_p = P_s$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

* The step-up transformer raises the voltage and lowers the current

$$(N_s \succ N_p \ , \ V_s \succ V_p \ , \ I_s \prec I_p)$$

* The step-down transformer lowers the voltage and raises the current

$$(N_s \prec N_p \ , \ V_s \prec V_p \ , \ I_s \succ I_p)$$

The reasons of the dissipated power in the transformers

1) Loss of magnetic flux .

Part of magnetic flux produced by the primary coil does not reach to the secondary coil .

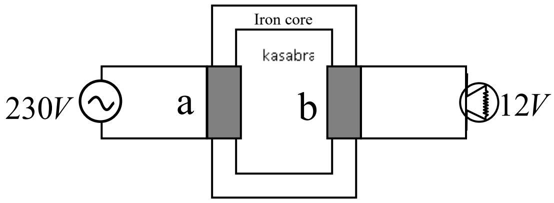
2) Currents induced in an iron core (eddy currents)

To counter this effect transformer cores are constructed by laminating layers of metal .

Q7) Transformers are used to obtain the appropriate voltage to operate the devices

1) What type of transformer is shown in the figure .
Explain your answer

2) Which of the two coils has the lowest number of turns ?



3) Which of the two coils has the lowest current ?

4) A student replaced the AC power supply with a powerful battery .
Describe what happens to the brightness of the lamp .

Q8) A transformer has (800) turns in the primary coil and (40) turns in the secondary coil , if the AC voltage across the primary coil is $(100\,V)$ and the current in the primary coil is $(5.0\,A)$, then answer the following

1) Calculate the output voltage . (voltage across the secondary coil) .
2) Calculate the output current . (current through the secondary coil) .
3) Calculate the power of the primary coil .

Q9) A transformer contains a primary coil with (200) turns and a secondary coil with (120) turns . The secondary is connected with a $(1.0\,K\Omega)$ resistor . If an input voltage $(75\,V)$ is applied across the primary coil :

1) What is the power dissipated in the resistor ?
2) What is the effective resistance of the primary circuit ?

Q10) Choose the correct answer in the following :

1) The number of turns of the transformer coils is $(240, 60)$, if used as a step-up transformer , then the output voltage will be ....

a) 4-times the input voltage b) quarter the input voltage
c) 2-times the input voltage d) half the input voltage

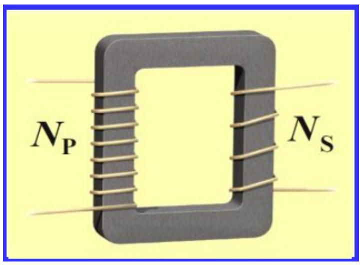
2) A transformer operates on an AC voltage of $(220\,V)$, the number of turns of one of its coils is (1800) turns and the other is (450) turns . If the transformer is used as a step-down transformer , then what is the output voltage .

a) $450\,V$ b) $880\,V$
c) $55\,V$ d) $110\,V$

3) A transformer has (20) turns in primary coil and (30) turns in secondary coil , what is the voltage across the secondary coil if the primary coil connect to a battery of $(12\,V)$ voltage ?

a) $18\,V$ b) $12\,V$
c) $8\,V$ d) $0.0\,V$

4) The figure shown a step – down transformer , where $(N_p = 8)$, $(N_s = 4)$ and the primary coil is connected to a source such that $(V_p = 220\,V)$.
What is the output voltage of the secondary coil ?



a) 220 V b) 110 V
c) 2.0 V d) 440 V

5) A transformer has (800) turns in the primary coil and (40) turns in the secondary coil . If the primary DC current is $(5A)$, what is the output current ?

a) $100A$ b) $0.25A$

c) $20A$ d) zero

6) A transformer has (800) turns in the primary coil and (40) turns in the secondary coil . If the primary AC current is $(5A)$, what is the output current ?

a) $100A$ b) $0.25A$

c) $20A$ d) zero

7) A transformer with (50) turns in its primary coil and (10) turns in its secondary coil is designed to deliver a power of $(1200W)$ with a voltage of $(60V)$. What is the current in the primary coil ?

a) $4A$ b) $100A$

c) $20A$ d) $5A$

Some uses of the transformers

1) Impedance matching to transmit power more efficiently as it does in a loudspeakers and Amplifiers .

The amplifier has high impedance and consider the power source, but the speakers have low impedance and consider the resistor .

2) Raise the voltage in the generating stations in order to reduce the lost power in the transmission lines . (Raising the voltage reduces the current in the transmission lines)

The transmitted power from the station : $P_{sent} = iV$

The dissipated power in the transmission lines : $P_{lost} = i^2 R$

Q11) Choose the correct answer in the following :

1) A high-volage current transmission lines transmit $(500MW)$ of power at a potential difference of $(350KV)$. If the resistance of the power lines is (50Ω), what is the power dissipated in the transmission lines ?

a) $102MW$ b) $72MW$

c) $201MW$ d) $36MW$

2) **The transmission of electric power occur at the highest possible voltage to reduce losses . By how much could the power loss be reduced by raising the voltage by a factor of (10)**

a) 10 b) 100

c) $\frac{1}{10}$ d) $\frac{1}{100}$

3) To reduce the dissipated power in the transmission lines, the transmitted electrical power should have :

a) high voltage and high current

b) high voltage and low current

c) low voltage and high current

d) low voltage and low current

درس 10.8 محذوف

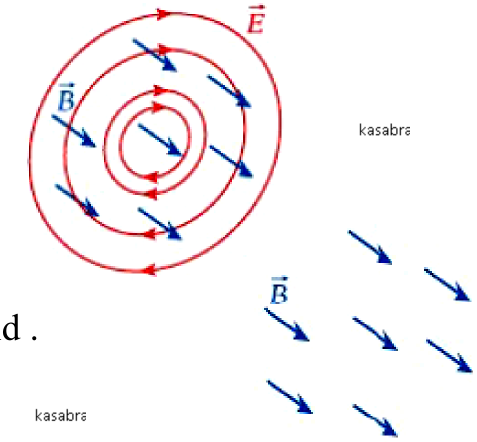
انتهت الوحدة

نهاية
الوحدة

Maxwell's Law of Induction for Induced Magnetic Fields (Lesson 11.1)

Faraday's Law of Induction :

$$\oint \vec{E}.d\,\vec{s} = -\frac{d\,\phi_B}{d\,t}$$



* The time-varying magnetic flux induces an electric field in a loops around the magnetic field lines .
* OR : The time-varying magnetic field induces an electric field in a loops around the magnetic field lines .
* The constant magnetic flux does not induce any electric field .
* The direction of $(\vec{E}_{ind})$ is the same direction of (i_{ind}) that determine by Lenz's Law .

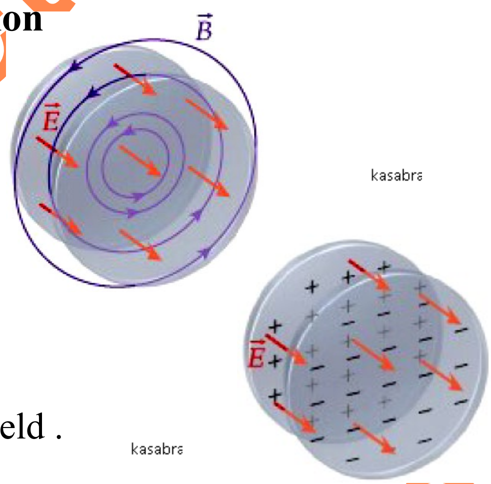
Q1) The current flowing in a solenoid that is long $(20.0\,cm)$ and a radius of $(2.0\,cm)$ and (500) turns decreases from $(3.0\,A)$ to $(1.0\,A)$ in $(0.1\,s)$.

1) Calculate the induced electric field inside the solenoid $(1.0\,cm)$ from its center .

2) Calculate the induced electric field inside the solenoid $(3.0\,cm)$ from its center .

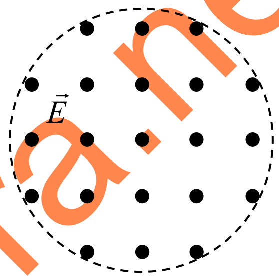
Maxwell's Law of Induction

$$\oint \vec{B}.d\,\vec{s} = \mu_o \varepsilon_o \frac{d\phi_E}{dt}$$



* The time-varying electric flux induces a magnetic field in a loops around the electric field lines .
* OR : The time-varying electric field induces a magnetic field in a loops around the electric field lines .
* The constant electric flux does not induce any magnetic field .

Q2) An electric field is directed perpendicular to a circular planer surface with radius $(6.0\,cm)$. If the electric field increases at a rate of $(10\,V\ /m.s)$,

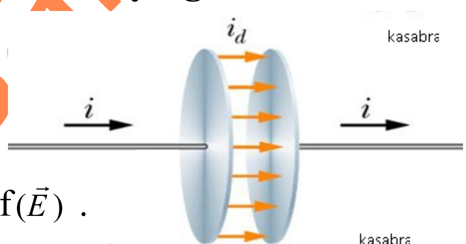


1) Calculate the induced magnetic field at a radial distance $(4.0\,cm)$ away from the center of the circular area .

2) Calculate the induced magnetic field at a radial distance $(10\ cm)$ away from the center of the circular area .

Displacement current i_d is a current produced by the time-varying electric field .

$$i_d = \varepsilon_o \frac{d\phi_E}{dt} = \varepsilon_o A \frac{dE}{dt}$$



The direction of the displacement current i_d

* If $(\vec{E})$ increases, the direction of i_d is in the same direction of $(\vec{E})$.
* If $(\vec{E})$ decreases, the direction of i_d is in the opposite direction of $(\vec{E})$.

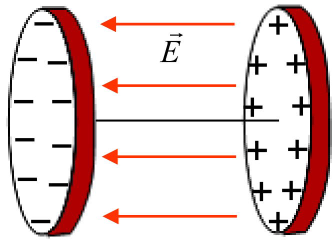
Displacement current is not caused by the movement of actual charges like conventional (or conduction) current (i). **In the figure :** $[i = i_d]$

Q3) A parallel plate capacitor has circular plates of radius $(10\,cm)$ as shown in the figure . What is the displacement current between the plates in the following cases :

1) When the electric field is increased at a constant rate of $(6.0\times10^{6}\,V/m.s)$.

2) When the electric field is decreased at a constant rate of $(3.0\times10^{4}\,V/m.s)$.

3) When the electric field is decreased according to the equation $(E=10^{4}-10^{3}\,t)$



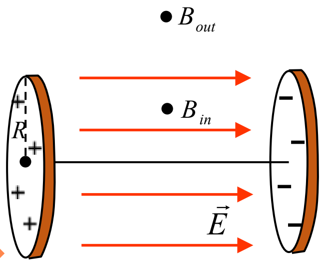
Calculating the magnetic field between the two circular plates of the capacitor

$$B_{out}=\frac{\mu_o\, i_d}{2\pi r}\quad ,\quad r\succ R$$

r : distance between the point and the center .

$$B_{in}=\frac{\mu_o\, i_d\, r}{2\pi R^2}\quad ,\quad r\prec R$$

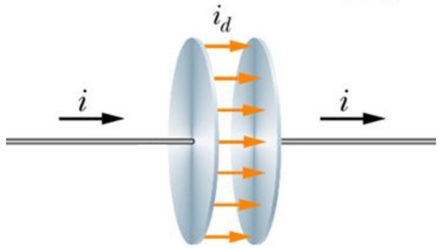
R : the radius of the capacitor plates .



Q4) In the figure shown , a wire with a variable current is connected to a parallel plate capacitor with circular plates of radius $(4.0\,cm)$. When the current in the wire is $(20\,A)$,What is the induced magnetic field due to the changing electric field in the following cases :

1) at a point that is a radial distance of $(1.0\,cm)$ from the center of the parallel plates .

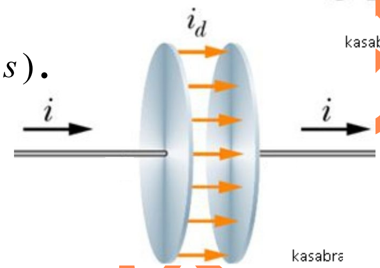
2) at a point that is a radial distance of $(5.0\,cm)$ from the center of the parallel plates .



Q5) A parallel plate capacitor has circular plates of radius $(10\,cm)$ that are separated by a distance of $(5\,mm)$ as shown in the figure . the potential across the capacitor is increased at a constant rate of $(1.2\,KV/s)$.

1) Calculate the magnetic field between the plates at a distance $(4.0\,cm)$ from the center .

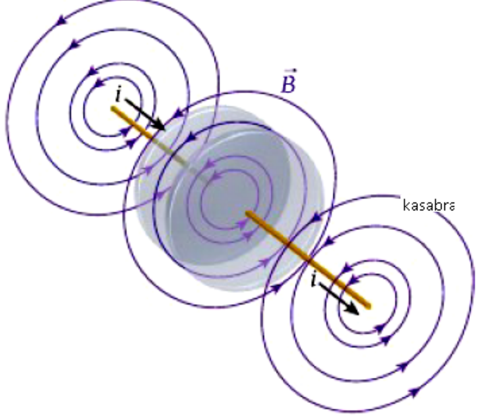
2) Calculate the magnetic field between the plates at a distance $(12\,cm)$ from the center .



Ampere's Law

$$\oint \vec{B}.d\,\vec{s}=\mu_o i_{enc}$$

B : the magnetic field due to the conventional (or conduction) current i_{enc}



The Maxwell-Ampere Law

$$\oint \vec{B}.d\,\vec{s}=\mu_o\varepsilon_o\frac{d\,\phi_E}{dt}+\mu_o i_{enc}$$

$$OR\quad \oint \vec{B}.d\,\vec{s}=\mu_o\,(i_d+i_{enc})$$

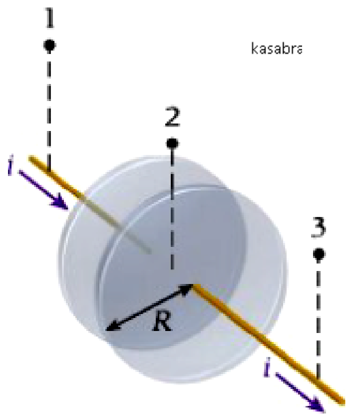
The Maxwell-Ampere Law describes two different sources of magnetic field :

1) The conventional current (or the conduction current)

2) The time-varying electric flux (or the displacement current)

Q6) Choose the correct answer in the following :

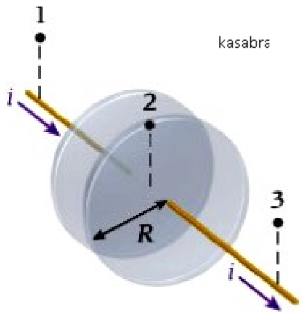
1) In the figure shown, the displacement current for the charging capacitor is equal to the conduction current in the wires . The points 1 , 2 , and 3 are located at the same perpendicular distance (r) from the center of the capacitor , such that $(r \succ R)$. Rank the magnetic fields at the three points from the largest magnitude to the smallest .



a) $B_1 = B_3 \prec B_2$ b) $B_1 = B_3 \succ B_2$

c) $B_1 = B_3 = B_2$ d) $B_1 \succ B_3 \succ B_2$

2) In the figure shown, the displacement current for the charging capacitor is equal to the conduction current in the wires . The points 1 , 2 , and 3 are located at the same perpendicular distance (r) from the center of the capacitor , such that $(r \prec R)$. Rank the magnetic fields at the three points from the largest magnitude to the smallest .



a) $B_1 = B_3 \prec B_2$ b) $B_1 = B_3 \succ B_2$

c) $B_1 = B_3 = B_2$ d) $B_1 \succ B_3 \succ B_2$

3) A parallel plate capacitor with a circular plates of radius $(4.0\,mm)$ and $(1.0\,mm)$ apart . Charge is being accumulated on the plates of the capacitor . What is the displacement current between the plates at an instant when the rate of charge accumulation on the plates is $(10\,\mu C\,/\,s)$?

a) $10\,\mu A$ b) $40\,\mu A$ c) $2.5\,\mu A$ d) $18\,\mu A$

Maxwell's Equations

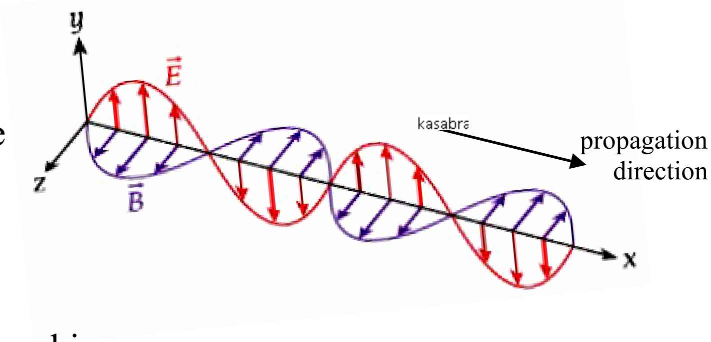
Maxwell's Equations describe how electrical charges, currents, electric fields, and magnetic fields affect each other , forming a unified theory of electromagnetism .

Name	Equation	Description
Gauss's Law for Electric Fields	$\oiint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$	The net electric flux through a closed surface is proportional to the net enclosed electric charge.
Gauss's Law for Magnetic Fields	$\oiint \vec{B} \cdot d\vec{A} = 0$	The net magnetic flux through a closed surface is zero (no magnetic monopoles exist).
Faraday's Law of Induction	$\oint \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt}$	An electric field is induced by a changing magnetic flux.
Maxwell-Ampere Law	$\oint \vec{B} \cdot d\vec{s} = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{enc}$	A magnetic field is induced by a changing electric flux or by a current.

درس 11.2 محذوف

The Electromagnetic Spectrum (Lesson 11.3)

The electromagnetic wave consists of two electric and magnetic fields and transmits energy in the direction of its propagation .



- The two fields are perpendicular to each other, and both are perpendicular to the direction of the wave propagation .
- The two fields are alternating, which means both are changed with time and changed with the position in space .
- The two fields are related together by the relationship :

$$E = c\,B$$

c : light's speed where $c = 3.0\times10^{8}\ m/s$

- All electromagnetic waves travel in the vacuum at the same speed, which is the light's speed c

$$c = \frac{1}{\sqrt{\mu_o\,\varepsilon_o}}$$

- Electromagnetic waves differ in its wavelength (λ) and its frequency (f) .

$$f = \frac{c}{\lambda}$$

Q7) The wavelength range for visible light is $(400\,nm)$ to $(700\,nm)$ in air . What is the frequency range of visible light ?

Q8) The antenna of a cell phone is a straight rod $(8.0\,cm)$ long . Calculate the operating frequency of the signal from this phone , assuming that the antenna length is $(\frac{1}{4})$ of the wavelength of the signal .

Q9) Choose the correct answer in the following :

1) What is the unit of the physical quantity expressed by the formula $(\frac{1}{\sqrt{\varepsilon_o\mu_o}})$?

a) $m.s$ b) $m.s^{-1}$
c) $A.m$ d) $A.m^{-1}$

2) What is the electric field amplitude of an electromagnetic wave whose magnetic field amplitude is $(5\times10^{-3}T)$

a) $6.7\times10^{5}\ V/m$ b) $1.5\times10^{6}\ V/m$
c) $6.7\times10^{6}\ V/m$ d) $1.5\times10^{3}\ V/m$

3) Which is incorrect statement about an electromagnetic wave traveling in vacuum ?

a) The energy is transported with speed C in the direction of propagation .
b) Both the electric field and the magnetic field exist in a plane perpendicular to direction of propagation .
c) The electric and magnetic field change in time but do not change with position in space .
d) The electric field vector and the magnetic field vector are always perpendicular to each other .

4) Which of the following statement concerning electromagnetic waves are incorrect ?

a) Electromagnetic waves in vacuum travel at speed of light .
b) The magnitudes of the electric field and the magnetic field are equal .
c) Both the electric field vector and the magnetic field vector are perpendicular to the direction of propagation .
d) An electromagnetic wave carries energy in its direction of propagation .

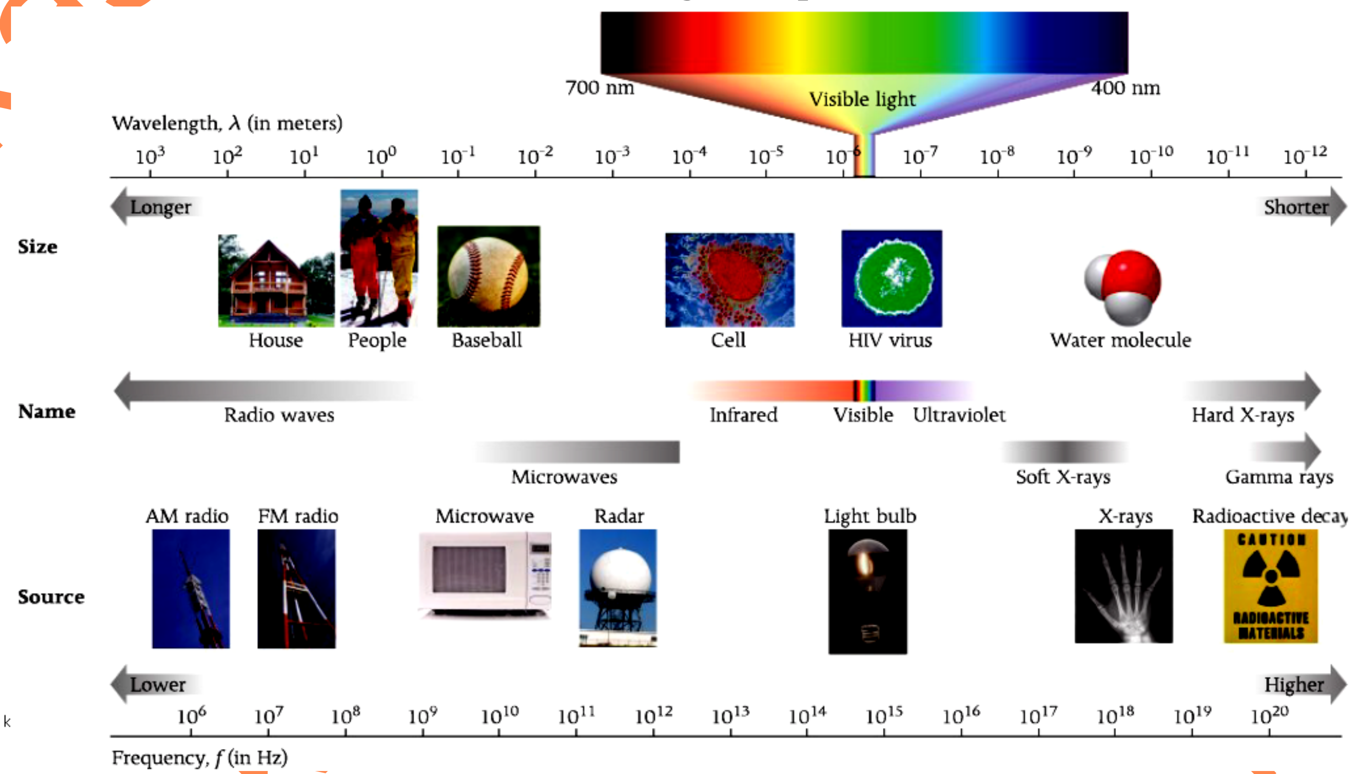
5) The Sharjah Radio station is transmitting on the $(49\,m)$ wavelength . Which frequency is the station transmitting on ?

a) $820\,KHz$ b) $6.12\,MHz$ c) $91.7\,MHz$ d) $15.8\,MHz$

6) If two communication signals were sent at the same time to the Moon , one via radio and one via visible light , which one would arrive at the Moon first ?

a) radio signal b) visible light
c) arrive together d) cannot be determined

The electromagnetic spectrum



The electromagnetic spectrum is arranged from the largest wavelength to the least wavelength .

1) Radio waves .

* They have the largest wavelength and the least frequency and energy .
* They are used in AM and FM radio .
* They are used in astronomy because they can pass easily through clouds of dust and gas .
* They are used in the telescope that utilize radio waves .

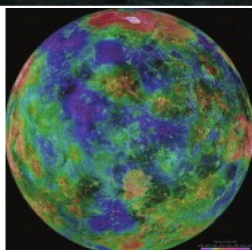


image for the surface of Venus by the microwaves

2) Microwaves .

* They are used in the microwave ovens .
* They are used in transmit phone messages through relay towers and satellites .
* They are used in radars because they can travel easily through the atmosphere and can reflect off from objects and a storm cloud .

3) Infrared waves .

* They cause a feeling of heat .
* They are used in automatic faucets and in remote controls units for TV .
* Detectors of infrared waves can be used to measure heat leaks and determine the location of the brewing volcanoes .
* Many animals have the ability to see infrared waves , so they can see in the dark .

4) Visible light .

* It is the only part of spectrum that we can see with our eyes .
* Its wavelengths range from to $400\,nm$ (blue) to $700\,nm$ (red) .
* The response of the human eye peaks at $(550\,nm)$ green .

5) Ultraviolet rays .

* The have high energy so it can damage the skin and cause sunburn .
* Earth's atmosphere particularly its ozone layer , prevents most of Sun's ultraviolet rays from reaching Earth's surface .
* They are used : - in hospital to sterilize equipment .
  - to produce optical properties such as fluorescence .

6) X-rays .

* They are used to produce medical images .
* They are used to determine the detailed molecular structure of any crystalline materials because their wavelength equals the distances between the atoms .

7) Gamma rays .

* They have the least wavelength and the largest frequency and energy .
* They are emitted in the decay of radioactive nuclei .
* They are used in medicine to destroy the cancer cells

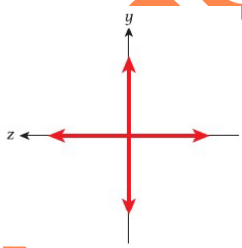
في درس 11.3 موضوع (Communication Frequency Bands) و (Traveling Electromagnetic Waves) غير مطلوب .

درس 11.4 + درس 11.5 + درس 11.7 كلها غير مطلوبة .

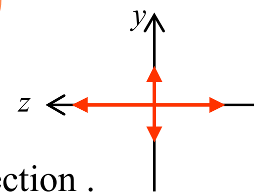
Polarization (lesson 11.6)

The **Polarization** is a process by which we obtain on an electromagnetic wave whose electric field oscillates in one direction .

* **The unpolarized light** is a light whose electric field oscillates in different directions such as the sunlight and the incandescent light bulb .



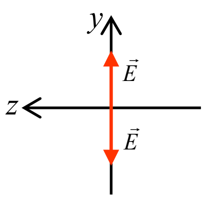
- Unpolarized light has equal components in the y- and z-directions .

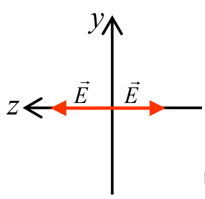


* The light in the shown figure is partially polarized in the z-direction .

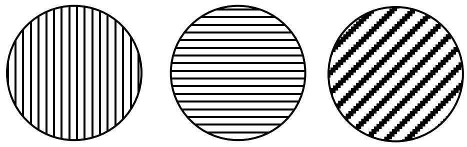
* **The polarized light** is a light whose electric field oscillates in one direction .

vertical polarized light (or in y-direction) * horizontal polarized light (or in z-direction)



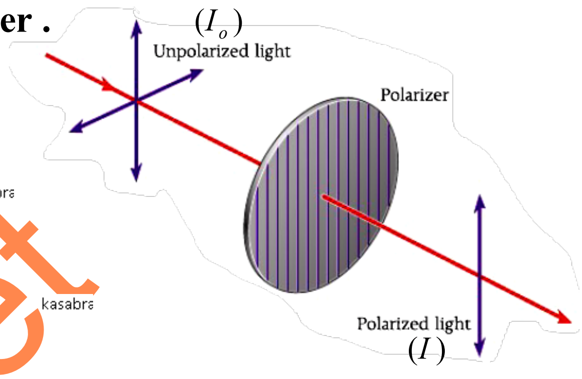


* Unpolarized light can be transformed to polarized light by passing the unpolarized light through a polarizer .
* Every polarizer has a polarizing axis or a polarizing direction .



* The polarizer allows only one component of the electric field vectors of the incident light waves passes through it .
* The components of the incident light on the polarizer that have the same direction as the polarizer are transmitted , but the components that are perpendicular to the polarizer are absorbed .
* The light passing through a polarizer emerges polarized in the polarizing direction .
* The purpose of the polarization : reducing the intensity of the light .

First : When an unpolarized light incident on a polarizer .



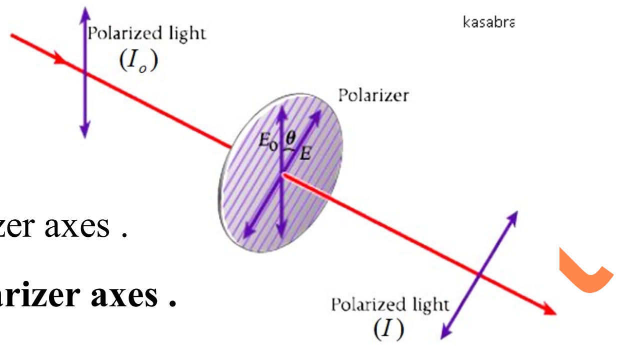
The intensity of the passing polarized light (I) reduce to the half of the unpolarized light intensity :

$$I = \frac{1}{2} I_o$$

Second : When a polarized light incident on a polarizer

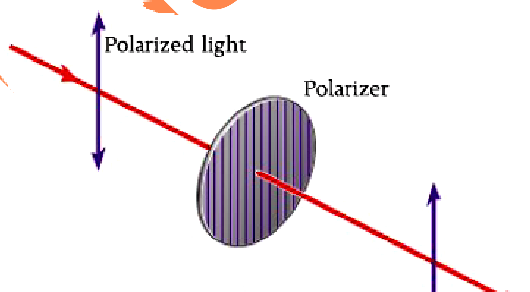
The intensity of the passing light from the polarizer is reduced and We use the malus's law to find it .

$$I = I_o \cos^2 \theta$$



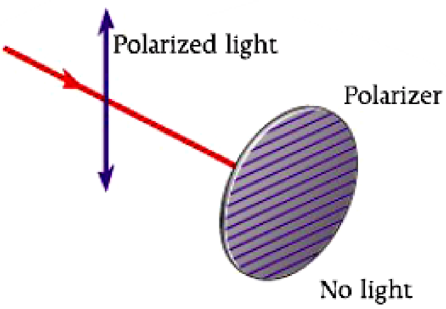
I_o : the intensity of the incident polarized light .
I : the intensity of the passing polarized light .
θ : the angle between the polarized light and the polarizer axes .

*** If the incident polarized light is parallel to the polarizer axes .**



$\theta = 0 \quad \Rightarrow I = I_o$

*** If the incident polarized light is perpendicular to the polarizer axes .**

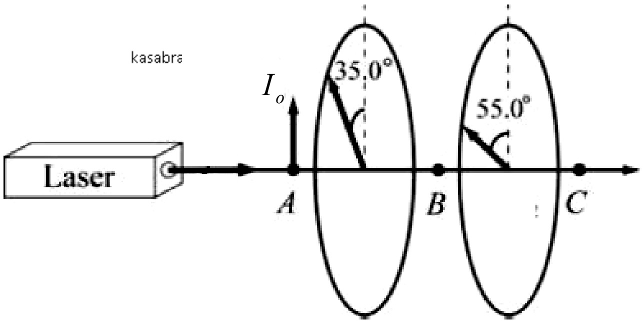


$\theta = 90^o \quad \Rightarrow I = 0$

Q10) A vertically polarized laser beam with intensity of $(10 W/m^2)$ passes through a polarized whose polarizing angle is (30^o) from the horizontal . What is the power of the laser beam when it emerges from the polarizer ?

Q11) A vertically polarized laser beam with intensity of $(1.0 W/m^2)$ passes through two polarizers . The first polarizer has a polarizing angle of (15^o) with respect to the vertical and the second polarizer has a polarizing angle of (45^o) with respect to the vertical . What is the intensity of the laser beam when it emerges from the two polarizers ?

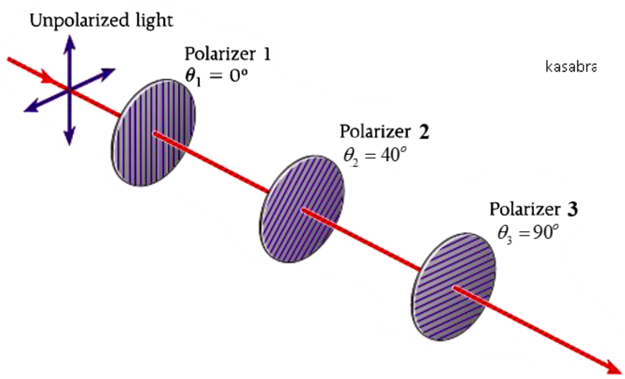
Q12) A laser produces light that is polarized in the vertical direction . The laser beam passes through two polarizers, which have polarizing angles of (35^o) and (55^o) from the vertical as shown in the figure . The laser beam has intensity of $(1.92\times10^4 W/m^2)$ at point (A) . What is the intensity of the laser light at point (C) ?



Q13) To visually examine sunspots through a telescope, astronomers have to reduce the intensity of the sunlight to avoid harming their retinas . They accomplish this intensity reduction by two polarizers on the telescope . The first polarizer has a polarizing angle of (28^o) relative to the horizontal, and the second has a polarizing angle of (88^o) . By what fraction is the intensity of the incident sunlight reduced by the polarizers ?

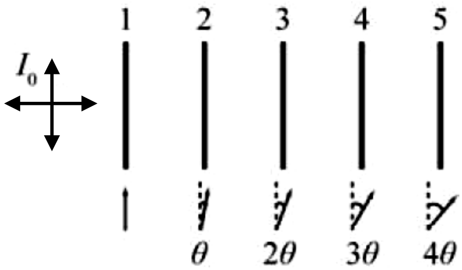
Q14) Unpolarized light with intensity of $(1.88 W/m^2)$ passes through tow polarizers . The emerging polarized light has intensity of $(0.38 W/m^2)$. What is the angle between the two polarizers ?

Q15) Unpolarized light with intensity (I_o) is initially incident on the first of three polarizers in a line . The first polarizer has a polarizing direction that is vertical . The second polarizer has a polarizing angle of (40^o) with respect to the vertical . The third polarizer has a polarizing angle of (90^o) with respect to the vertical .
What is the intensity of the light after passing through all three polarizers, in terms of the initial intensity (I_o) ?



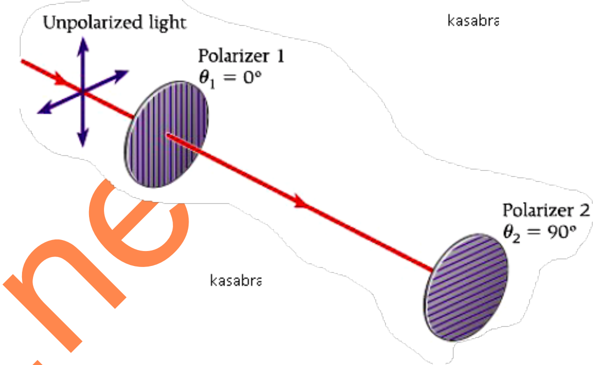
Q16) Unpolarized light of intensity (I_o) is incident on a series of five polarizes , with the polarization direction of each rotated (10^o) from that of the preceding one as shown in the figure .

What fraction of the incident light will pass through the series ?



Q17) Choose the correct answer in the following :

1) The figure shows unpolarized light incident on polarizer 1 with angle $(\theta_1 = 0^o)$ relative to the vertical and then on polarizer 2 with angle $(\theta_2 = 90^o)$ relative to the vertical , which of the following statement is true ?



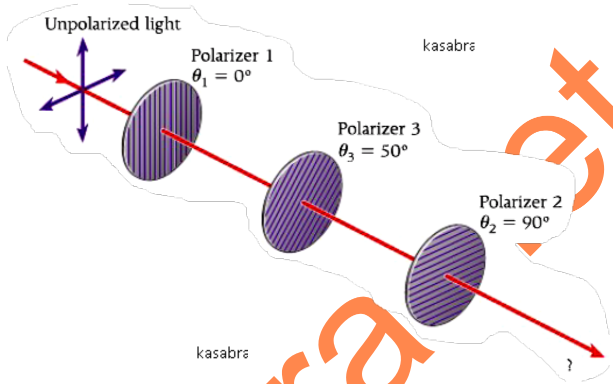
a) No light passes through the two polarizers .

b) Less than half of the light passes through the three polarizers .

c) Exactly half of the light passes through the three polarizers .

d) More than half of the light passes through the three polarizers .

2) In the preceding branch , if polarizer 3 with angle is placed between polarizer 1 and polarizer 2 , which of the following statement is true ?



a) No light passes through the two polarizers .

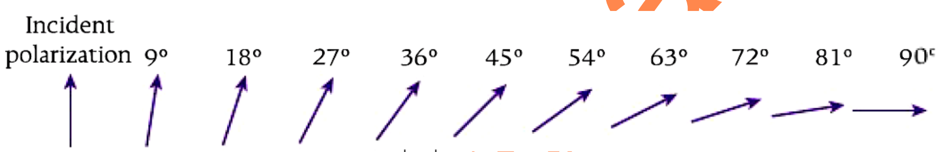
b) Less than half of the light passes through the three polarizers .

c) Exactly half of the light passes through the three polarizers .

d) More than half of the light passes through the three polarizers .

3) A polarized light is incident on a series of ten polarizes as shown in the figure , if the polarization direction of each rotated (9^o) from that of the preceding one . What fraction of the intensity of the incident light is transmitted through the ten polarizes ?

a) 0.10
b) 0.98
c) 0.78
d) 0.50



درس 11.7 محذوف

انتهت الوحدة 11