SUBJECT: PHYSICS (THEORY)
CLASS: XII
SESSION: 2024-25

SECTION-A

1. (*d*) (1)

Note: Electric field lines are towards the charge for both the charges.

2 (*a*) (1)

Note: Electric field is a vector quantity. If charges are interchanged, direction of E will change but V is a scalar quantity and A & B are at same distance from centre so V remains unchanged.

3. (*c*) (1)

Formula used : $\phi_0 = \dfrac{hc}{\lambda_0}$

$$\phi_0 = \frac{6.63\times10^{-34}\times3\times10^{8}}{5420\times10^{-10}} = 0.0037\times10^{-16}$$

$$\text{In } eV = \frac{\phi_0}{e} = \frac{0.0037\times10^{-16}}{1.6\times10^{-19}} = 2.29\,eV$$

4 (*d*) (1)

Note: $10^{-15}\,m = 1$ fermi

5. (*a*) (1)

Note: Charge Q is equally distant from both the magnets hence force due to both the magentic fields are equal & opposite.

6. (*d*) (1)

Note: As magnet goes inside the coil, flux linked increases and induced current produces in one direction. Till the time it is inside the coil, deflection is zero. when it goes out, flux decreases and deflection is in the other direction.

7. (*a*) (1)

$$B = \frac{C}{A} = \frac{\text{Electric field}}{\text{Current density}} = \frac{E}{j} = \frac{1}{\sigma} = \rho$$

8. (*a*) (1)

Note: magnetic fields due to two semi-circular curves, at the centre are equal and opposite.

9. (*a*) (1)

Concept applied: Lenz Law.

10. (*a*) (1)

11. (*c*) (1)

Note: For pure capacitor, $I = \dfrac{E}{X_c} = \dfrac{1}{\omega C}$

$$I \propto \frac{1}{\omega} \propto \frac{1}{f}$$

12. (*d*) (1)

Note: $p = \dfrac{h}{\lambda}$

13. (*b*) (1)

If incident radiation is less than work function of metal, electrons are not emitted.

14. (*c*) (1)

15. (*a*) (1)

16. (*c*) (1)

With white light, coloured and overlapped fringes are formed.

SECTION-B

17. (*i*) Equating with standard equation (1 + 1)

$By = B_0 \sin(\omega t + kx)\ T.$

$k = 300\pi$

Formula $\lambda = \dfrac{2\pi}{k} = \dfrac{2\pi}{200\pi} = \dfrac{1}{150}\,m$

(*ii*) $E_0 = B_o c = 8\times10^{-6}\times\times10^{8} = 2400\ V/m$

$\therefore E = E_0 \sin(wt + kx)\ N/C$

$E = 2400 \sin(2\times10^{11} t + 300\pi x)\ N/C.$

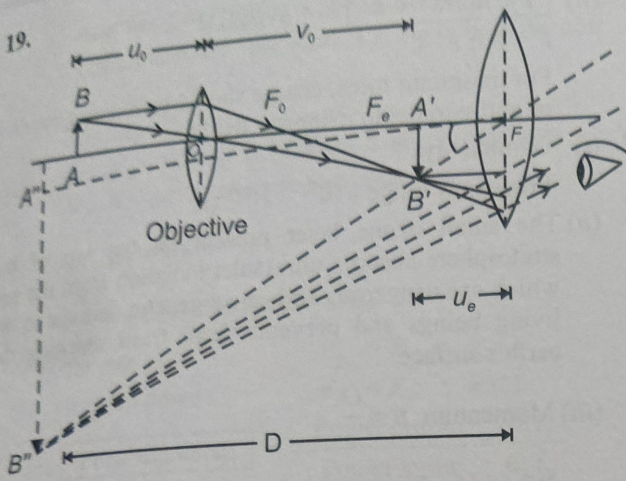
18. $\lambda e = \lambda\alpha.$ (2)

$$\frac{h}{\sqrt{2m_e k_e}} = \frac{h}{\sqrt{2m_\alpha k_\alpha}}$$

$$\frac{Ke}{K\alpha} = \frac{m_\alpha}{m_e} = 7294$$

$$\Rightarrow Ke = 7294\,K\alpha$$

(1+1)

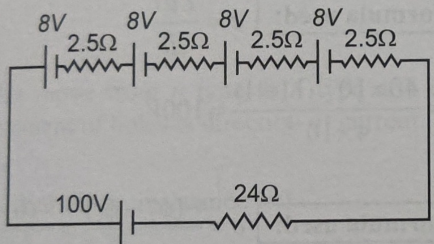
19. 

Magnifying power,

$$m = \frac{-v_0}{u_0}\left(1+\frac{D}{Fe}\right)$$

where D = Least distance of distinct vision

20. (*i*) (1+1)



Charging current

$$I = \frac{\text{total } emf}{\text{total resistance}}$$

$$= \frac{100-32}{(2.5\times4)+24} = \frac{68}{34} = 2A$$

(*ii*) $V = E + Ir$

$= 32 + 2 \times 10 = 52\ V$

21. **Formula used:** $\frac{1}{f} = \left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

(*i*) $n_1 = 1.65$

Take $\left(\frac{1}{R_1}-\frac{1}{R_2}\right) = K$

$$\frac{1}{f'} = \left(\frac{1.5}{1.65}-1\right)K = \frac{-0.15}{1.65}K$$

$$f' = -\frac{165}{15}K = -11K$$

It behaves as diverging lens and its focal length increases.

(*ii*) $n_1 = 1.33$

$$\frac{1}{f''} = \left(\frac{1.5}{1.33}-1\right)K = \frac{.17}{1.33}K$$

$$f'' = \frac{133}{17}K = 7.82\ K$$

It behaves as converging lens and its focal length also increases.

21. On AC surface (1+1)

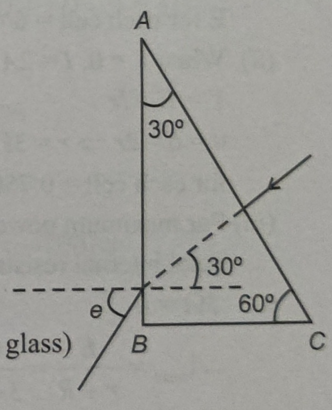
light ray goes straight

As $\angle i = 0$

On AB surface

$\angle i = 30°$

According to Snell's Law



$$\frac{\sin i}{\sin r} = \frac{n_1}{n_2}$$

$$\frac{\sin 30°}{\sin e} = \frac{1}{\sqrt{3}} \quad (n_2 = \text{air},\ n_1 = \text{glass})$$

$$\sin e = \frac{\sqrt{3}}{2} = \sin 60° \Rightarrow e = 60°$$

SECTION - C

22. (*i*) Formula used $E = h\nu = \frac{hc}{\lambda}$ (1+2)

$\lambda = 275\ nm = 275 \times 10^{-9}\ m$

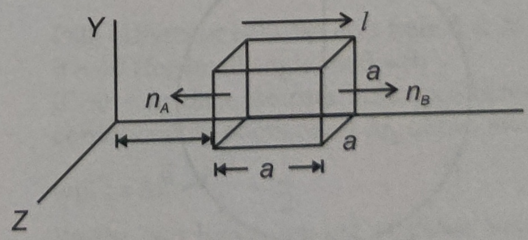
$$E = \frac{6.63\times10^{-34}\times3\times10^{8}}{275\times10^{-9}\times1.6\times10^{-19}} = 4.5\ eV$$

Transition = 4 → 2.

(*ii*) $\Delta E = \frac{hc}{\lambda} \Rightarrow \lambda \propto \frac{1}{\Delta E}$

(*a*) Transition 4 → 3 ΔE is minimum, λ is maximum.

(*b*) Transition 3 → 1 ΔE is maximum, λ is minimum.

23. 

$\because E_x = \alpha x = 400$ x

$E_y = E_z = 0$

$= -400\ a^3 + 800\ a^3 = 400\ a^3$

$= 400 \times (.1)^3$

$\phi_{Net} = 0.4\ Nm^2C^{-1}$

$\because \phi_{Net} = q_{enclosed}/\epsilon_0$

$\therefore q_{in} = \epsilon^0 \phi_{Net}$
$= 8.85 \times 10^{-12} \times 0.4$
$= 3.540 \times 10^{-12}\ C$
ϕ_{net} = Electric flux with two planes along yz plane.

24. **Formula used:** $E_k = \frac{1}{4\pi \epsilon_0} \frac{(Ze)(2e)}{r_0}$

$E_k = 8\ MeV = 8 \times 10^6 \times 1.6 \times 10^{-19}\ J$

$r_0 = \frac{1}{4\pi \epsilon_0} \frac{(Ze)(2e)}{E_k}$

$= \frac{9\times10^9 \times 2\times 80(1.6\times10^{-19})^2}{8\times1.6\times10^{-13}}$

$= 2.82 \times 10^{-14}\ m$

$r_0 \propto \frac{1}{E_K}$

If kinetic energy is doubled, r_0 will be halved.

25. **Formula used:** $V = E - Ir$ (1+1+1)

(*i*) For $I = 0$, $V = E$

$\therefore E$ for 4 cells from the graph = $6V$

E for each cell = 6/4 = 1.5 V.

(*ii*) When $V = 0$, $I = 2A$

$V = E - Ir$

$0 = 6 - 2r \Rightarrow r = 3\Omega$

for each cell = 0.75Ω

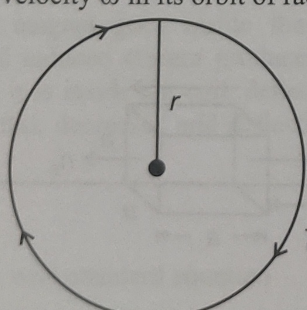
(*iii*) For maximum power dissipation

Total internal resistance = external resistance

$3\Omega = R$

$\therefore I_{max} = \frac{E}{r+R} = \frac{6}{3+3} = \frac{6}{6} = 1A$

26. (*i*) An electron is revolving with linear velocity v and angular velocity ω in its orbit of radius r.



Angular velocity $\omega = \frac{v}{r}$

Time period of orbit $T = \frac{2\pi}{\omega} = \frac{2\pi r}{v}$

Current constituted by electron in its one revolution

$I = \frac{e}{T} = \frac{ev}{2\pi r} . \pi r^2$ $M = \frac{1}{2} evr.$

(*ii*) **Formula used:** $F = qvB\sin\theta$

$F = 0$ if $\theta = 0°$

For minimum force, charge should be moving parallel or anti-parallel to magnetic field.

27. (*i*) Gamma rays (1+1+1)

Frequency range $-10^{18} - 10^{23}\ Hz$.

(*ii*) The small ozone layer present on the top of the stratosphere absorbs ultraviolet radiation from the sun which are dangerous and cause genetic damage to the living beings and prevents them from reaching the earth's surface.

(*iii*) Momentum $p = \frac{U}{c}$

When U = Energy transferred.

c = Speed of light

Due to the large value of speed of light, the amount of momentum transferred by the em waves incident on the surface is small.

28. (*i*) **Formula used:** $e = \frac{LdI}{dt}$ (1.5+1.5)

$e = \frac{40\times10^{-3}(11-1)}{4\times10^{-3}} = 100V.$

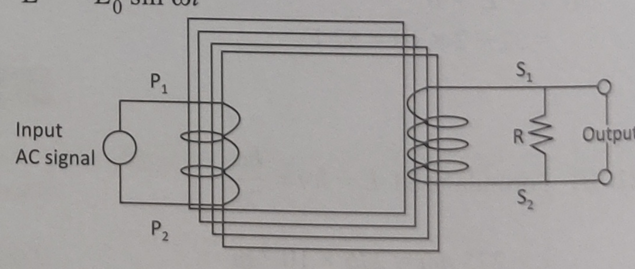
(*ii*) **Formula used:** $e = \frac{-(\phi_2 - \phi_1)}{t} = \frac{-(0 - NBA)}{t}$

$t = \frac{NBA}{e} = \frac{50\times2\times10^{-2}\times10^{-2}}{0.1} = 0.1s$

OR

(*i*) **Theory & Working:** Alternating e.m.f supplied by the a.c. source is

$E = E_0 \sin \omega t$



If we assume the primary coil to be pure inductance I_P (primary current) lags E_P by 90°.

$\therefore \cos\phi = 0, P = 0,$

No power is dissipated in primary.

Primary current induces a flux in the core. As core is connected to secondary coil also so this flux is linked with secondary coil. Flux changes with the change in primary current and an e.m.f induces in secondary circuit. If circuit is closed induced current flows in the circuit.

According to Faraday's law of induction.

The induced emf per turns is same in both the coil

$\therefore \frac{E_P}{n_P} = \frac{E_S}{n_S}$

E_P, E_S – voltage in primary & secondary coils

n_P, n_s – no. of turns in two coils

$\therefore E_S = E_P \frac{n_s}{n_p}$

$\frac{n_s}{n_p} = k$ (transformation ratio)

for step up $E_S > E_P \therefore k > 1$

for step down $E_S < E_P \therefore k < 1$

(ii) **Formula used:** $\eta = \frac{\text{Power output}}{\text{Power input}} = \frac{E_s I_s}{E_p I_p}$

$\frac{80}{100} = \frac{20 \times 1A}{200 \times I_p}$

$I_p = \frac{20 \times 1 \times 100}{200 \times 80} = 0.125A \quad \left[I_s = \frac{E_s}{R_s} = \frac{20}{20} = 1A\right]$

(ii) **Formula used:** $\eta = \frac{\text{Power output}}{\text{Power input}} = \frac{E_s I_s}{E_p I_p}$

$\frac{80}{100} = \frac{20 \times 1A}{200 \times I_p}$

$I_p = \frac{20 \times 1 \times 100}{200 \times 80} = 0.125A \quad \left[I_s = \frac{E_s}{R_s} = \frac{20}{20} = 1A\right]$

SECTION-D

29. (i) (c)

As *p-n* junction diode doesn't follow ohm's law.

(ii) (d)

(iii) (d)

Holes move from *p* type to *n* type and direction of movement of holes is direction of current.

(iv) (c)

For ideal diode, resistance = 0

$\Delta V = 3 - 1 = 2V$

$\Delta V = IR \rightarrow I = \frac{2}{200} = 0.01A$

OR

(iv) $n_e > n_h$, In *p*-type holes concentration is more than electron concentration.

30. (i) (c) (4)

Formula used: $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{d}{f_1 f_2}$

(ii) (a)

$P = P_1 + P_2 \quad \Rightarrow P = 1.5D + 1D = +2.5D$

(iii) (b)

$f = \frac{1}{P} = \frac{1}{5}m = \frac{100}{5} = 20cm$

(iv) (b)

$f = \frac{f_1 f_2}{f_1 + f_2} = \frac{(25)(-20)}{25-20} = -100\,cm$

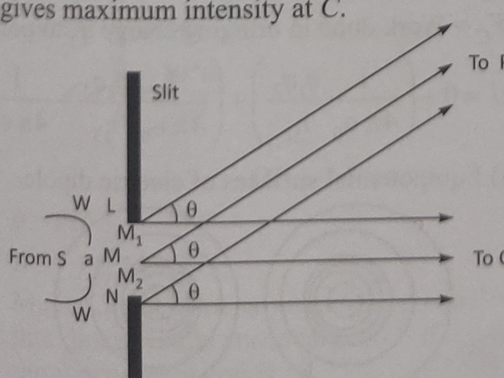
OR

(iv) (b)

$P = \frac{1}{f}(metre)$ Focal length of diverging less is negative.

SECTION-E

31. (i) At the central point *C*, the wavelets from the two parts of wave front coming from the slit have zero path difference which means they are in same phase and it gives maximum intensity at *C*.



Path difference between rays from L & $N = NQ = a \sin \theta \approx a\theta$ (for small angle $\sin \theta \approx \theta$)

if $a\theta = \lambda$, then the path difference between any two corresponding points M_1 & M_2 of two halves of the slit will be $\Delta x = \frac{a\theta}{2} = \frac{\lambda}{2}$

So the two halves are out of phase and cancel each other and net intensity at *P* will be zero.

hence $\theta = \frac{\lambda}{a}$ condition of first maxima. As maxima is on both sides of central maxima. half angular width,

$\theta = \frac{\lambda}{a}$

Total angular width of central maximum $= \frac{2\lambda}{a}$

Linear width of central maximum $= \frac{2\lambda D}{a}$
where D = distance of screen.

(*ii*) **Formula used:** $a\sin\theta = (2n+1)\frac{\lambda}{2}$

when θ is small, $\sin\theta \simeq \theta$

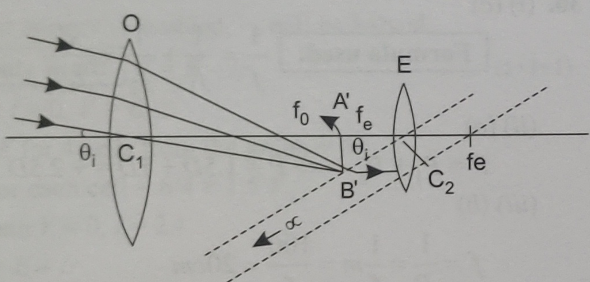
$$a\theta = \frac{3\lambda}{2} \Rightarrow \theta = \frac{3\lambda}{2a}$$

$$\theta = \frac{3\times 5890\times 10^{-10}}{2\times 0.25\times 10^{-3}} = 3.534\times 10^{-3}\ rad$$

Total width $= 2\theta = 7.068 \times 10^{-3}\ rad$

OR

(*i*) **Normal adjustment:** The length of telescope is so adjusted that real & inverted image of the parallel beam coming from distant object, is formed at focus of eye-piece so that the final image is formed at infinity **(2M)**



Magnifying power: In normal adjustment it is defined as the ratio of the angle subtended at the eye by the final image to the angle subtended at the eye, by the object directly, when the final image and the object both lie at infinite distance from the eye.

$$m = \frac{\tan\theta_i}{\tan\theta_o} = \frac{\frac{A'B'}{B'C_2}}{\frac{A'B'}{C_1B'}} = \frac{C_1B'}{C_2B'} \quad \textbf{(1M)}$$

$$m = \frac{f_o}{-f_e}$$

(*ii*) **Formula used:** $m = \frac{fo}{fe} = 7 \Rightarrow fo = 7\,fe$ **(2M)**

In normal adjustment $L = fo + fe = 40$

$7Fe + Fe = 40 \Rightarrow fe = 5\ cm$

$fo = 7\times 5 = 35\ cm$

32. (*i*) **Gauss theorem** **(3+2)**

The surface integral of electrostatic field $\vec{E}$ over any closed surface S, enclosing a volume V in vacuum i.e. total electric flux is $\frac{1}{\epsilon_0}$ times the total charge (Q) enclosed in the surface

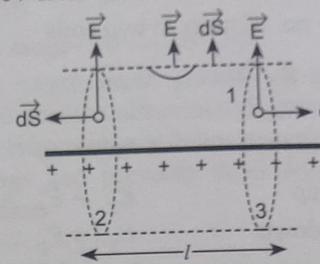
$$\phi_E = \oint \vec{E}\cdot\vec{ds} = \frac{Q}{\varepsilon_0}$$

Expression for electric field

⇒ Consider an infinitely long line charge.

⇒ linear charge density $\lambda = Q/l$

⇒ Gaussian surface - cylinder of radius r, if point is at a distance r from the wire.



According to Gauss theorem-

$$\phi_E = \oint \vec{E}\cdot\vec{ds} = \oint_1 \vec{E}\cdot\vec{ds_1} + \oint_2 \vec{E}\cdot\vec{ds_2} + \oint_3 \vec{E}\cdot\vec{ds_3} = \frac{q}{\varepsilon_0}$$

1 = curved surfaces

2, 3 = flat surfaces $[\theta = 90°, \cos\theta = 0]$

$$\therefore\ \phi_E = \oint_1 \vec{E}\cdot\vec{ds_1} = \frac{q}{\varepsilon_0}$$

$$= E\int ds_1 = \frac{q}{\varepsilon_0} \Rightarrow E\cdot 2\pi rl = \frac{\lambda l}{\varepsilon_0}$$

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

(*ii*) (*a*) In Outer region of *I* plate

$E_{net} = 0$

(*b*) Between the plates $E = \frac{\sigma}{\epsilon_0}$

$$= \frac{17\times 10^{-22}}{8.854\times 10^{-12}} = 1.92\times 10^{-10}\ N/C$$

OR **(1+2+2)**

(*i*) **Electrostatic Potential** : It is defined as the amount of work alone in bringing a unit charge from infinity to a point.

SI unit ; J/Coulornb or Volt.

$U = W_A + W_B + W_C$

where

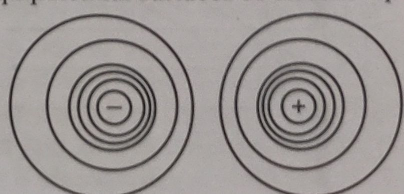
W_A = Work done in bringing charge q_1 to point *A*.

W_B = Work done in bringing charge q_2 to point *B*.

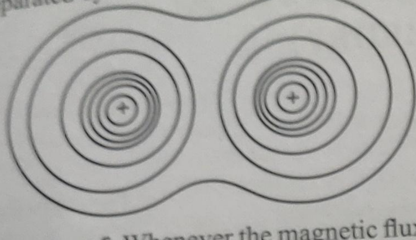
W_C = Work done in bringing charge q_3 to point *C*.

$$U = 0 + \left(\frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r_{12}}\right) + \left(\frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r_{13}} + \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r_{23}}\right)$$

(*ii*) (*a*) Equipotential surfaces of electric dipole.



(*b*) Equipotential surfaces of two identical positive charges - separated by a small distance.



33. (*i*) **Induced emf:** Whenever the magnetic flux linked with a closed circuit changes, an emf is induced in it, called induced emf **Faraday's Law of Electromagnetic induction–**

(*a*) **First Law:** Whenever the magnetic flux linked with a closed circuit changes, an emf is induced in it which lasts only as long as the flux is changing. The phenomenon is called electromagnetic induction.

(*b*) **Second Law:** The magnitude of the induced emf is equal to the rate of the change of magnetic flux linked with the closed circuit.

Mathematically $e = -\frac{d\phi}{dt}$

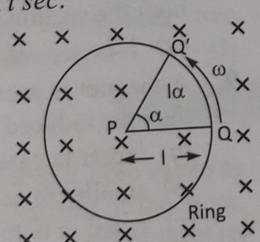
OR

(*ii*) A conducting rod PQ of length l rotates with angular velocity ω over a conducting ring in a uniform magnetic field B.

Let the rod PQ describes by α in t sec.

Area swept by the rod.

$$A = \frac{1}{2} l \times l\alpha = \frac{1}{2} l^2 \alpha$$



Change in flux

$$d\phi = B\, dA$$

Hence emf induced in the rod

$$e = \frac{d\phi}{dt} = B\frac{dA}{dt}$$

$$= B\frac{1}{2} l^2 \frac{d\alpha}{dt}$$

$$= \frac{1}{2} B l^2 \omega$$

Current induced

$$I = \frac{e}{R} = \frac{B l^2 \omega}{2R}$$

OR

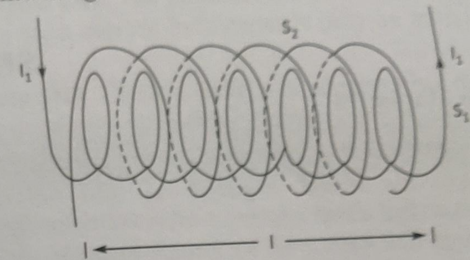
(*i*) $\phi = MI$

If $I = 1A$, $M = \phi$

Mutual inductance is numerically equal to magnetic flux linked with secondary coil if current flowing through primary coil is $1A$.

SI Unit $M = \frac{\phi}{I} = \frac{Weber}{Ampere} = \text{Henry}$

(*ii*) Consider two solenoids s_1 and s_2 such that they are intermingled with each other.



Let length of each solenoid be l and area of cross-section of each solenoid be A

N_1 = Number of turns in coil s_1

N_2 = Number of turns in coil s_2

Magnetic field due to current I_1 in coil s_1

$$B_1 = \mu_0 n_1 I_1$$

Where $n_1 = \frac{N_1}{l}$

Magnetic flux linked with the other coil.

$$\phi_2 = N_2 B_1 A$$

$$= N_2 \mu_0 n_1 I_1 A$$

$$\phi_2 = \mu_0 \frac{N_1 N_2}{l} A I_1$$

M = Mutual inductance of coils

$$\phi_2 = M I_1$$

Equating both the expressions of ϕ_2

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

Note: Mutual inductance is defined for both the coils and same for both.

(*iii*) Let current in coil c_2 be I_2

Magnetic field due to current I_2,

$$B_2 = \mu_0 \frac{N_2}{l_2} I_2$$

Magnetic flux linked with coil c_1

$$\phi_1 = N_1 B_2 A_1$$

$$= N_1 \left(\mu_0 \frac{N_2}{l_2} \right) I_2 . A_1$$

emf induced in the coil c_1

$$e = \frac{d\phi_1}{dt}$$

$$= \frac{\mu_0 N_1 N_2 A_1}{l_2} \frac{dI_2}{dt}$$