COMMON PRE-BOARD EXAMINATION 2023-24

Subject: PHYSICS (042)

Class XII

MARKING SCHEME

SECTION A

1. A hollow metallic sphere of radius 5cm is charged so that the potential on its surface is 10V. The potential at the centre of the sphere is — 1

   (a) 0V

   (b) 10V

   (c) Same as at a point 5cm away from the surface

   (d) Same as at a point 25cm away from the surface

2. When 10^{14} electrons are removed from a neutral metal sphere, the charge on the sphere becomes — 1

   (a) 16μC

   (b) -16μC

   (c) 32μC

   (d) -32μC

3. Which of these particles (having the same kinetic energy) has the shortest de-Broglie wavelength? — 1

   (a) Electron

   (b) Alpha particle

   (c) Proton

   (d) Neutron

4. The time period of an electron in n^{th} Bohr's orbit is proportional to — 1

   (a) n^3

   (b) n^2

(c) n

(d) 1/n

5. An electric current pass through a long straight wire at a distance 5cm from the wire. The magnetic field is B. The field at 20cm from the wire would be 1

(a) B/16

(b) B/4

(c) B/3

(d) B/2

6. Which of the following is not a diamagnetic material? 1

(a) Bismuth

(b) Copper

(c) Nitrogen (STP)

(d) Sodium

7. A galvanometer of resistance 25Ω gives full scale deflection for a current of 10mA. What resistance is to be connected in its series so that it can work as voltmeter of range 10V? 1

(a)10000Ω

(b)10025Ω

(c)975Ω

(d)9975Ω

8. Two long straight wires are set parallel to each other. Each carries a current 'i' in the same direction and the separation between them is 2r. The intensity of the magnetic field midway between them is 1

(a)$\frac{\mu_o i}{2\pi r}$

(b) $\frac{\mu_o i}{2r}$

(c)zero

(d) $\frac{\mu_o i}{4\pi r}$

9. If the rms current in a 50Hz ac circuit is 5A, the value of the current 1/300s after its value become zero is 1

(a) $5\sqrt{2}$ A

(b) $5\sqrt{\frac{3}{2}}$ A

(c) $\frac{5}{6}$ A

(d) $\frac{5}{\sqrt{2}}$A

10. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic wave, the direction of propagation of electromagnetic wave is along 1

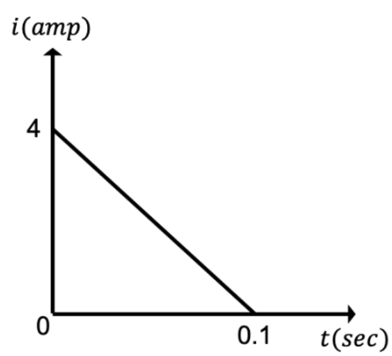
(a) $\vec{E}$

(b) $\vec{B}$

(c) $\vec{B}$x$\vec{E}$

(d) $\vec{E}$x$\vec{B}$

11. In a coil of resistance 10Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is 1



(a) 8

(b) 2

(c) 6

(d) 4

12. Which of the following series in the spectrum of hydrogen atom lies in the visible region of the electromagnetic spectrum? 1

(a) Paschen series

(b) Balmer series

(c) Lyman series

(d) Brackett series

13. **a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.** 1

14. **c) If Assertion is true but Reason is false.** 1

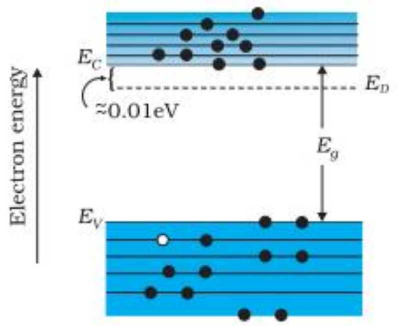
15. **b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.** 1

16. **a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.** 1

SECTION B

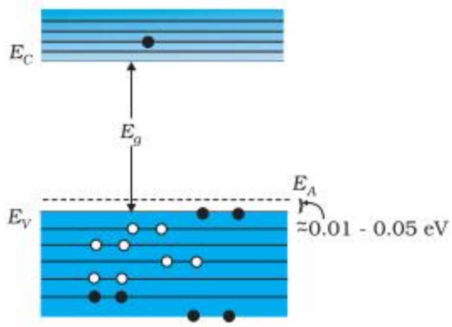
17. 2

n-type:



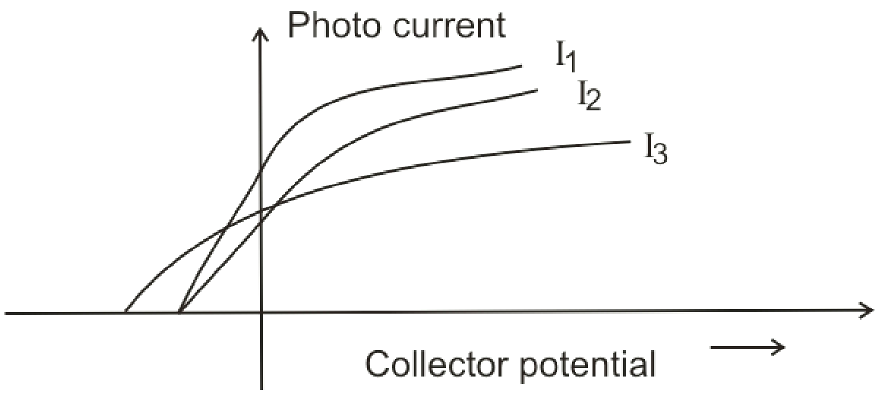
(1m)

p-type:



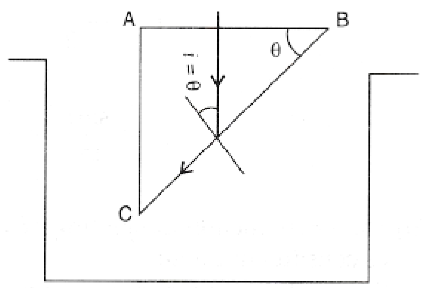
(1m)

18. For a given frequency, intensity of light in the photon picture is determined by the number of photons crossing unit area per unit time. **(1m)** 2



(1m)

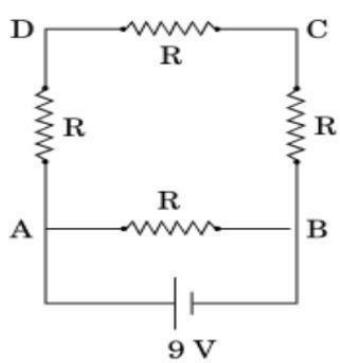
19. 2



$$\frac{\sin\theta}{\sin 90} = \frac{n_w}{n_g} \qquad (\mathbf{1m})$$

$$\sin\theta = \frac{4/3}{3/2} = \frac{8}{9} \qquad (\mathbf{1m})$$

20. 2



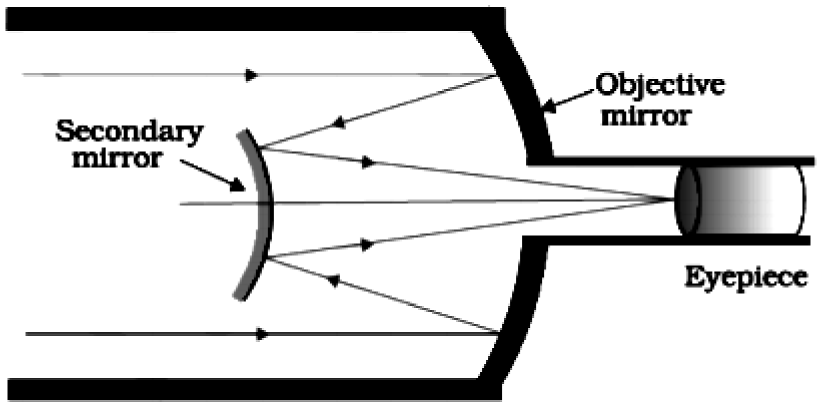
Resistance= R_s= $R_1+R_2+R_3$=4+4+4=12Ω (**1/2m)**

Net resistance=R_p=12x4/16=3Ω **(1/2m)**

Current drawn from the source=I=V/R=9/3=3Ω **(1/2m)**

Potential difference across CD=V_{CD}=4x3/4=3V **(1/2m)**

21. Reflecting telescope: 2

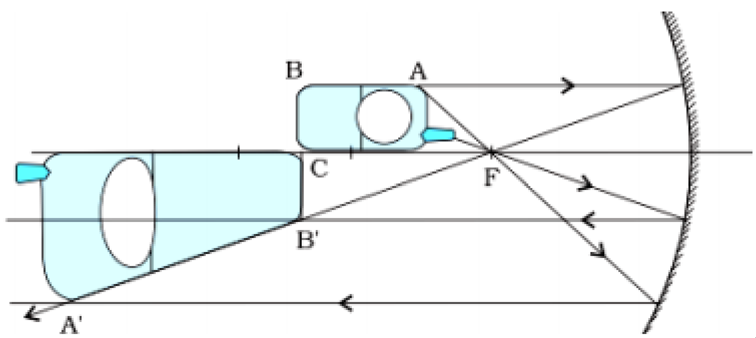


(1m)

Advantages of reflecting telescope: (any two)

(i) Large light gathering power
(ii) Large magnifying power
(iii) No chromatic aberration
(iv) Spherical aberration is removed
(v) Easy mechanical support **(1m)**

(OR)



(1m)

As shown in the diagram, a mobile phone lies along the principal axis of a concave mirror. It is clearly observed that the portion of the mobile phone which is at C will form an image of the same size only at C. We can see that the height of one end of the mobiles remains the same.

Now, the portion of the mobile phone which lies between C and F will form an enlarged image beyond C as shown in the diagram. We can notice that the magnification of each part of the mobile phone cannot be uniform because of the different locations. This is the reason why the image formed is not uniform. **(1m)**

SECTION C

22. Number of atoms in 3 gram of Cu coin = $(6.023 \times 10^{23} \times 3) / 63 = 2.86 \times 10^{22}$ **(½ m)** 3

Each atom has 29 Protons & 34 Neutrons

Thus Mass defect $\Delta m = 29 \times 1.00783 + 34 \times 1.00867 - 62.92960\ u = 0.59225u$ **(1m)**

Nuclear energy required for one atom $= 0.59225 \times 931.5$ MeV **(½ m)**

Nuclear energy required for 3 gram of Cu =0.59225 X 931.5 X 2.86X 10^{22}MeV

= 1.58 X 10^{25} MeV **(1m)**

(OR)

Number of atoms present in 2 g of deuterium $= 6 \times 10^{23}$

Number of atoms present in 2.0 Kg of deuterium $= 6 \times 10^{26}$ **(1m)**

Energy released in fusion of 2 deuterium atoms

$= 3.27$ MeV **(1m)**

Energy released in fusion of 2.0 Kg of deuterium atoms

$$= \frac{3.27}{2} \times 6 \times 10^{26} \text{ MeV}$$

$$= 9.81 \times 10^{26} \text{ MeV}$$

$$= 15.696 \times 10^{13} \text{ J}$$ **(1m)**

Energy consumed by bulb per sec = 100 J

Time for which bulb will glow $= \frac{15.696 \times 10^{13}}{100}$ s $= 4.97 \times 10^{4} year$

23. Force on charge q due to the charge -4q 3

$\vec{F}_1 = \frac{k\,4q^2}{l^2}$ *along AB* **(1/2m)**

Force on charge q due to the charge 2q

$\vec{F}_2 = \frac{k\,2q^2}{l^2}$ *along CA* **(1/2m)**

The forces F_1 and F_2 are inclined to each other at an angle of 120^0

Hence, resultant force on charge q

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos 120}$$ **(1/2m)**

$$F = \sqrt{F_1^2 + F_2^2 - F_1F_2}$$

$$F = \frac{k\,q^2}{l^2}\sqrt{16 + 4 - 8}$$

$$F = \frac{2\sqrt{3}k\,q^2}{l^2}\ (\mathbf{1/2m})$$

Potential energy of the system

$U = \frac{k\,q^2}{l}[-4 + 2 - 8]$ **(1/2m)**

$$U = -10\frac{k\,q^2}{l}$$

Work done to separate the charges=

$$W = 10\frac{k\,q^2}{l}\qquad (\mathbf{1/2m})$$

24. Balmer Series- 3

$$\frac{1}{\lambda_b} = \mathrm{R}\left(\frac{1}{2^2} - \frac{1}{\mathrm{n_i}^2}\right) = \frac{R}{4}$$ **(1m)**

Paschen series-

$$\frac{1}{\lambda_p} = \mathrm{R}\left(\frac{1}{3^2} - \frac{1}{\mathrm{n_i}^2}\right) = \frac{R}{9}$$ **(1m)**

Ratio=

$$\frac{\lambda_\mathrm{b}}{\lambda_\mathrm{p}} = \frac{4/\mathrm{R}}{9/\mathrm{R}} = \frac{4}{9}$$ **(1m)**

25. 3

Supply voltage, $V = 230V$

Initial current drawn, $I_1 = 3.2A$

Initial resistance $= R_1$, which is given by the relation,

$$R_1 = \frac{V}{I}$$ **(1/2m)**

$$= \frac{230}{3.2} = 71.87\Omega$$

Steady state value of the current, $I_2 = 2.8A$

Resistance at the steady state $= R_2$, which is given as

$$R_2 = \frac{230}{2.8} = 82.14\Omega$$ **(1/2m)**

(1m)

$$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$$

(1/2m)

$$T_2 = 27^\circ C = \frac{82.14 - 71.87}{71.87 \times 1.7 \times 10^{-4}} = 840.5$$

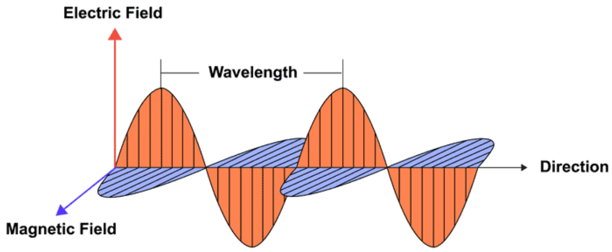
(1/2m)

$$T_2 = 840.5 + 27 = 867.5^\circ C$$

26. Statement -Biot-savart's law **(1m)**
Derivation for field **(2m)**

27. (a) An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field, and so on. The oscillating electric and magnetic fields thus regenerate each other and propagates through space in the form of waves. **(1m)**

(b)



(1m)

(c) The ultraviolet rays coming from outer space are prevented by the ozone layer on top of the stratosphere to enter the inner layers of earth's atmosphere. These rays being harmful for life on earth, the presence of the thin ozone layer is crucial for human survival. **(1m)**

28.

The magnetic field inside the long solenoid is given by

$B = \mu_0 ni$ **(1/2m)**

Flux produced in the small solenoid because of the long solenoid, $\phi = (\mu_0 ni) \times (N\pi R^2)$ **(1/2m)**

(a) The emf developed in the small solenoid is given by

$$e = \frac{d\phi}{dt} = \frac{d}{dt}(\mu_0 niN\pi R^2)$$ **(1/2m)**

$$e = \mu_0 nN\,\pi R^2 \frac{di}{dt}$$

Substituting $i = i_0 \sin \omega t$, we get **(1/2m)**

$e = \mu_0 nN\pi R^2 i_0 \omega \cos \omega t$

(b) Let the mutual inductance of the coils be m.

Flux ϕ linked with the second coil is given by

$\phi = (\mu_0\ ni) \times (N\pi R^2)$

The flux can also be written as

$\phi = mi$

$\therefore (\mu_0\ ni) \times (N\pi R^2) = mi$

And, **(1/2m)**

$m = \pi\mu_0 nNR^2$ **(1/2m)**

SECTION D

Case Study Based Questions

29. 4

(i)The increase in the width of the depletion region in a p-n junction diode is due to:

(a) increase in forward current

(b) forward bias only

(c) reverse bias only

(d) both forward bias and reverse bias

(ii) In half wave rectification, if the input frequency is 60 Hz, then the output frequency would be

(a) Zero

(b) 30 Hz

(c) 60 Hz

(d) 120 Hz

(iii) A pure Si crystal has $5x10^{28}$ atoms/m^3. It is doped by 1 ppm concentration of As atom. The number of holes per unit volume is (consider $n_i = 1.5 \times 10^{16}\ m^{-3}$)

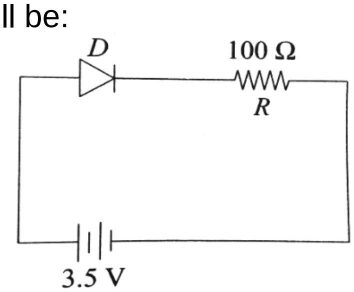
(a) $4.5x10^{9}\ m^{-3}$

(b)$4x10^{9}\ m^{-3}$

(c)$2x10^{9}\ m^{-3}$

(d)$2.25x10^{10}\ m^{-3}$

(iv) In the given figure, a diode D is connected to an external resistance R = 100 Ω and an e.m.f. of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:



(a) 40 mA

(b) 20 mA

(c) 35 mA

(d) 30 mA

30. A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex lens is of three types: Double convex lens, Plano convex lens and Concavo-convex lens. Concave 4

lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types: Double concave lens, Plano concave lens and Convexo-concave lens.

(i) The radius of curvatures of two surface of a convex lens is R. For what value of μ of its material will its focal length become equal to R?

(a) 1

(b) 1.5

(c) 2

(d) infinite

(ii) An object is placed in front of a lens which forms its erect image of magnification 3. The power of the lens is 5D. The distance of the image from the lens is

(a) -40cm

(b) 40cm

(c) -80cm

(d) 80cm

(iii) The focal length of a concave lens of $\mu=1.5$ is 20cm in air. It is completely immersed in water $\mu=4/3$. Its focal length in water will be

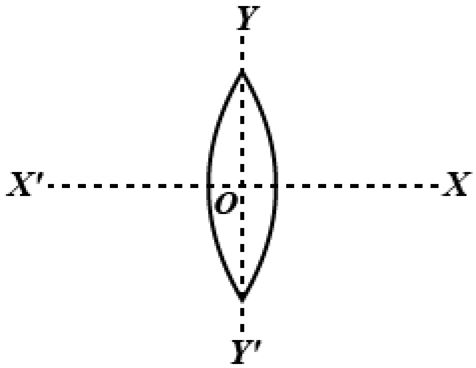
(a) 20cm

(b) 40cm

(c) 60cm

(d)80cm

(iv) An equiconvex lens is cut into two halves along (i) XOX' and (ii) YOY' as shown in the figure. Let f,f' and f'' be the focal lengths of the complete lens, of each half of the lens in case (i) and case (ii) respectively. The correct statement from the following is



(a) f'=2f and f''=f

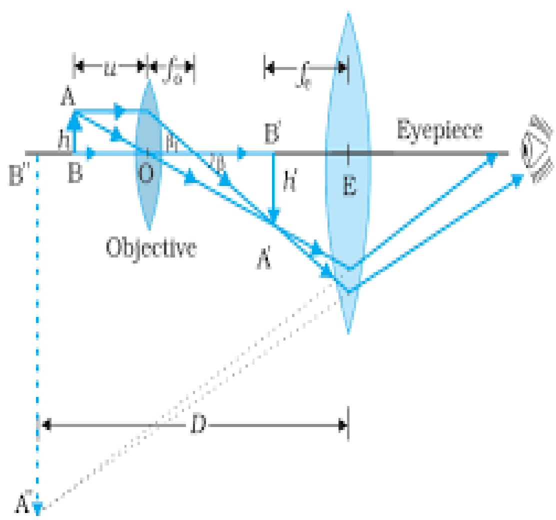
(b) f'=f and f''=f

(c) f'=2f and f''=2f

(d) f'=f and f''=2f

SECTION E

31. (a) 5



(1m)

Expression for magnification: (steps and final answer 2m)

(b)

(1m)

$u_0 = -2.5$cm and $f_0 = 1.25cm$

Now , $-\frac{1}{u_0} + \frac{1}{v_0} = \frac{1}{f_0}$ $or\ v_0 = 2.5cm$

(1m)

To find u_e, we have:

$v_e = \infty$ and $f_e = 5cm$

Calculating using the same formula as above, we get:

$u_e = -5cm$

∴ L = 2.5 + 5 = 7.5 cm

(OR)

(a) When two light sources produce waves having the same frequency and have a constant phase difference with time, they are called to be coherent. **(1m)**

The two conditions for two light sources to be coherent are as follows:
-The coherent sources of light must have originated from a single source and must be monochromatic (that is they have a single wavelength) in nature.
-The path difference between the light waves from the two sources must be small. **(1m)**

(b)

$\frac{s}{b} \le \frac{\lambda}{d}$ $(\mathbf{1m})$

(c)

$$\Rightarrow 10\frac{\lambda D}{d} = \frac{2\lambda D}{a}$$

$$\Rightarrow a = \frac{d}{5}\text{mm} = 0.2\text{ mm}$$

(1m)

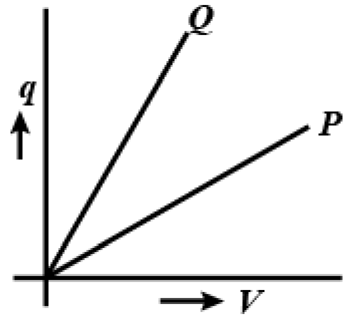
(d)

$$\lambda' = \frac{\lambda}{n} = \frac{\lambda}{4/3}$$

(1m)

32. (a) The given graph shows the variation of charge 'q' with potential difference 'V' for two capacitors C_1 and C_2. The two capacitors have same plate separation but the 5

plate area of C_2 is double that of C_1. Which of the two graphs P and Q corresponds to capacitors C_1 and C_2 and why?



Q represents C_2 and P represents C_1

Reason: From the graph the slope q/v= Capacitance is greater for Q.

Also according to given conditions the capacitance $\frac{\varepsilon A}{d}$ i.e $C \propto A$

so capacitance is larger for the

C_2 because the area of its plates is large and d for the two capacitor is same.

Hence, Q represents C_2. **(1m)**

(b) Consider two capacitors arranged in parallel.

In this case, the same potential difference is applied across both the capacitors. But the plate charges ($\pm Q_1$) on capacitor 1 and the plate charges ($\pm Q_2$) on the capacitor 2 are not necessarily the same. **(1/2m)**

$Q_1 = C_1V$, $Q_2 = C_2V$ **(1/2m)**

The net charge is

$Q = Q1 + Q2$ **(1/2m)**

$CV = C1V + C2V$ **(1/2m)**

The effective capacitance C is

$C = C1 + C2$

(c)

When switch S is closed, p.d. across each capacitor is 6V **(1/2m)**

$V_1 = V_2 = 6V$

$C_1 = C_2 = 1\mu C$

∴ Charge on each capacitor **(1/2m)**

$q_1 = q_2$ (=CV) =(1μF) x (6V) = 6μC

(1/2m)

When switch S is opened, the p.d. across C_1 remains 6V, while the charge on capacitor C_2 remains 6μC. After insertion of dielectric between the plates of each capacitor, the new capacitance of each capacitor becomes **(1/2m)**

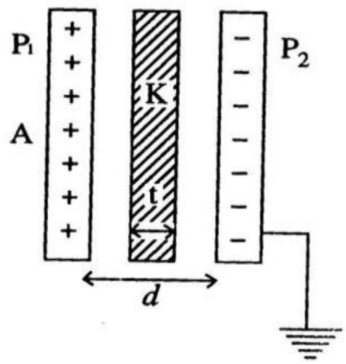
$C_1' = C'_2 = 3x1\mu F = 3\mu F$

(i) Charge on capacitor C_1, $q_1' = C_1' V_1 = (3\mu F) \times 6V = 18\mu C$ Charge on capacitor C_2 remains 6μC

(1/2m)

(OR)

(a)Let us consider a dielectric slab of thickness t introduced in the gap between the plates of a parallel plate capacitor. **(1/2m)**



(1/2m)

The potential difference between the plates is given by $V = E_0(d-t) + \frac{E_0}{K}t$ **(1/2m)**

$$V = \left[\frac{Q}{A\varepsilon_0}\left((d-t) + \frac{t}{K}\right)\right]$$

(1/2m)

The capacitance is

$$C = \frac{Q}{V} = \frac{\varepsilon_0 A}{(d-t) + \frac{t}{K}}$$ **(1/2m)**

(b)

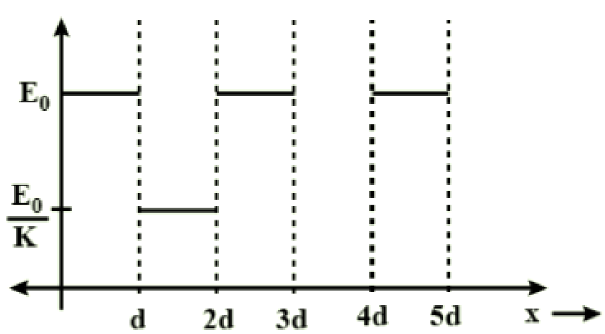
(1/2m)

$$V = E_0 d + \frac{E_0}{k} d + E_0 d + 0 + E_0 d$$

(1/2m)

$$V = 3 E_0 d + \frac{E_0}{k} d$$

(1m)

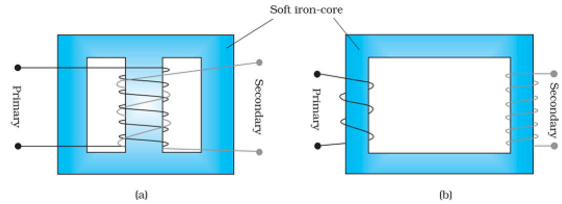


33. (a) ***Transformer-*** **(3m)**

It is a device used to increase the given ac voltage without a change in its frequency.

Principle-It is based on the principle of mutual induction.

Construction- It consists of two sets of coils, insulated from each other. They are wound on a soft iron core, either one on top of the other or on separate limbs of the core.



Two arrangements for winding of primary and secondary coil in a transformer: (a) two coils on top of each other, (b) two coils on separate limbs of the core.

One of the coils is the input coil called primary coil (having N_p turns) and the other is the output coil called secondary coil (having N_s turns)

Working-When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. The value of this emf depends on the turns in the secondary. Let us consider an ideal transformer in which the primary has negligible resistance and all the flux in the primary is also linked with the secondary.
Let φ be the flux in each turn in the core due to current in primary. Then the induced emf e_s in the secondary and primary is given by

$$e_s = -N_s \frac{d\emptyset}{dt} - - - (1)$$

$$e_p = -N_p \frac{d\emptyset}{dt} - - - (2)$$

Since the primary has zero resistance.

$.e_p = V_p.$

If the secondary is an open circuit or current drawn from it is small, then $e_s = V_s$.

Therefore

$$V_s = -N_s \frac{d\emptyset}{dt} - - - (3)$$

$$V_p = -N_p \frac{d\emptyset}{dt} - - - (4)$$

From (3) & (4) we get,

$$\frac{Vs}{V_p} = \frac{N_s}{N_p} - - - -(5)$$

For an ideal transformer, Power input=power output
$V_p I_p = V_s I_s$

$$\frac{V_s}{V_p} = \frac{I_p}{I_s} = \frac{N_s}{N_p} --- (6)$$

(b)No. **(1m)**

A step up transformer steps of the voltage while its steps down the current. So the input and output power remain same (provided there is no loss). Hence there is no violation of the principle of energy conservation.

(c) **(1m)**

Here, $n_P = 200, n_s = 1000,$

$P_i = 10kW = 10000W, E_P = 200V$

$E_s = ?, I_P = ?$

As $\frac{E_s}{E_P} = \frac{n_s}{n_P} = \frac{1000}{200} = 5$

Also, $E_P I_P = P_i = 1000,$

$$I_P = \frac{10000}{E_P} = \frac{10000}{200} = 50A$$

(OR)

(a) Phasor diagram for a series LCR circuit connected to an ac source of voltage and derivation for current flowing in the circuit and the phase angle between the voltage across resistor and the net voltage in the circuit. **(3m)**

(b) **(1m)**

$$v = v_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2 \times 3.14\sqrt{8 \times 2 \times 10^{-6}}}$$

$$= \frac{1000}{8 \times 3.14} = 39.8 \text{ hertz.}$$

(c) **(1m)**