CLASS : XII

SUBJECT – PHYSICS

SOLUTIONS

1. (d) 10^{-3} to 10^{6} Ωcm
2. (b) Increases
3. (d) complete image will be formed
4. (b) Opposes the rise
5. (c) 2 : 1
6. (c) $\frac{2}{\ln(2)}$ MΩ
7. (c) $\frac{2I_m}{\pi}$
8. (a) 0.9 Å
9. (a) Wavelength increases
10. (b) Davisson-Germer experiment
11. (b) $e(v_x B_y + v_y B_x)\hat{k}$
12. (b) Common emitter
13. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
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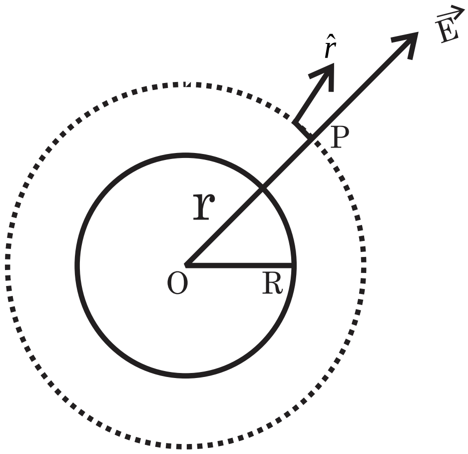
17. Gauss's law

The surface integral of electrostatic field $\vec{E}$ produced by any surface over any closed surface S enclosing a volume V in vacuum

i.e., total electric flux over the closed surface S in vacuum, is $\frac{1}{\varepsilon_0}$ times the total charge (Q) contained inside S, i.e.

$$\phi_E = \oint \vec{E}.d\vec{s} = \frac{Q}{\varepsilon_0}$$

$\rightarrow$ Electric field outside a uniformly charged spherical shell.



$$\oint_S \vec{E}.d\vec{s} = \oint_S \vec{E}.\hat{n}\,d\,s$$

$$E\oint_S ds = \frac{q}{\varepsilon_0}$$

$$E.\left(4\pi r^2\right) = \frac{q}{\varepsilon_0}$$

$$E = \frac{q}{4\pi\varepsilon_0 r^2}$$

18. l = 31.4 cm

m = 0.2 Am

M = ?

R = radius of semicircle

$\therefore L = \pi r \Rightarrow r = \frac{l}{\pi} = \frac{31.4}{3.14}$

r = 10 cm = 0.1m

M = m × 2r

= 0.2 × 2 × 0.1 = 0.04 Am^2

19. Function of a transformer –

A transformer is a device that changes (increases or decreases) the alternating voltage white keeping the frequency constant.

- If it increase voltage, it is called set-up transformer.
- If it decreases the voltage, it is called a stepdown transformer.
- It works on the principle of electromagnetic induction.

Conservation of power in an ideal transformer.

V_P = Primary voltage

I_P = Primary current

V_S = Secondary voltage
I_S = Secondary current
N_P, N_S = no. of turns in primary and secondary coils.

Then, $\frac{V_S}{V_P} = \frac{N_S}{N_P}$

For ideal transformer,
input Power = Output Power
$V_P I_P = V_S I_S$
This shows that when voltage increases, current decreases proportionally, and total power remains constant, hence power is conserved.

20. Conductivity, $\sigma = e\,(n\mu_e + p\mu_n)$
$e = 1.6 \times 10^{-19}$C
$\therefore\ \sigma = (1.6 \times 10^{-19})\ \{(8 \times 10^{13} \times 24000) + [4 \times 10^{12} \times 200]$

$$\rho = \frac{1}{\sigma} = 3.25\ \Omega cm$$

Here, $n = 8 \times 10^{13}\ cm^{-3}$
$P = 4 \times 10^{13}\ cm^{-3}$
Since, n > P, the semiconductor is n-type.

21. Photoelectric work function (ϕ)
The work function ϕ of a metal is the minimum energy required to remove an electron from the surface of the metal.
It is a property of material.
S.I. Unit = Joule
$\phi = hv_0$
Stopping Potential (V_s)
The stopping potential (V_s) is the minimum (negative) potential applied to the collector with respect to the emitter that just stops the most the most energetic photoelectrons from reaching the collector,
i.e., it reduces the potocurrent to zero
$K_{max} = hv - \phi$
$eV_s = K_{max} = hv - \phi$

$$V_s = \frac{hv - \phi}{e}$$

If hv < ϕ, no electrons are emitted and no stopping potential exists.

22. The max value of the input voltage,

$$V_0 = \sqrt{2}V_{rms}$$

$$= \sqrt{2} \times 220 = 311.08$$

311.08 to primary of transformer
Max. value of output voltage across secondary of transformer,

$$V_s = \frac{n_s}{n_p} \times V_p$$

$$V_s = \frac{1}{12} \times 311.08 = 25.92 \approx 26V$$

$$V_{d_c} = \frac{V_s}{\pi} = \frac{26}{3.14} = 8.28V$$

23. For incident light of wavelength λ,
$k_{max} = k$
For light of wavelength λ_2, $k_{max} = 2k$

Hence, $h_c\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right) = k$

and, $h_c\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right) = 2k$

$$\Rightarrow 2\left(\frac{1}{\lambda}, \frac{-1}{\lambda_0}\right) = \frac{1}{\lambda_2} - \frac{1}{\lambda_0}$$

$$\Rightarrow \frac{1}{\lambda_0} = \frac{2}{\lambda_1} - \frac{1}{\lambda_2}$$

$$\lambda_0 = \frac{\lambda_1\lambda_2}{(2\lambda_2 - \lambda_1)}$$

and work function of the metal,

$$\phi_0 = \frac{hc}{\lambda_0} = \frac{h_c(2\lambda_2 - \lambda_1)}{\lambda_1\lambda_2}$$

24. Induced emf at any time t,

$e = \frac{LdI}{dt}$, this opposes the growth of current.

For a small time dt, the amount of work done required to flow the current,
dW = eldt
= LI
Hence, Total work done to increases the current from zero to maximum value I is,

$$W = \int dw$$

$$= \int_0^1 LIdI = \frac{Ll^2}{2}$$

$$\Rightarrow E = \frac{1}{2}LI^2$$

(b) from $U_B = \frac{1}{2}LI^2 = \frac{1}{2}L\left(\frac{B}{\mu_0 n}\right)^2 \ (\because B = \mu_0 ni)$

$$\Rightarrow U_B = \frac{1}{2}(\mu_0 n^2 Al)\left(\frac{B}{\mu_0 n}\right)^2$$

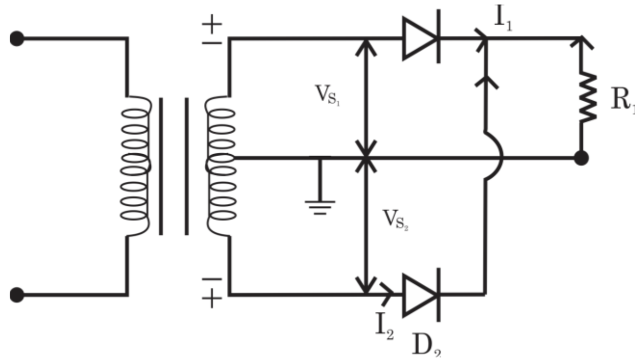
$$= \frac{1}{2\mu_0}B^2 AL$$

Magnetic energy per unit volume is,

$$\mu_0 = \frac{V_B}{V}$$

$$\mu_b = \frac{U_B}{Al} = \frac{B^2}{2\mu_0}$$

25.



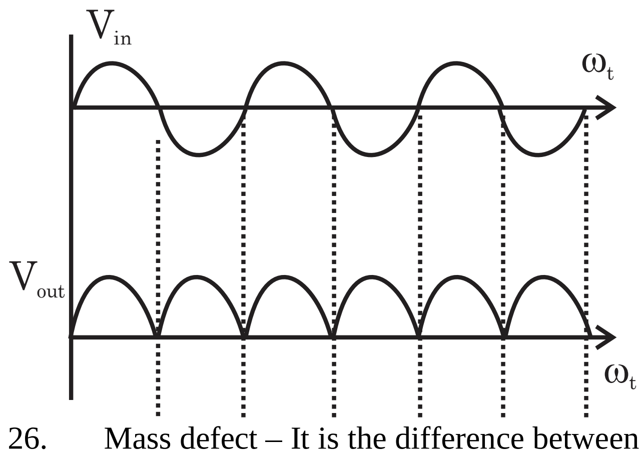
During the positive half cycle –

When the top terminal of the AC source is positive and the bottom is negative, diodes D_1 becomes forward biased, allowing current to flow through the R_L. D_2 becomes reverse – biased and blocks current.

During the negative half cycle

When the top terminal of the AC source is negative and the bottom is positive, diode D_2 become forward biased. The current now flow through D_2, R_L in the same direction as before. D_1 becomes reverse – biased and blocks current.

$$V_{DC} = \frac{2\times V_{Peak}}{\pi}$$



26. Mass defect – It is the difference between the sum of masses of the nucleons of nucleus and the rest mass of nucleus.

It is denoted by

$$\Delta m = \left[m_p Z + m_n\left(A-Z\right)_u\right] - M$$

Binding energy = The energy required to split the nucleus into its constituent nucleons is known as binding energy. It is measured as the energy equivalent to mass defect.

Binding energy = ΔmC^2.

In nuclear fission, a heavy nucleus (e.g. U – 235) splits into smaller nuclei, releasing energy. This occurs because the binding energy per nucleon of the smaller fragments is higher than that of the original nucleons, leading to the release to excess energy.

(b) Mass of deuteron, m_d = 2.013553 u

Total mass of proton and neutron

= $m_d + m_n$

= (1.007277) + 1.008665)

= 2.0159424

Mass defect, Δm = 2.015942 – 2.013553 $\div$0.0023894

Binding energy, B.E. = Δm = 931.5

= 0.002389 × 931.5 = 2.225 MeV

27. (a) displacement current, $I_d = \varepsilon_0 \dfrac{d\phi_E}{dt}$

Conduction current, $I_C = I = \dfrac{d\phi}{dt}$

Since the changing electric field inside the capacitor produces a displacement current equal to the conduction current,

We have, $I_C = I_d$

Thus, at all points in the circuit, the total current remains continuous

$I_c + I_d = I$

(b) Yes, Kirchoff's function rule states that the sum of currents entering a function is equal to the sum of currents leaving the function. In a capacitor, although there is no physical movement of charge across the plates, displacement current ensures continuity. Therefore, Kirchhoffs function rule remains valid.

28. (i) Let RS moves with speed V right and also RS is at distance X_1 and X_2 from PQ at instants t_1 and t_2 respectively.

Change in flux,

$$d\phi = \phi_2 - \phi_1 = Bl\left(x_2 - x_1\right)$$

$$\left(\because \phi = \vec{B}.\vec{A} = BA\cos 0^o = Blx\right)$$

$$\Rightarrow d\phi = Bldx$$

$$\Rightarrow \frac{d\phi}{dt} = Bl\frac{dx}{dt}\ \left(\because v = \frac{dx}{dt}\right)$$

$$I = \frac{VBl}{R}$$

(ii) Magnetic force = BIlsin 90º

$$I = \frac{VBl}{R} \; Bl = \frac{VB^2l^2}{R^2}$$

Now, external force must be equal to magnetic force

$\therefore$ External force $= \dfrac{VB^2l^2}{R}$

(iii) As, P = I^2R

$$P = \left(\frac{VBl}{R}\right)^2 \times R = \frac{V^2B^2l^2}{R^2} \times R$$

$$P = \frac{V^2B^2l^2}{R}$$

OR

Self inductance of a coil is the property of the coil in which it posses the change of current flowing through it. Inductance is attained by a coil due to a self induced emf produced in the coil itself.

By changing the current flowing it. Self-indiction of the long solenoid of indicutance L, the magnetic field inside such a solenoid is constant at any point and given by,

$$B = \frac{\mu_0 NI}{\ell}$$

Magnetic flux through each turn of solenoid

ϕ = B × area of each turn

$$\phi = \frac{\mu_0 NI}{\ell} \times A$$

Total flux = flux × total no. of turns

$$N\phi = N\left(\frac{\mu_0 NI}{\ell} \times A\right) \quad \ldots\ldots. (1)$$

$N\phi$ = LI ……. (2)

From (1) and (2) $LI = N\left(\dfrac{\mu_0 NI}{\ell} \times A\right)$

$$L = \frac{\mu_0 N^2 A}{\ell} \quad \ldots\ldots. (3)$$

The magnitude of emf is given by,

$$|e| = \frac{LdI}{dE} \quad \ldots\ldots. (4)$$

Multiplying both sides with I,

eIdt = LidI

as, $I = \dfrac{dq}{dt}$

workdone, dω = voltage × charge

dω = e×dq = eIdt

substitude the values in equation LI ……. (4)

dω = LIdt

by ineqrating both sides

$$\int_0^{\omega} d\omega = \int_0^{I_0} d\omega LIdt$$

$$\omega = \frac{1}{2} LI_0^2$$

This work done is in increasing the current flow through inductor is stored as potential energy (U) in the magnetic field of inductor $U = \dfrac{1}{2} LI_0^2$

29. (a) $\rightarrow$ d. $\vec{E} \times \vec{B}$
(b) $\rightarrow$ b. proton
(c) $\rightarrow$ a. polarisation

Or

$\rightarrow$ d. frequency

(d) $\rightarrow$ b. in phase and perpendicular to each other

30. When thin transparent sheet is placed over one slit in a double-slit experiment, it introduces an additional path difference. This cause the entire interference pattern to shift. The shift is given by,

$$\Delta x = \frac{D}{d}(\mu - 1)t$$

Fringe width, $\beta = \dfrac{\lambda D}{d}$

λ = 600 nm = 600 × 10^{-9} m

d = 0.3 mm = 0.3 × 10^{-3} m

D = 2m

$$\frac{\beta = \left(600 \times 10^{-2}\right)(2)}{0.3 \times 10^{-3}} = 4 \text{ mm}$$

For μ = 1.5 and t = 0.01 mm = 0.01 × 10^{-3} m the shift is,

$$\Delta x = \frac{D}{d}(\mu - 1)t$$

$$\frac{2}{0.3 \times 10^{-3}}\left(1.5^{-1}\right)\left(0.01 \times 10^{-3}\right)$$

Δx = 6.67 mm

Number of fringes shifted (N) is the total shift divided by the fringe width

$$N = \frac{\Delta x}{\beta} = \frac{6.67 \times 10^{-3}}{4 \times 10^{-3}} = 1.667$$

The new path difference (Δ) is the sum of the original path difference (Δ_0) and the additional path difference caused by sheet. The additional path difference is

$(\mu-1)t$

$\Delta = \Delta_0 + (\mu-1)t$

If shift equals on fringe, then $\Delta x = \beta$

$$\beta = \frac{D}{d}(\mu-1)t \Rightarrow t = \frac{\beta d}{d(\mu-1)}$$

$$t = \frac{(4\times10^{-3})(0.3\times10^{-3})}{2(1.5-1)} = 1.2\,\mu m$$

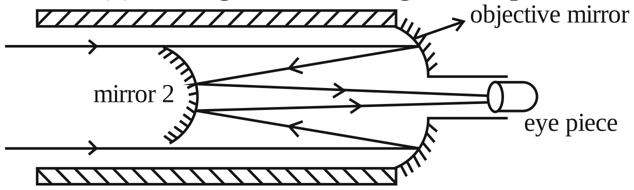
(a) The interference pattern shifts upwards (or toward the slit with the sheet) because the path of light through the sheet is optically longer.

(b) The pattern shifts by 1.67 fringe width

(c) Path difference, $\Delta = \Delta_0 + (\mu-1)t$

(d) Thickness, $t = 1.2 \times 10^{-6}$ m

31. (a) Cassegrain reflecting telescope



Rays coming from infinity will be parallel to each other fall the objective mirror. Reflecting from objective mirror falls on the spherical mirror-2 which reflects its and allow it to fall on eye-piece forming an image.

(b) For the eye-piece

$$\frac{1}{u_C} = \frac{1}{v_C} - \frac{1}{f_e}$$

$$= \frac{1}{40} - \frac{1}{10} = \frac{3}{40}$$

$$u_e = \frac{40}{3} \text{ cm}$$

magnification produced by eye-piece is,

$$m_e = \frac{v_e}{u_e} = \frac{40}{40/3} = 3$$

Diameter of the image formed by the objective is, D = 6/3 = 2 cm

$\therefore$ angle substend by it on the objective will be,

$$d = \frac{D}{1.5\times10^{11}} \text{ rad}$$

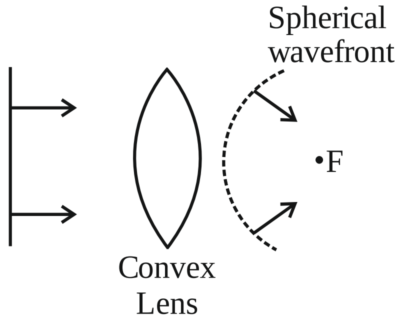
Now, angle subtended by the image at the objective = angle subtended by the sun

$$d = \frac{\text{size of image}}{f_0} = \frac{2}{200} = \frac{1}{100} \text{ rad}$$

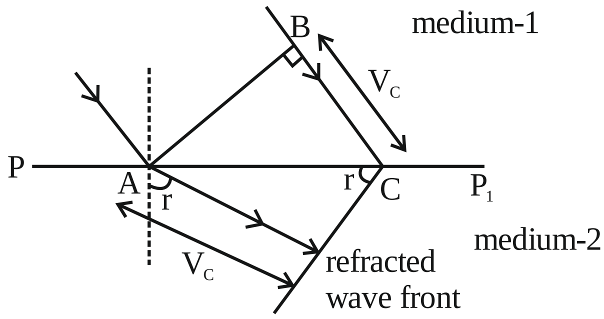
$$\therefore \frac{D}{1.5\times10^{11}} = \frac{1}{100} \Rightarrow D = 1.5\times10^{9}$$

OR

(a)



(b) According to Huygens principle, each point of the wavefront is the source of the secondary disturbance and the wavelets emanating from these points spread out in all direction with the speed of the wave. These waves emanating from the wavefront are usually referred to as secondary wavelets and if we draw a common tangent to all these spheres, we obtain the new position of the wavefront of a leter time.



$BC = V_1\tau$

$AE = V_2\tau$

$$\sin i = \frac{BC}{AC} = \frac{V_1\tau}{AC}$$

$$\sin r = \frac{V_2\tau}{AC}$$

$$\frac{\sin i}{\sin r} = \frac{V_1\tau}{V_2\tau}$$

As, $n_1 = \dfrac{C}{V_1}$ and $n_2 = \dfrac{C}{V_2}$

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

(c) $\lambda = 590$ nm

$n = 1.5$

$$v_2 = \frac{c}{n} = \frac{3\times10^8}{1.5} = 2\times10^8 \text{ ms}$$

$$\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2} \Rightarrow \frac{3\times10^8}{590\times10^{-4}} = \frac{2\times10^8}{\lambda_2}$$

$\therefore \lambda_2 = 393 \times 10^{-9}$ m = 393 nm

32. (i) Electric field between the plates of a parallel plate capacitor,

$$E = \frac{\sigma}{\varepsilon_0} \Rightarrow \sigma = \frac{Q}{A}$$

Potential difference between plates,

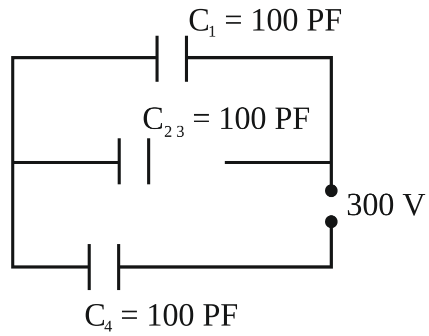
V = Ed

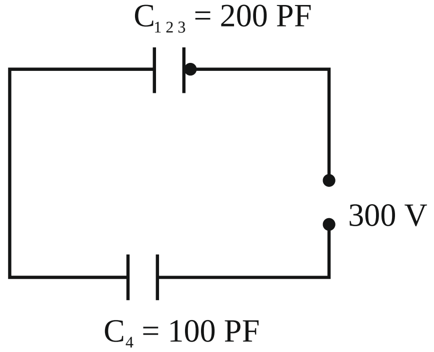
$$\therefore V = \frac{Q}{\varepsilon.A}.d$$

Capacitance, $C = \frac{Q}{V}$

$$\therefore C = \frac{Q}{\left(\frac{Qd}{\varepsilon.A}\right)} = \frac{\varepsilon_0 A}{d}$$

(ii)





Equivalent capacitance, = $\frac{200}{3}$ PF

Charge on $C_4 = \frac{200}{3} \times 10^{-12} \times 300$

= 2×10^{-8} C

Potential difference across

$$C_4 = \frac{200 \times 10^{-12} \times 300}{3 \times 100 \times 10^{-12}} = 200 \text{ V}$$

Potential difference across

$C_1 = 100 \times 10^{-12} \times 100$

= 1×10^{-8} C

P.D across C_2 and C_3 series combination = 100 V

= 1×10^{-8} C

P.D across C_5 and C_3 series combination = 100 V

P.D across C_2 and C_3 each

= $200 \times 10^{-12} \times 50 = 1 \times 10^{-8}$ C

OR

(i) Electric field in the vaccuum space between the plates is $E_0 = \frac{\sigma}{\varepsilon_0}$

(ii) Electric field inside the dielectric slab is

$$E = \frac{E_0}{K} = \frac{\sigma}{K\varepsilon_0}$$

Potential difference V. with slab,

$V = E_0(d–t)+Et$

$$\frac{\sigma}{\varepsilon_0}(d-t) + \frac{\sigma}{K\varepsilon_0}t$$

$$V = \frac{\sigma}{\varepsilon_0}\left(d - t + \frac{t}{k}\right)$$

Substuting, $\sigma = \frac{Q}{A}$,

$$\therefore V = \frac{Q}{A\varepsilon_0}\left[d - t + \frac{t}{k}\right]$$

Capacitance,

$$C = \frac{Q}{V} = \frac{Q}{\frac{\sigma}{\varepsilon_0}\left(d - t + \frac{t}{k}\right)} = \frac{A\varepsilon_0}{d - t + \frac{t}{k}}$$

(iii) Initial energy stored in C_1 $u_i = \frac{1}{2}C_1 V_0^2$

when switch is closed, two capacitors are in parallel.

$C_{eq} = C_1 + C_2$

Total charge difference across both capacitors is,

$$V_f = \frac{Q_{total}}{C_{eq}} = \frac{C_1 V_0}{C_1 + C_2}$$

Find energy stored in the system is,

$$V_f = \frac{1}{2}C_{eq}V_f^2 = \frac{1}{2}(C_1 + C_2)\left(\frac{C_1 V_0}{C_1 + C_2}\right)^2$$

$$V_f = \frac{1}{2}\frac{C_1^2 + V_0^2}{C_1 + C_2}$$

Ratio of V_f of V_i

$$\frac{V_f}{V_i} = \frac{C_1}{C_1 + C_2}$$

ratio of energies before and after connection S,

$$\frac{V_i}{V_f} = \frac{C_1 + C_2}{C_1} = 1 + \frac{C_1 + C_2}{C_1}$$

33. (a) $X_L = 2\pi f L$

$$L = \frac{X_L}{2\pi f} = \frac{20}{2 \times 3.14 \times 100} = 0.032\,\text{H}$$

(b) A battery is a source of D.C. and thus f =

OH_2

As $X_L = 2\pi fL$, the inductive reactance of the inductor becomes zero.

(c) $P_{avg} = V_{rms}\, l_{rms} \cos\phi$

$\phi = 90^o$ for pure inductive circuit

$\pi_{avg} = 0$

(d) Power dissipated in an LCR circuit is maximum when $X_L = X_C$

$$f = \frac{1}{2\pi\sqrt{LC}} = 0.398 \times 10^3\ H_2$$

$f = 398\ H_2$

OR

(a) Voltage across the secondary coil is given by

$$\frac{N_P}{N_S} = \frac{V_P}{V_S}$$

$$V_S = V_P \times \left(\frac{N_S}{N_p}\right) = 240 \times \frac{50}{500} = 24\ V$$

(b) Current in secondary coil,

$$I_S = \frac{V_S}{R_S} = \frac{24}{20} = 1.2\,A$$

Current in Primary coil,

$$\frac{I_P}{I_S} = \frac{N_S}{N_P} \Rightarrow I_P = \frac{N_S}{N_P} \times I_S$$

$$= \frac{50}{500} \times 1.2 = 0.12\ A$$