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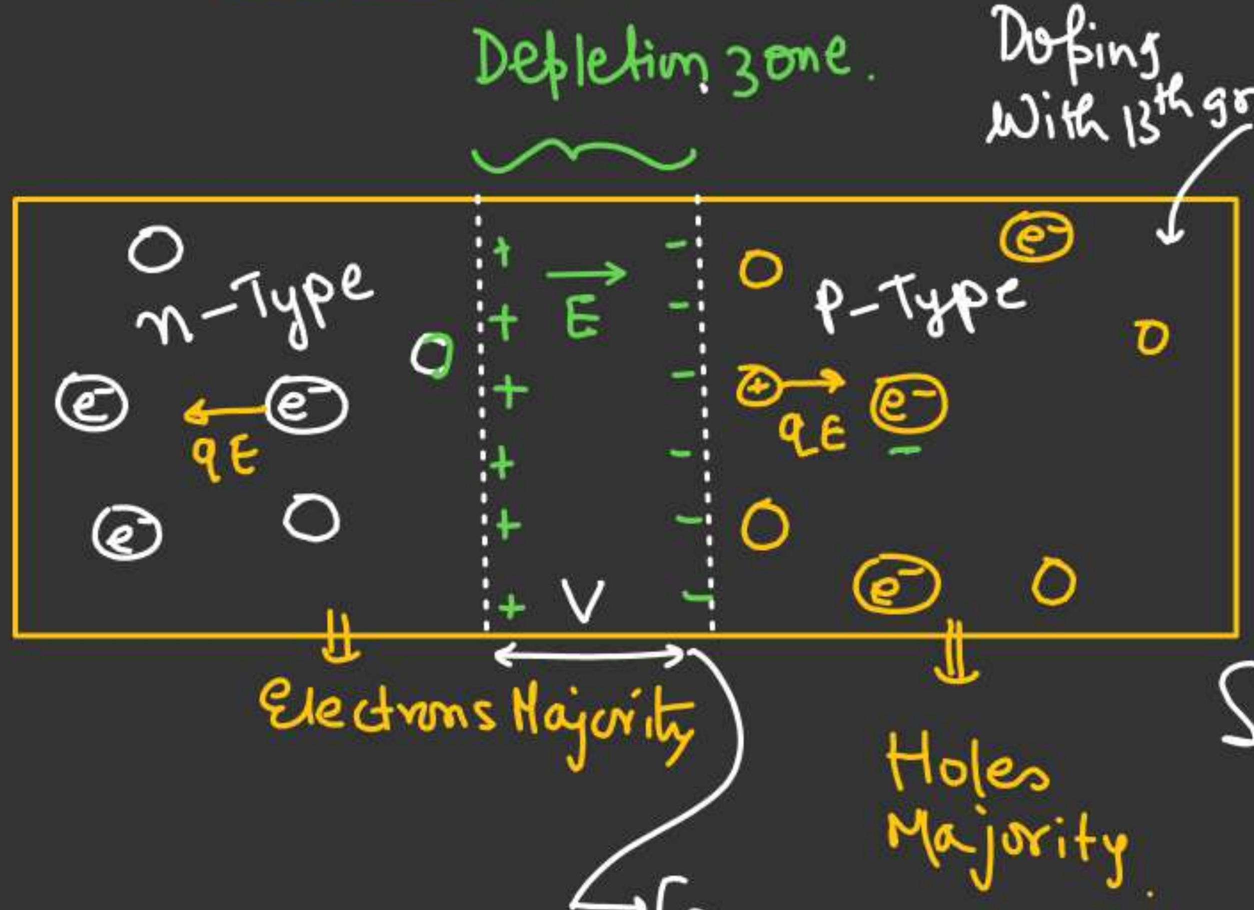
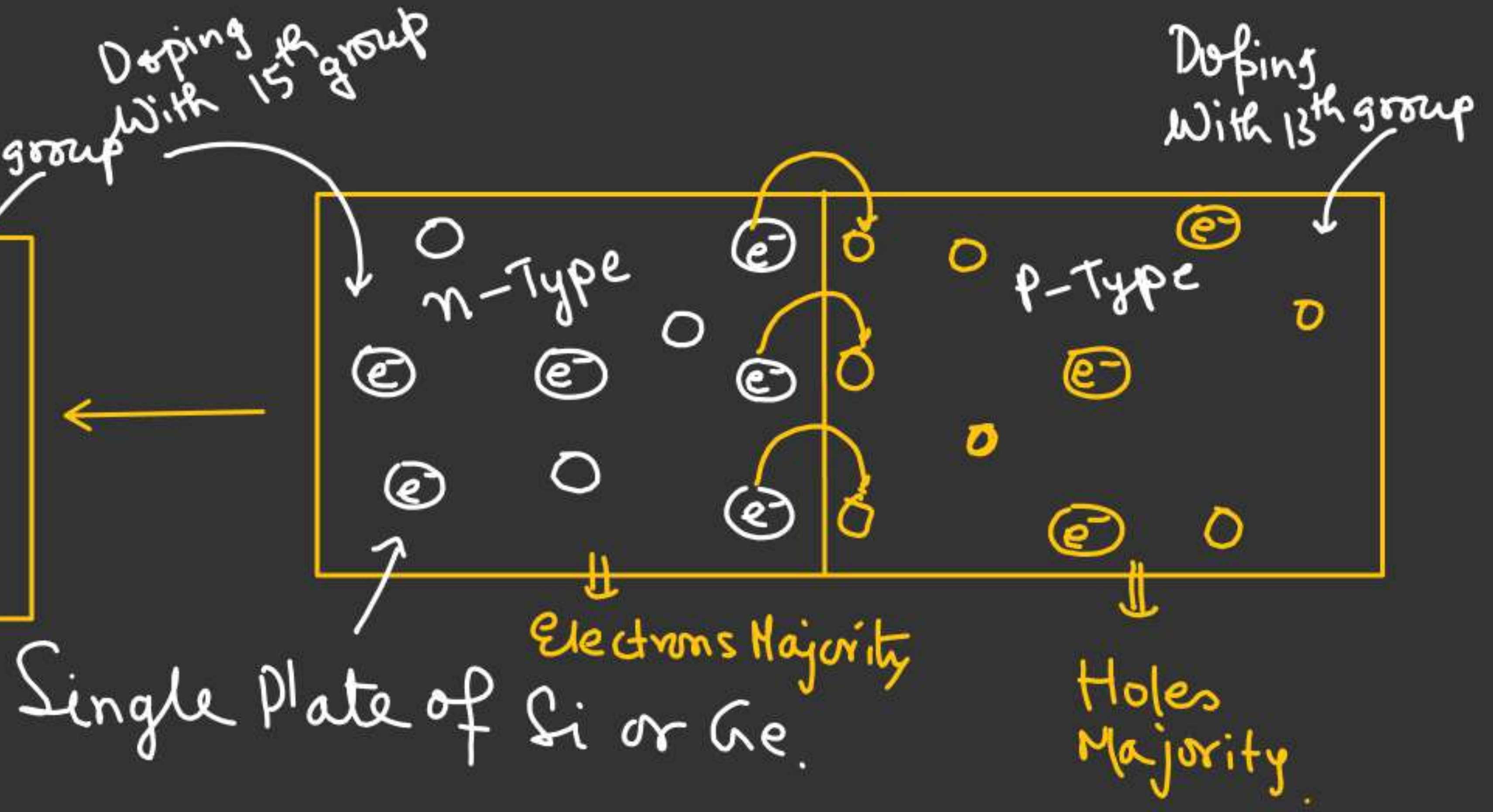
P-N JUNCTION





Due to barrier potential further diffusion process will supress.

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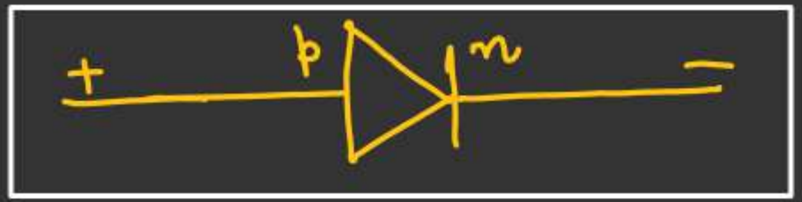
Diode → p-n junction as a diode.



(Direction of Current)

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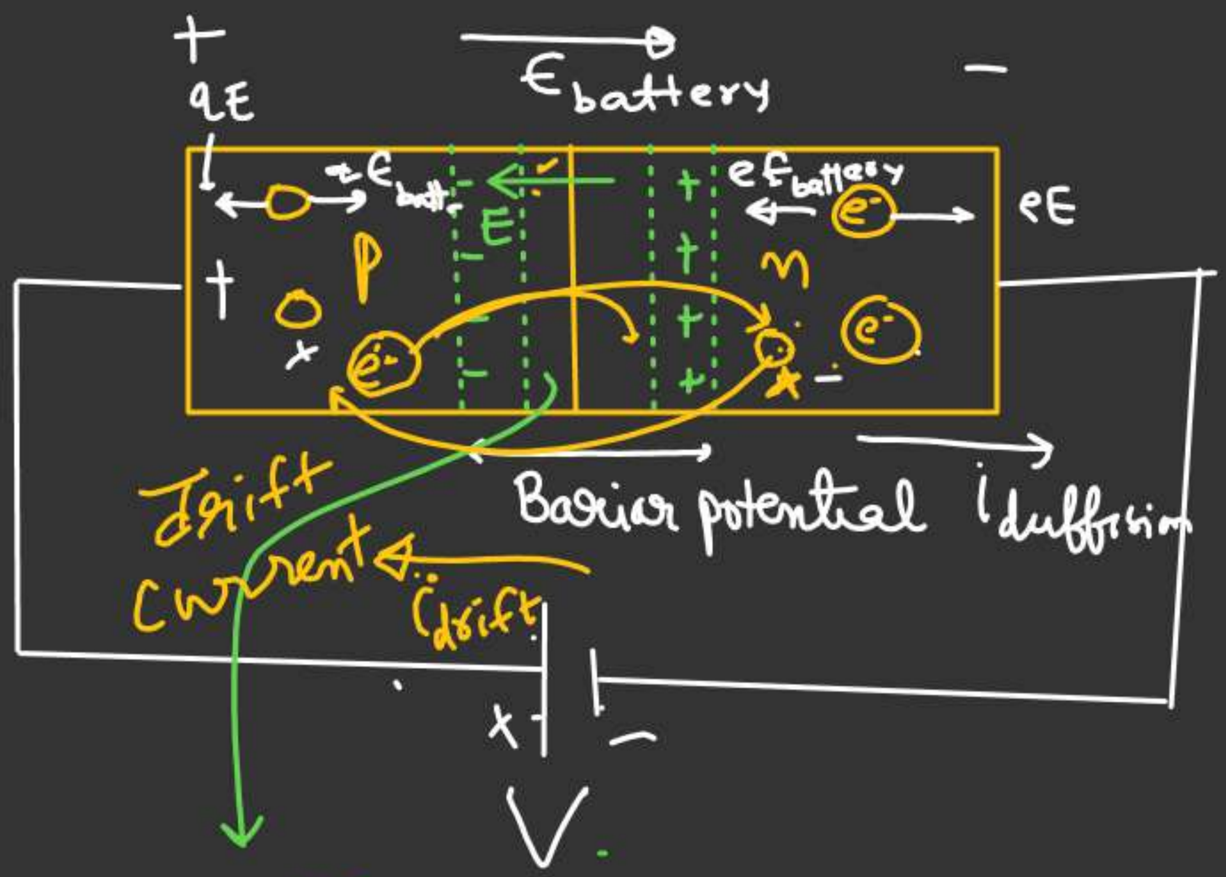
Biasing of P-N junction

Forward biasing

→ Diffusion Current :-

→ Drift Current :-

↳ Due to Minority charge Carries. which are drifted by barrier potential Electric field.



① Barrier potential decreases. & Diffusion start

② offer very low resistance.

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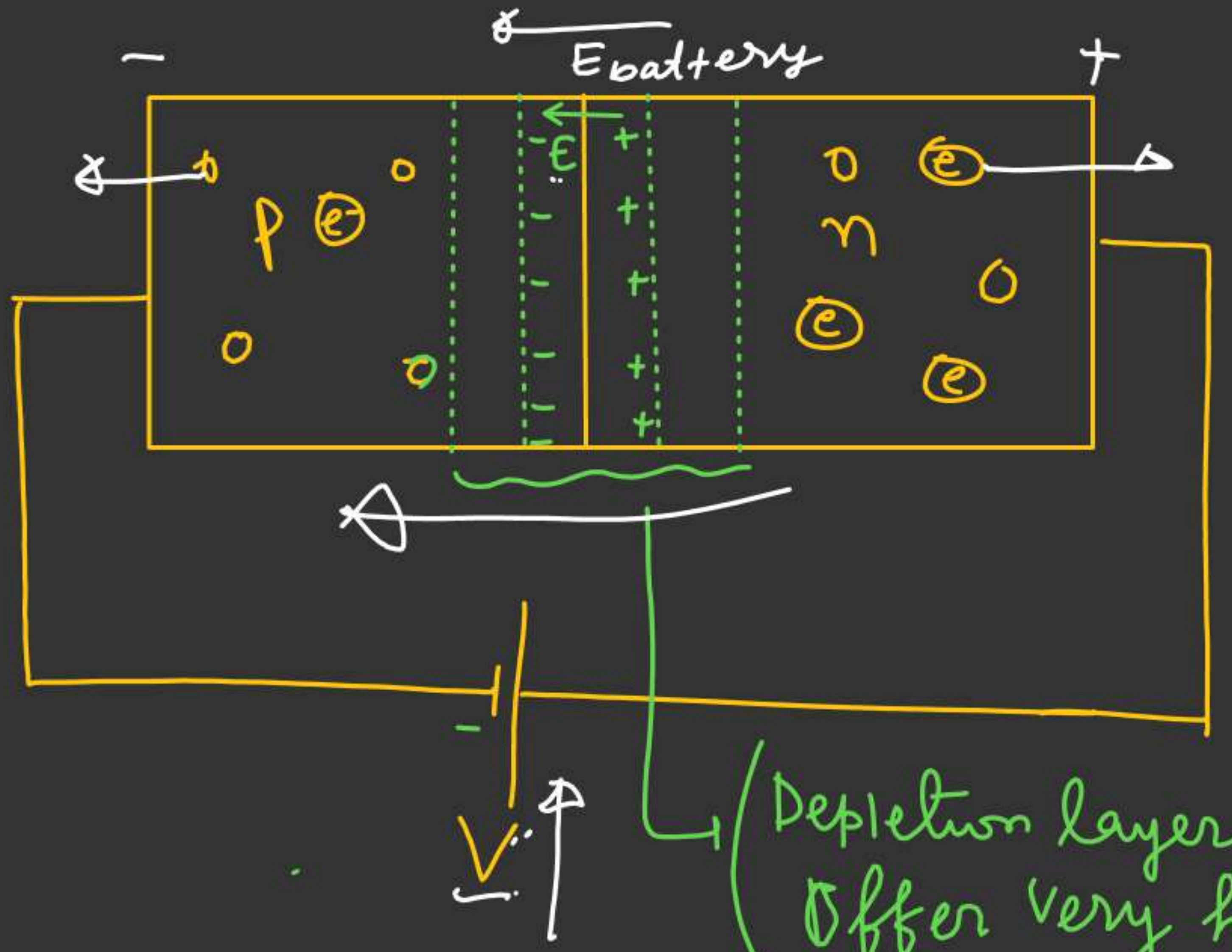
Reverse biasing



(Depletion layer increases.
Offer very high resistance)

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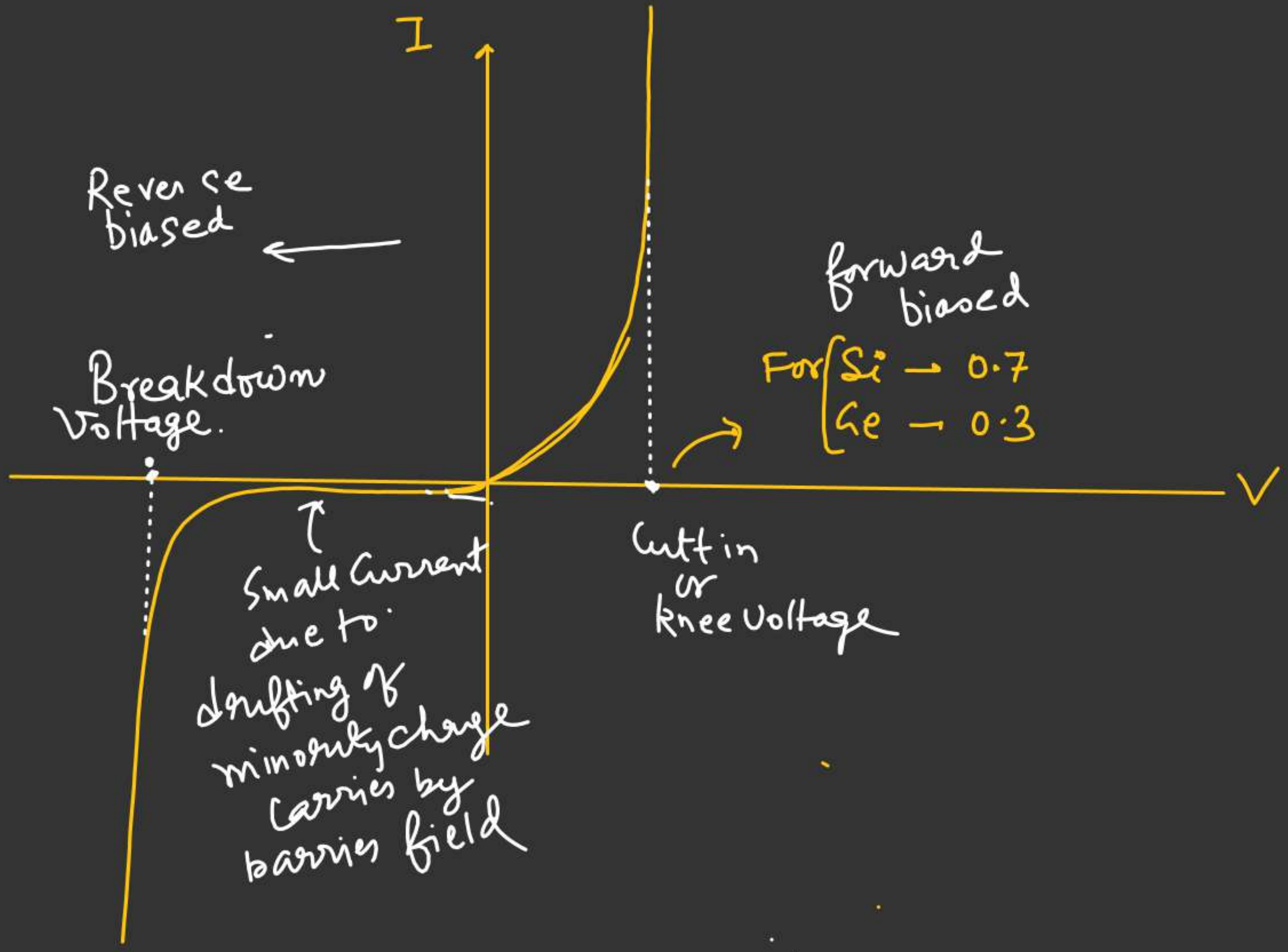

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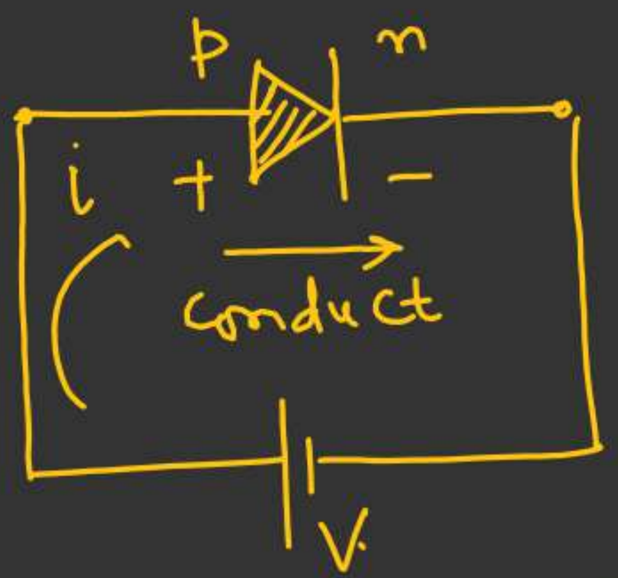
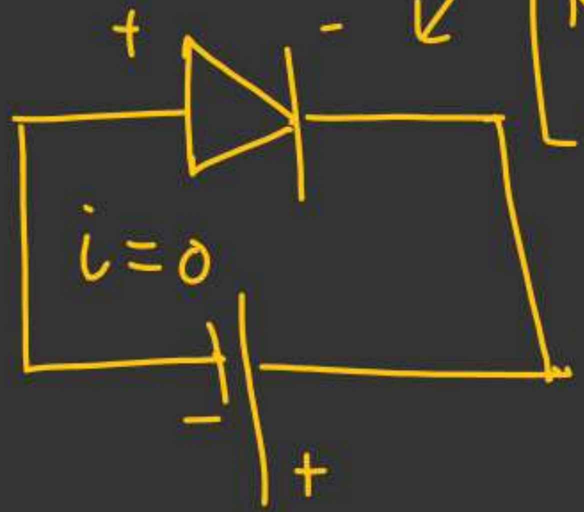
Diode → p-n junction as a diode.

↳ Diode will Conduct in forward biasing.

↳ Not Conduct i.e open Ckt in reverse biasing.

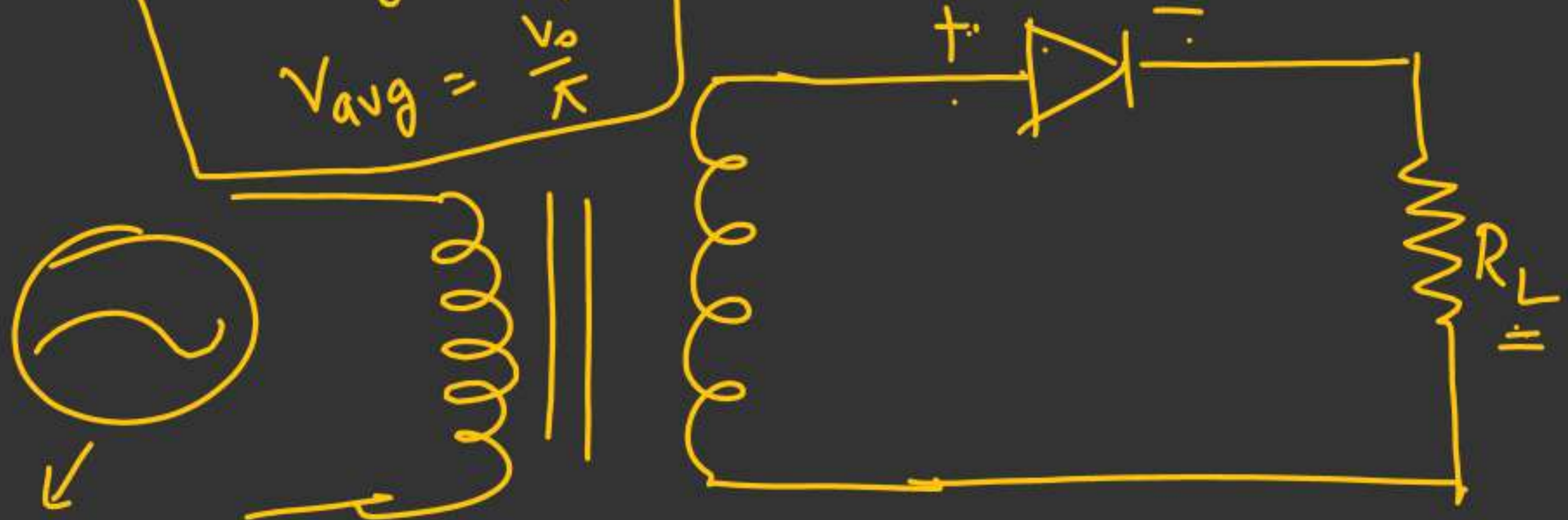




[Reverse biasing

Diode as a half wave rectifier

$$\boxed{\begin{aligned} I_{avg} &= \frac{I_0}{\pi} \\ V_{avg} &= \frac{V_0}{\pi} \end{aligned}}$$ ✓



For +ve half Signal
↳ Diode in forward biasing Mode → conduct

For -ve half Signal
↳ Diode in reverse biasing Mode → Not Conduct

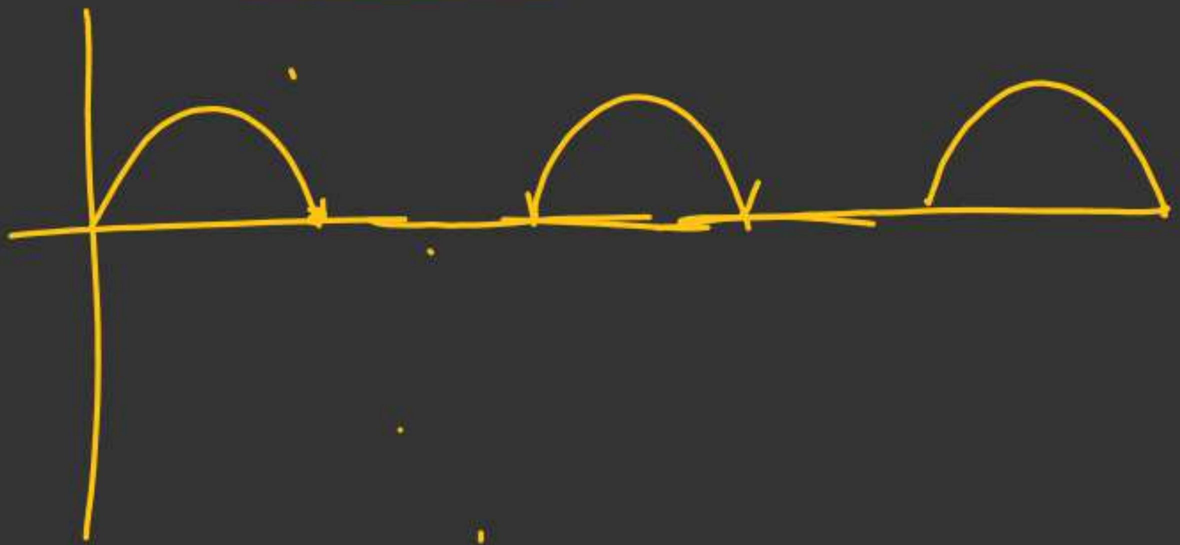
Input Signal

AC → Flu

Input Signal

=

output signal →



$I = I_0 \sin\omega t$

$$I_{avg} = \frac{\int_0^{\pi} I_0 \sin\omega t\,dt}{\int_0^{\pi} dt} = \frac{I_0}{\pi}$$

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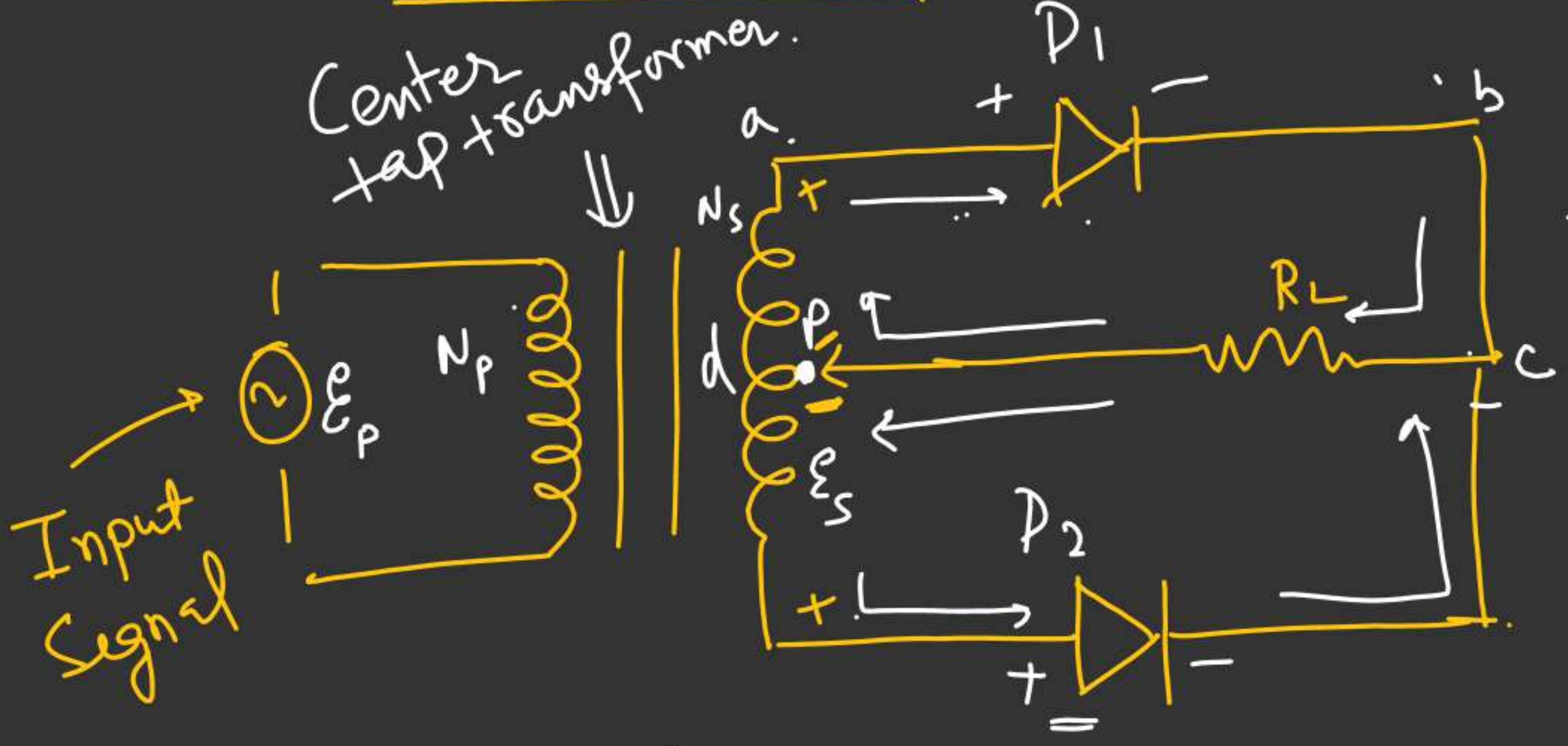
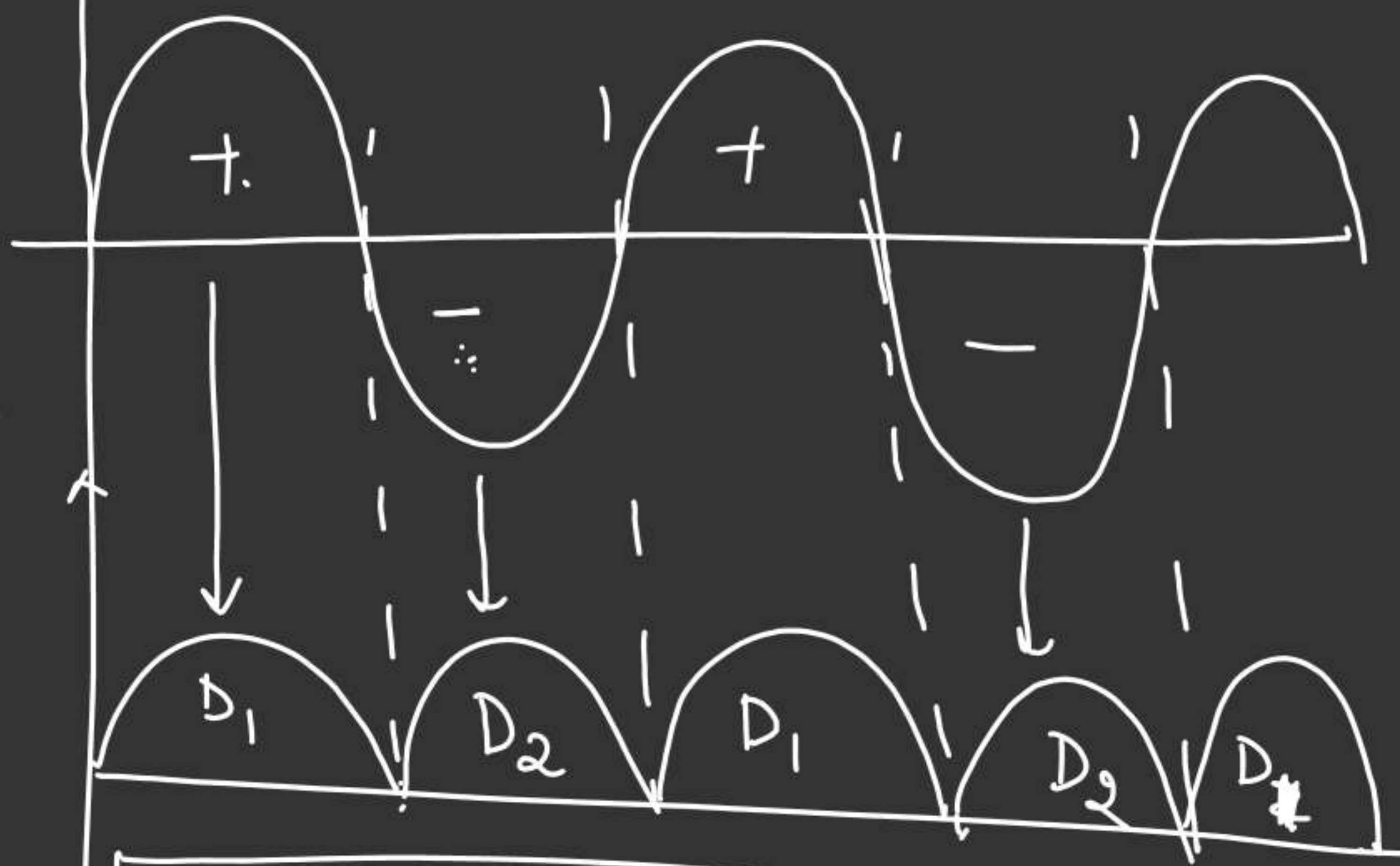
Full Wave Rectifier





$$\frac{\mathcal{E}_p}{\mathcal{E}_s} = \frac{N_p}{N_s} \checkmark$$

$$\boxed{\mathcal{E}_s = \frac{N_s}{N_p} \times \mathcal{E}_p} \checkmark$$

$$\boxed{V_{avg} = \frac{2V_0}{\pi},\ I_{avg} = \frac{2I_0}{\pi}}$$

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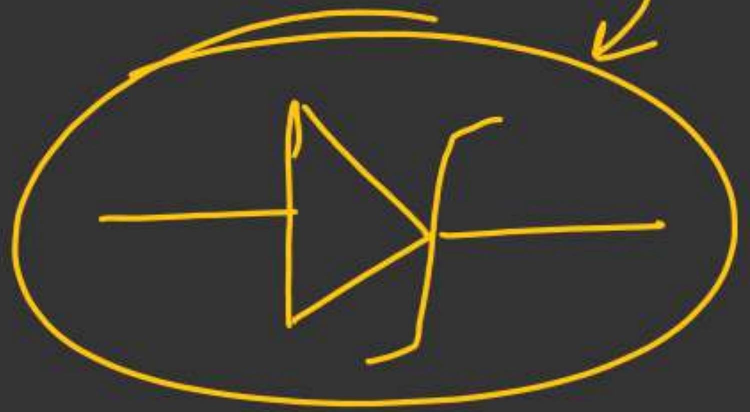
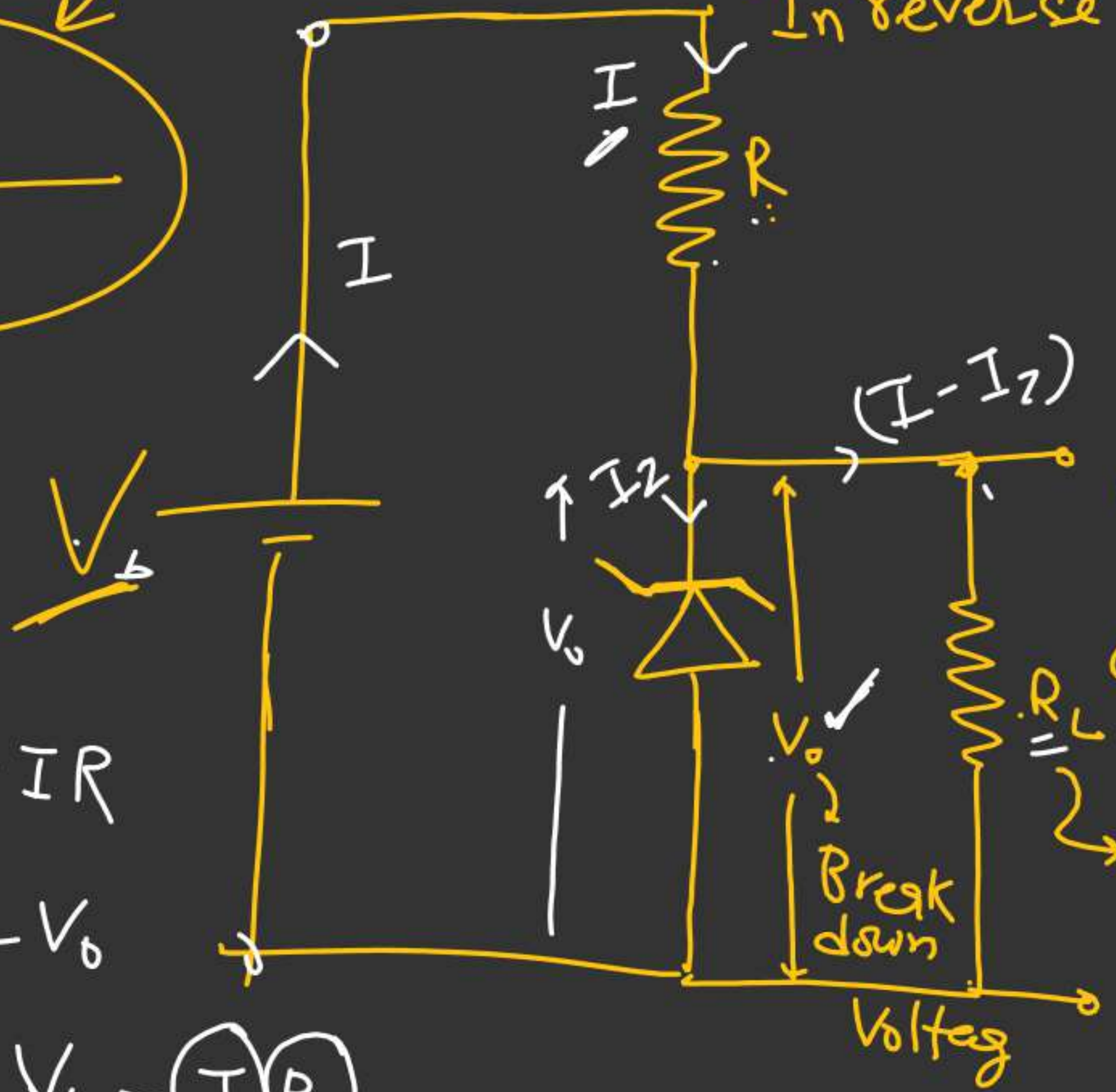
Zener Diode



① Zener diode work in reverse biasing mode.

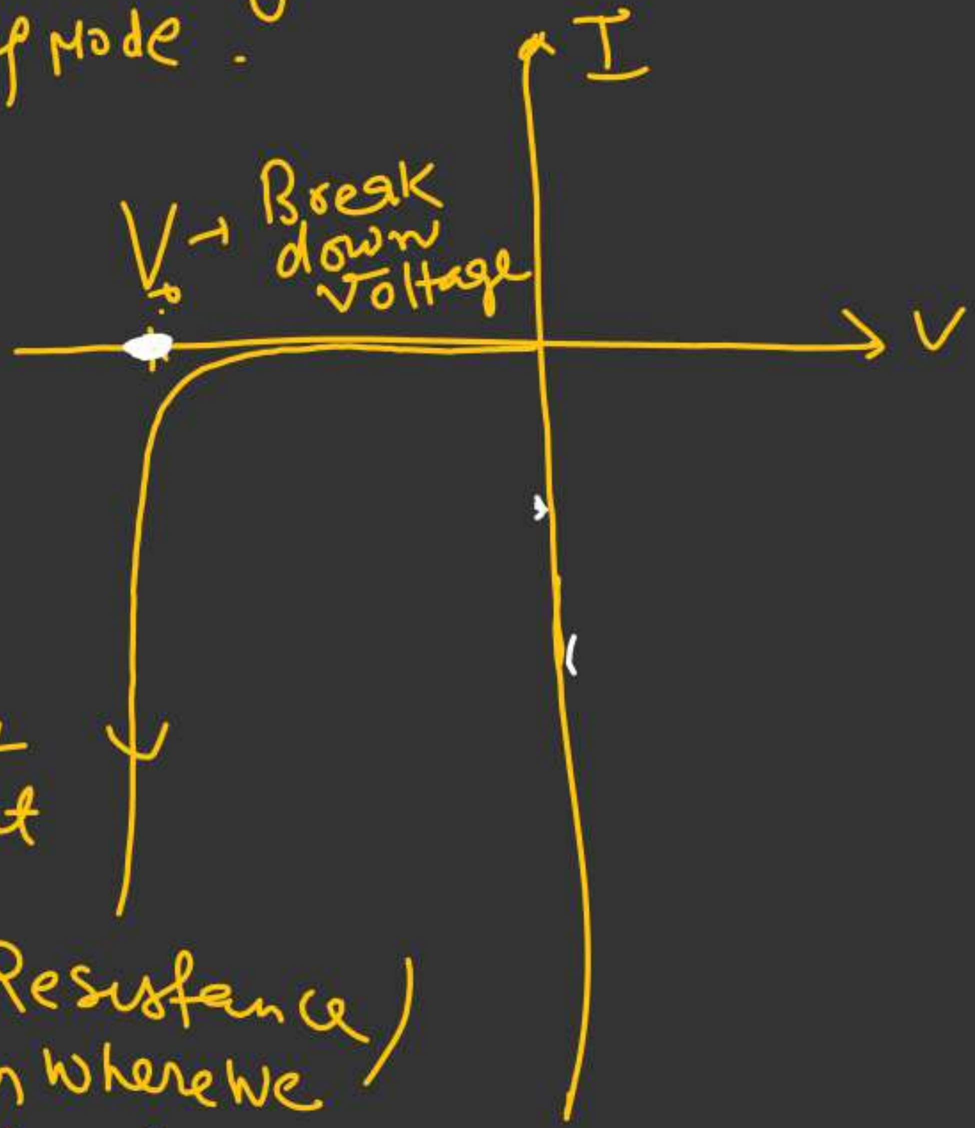


$V_{R_L} = V_0$

$\Downarrow$

Constant output

R_L → (Load Resistance from where we get output)



$$V_b = V_0 + IR$$

$$IR = V_b - V_0$$

$$V_0 = V_b - I R$$

V_0 ⇓ Constant

I → Chang.

R → Changing

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SEMICONDUCTORS

Imp :

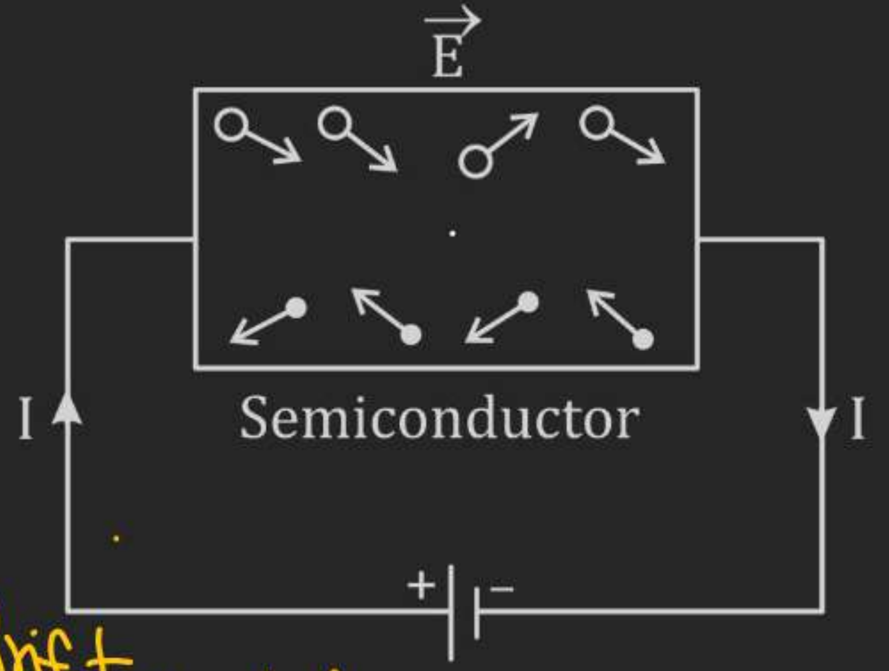
ELECTRICAL CONDUCTIVITY OF A SEMICONDUCTOR

Consider a block of semiconductor of length l, area of cross-section A, and having free electron density n_e and hole density n_h.

suppose a potential difference V is applied across its ends. The electric field setup inside it will be $\left[E = \frac{V}{l}\right]$

Mobility — $\mu = \frac{E}{v_d}$

Electrons begin to drift with velocity v_e in the opposite direction of E while holes drift in the direction of E with velocity v_h.



Total current = Electron current + Hole current

$I = I_e + I_h$ → hole current   [μ_e = Electron mobility]

$I_e = n_e eAV_e, I_h = n_n\ eAV_h$ [μ_n = Hole Mobility]

$I = eA(n_e v_e + n_h v_h)$ ✓

V_e = drift velocity of e^- $I = neAv_d$ v_h = drift velocity of hole

SEMICONDUCTORS

If R is the resistance of the semiconductor block and P its resistivity $R = P\frac{l}{A}$.

If the applied field E is low the Semiconductor obey ohm's law.

$$I = \frac{V}{R} = \frac{El}{Pl/A} = \frac{EA}{P} \Rightarrow I = \frac{EA}{P} = eA(n_e v_e + n_h v_h)$$

$$\frac{E}{P} = e(n_e v_e + n_h v_h),\left(\mu_e = \frac{v_e}{E}\right),\left(\mu_h = \frac{v_h}{E}\right)$$

$$\frac{E}{P} = e(n_e \mu_e E + n_h \mu_h E) \Rightarrow \boxed{\frac{1}{P} = e(n_e \mu_e + n_h \mu_h).}$$

imp.

$$\boxed{\sigma = \frac{1}{P} \Rightarrow \sigma = e(n_e \mu_e + n_h \mu_h)}$$

SEMICONDUCTOR & DIODE

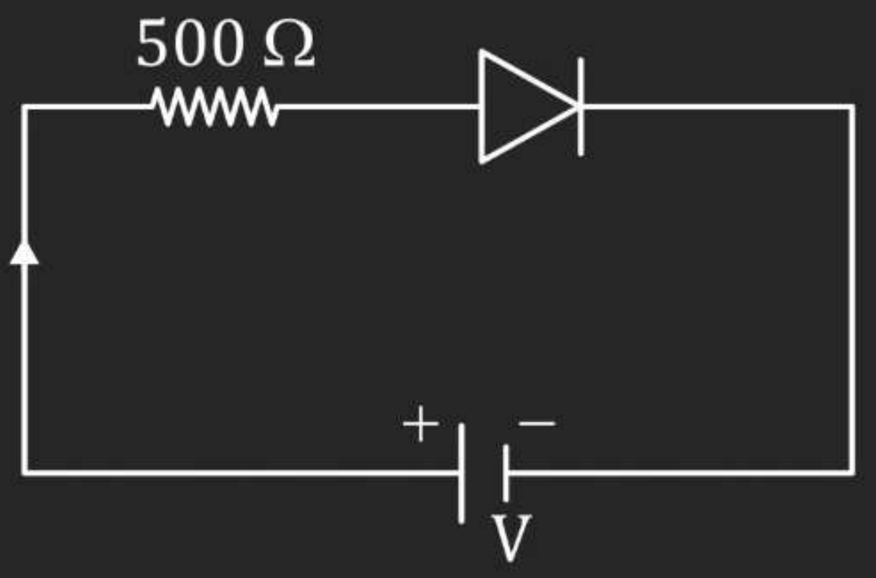
Q.1 Mobilities of electrons and holes for an intrinsic silicon is $0.64\ \mathrm{m^2\ V^{-1}\ s^{-1}}$ and $0.36\ \mathrm{m^2\ V^{-1}\ s^{-1}}$ respectively. If the electron and hole densities are equal to $1.6 \times 10^{19}\ \mathrm{m^{-3}}$. What is the conductivity of silicon?

SEMICONDUCTOR & DIODE

Q.2 When the voltage drop across a p-n junction is increased from $0.80\ \mathrm{V}$ to $0.82\ \mathrm{V}$, the change in the diode current is $20\ \mathrm{mA}$. What is the dynamic resistance of the diode?

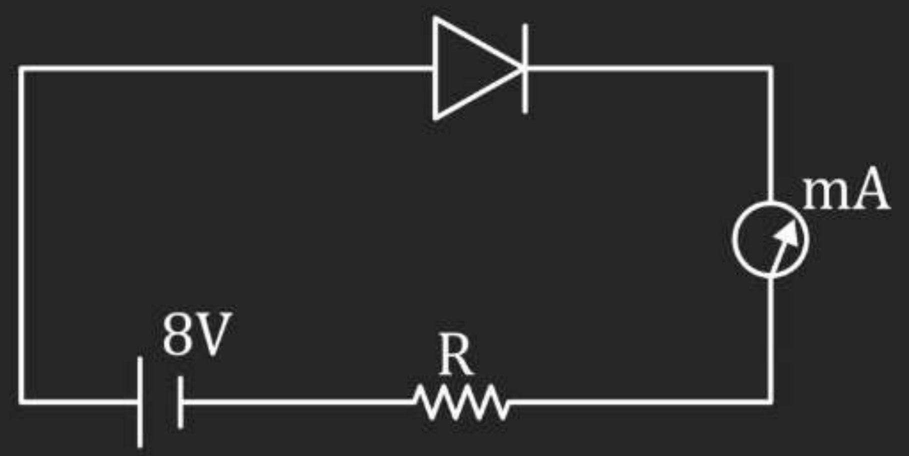
SEMICONDUCTOR & DIODE

Q.3 In the given circuit the voltage drop across the diode is $0.8\ \mathrm{V}$, if the diode can withstand current upto maximum of $30\ \mathrm{mA}$, then find the maximum voltage of the battery



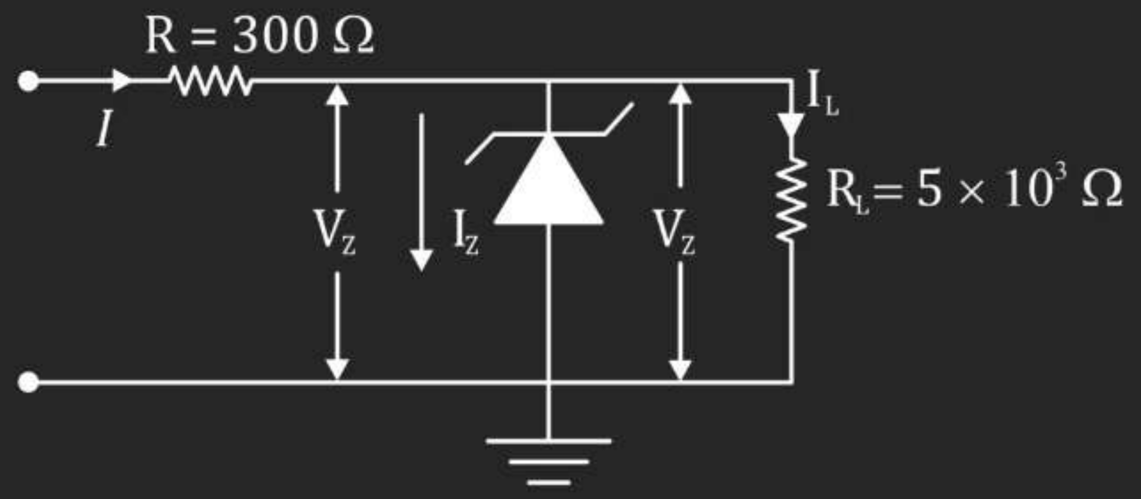
SEMICONDUCTOR & DIODE

Q.4 In the given circuit a silicon diode with knee voltage $0.7V$ is forward biased with a battery of e.m.f $8\ V$. The current in the circuit is $40\ mA$. Find the power drop at resistor R and diode.



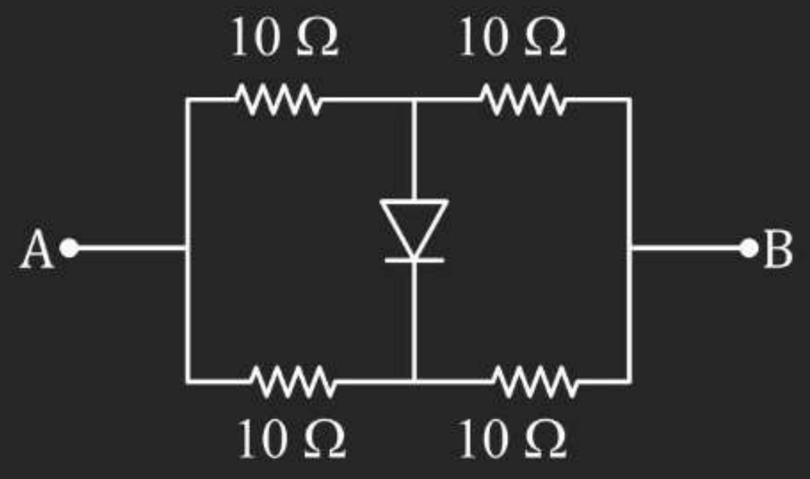
SEMICONDUCTOR & DIODE

Q.5 In the given figure, what is the voltage needed to maintain $25\ \mathrm{V}$ across the load resistance R_L, if Zener diode required a minimum current of $20\ \mathrm{mA}$ to work satisfactorily?



SEMICONDUCTOR & DIODE

Q.6 Four equal resistors, each of resistance 10Ω, are connected as shown in the circuit diagram. The equivalent resistance between A and B is



(A) 5Ω

(B) 10Ω

(C) 20Ω

(D) 40Ω

SEMICONDUCTOR & DIODE

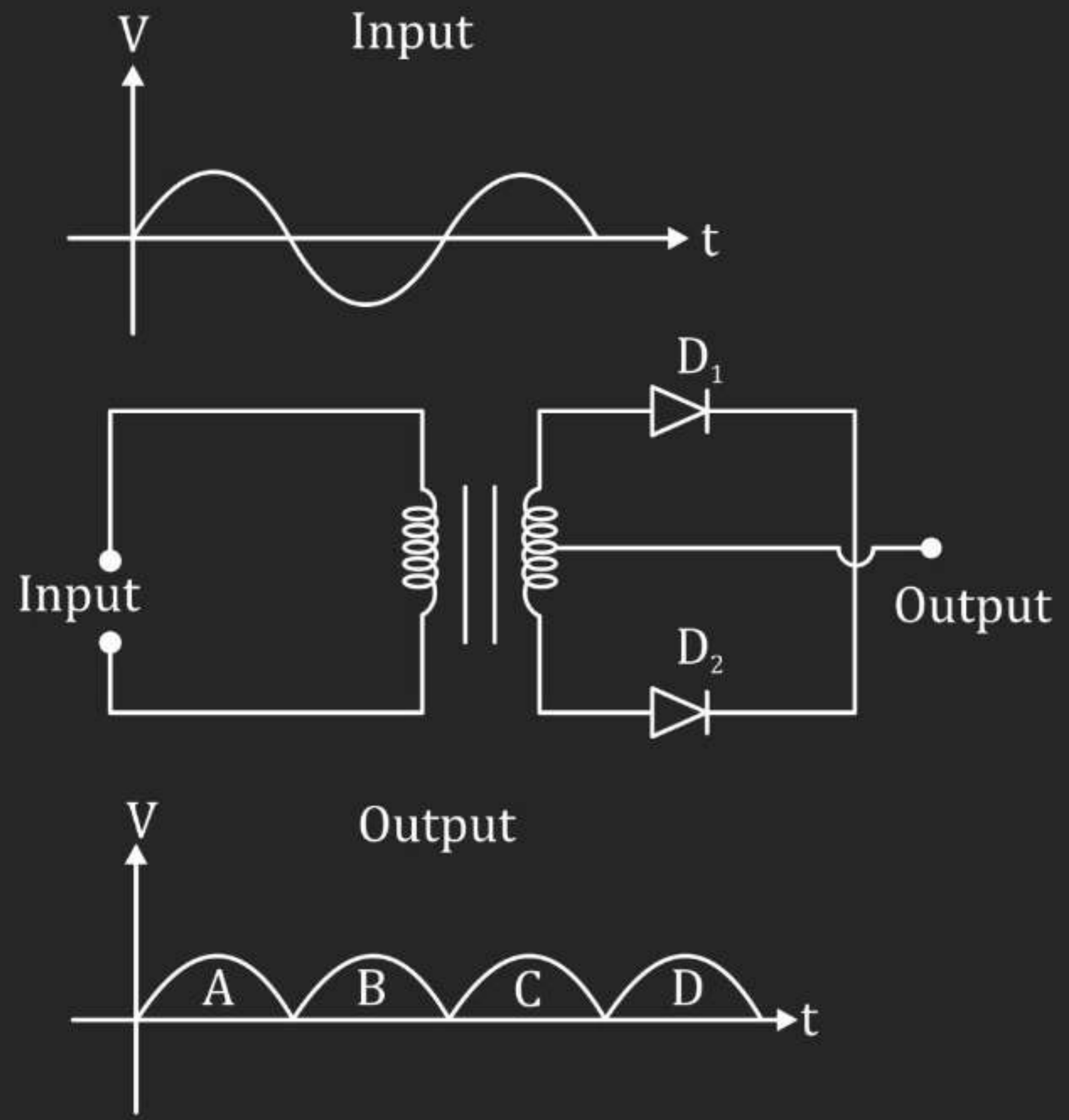
Q.7 A full wave rectifier circuit along with the input and output are shown in the figure. The contribution from the diode D_2 is (are)

(A) C

(B) A, C

(C) B, D

(D) A, B, C, D



Q.8 In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be

(A) 50 Hz

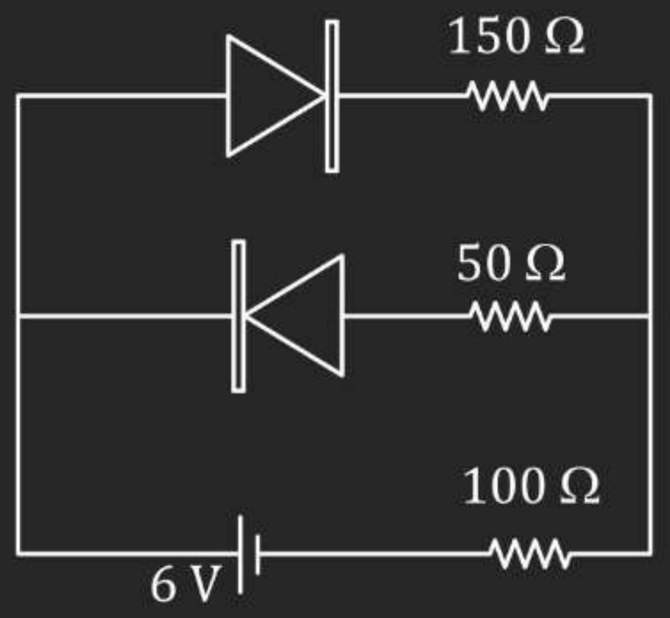
(B) 100 Hz

(C) 25 Hz

(D) 70 Hz

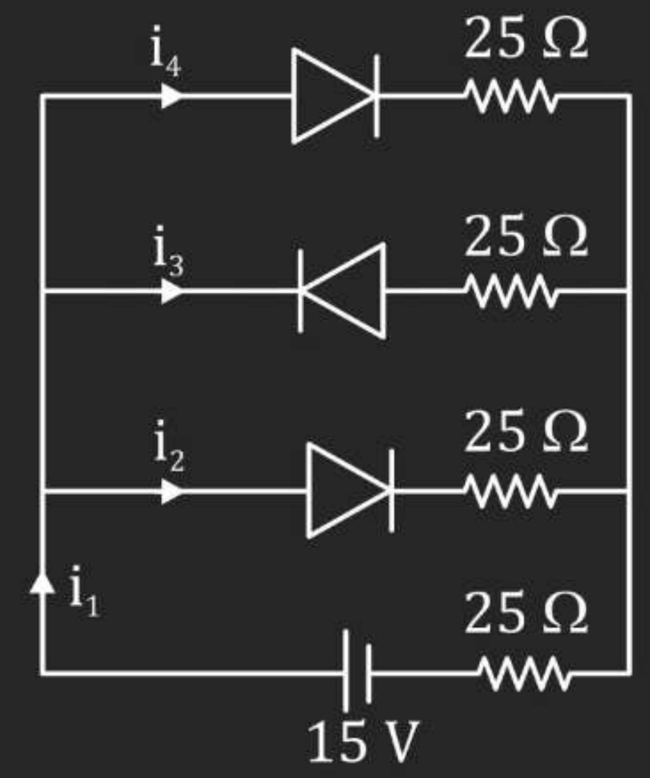
SEMICONDUCTOR & DIODE

Q.9 The circuit contains two diodes each with a forward resistance of 50Ω and with infinite reverse resistance. The current (in A) through 100Ω resistor is



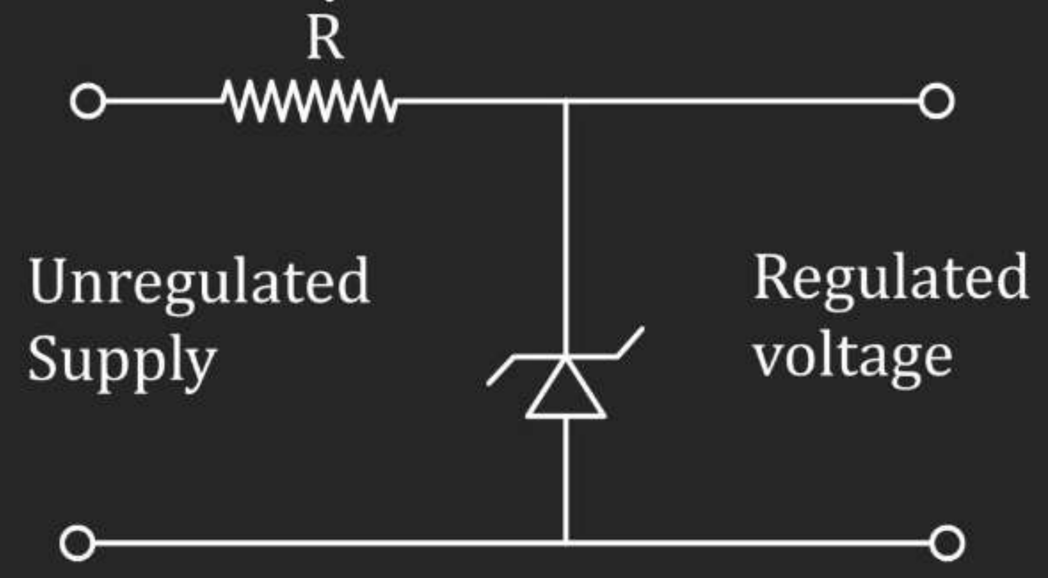
SEMICONDUCTOR & DIODE

Q.10 In the circuit shown, if each diode has a forward biased resistance of 75Ω and infinite resistance in reverse bias, what will be the value of current i_1 (in A)?



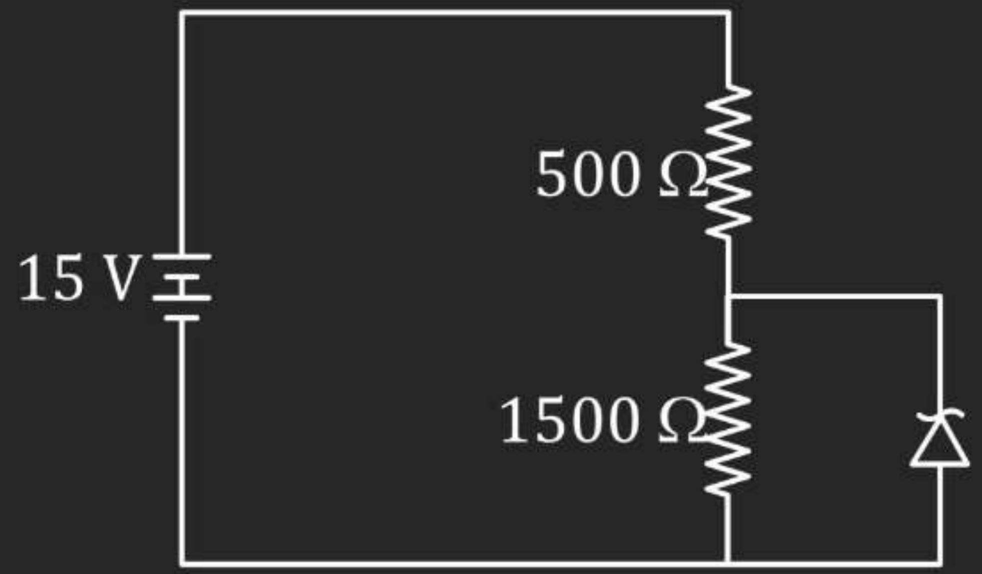
SEMICONDUCTOR & DIODE

Q.11 A Zener diode of power rating $2\ \mathrm{W}$ is to be used as a voltage regulator. If Zener has a breakdown of $5\ \mathrm{V}$ and it is being fed with voltage fluctuating between $3\ \mathrm{V}$ and $7\ \mathrm{V}$, what should be value of R for self operation?



SEMICONDUCTOR & DIODE

Q.12 In the circuit, the current through Zener diode is $\mathrm{n\ mA}$. Value of n, is (the breakdown voltage is $10\ \mathrm{V}$)



Q.13 Mobility of electrons in a semiconductor is defined as the ratio of their drift velocity to the applied electric field. If, for an n-type semiconductor, the density of electrons is $10^{19}\ m^{-3}$ and their mobility is $1.6\ m^2/(V.s)$ then the resistivity of the semiconductor (since it is an n-type semiconductor contribution of holes is ignored) is close **[JEE (Main)-2019]**

(A) $2\Omega m$

(B) $0.2\Omega m$

(C) $0.4\Omega m$ ✓ Check

(D) $4\Omega m$

$$\boxed{\frac{1}{\rho} = e(\mu_e n_e + \underbrace{\mu_h n_h}_{0})}$$

n = No of electrons per unit volume

$$\frac{1}{\rho} = e(\mu_e n_e)$$

Q.14 Drift speed of electrons, when $1.5\ \mathrm{A}$ of current flows in a copper wire of cross section $5\ \mathrm{mm}^2$, is v. If the electron density in copper is 9×10^{28} / m^3 the value of v in $\mathrm{mm/s}$ is close to (Take charge of electron to be $= 1.6 \times 10^{-19}\mathrm{C}$) [JEE (Main)-2019]

(A) 0.02

(B) 0.2

(C) 3

(D) 2

SEMICONDUCTOR & DIODE

Q.15 Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_0 changes by (assume that the Ge diode has large breakdown voltage)

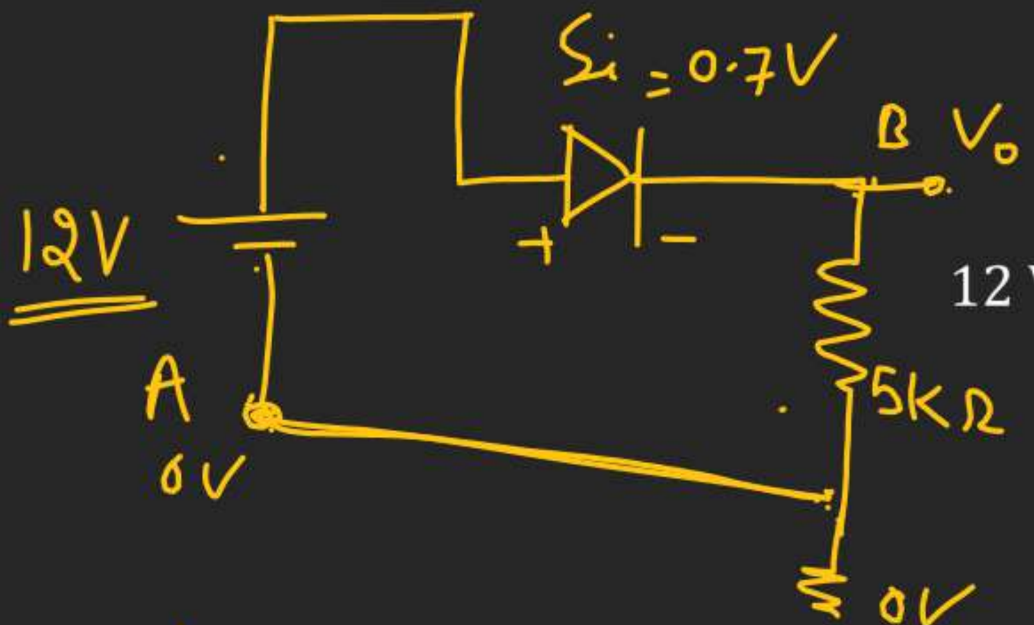
[JEE (Main)-2019]

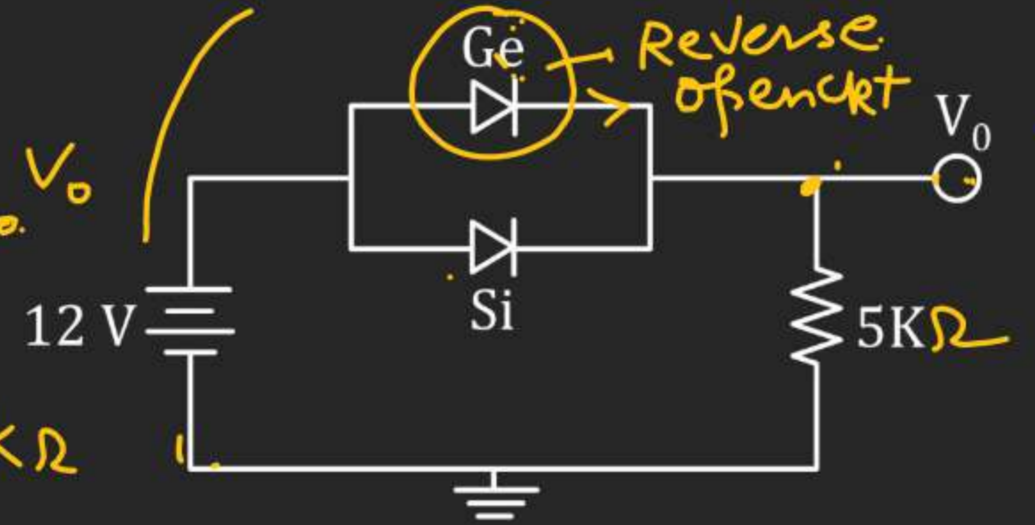
(A) 0.2 V

(B) 0.4 V

(C) 0.6 V

(D) 0.8 V





$12 - 0.3 = (V_0)_i$

$11.7 = (V_0)_i$

$V_A + 12 - 0.7 = (V_0)_f$

0

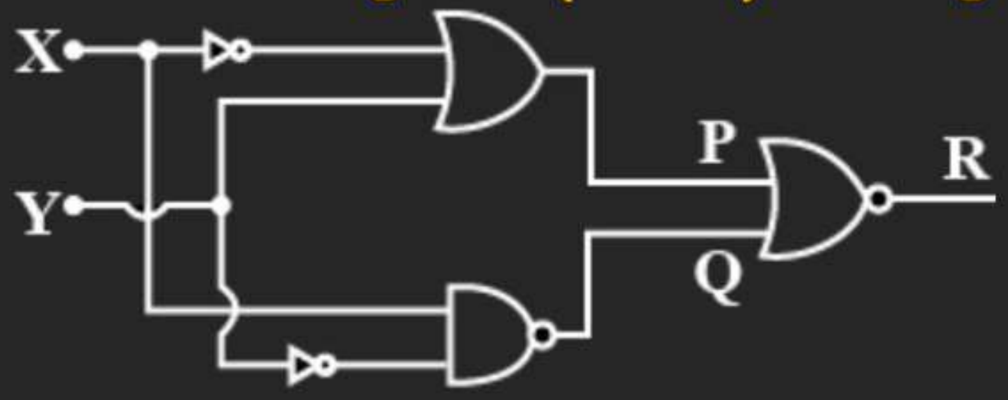
$11.3 = (V_0)_f$

$\Delta V = (V_0)_i - (V_0)_f$

SEMICONDUCTOR & DIODE

Q.16 To get output ' 1 ' at R, for the given logic gate circuit the input values must be

[JEE (Main)-2019]



(A) $X = 1, Y = 1$

(B) $X = 0, Y = 0$

(C) $X = 1, Y = 0$

(D) $X = 0, Y = 1$

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Q.17 For the circuit shown below, the current through the Zener diode is

[JEE (Main)-2019]

(A) Zero

(B) 9 mA

(C) 14 mA

(D) 5 mA

$$i = \frac{120-50}{5\times10^3}$$

$$i = \left(\frac{70}{5\times10^3}\right)$$

$$i = 14\,mA$$

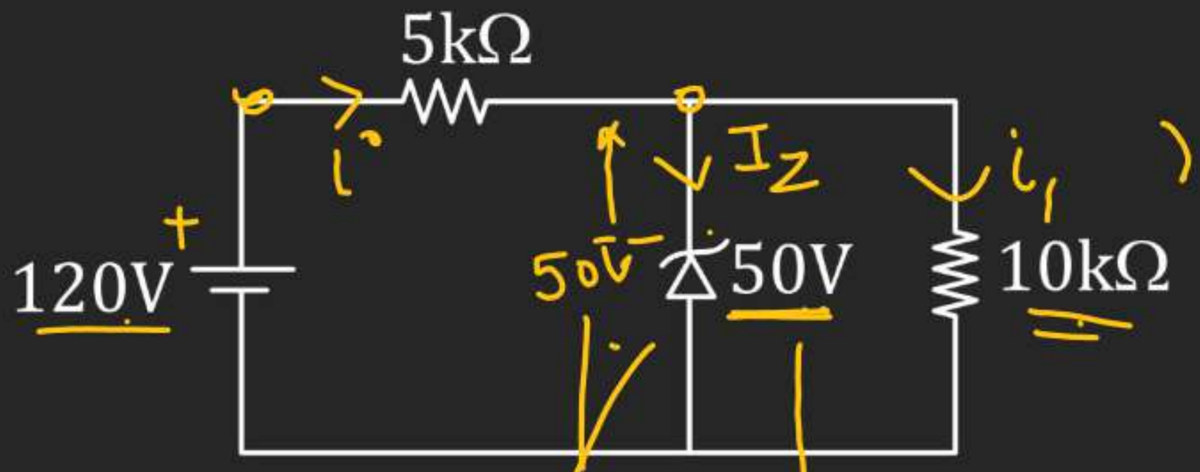
$$i_1 = \frac{50}{10\times10^{-3}}$$

$$= 5\,mA$$

$$I_Z = i - i_1$$

$$= (14-5)\,mA$$

$$= 9\,mA$$



Reverse Biase.

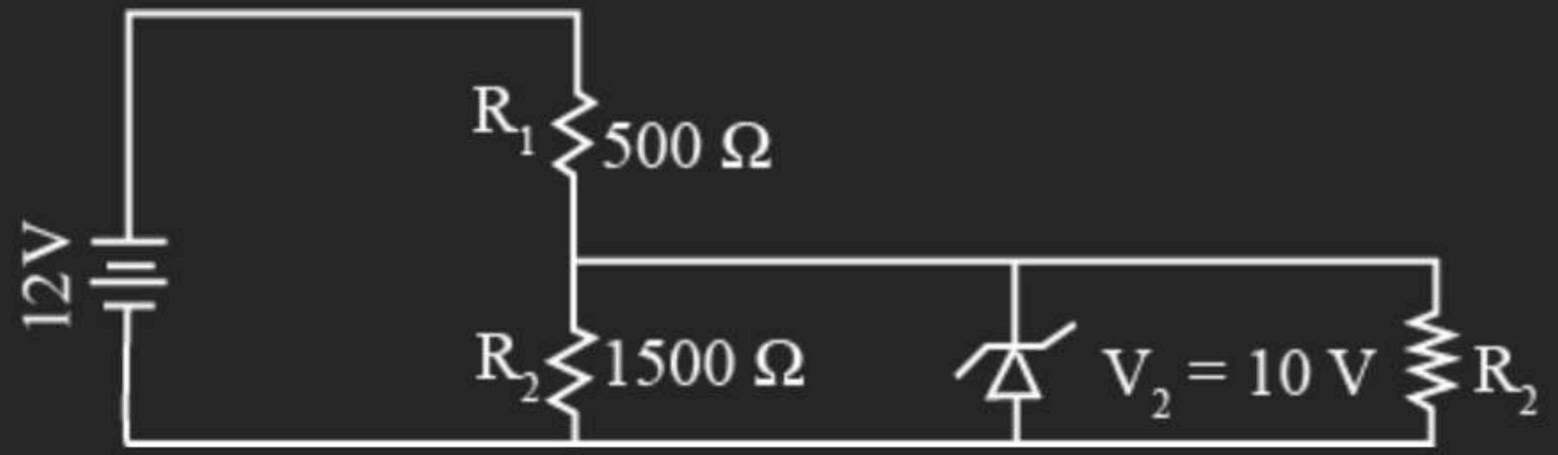
Breakdown voltage

V = 50V

SEMICONDUCTOR & DIODE

Q.18 In the given circuit the current through Zener Diode is close to

[JEE (Main)-2019]



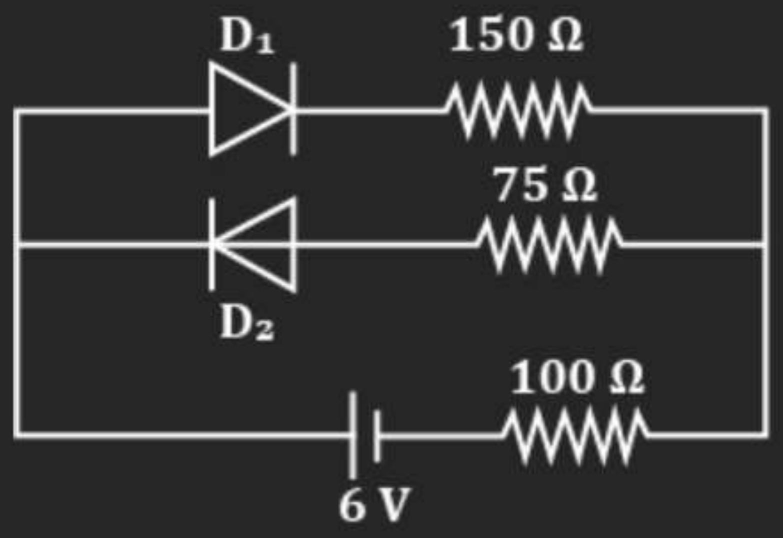
(A) 6.7 mA

(B) 0.0 mA

(C) 4.0 mA

(D) 6.0 mA

Q.19 The circuit shown below contains two ideal diodes, each with a forward resistance of 50Ω. If the battery voltage is $6\ V$, the current through the 100Ω resistance (in amperes) is [JEE (Main)-2019]



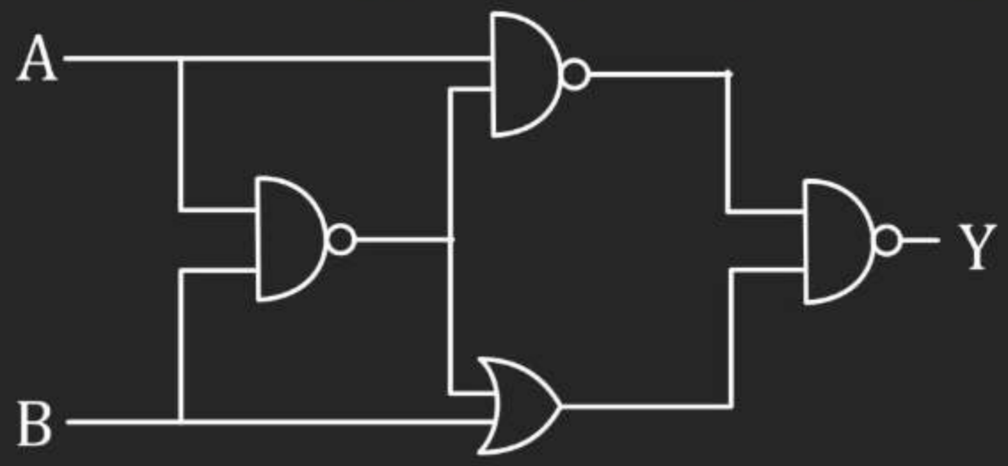
(A) 0.036

(B) 0.020

(C) 0.030

(D) 0.027

Q.20 The output of the given logic circuit is: [JEE (Main)-2019]



(A) $A\bar{B} + \bar{A}B$

(B) $A\bar{B}$

(C) $AB + \overline{AB}$

(D) $\bar{A}B$

SEMICONDUCTOR & DIODE

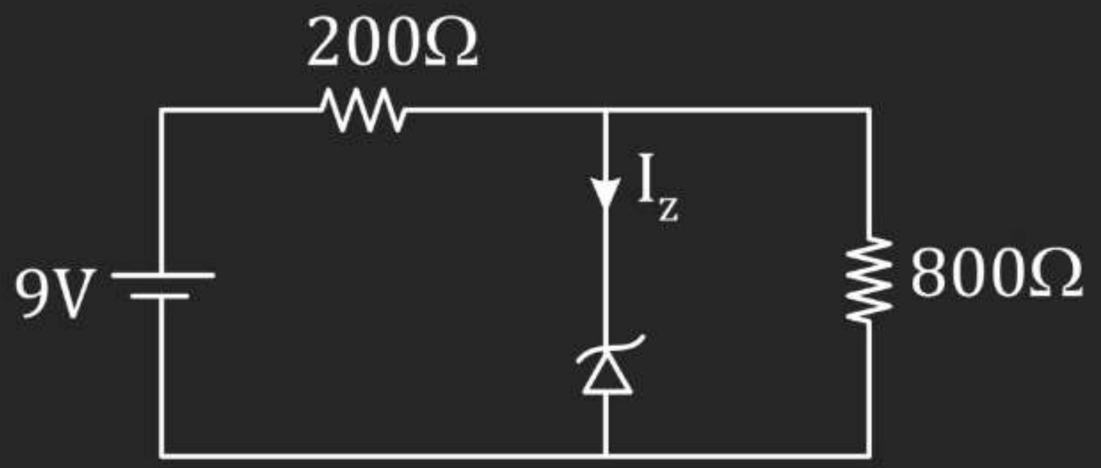
Q.21 The reverse breakdown voltage of a Zener diode is $5.6\ \mathrm{V}$ in the given circuit. The current I_Z through the Zener is [JEE (Main)-2019]

(A) $15\ \mathrm{mA}$

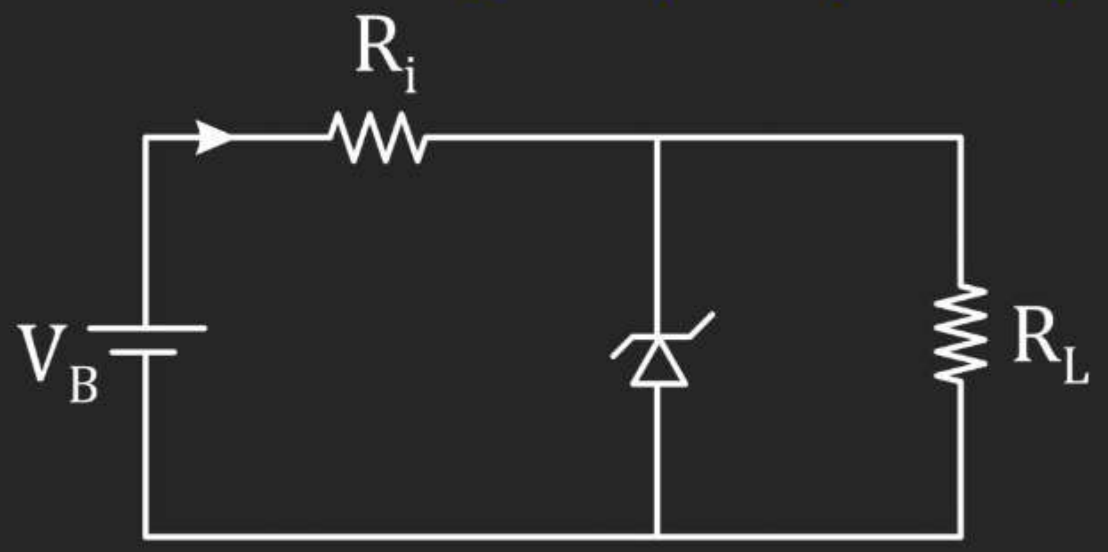
(B) $7\ \mathrm{mA}$

(C) $10\ \mathrm{mA}$

(D) $17\ \mathrm{mA}$



Q.22 The figure represents a voltage regulator circuit using a Zener diode. The breakdown voltage of the Zener diode is 6 V and the load resistance is, $R_L = 4k\Omega$. The series resistance of the circuit is $R_i = 1k\Omega$. If the battery voltage V_B varies from 8 V to 16 V, what are the minimum and maximum values of the current through Zener diode? **[JEE (Main)-2019]**



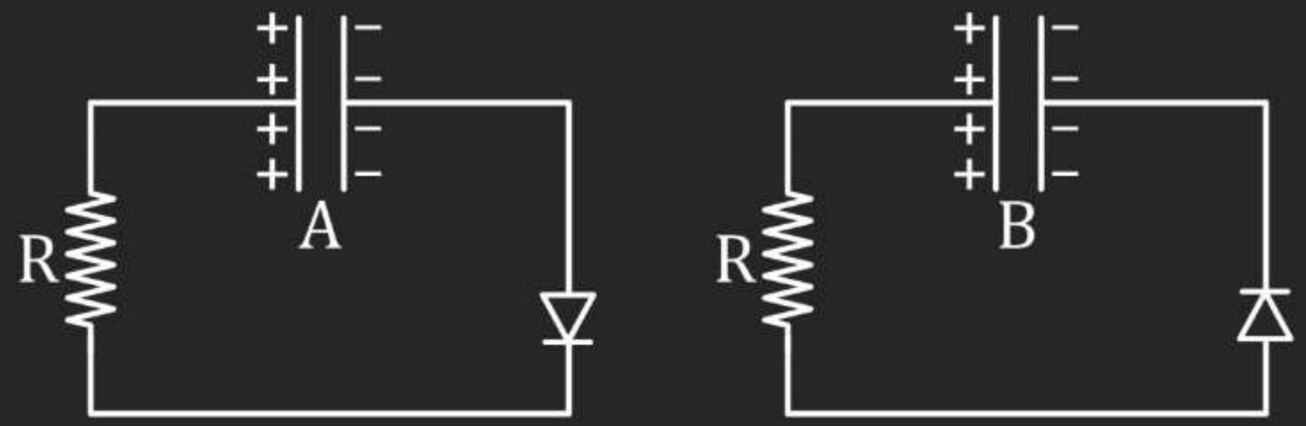
(A) $0.5\text{ mA}; 6\text{ mA}$

(B) $0.5\text{ mA}; 8.5\text{ mA}$

(C) $1.5\text{ mA}; 8.5\text{ mA}$

(D) $1\text{ mA}; 8.5\text{ mA}$

Q.23 Two identical capacitors A and B, charged to the same potential $5\,V$ are connected in two different circuits as shown below at time $t = 0$. If the charge on capacitors A and B at time $t = CR$ is Q_A and Q_B respectively, then (Here e is the base of natural logarithm) **[JEE (Main)-2020]**



(A) $Q_A = \frac{CV}{2}, Q_B = \frac{VC}{e}$

(B) $Q_A = VC, Q_B = CV$

(C) $Q_A = \frac{CV}{e}, Q_B = \frac{VC}{2}$.

(D) $Q_A = VC, Q_B = \frac{VC}{e}$

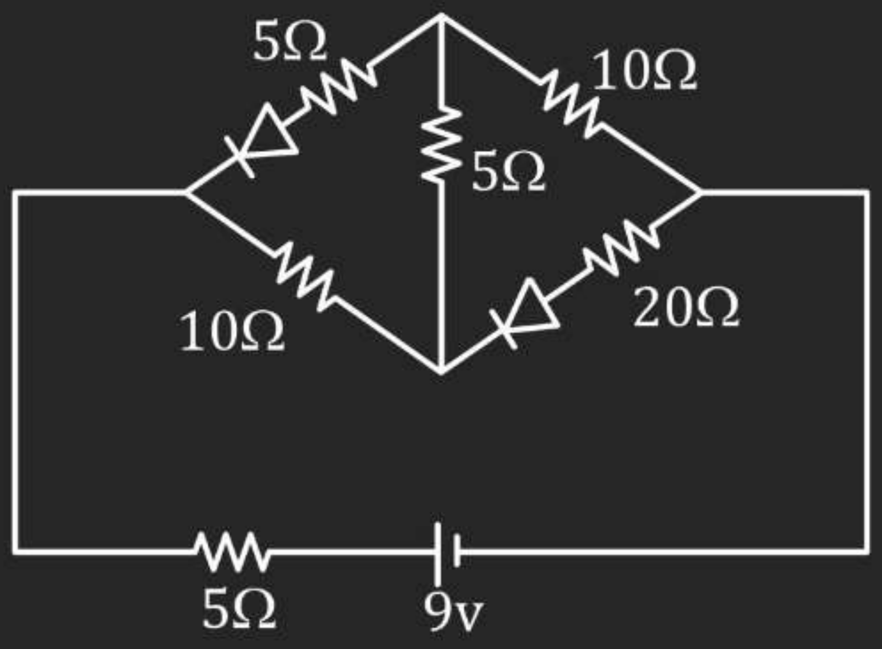
Q.24 The current i in the network is [JEE (Main)-2020]

(A) 0.3 A

(B) 0.6 A

(C) 0 A

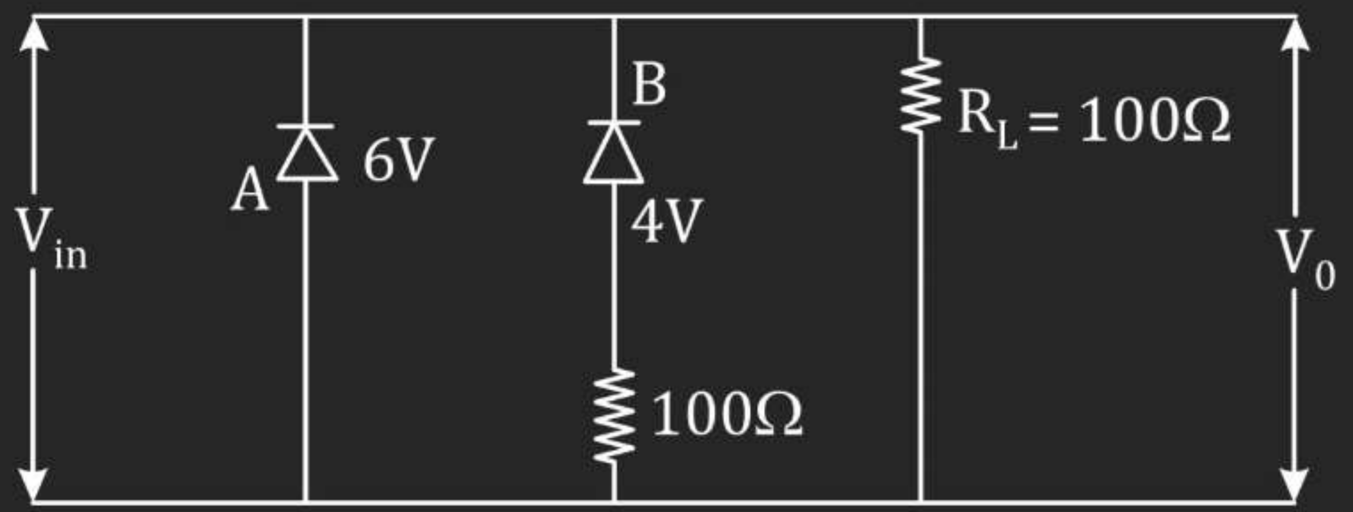
(D) 0.2 A



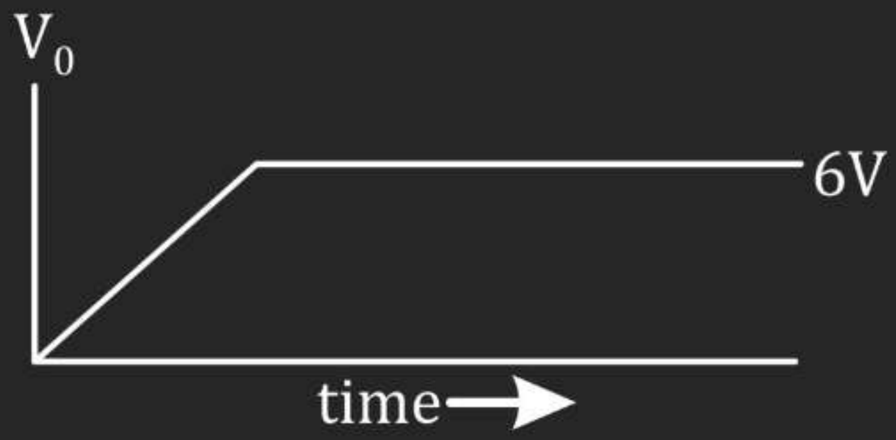
SEMICONDUCTOR & DIODE

Q.25 Two Zener diodes (A and B) having breakdown voltages of $6\ V$ and $4\ V$ respectively, are connected as shown in the circuit below. The output voltage V_0 variation with input voltage linearly increasing with time, is given by $\left(V_{input} = 0\ V \text{ at } t = 0\right)$

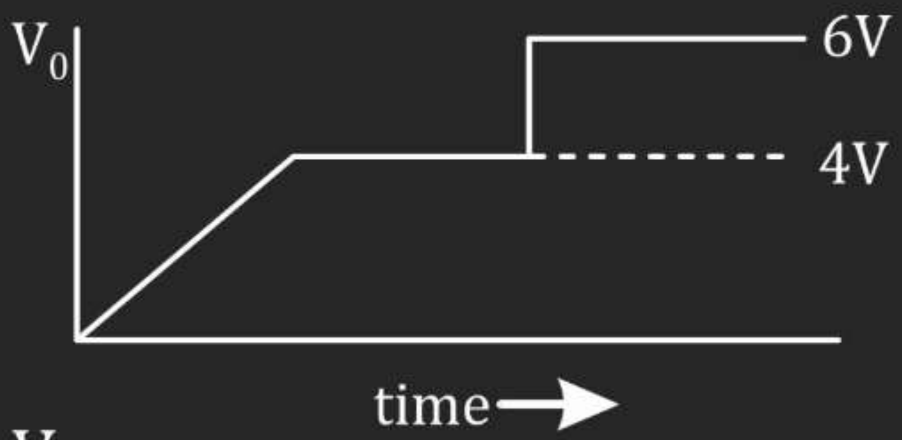
(figures are qualitative) **[JEE (Main)-2020]**



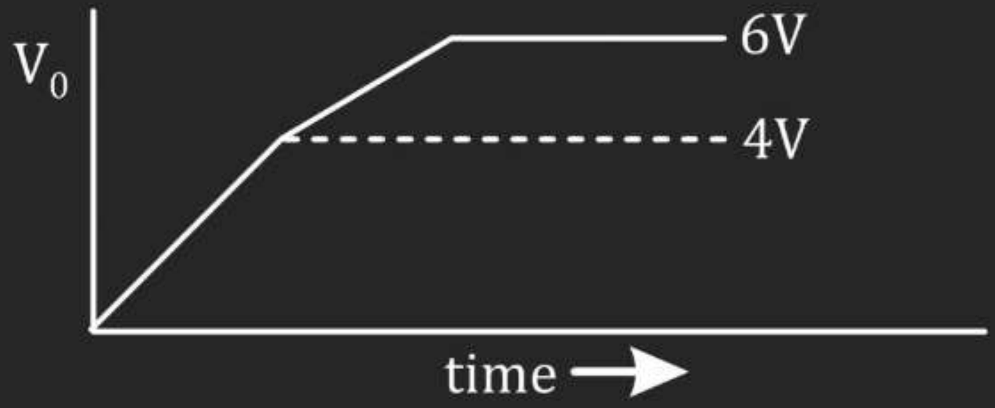
(A)



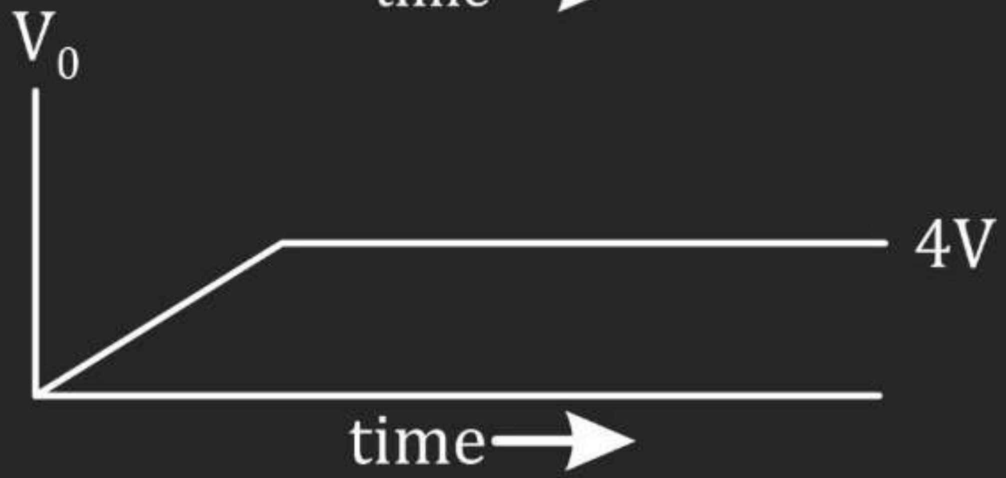
(B)



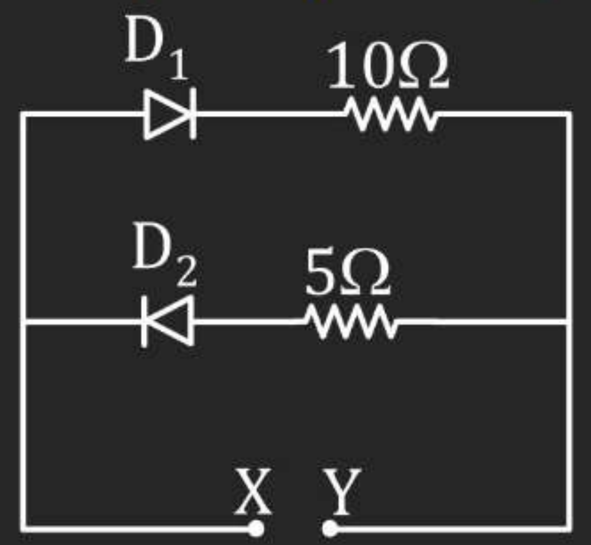
(C)



(D)



Q.26 A $5\ V$ battery is connected across the points X and Y. Assume D_1 and D_2 to be normal silicon dio des. Find the current supplied by the battery if the +ve terminal of the battery is connected to point X. **[JEE (Main)-2021]**



(A) $-1.5\ A$

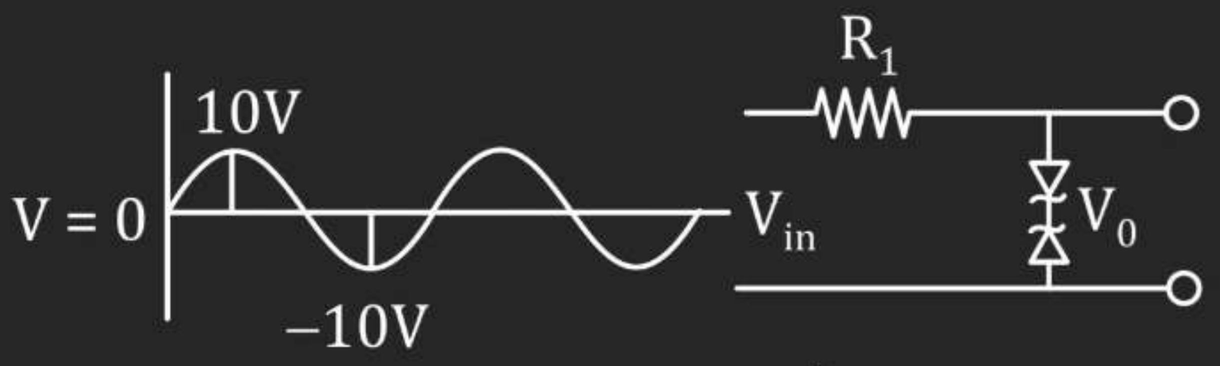
(B) $\sim 0.5\ A$

(C) $\sim 0.43\ A$

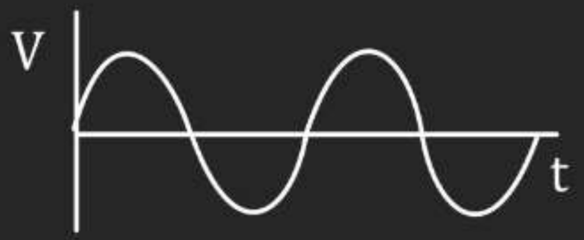
(D) $\sim 0.86\ A$

Q.27 Take the breakdown voltage of the zener diode used in the given circuit as $6\,\text{V}$. For the input voltage shown in figure below, the time variation of the output voltage is (Graphs drawn are schematic and not to scale)

[JEE (Main)-2020]



(A) 

(B) 

(C) 

(D)