ZENER DIODE

Semiconductor -1

CONCEPT PYQs

JEE MAIN

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List of Content on Eduniti YouTube Channel:

1. PYQs Video Solution Topic Wise:
   (a) JEE Main 2018/2020/2021 Feb & March
2. Rank Booster Problems for JEE Main
3. Part Test Series for JEE Main
4. JEE Advanced Problem Solving Series
5. Short Concept Videos
6. Tips and Tricks Videos
7. JEE Advanced PYQs
8. Formulae Revision Series

........and many more to come

TOPICS COVERED

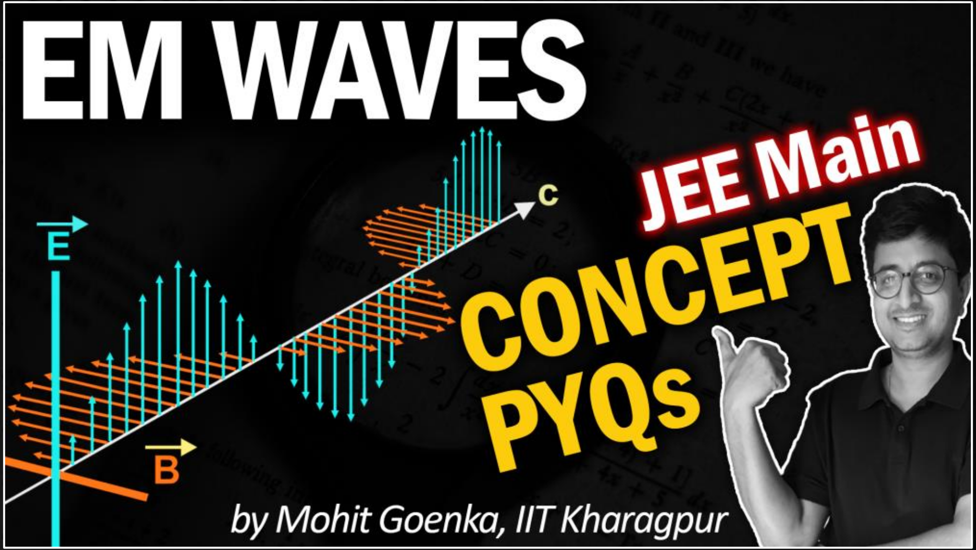
1. Fundamentals of PN Diode
2. Forward and Reverse Biased
3. Zener Diode
4. PYQs (Build your understanding)

Playlist Link in Description

MODERN PHYSICS - PART 1
FORMULAE
ATOMIC PHYSICS

MODERN PHYSICS - PART 2
FORMULAE
PHOTOELECTRIC EFFECT

"FREE PDF NOTES"



ELECTROSTATICS
FORMULAE

ALTERNATING CURRENT
FORMULAE

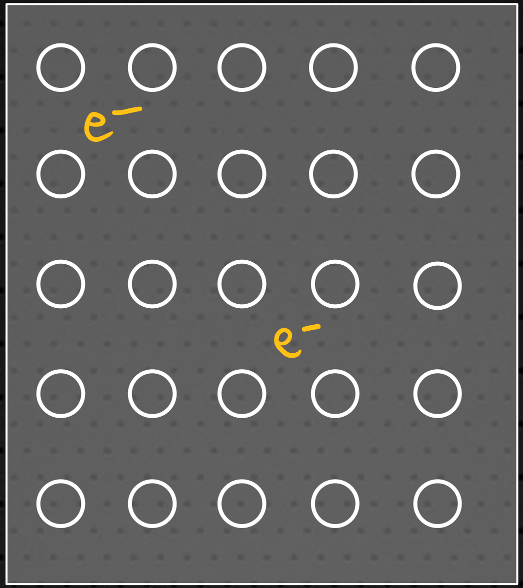
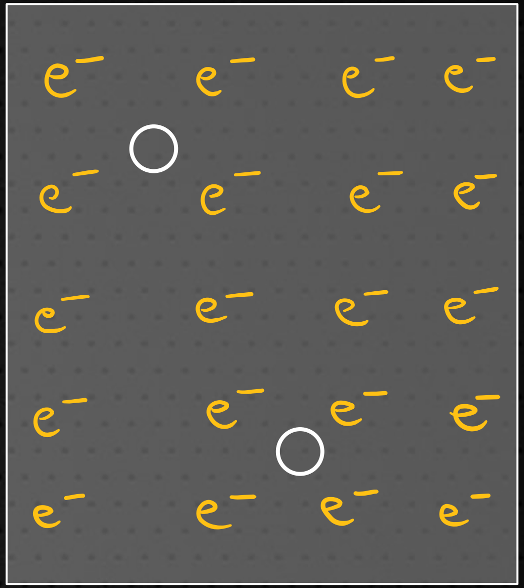
...MANY MORE

1. FUNDAMENTALS

○ → holes

e^- → conduction electron

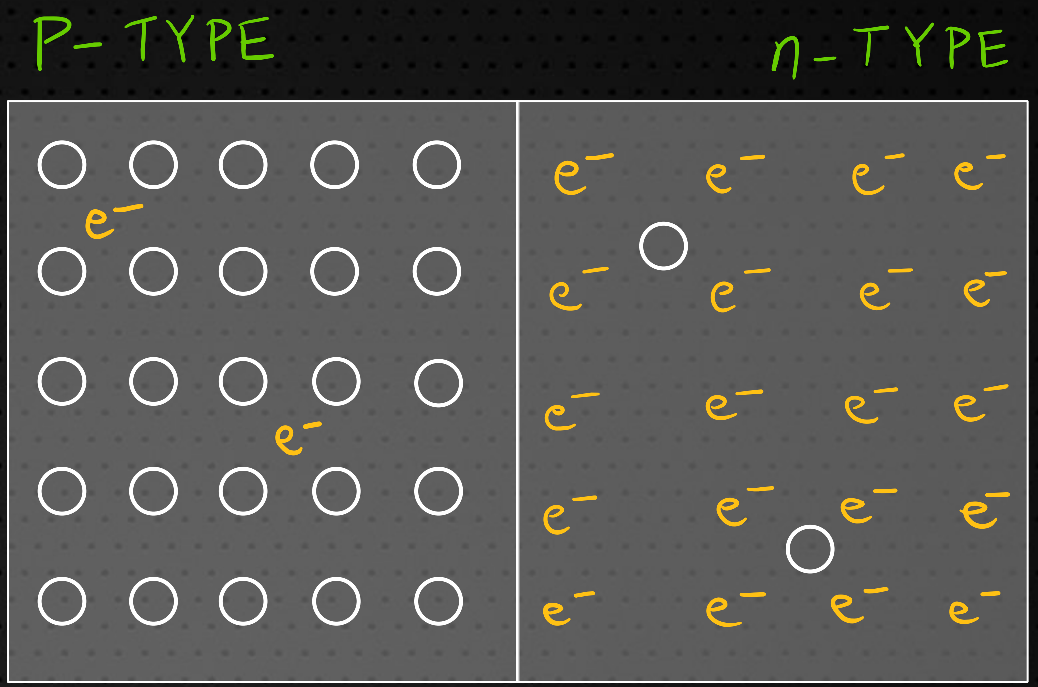
Extrinsic semiconductor

	P-TYPE (Trivalent impurity)	n-TYPE (Pentavalent impurit)
		
Majority charge carriers	holes	electrons
Minority charge carriers	electrons	holes

1. FUNDAMENTALS

○ → holes

e^- → conduction electron



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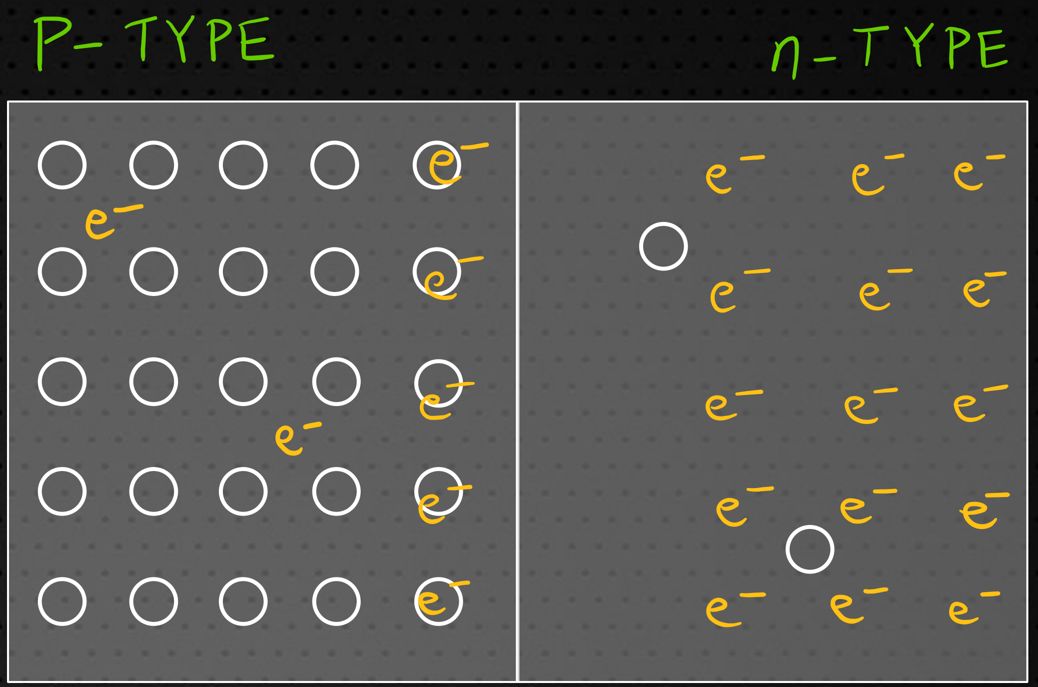
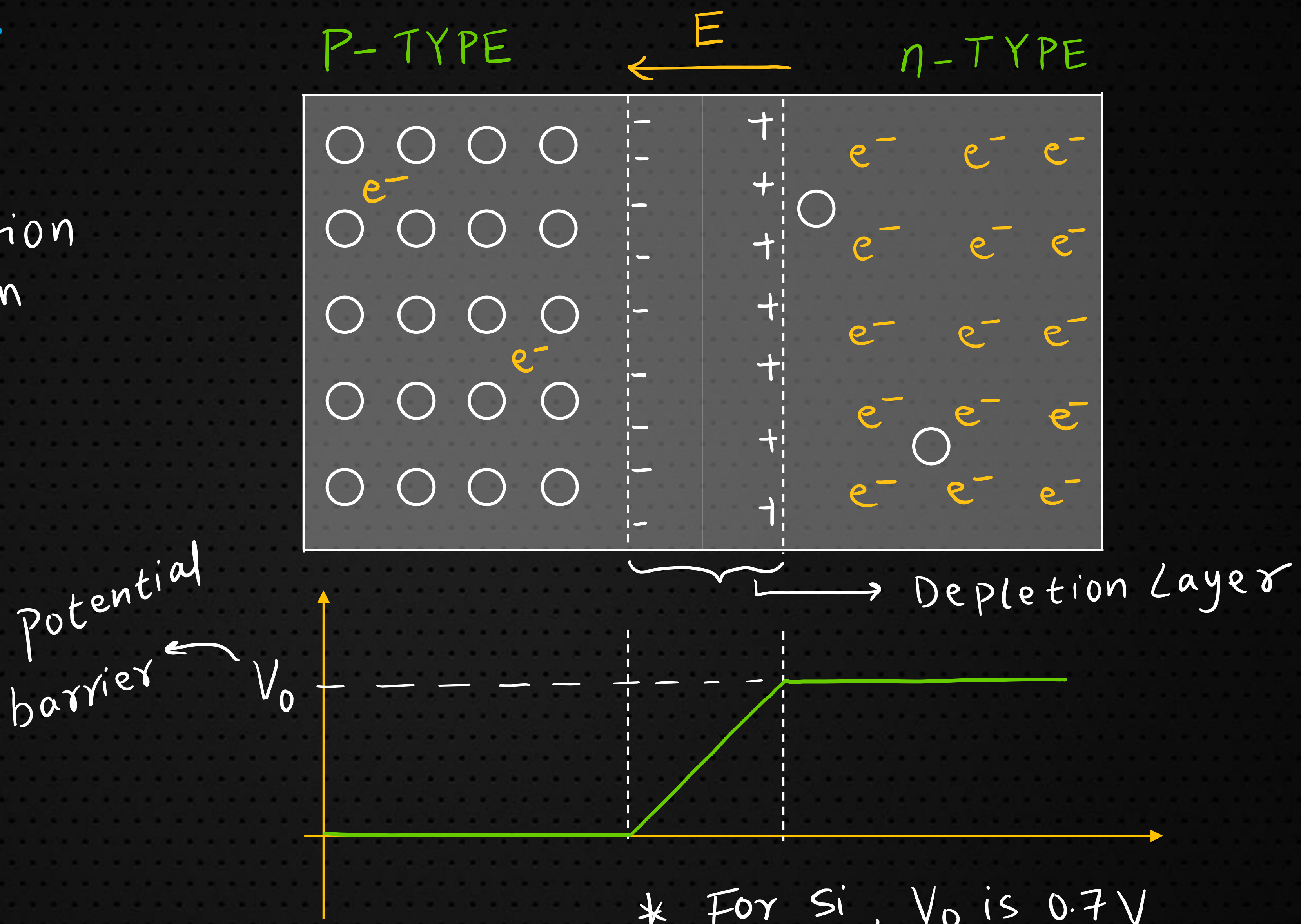


1. FUNDAMENTALS

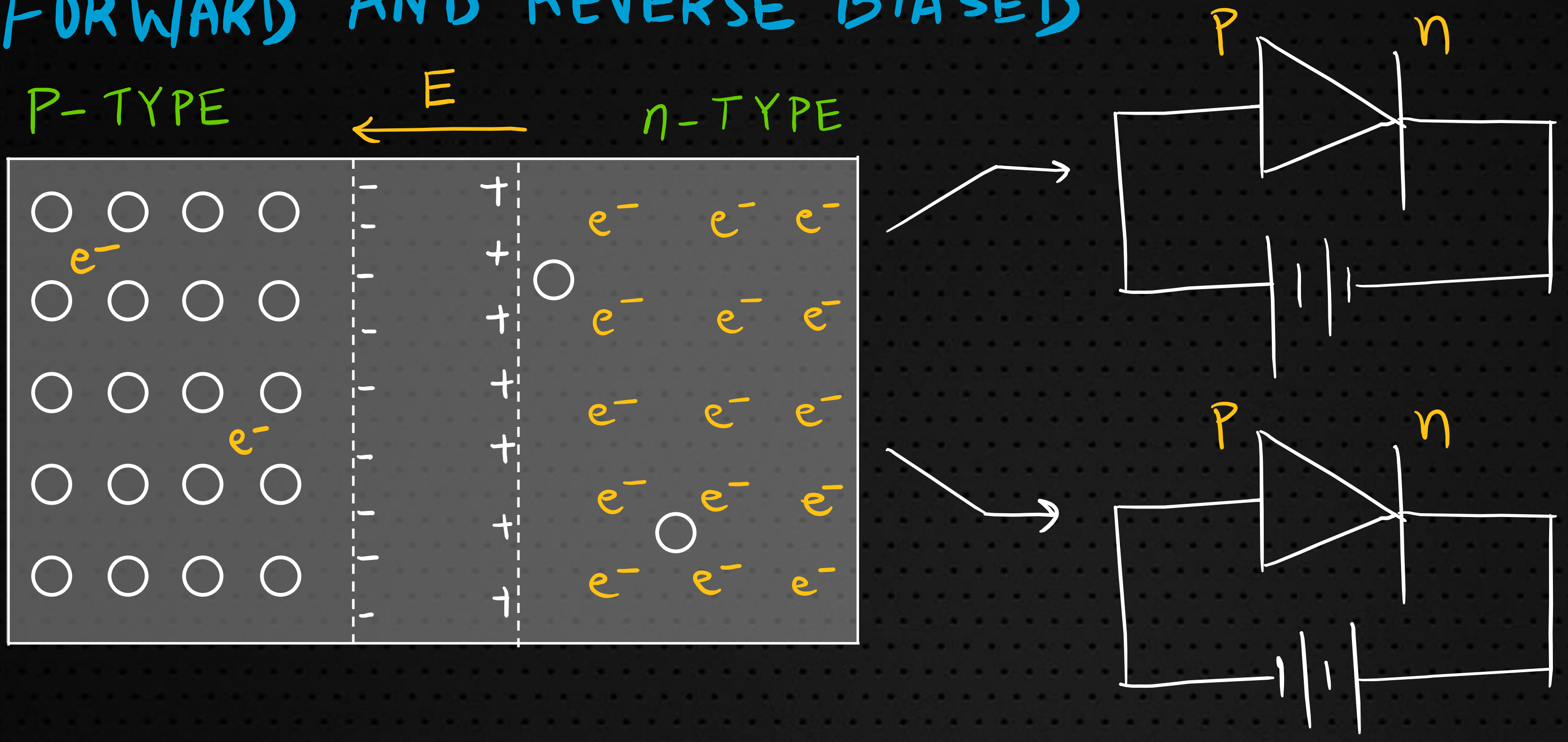
○ ⟶ holes

e^- ⟶ conduction electron



* For Si, V_0 is 0.7 V

2. FORWARD AND REVERSE BIASED



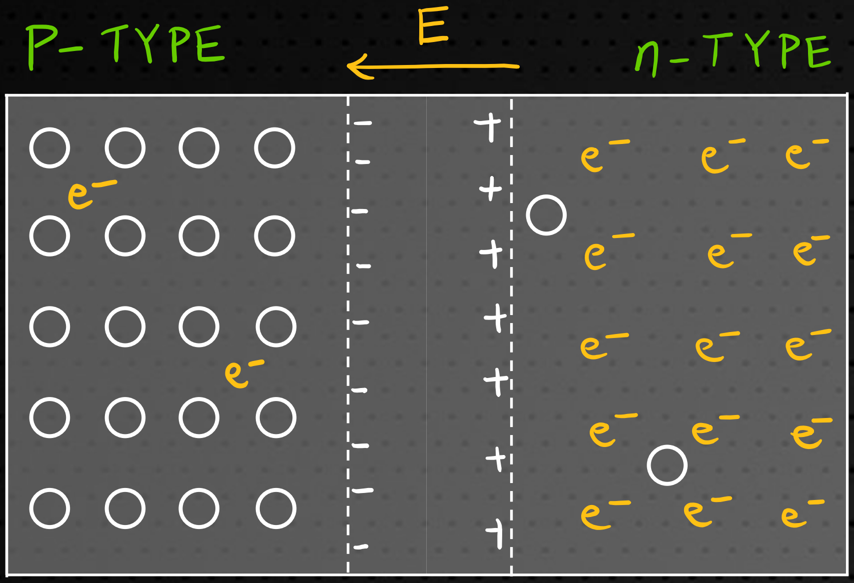
Forward biased

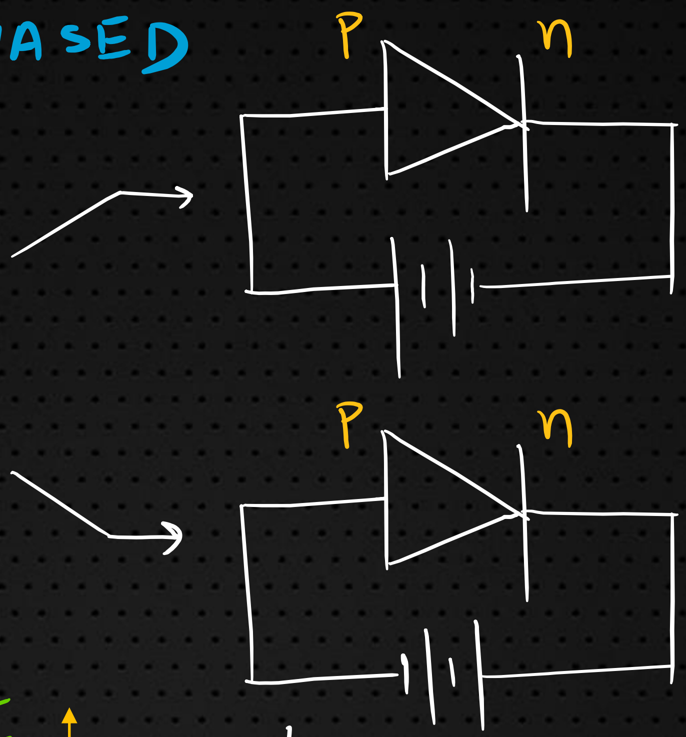
↳ current due to majority charge carriers.

Reverse biase

↳ very small current due to minority charge carriers.

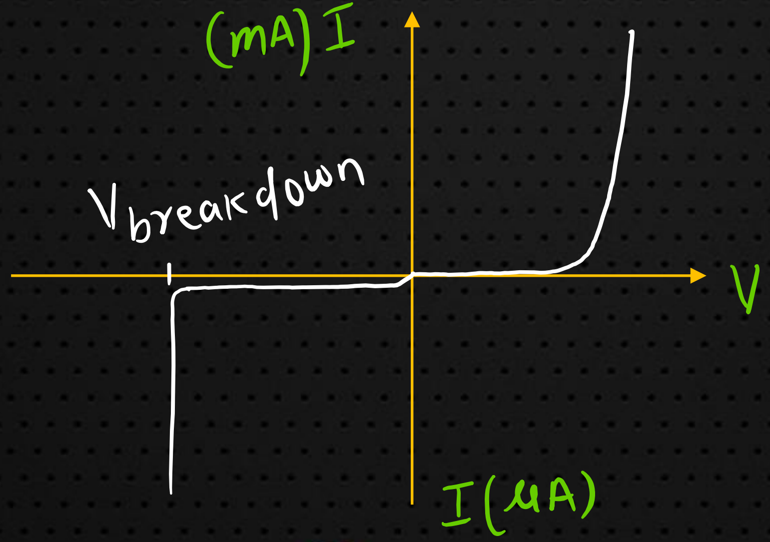
2. FORWARD AND REVERSE BIASED





Forward biased
↳ Current due to majority charge carriers.

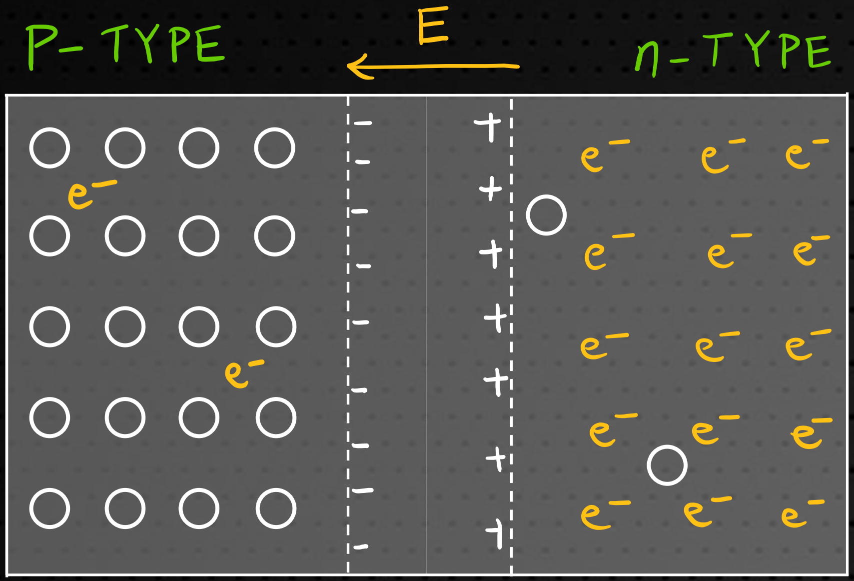
Reverse biase
↳ very small current due to minority charge carriers.

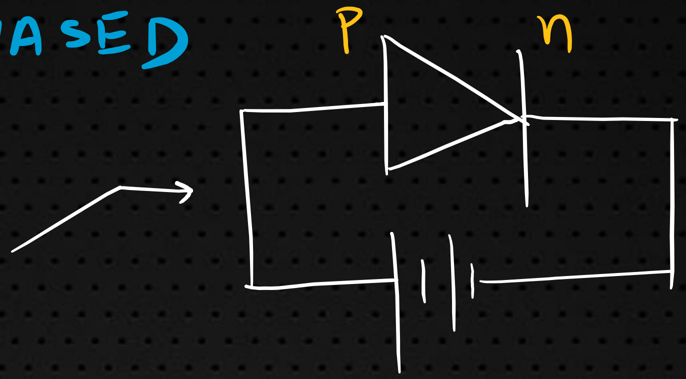


1

For ideal diode Resistance is zero (FB) and infinite (RB).

2. FORWARD AND REVERSE BIASED





Forward biased

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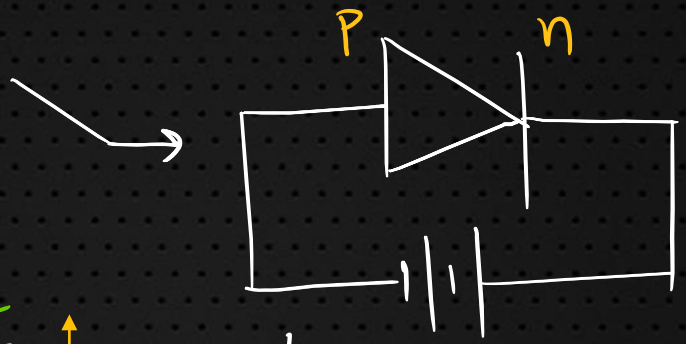
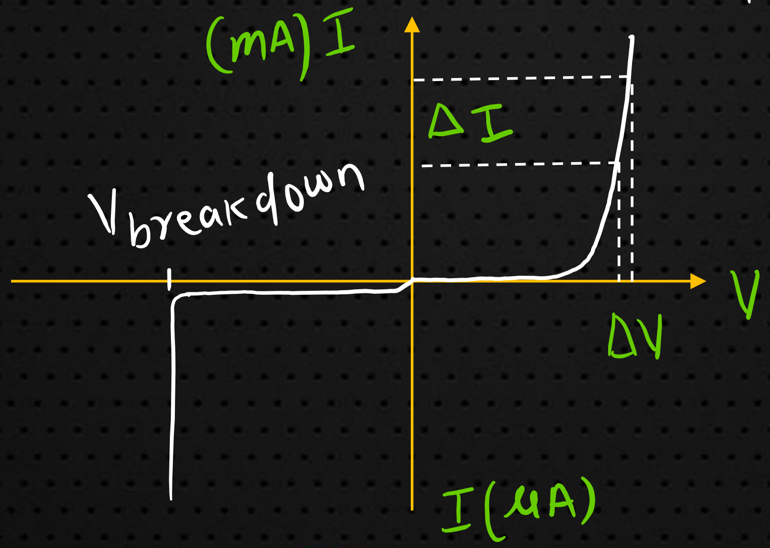


Reverse biase

↳ very small current due to minority charge carriers.

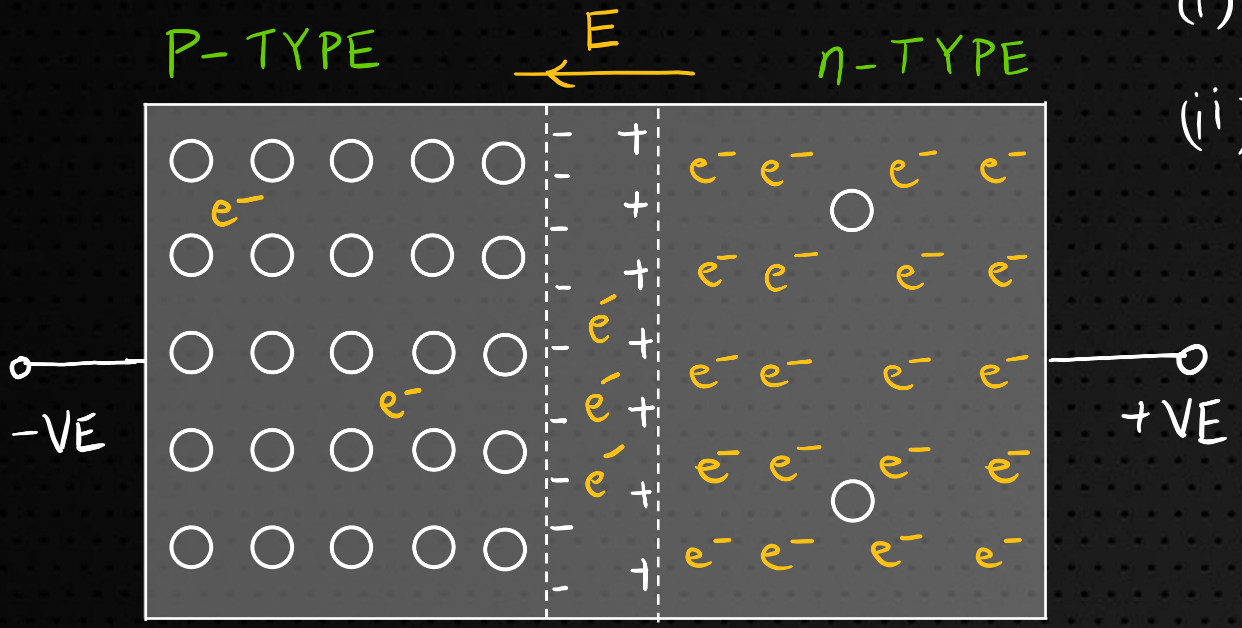


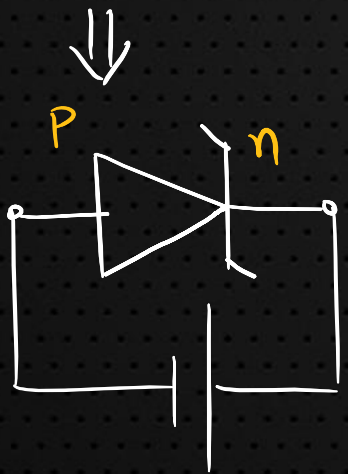
(2)

Dynamic Resistance,

$$R = \frac{\Delta V}{\Delta I}$$

3. ZENER DIODE





(i) It is heavily doped

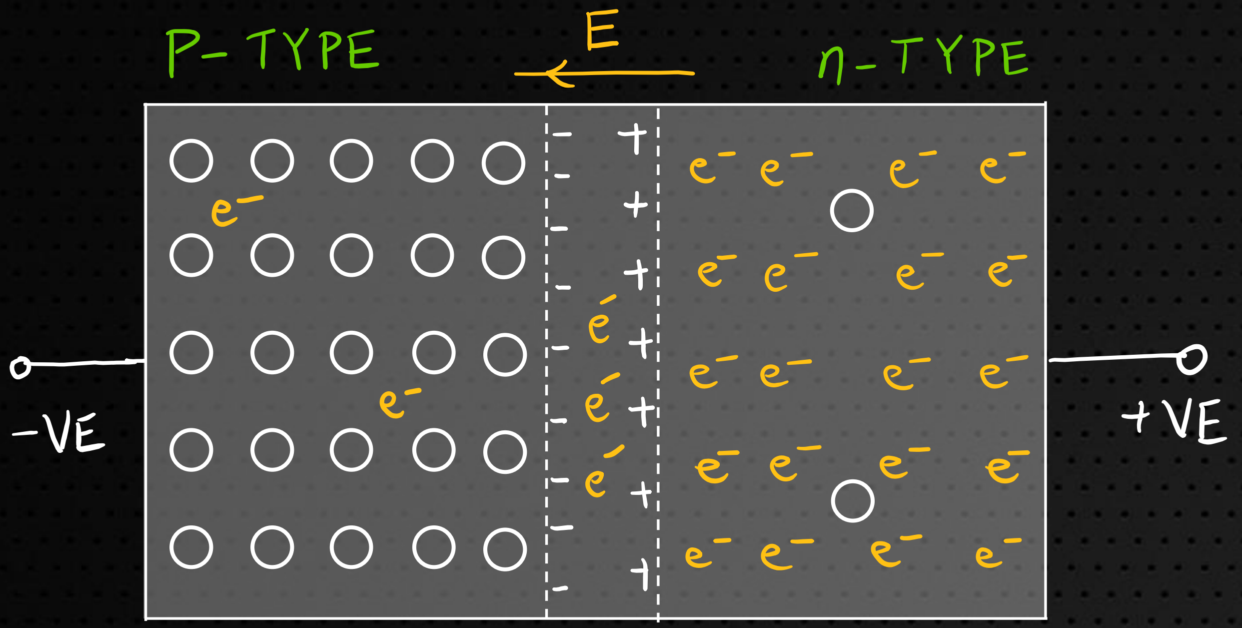
(ii) Depletion region very thin
⇒ E is very large.

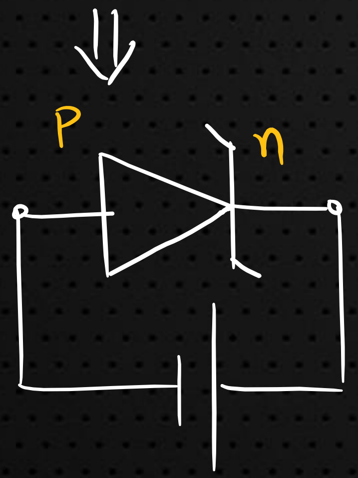
(iii) In RB state, E strength ↑
and e^- covalent bonds in depletion region breaks.

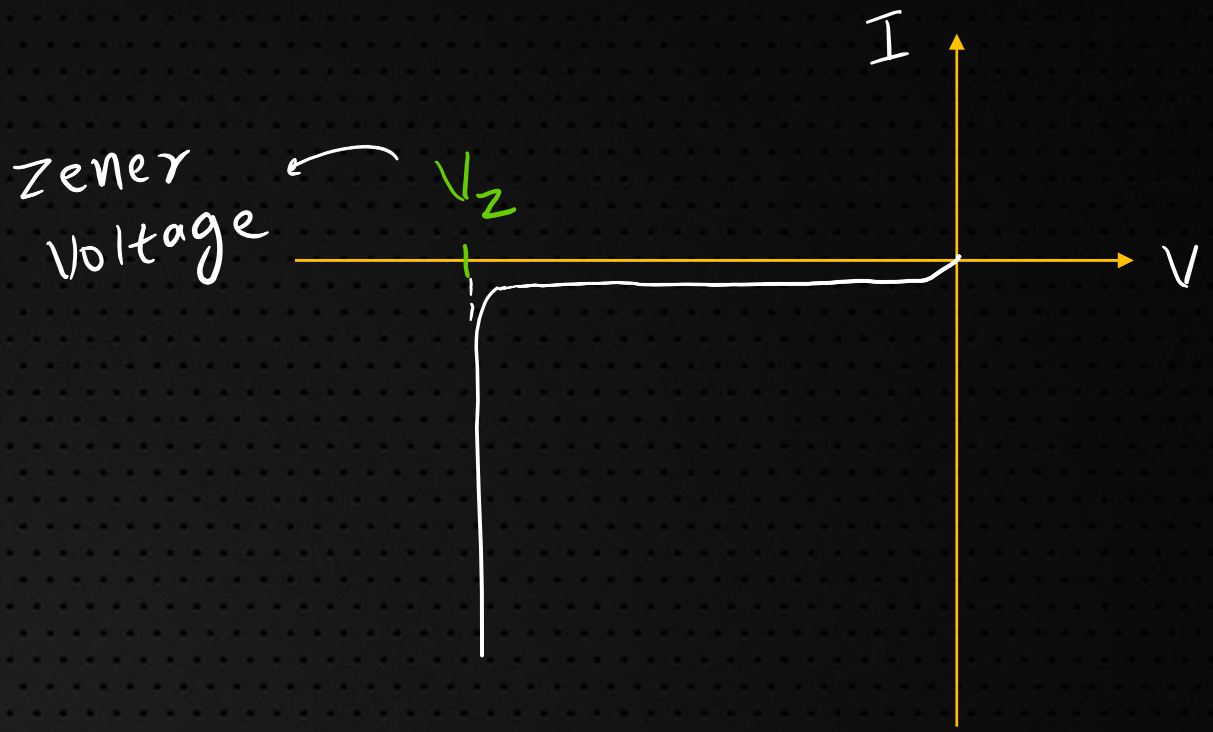
(iv) This e^- moves to n side and reverse current flows from n to p.

Zener Breakdown

3. ZENER DIODE

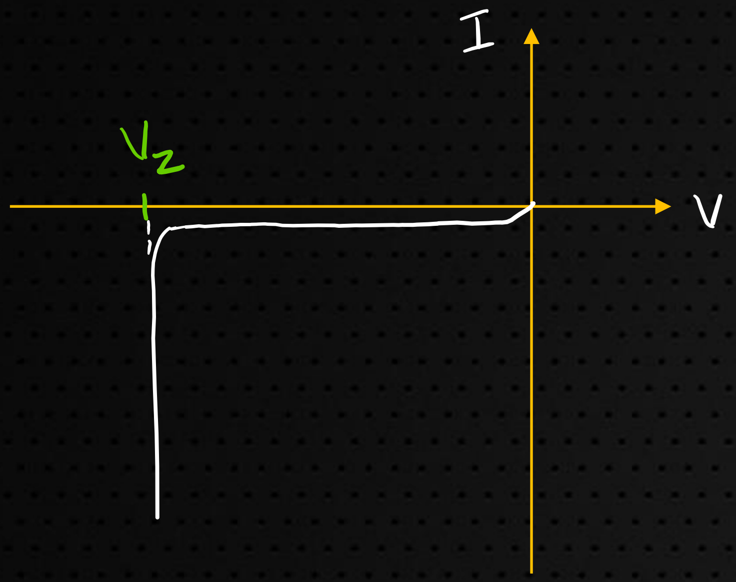


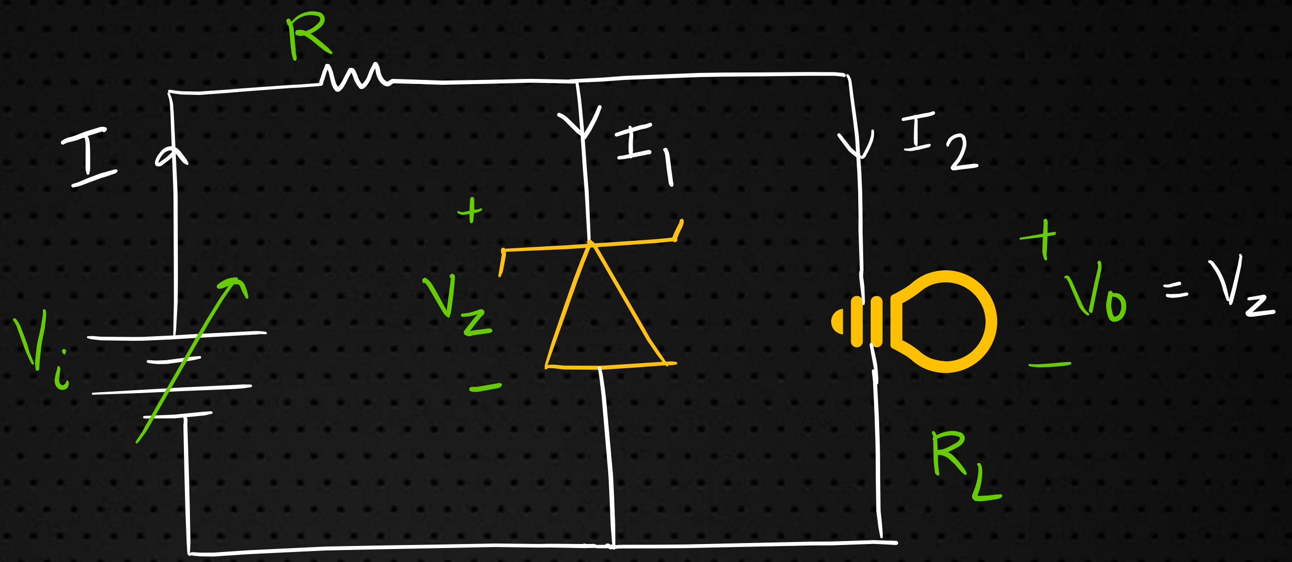




USED AS Voltage Regulator.

3. ZENER DIODE





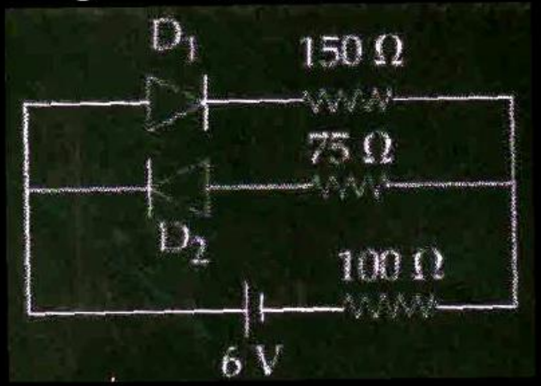
① ↳ As p.d. across crosses V_z (breakdown voltage), almost all current passes through diode.

② ↳ And constant V_z is across it

③ $I_2 = \frac{V_z}{R_L}$ ④ $I = I_1 + I_2$

5 PYQs For UNDERSTANDING

1. The circuit shown below contains two ideal diodes, each with a forward resistance of 50Ω. If the batterty voltage is 6V, the current through the 100Ω resistance (in Amperes) is



(a) 0.036 (b) 0.020

(c) 0.027 (d) 0.030

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Solution on Next Page

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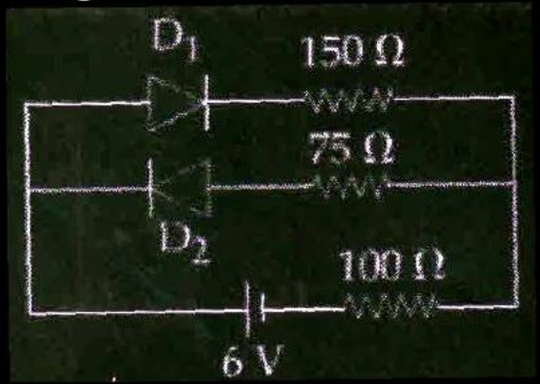

(a) 0.036 ✓(b) 0.020
(c) 0.027 (d) 0.030

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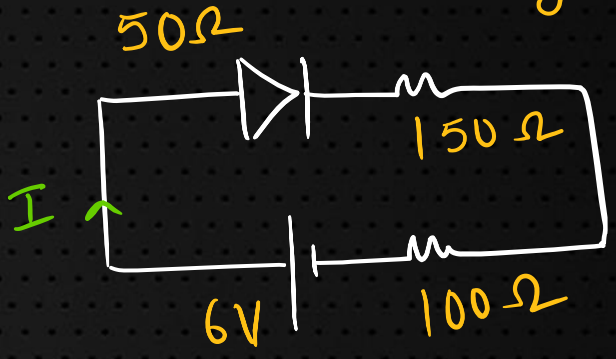
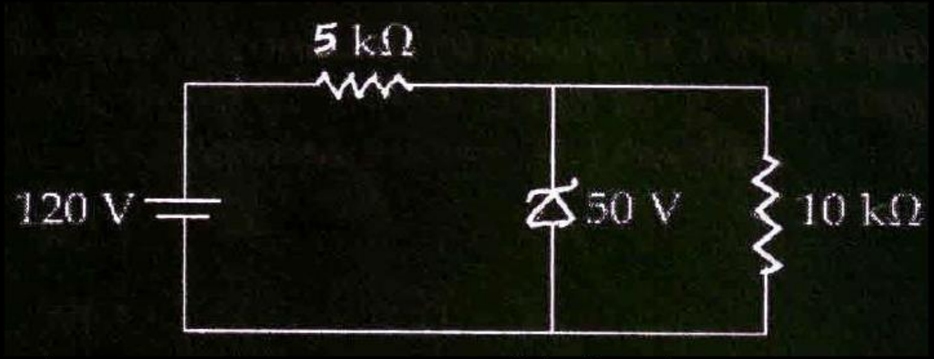
Sol^n:

Ideal diode in reverse state offers infinite resistance. ∴ no current through D_2



$$I = \frac{6}{5+150+100} = \boxed{0.02\ A}$$

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



(a) 9 mA (b) 5 mA
(c) Zero (d) 14 mA

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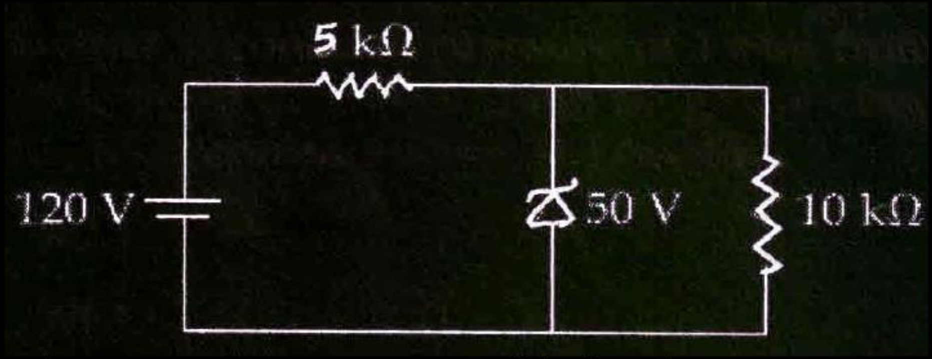

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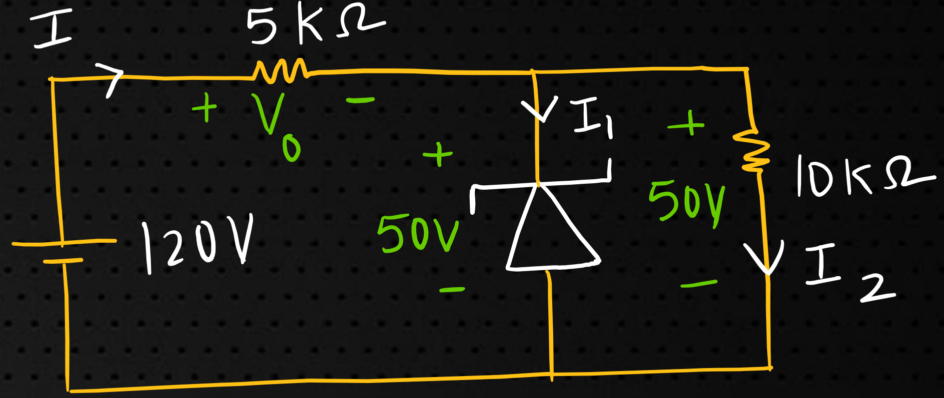
Solⁿ: Zener diode is in Breakdown mode.



$$I_2 = \frac{50\,V}{10\,K\Omega} = 5\,mA$$

$$V_0 = 120 - 50 = 70\,V$$

$$\therefore I = \frac{70\,V}{5\,K\Omega} = 14\,mA$$

$$\Rightarrow I_1 = I - I_2 = 14 - 5 = \boxed{9\,mA}$$

3. In the given circuit, the current through Zener Diode is close to

(a) 0.0 mA (b) 6.7 mA

(c) 4.0 mA (d) 6.0 mA

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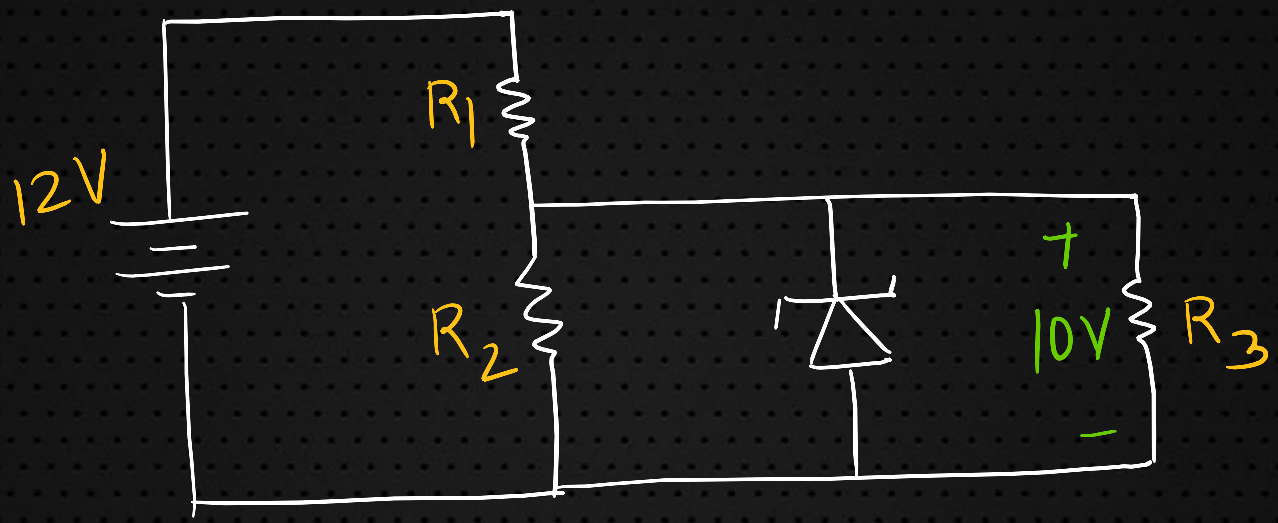
$R_1 = 500\,\Omega$

$R_2 = 1500\,\Omega$



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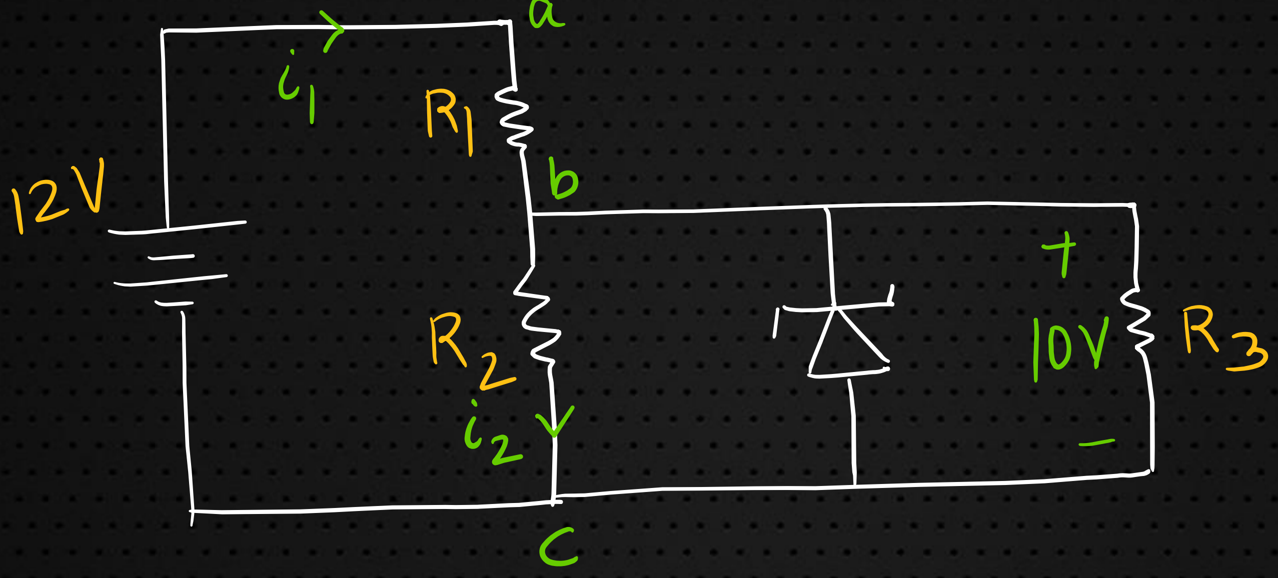

Sol^n: Assume Zener in Breakdown mode.

$\therefore V_{bc} = 10V$ and $V_{ab} = 2V$

$i_1 = \frac{2}{500} = 4\,mA$

$i_2 = \frac{10}{1500} = 6.7\,mA$

$\because i_1 < i_2$ not possible

Hence Zener is not in Breakdown and current through it is $\boxed{\text{Zero.}}$

4. Figure shows a *DC* voltage regulator circuit, with a Zener diode of breakdown voltage = 6V. If the unregulated input voltage varies between 10 V to 16 V, then what is the maximum Zener current?

(a) 2.5 mA (b) 1.5 mA

(c) 7.5 mA **(d)** 3.5 mA

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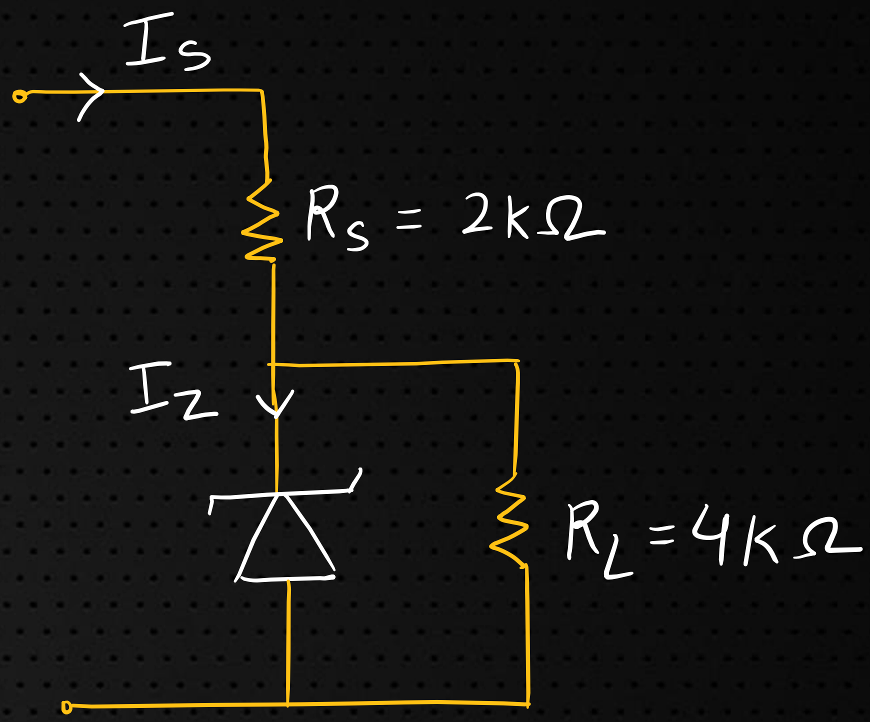

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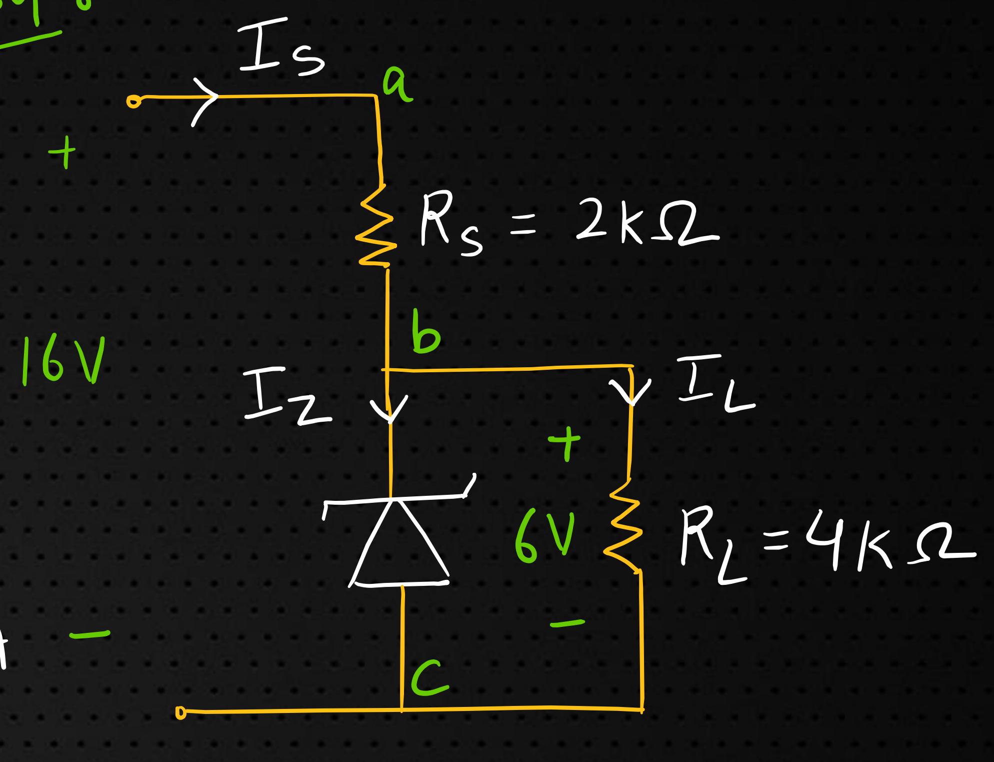
Sol^n:



I_z is max when $V_{in} = 16V$

also zener will be in Breakdown mode

$\therefore I_L = \frac{6V}{4k\Omega} = 1.5mA$

$V_{ab} = 16 - 6 = 10V$

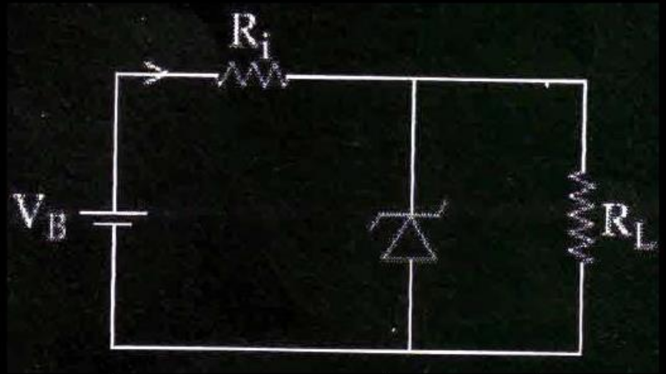
$\therefore I_s = \frac{10V}{2k\Omega} = 5mA$

$\Rightarrow I_z = I_s - I_L$

$= 5 - 1.5 = \boxed{3.5mA}$

Solution on Next Page

5. 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, $R_L = 4\ \text{k}\Omega$. The series resistance of the circuit is $R_i = 1\ \text{k}\Omega$. 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?



(a) 0.5 mA; 6 mA
(b) 1 mA; 8.5 mA
(c) 0.5 mA; 8.5 mA
(d) 1.5 mA; 8.5 mA

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Sol^n: $I_2 = \frac{6V}{4k\Omega} = 1.5mA$

For Min: $V_B = 8V$, $V_1 = 8-6 = 2V$

$\therefore I = \frac{2V}{1k\Omega} = 2mA$

$\Rightarrow I_1 = I - I_2 = \boxed{0.5mA}$

For Max: $V_B = 16V$, $V_1 = 16-6 = 10V$

$\therefore I = \frac{10V}{1k\Omega} = 10mA$

$\Rightarrow I_1 = I - I_2$

$= \boxed{8.5mA}$

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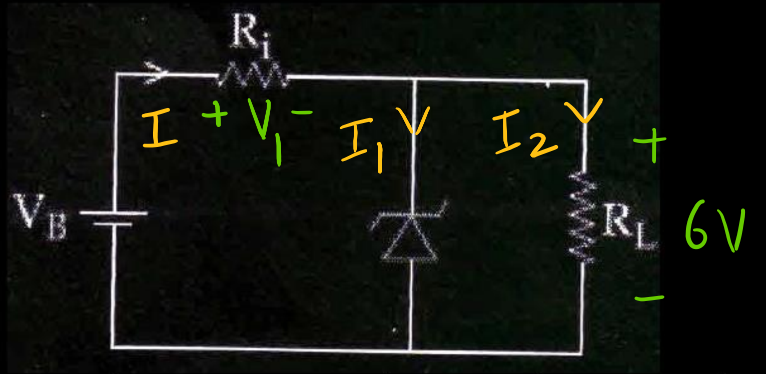

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