Section 30
MOSFET Introduction

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PURDUE UNIVERSITY

School of Electrical and Computer Engineering

Section 30
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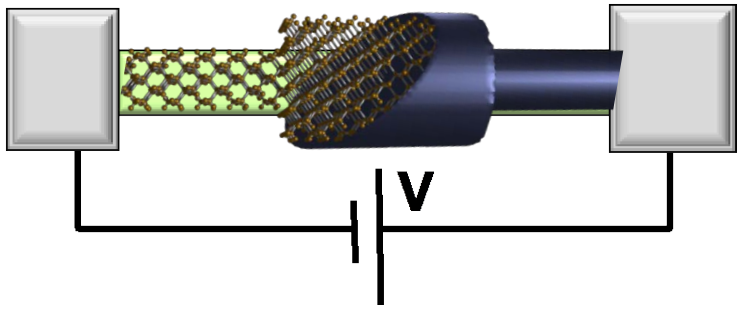
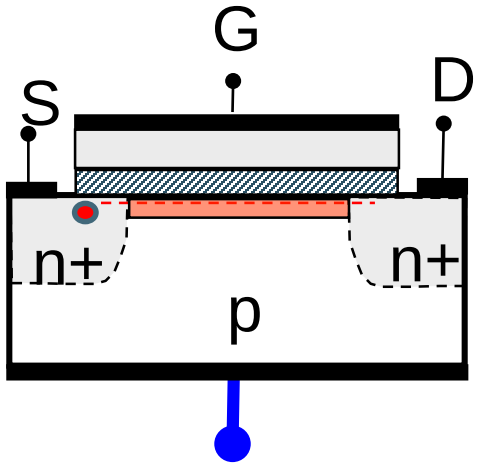


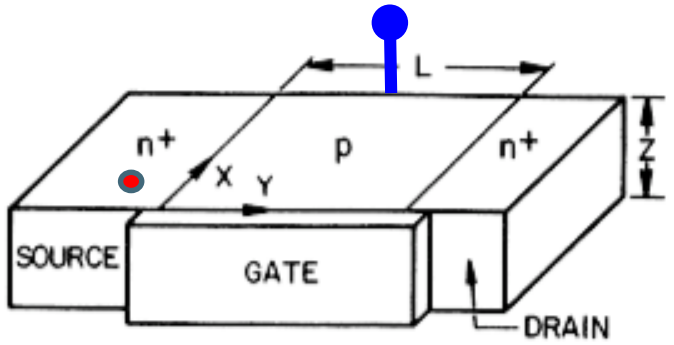
$$I = G \times V$$
$$= q \times n \times v \times A$$

charge density, velocity, area

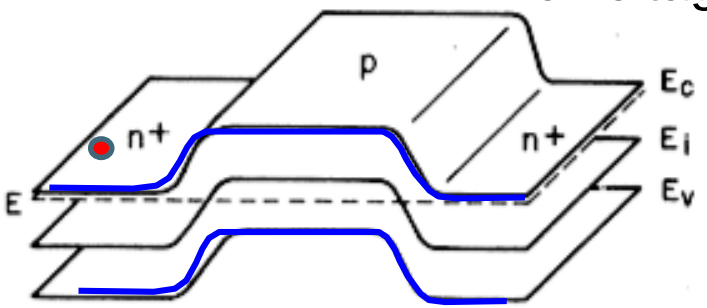
	Equilibrium	DC	Small signal	Large Signal	Circuits
PN Diode					
Schottky Diode					
BJT/ HBT					
MOScap MOSFET					

Subthreshold Region ($V_G < V_{th}$)

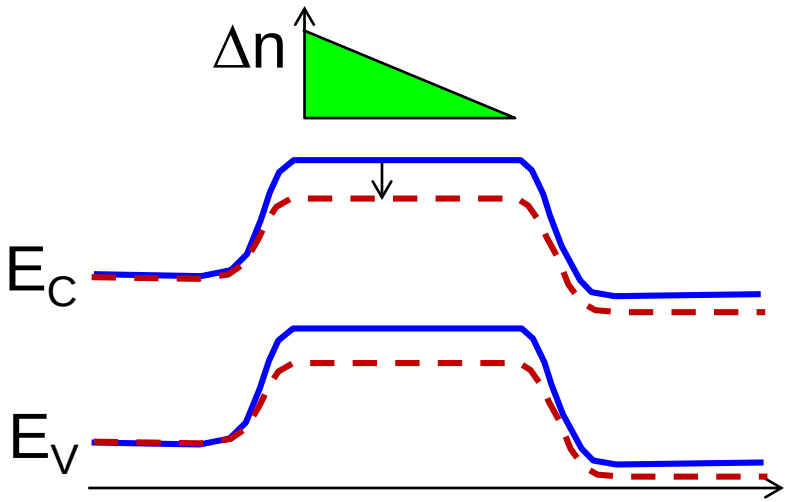




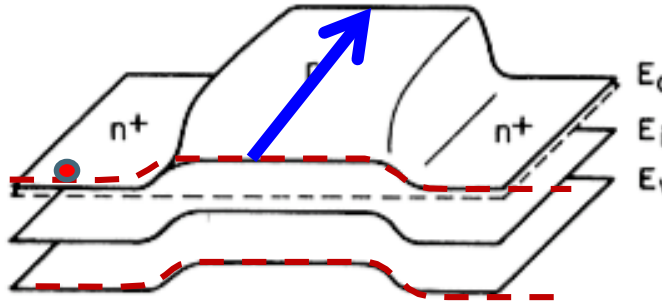
No voltages



Looks like
2 pn junctions
In 2D – not 1D



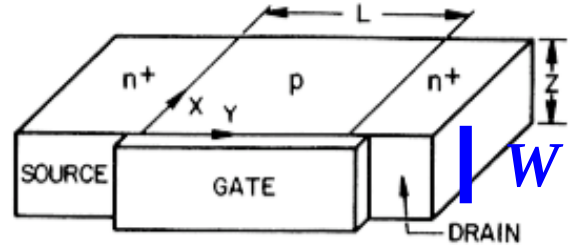
What happens with a gate bias?
Remember this is a 2D device!

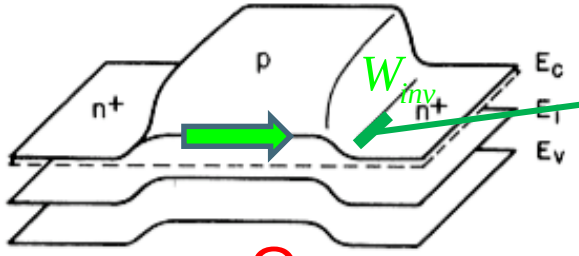


MOScap as discussed before with surface psi_s

Back-gate grounded => fixed potential

Subthreshold Region ($V_G < V_{th}$)

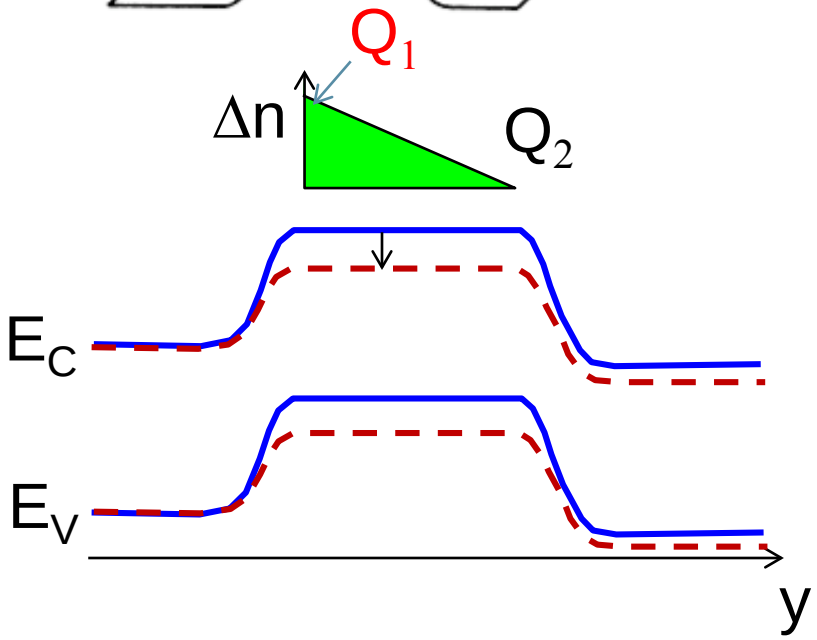


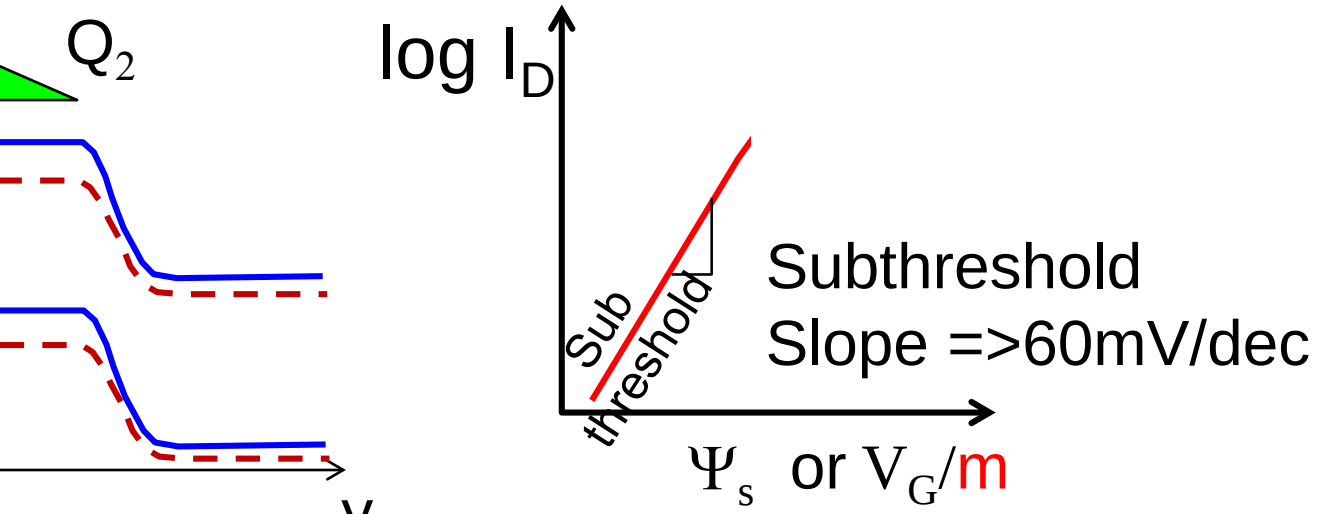


$$I_D = qD_n \frac{Q_1 - Q_2}{L_{ch}}$$

$$= q\frac{D}{L_{ch}}\left[W \times W_{inv} \times \frac{n_i^2}{N_A}\left(e^{q\psi_s\beta} - 1\right)\right]$$

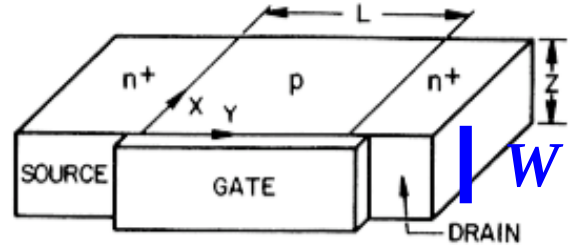
$$\approx qWW_{inv}\frac{D}{L_{ch}}\frac{n_i^2}{N_A}\left(e^{qV_G\beta/m} - 1\right)$$

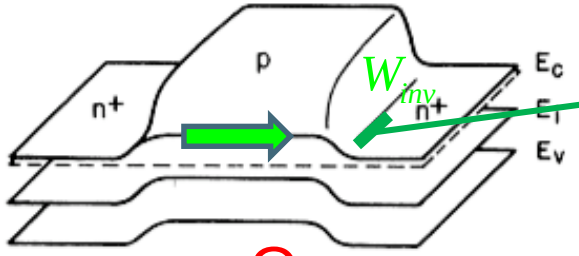




m = body coefficient
typically 1.1~1.4

Subthreshold Region ($V_G < V_{th}$)





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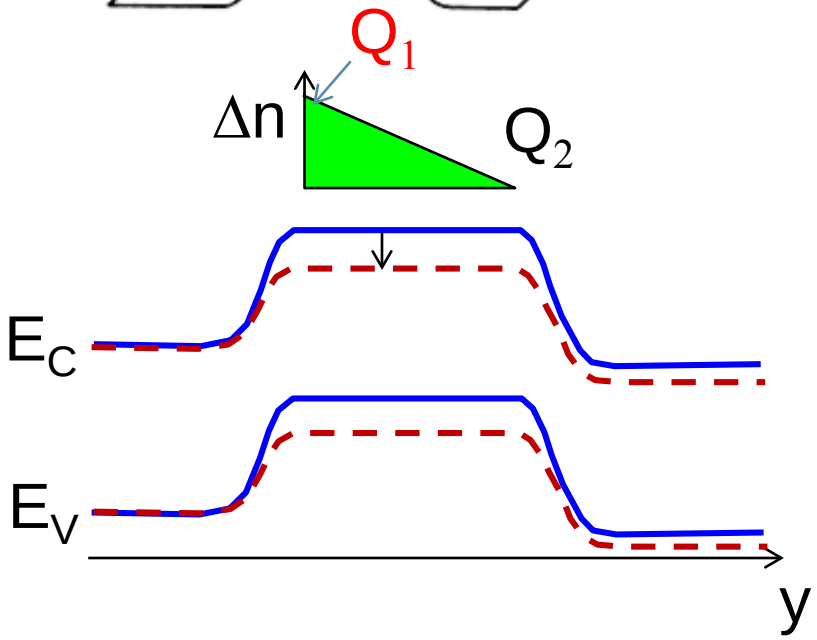

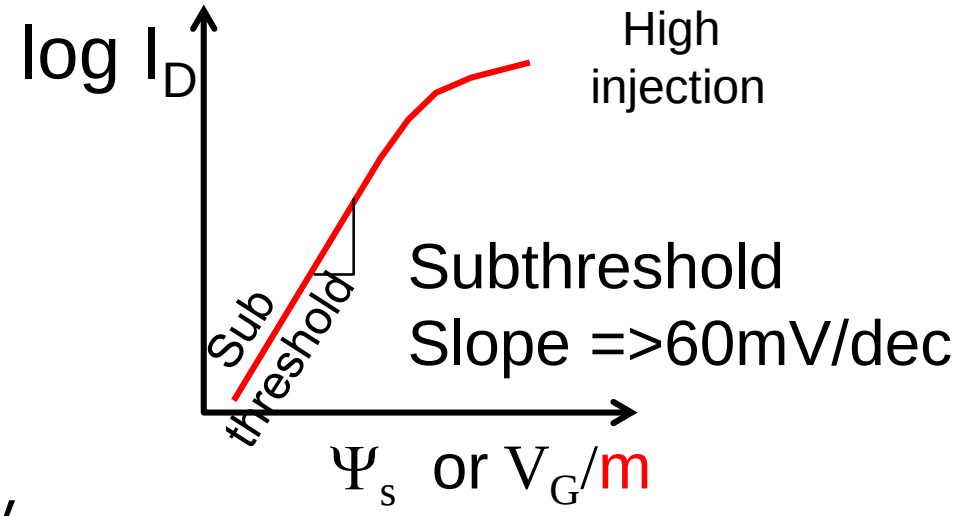

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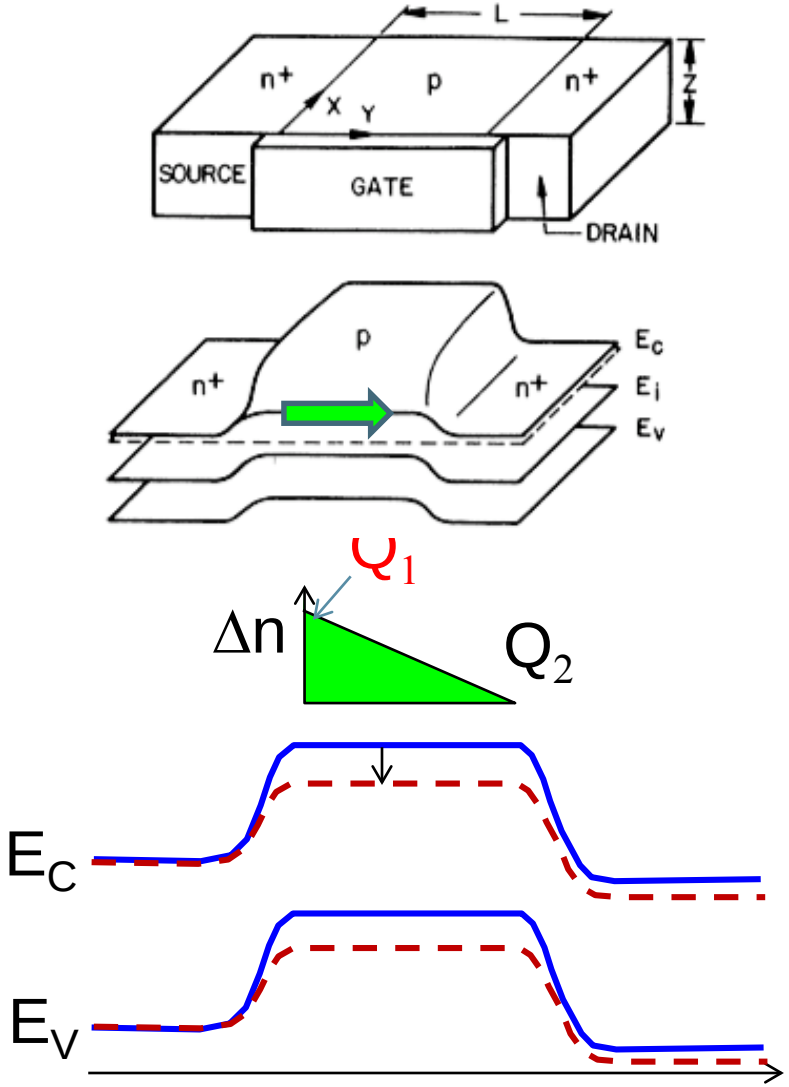
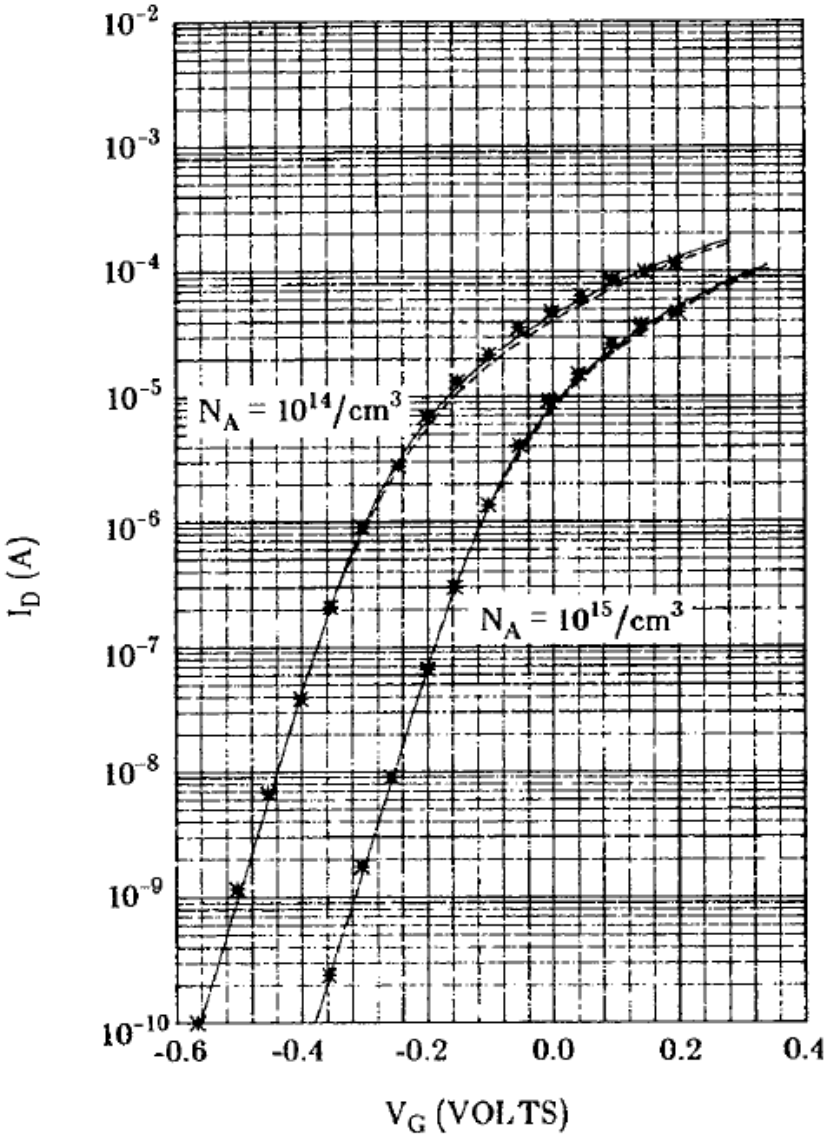




Recall the definition of body coefficient (*m*)

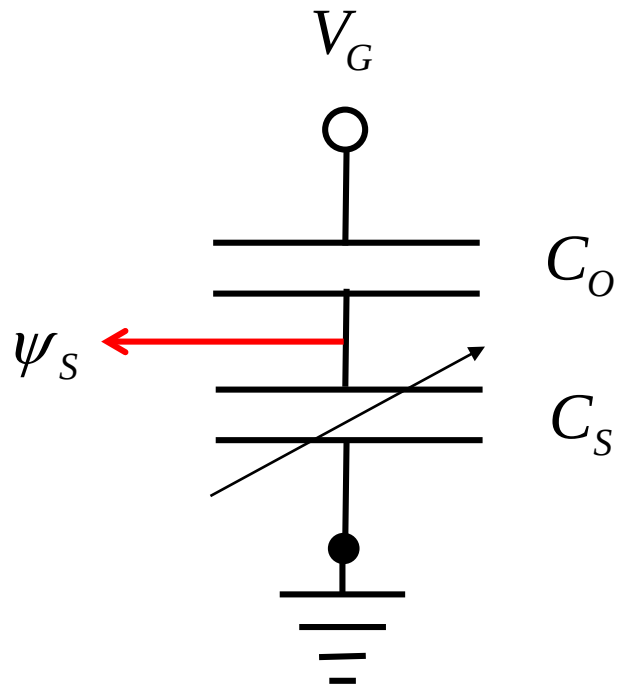
$$m = \left(1 + C_S / C_O\right)$$

'Body Effect Coefficient'

$$m = \left(1 + \kappa_S x_O / \kappa_0 W_T\right)$$

in practice:

$$1.1 \le m \le 1.4$$



$$\psi_S = \frac{C_O}{C_O + C_S} V_G \equiv \frac{V_G}{m}$$

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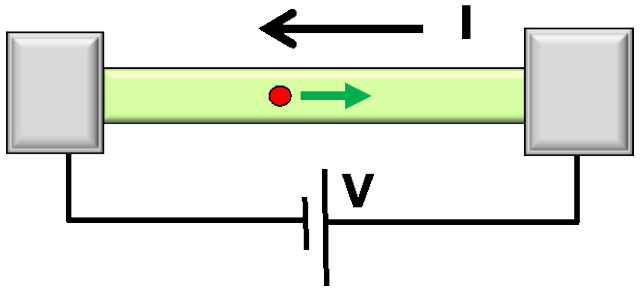

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charge density velocity area

1
- 30.1 Sub-threshold (depletion) current status

2
- 30.2 Above-threshold, inversion current

3
- 30.3 Velocity saturation in simplified theory

4
- 30.4 Comments on bulk charge theory & small transistors

Ref: Sec. 16.4 of SDF Chapter 18, SDF

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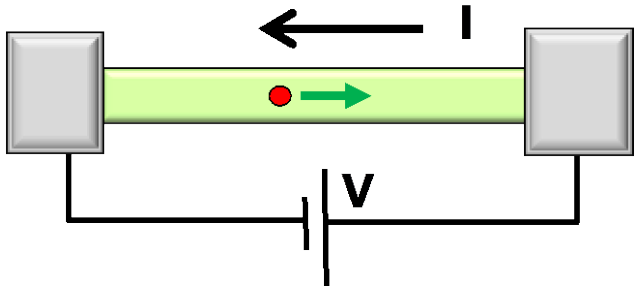

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