

An aerial photograph of a large solar farm. The panels are arranged in a grid pattern, with rows of rectangular panels extending across the landscape. The panels are dark blue or black, and the grid lines are light gray. The perspective is from a high angle, looking down at the panels.

Dispositivos Fotovoltaicos: Materiais e Tecnologia

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Avaliação

Avaliação contínua

Teste (8 valores minimo)	60%
Relatório dos trabalhos de laboratório	20%
Relatório PVFactory	20%

A aprovação à disciplina faz-se por avaliação contínua ou exame final

Nota: Quem tiver mais do 17 valores no teste ou no exame final terá que fazer um exame oral

Relatório de laboratório (até à data do 1º exame)

An aerial photograph of a large solar farm. The solar panels are arranged in a grid pattern, with rows of panels extending across the landscape. The panels are dark blue or black, and the grid lines are light gray or white. The perspective is from a high angle, looking down at the panels.

PART 1

Materials



Materials Science



Engineering Materials



Materials for
Photovoltaics

BIBLIOGRAPHY

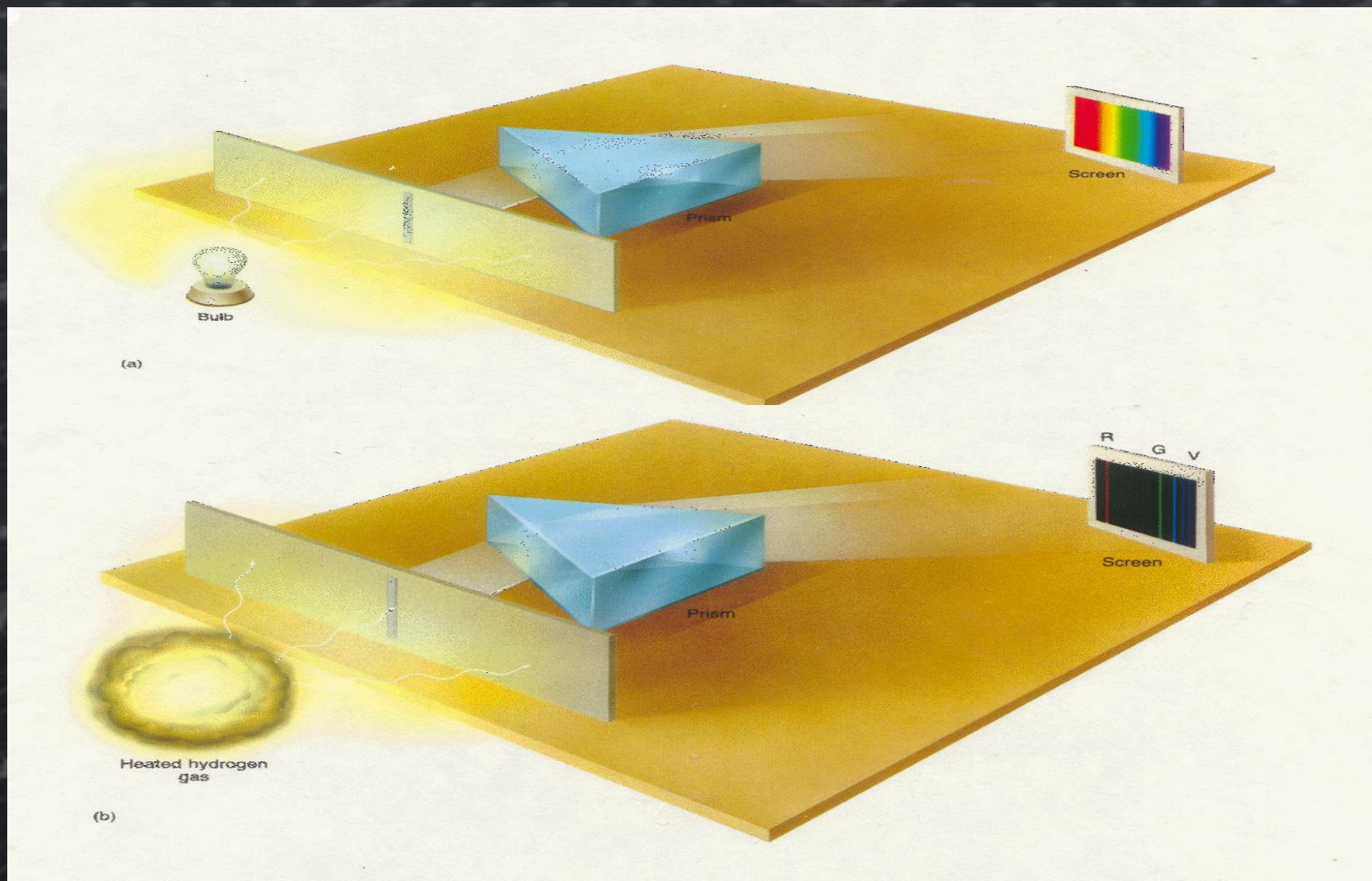
Introduction to Materials Science and Engineering, W. Smith, Ed
McGraw Hill

Crystalline Silicon Solar Cells, A Goetzberger, Ed. J. Wiley

Handbook of Photovoltaic Science and Engineering, A. Luque, Ed.
J.Wiley

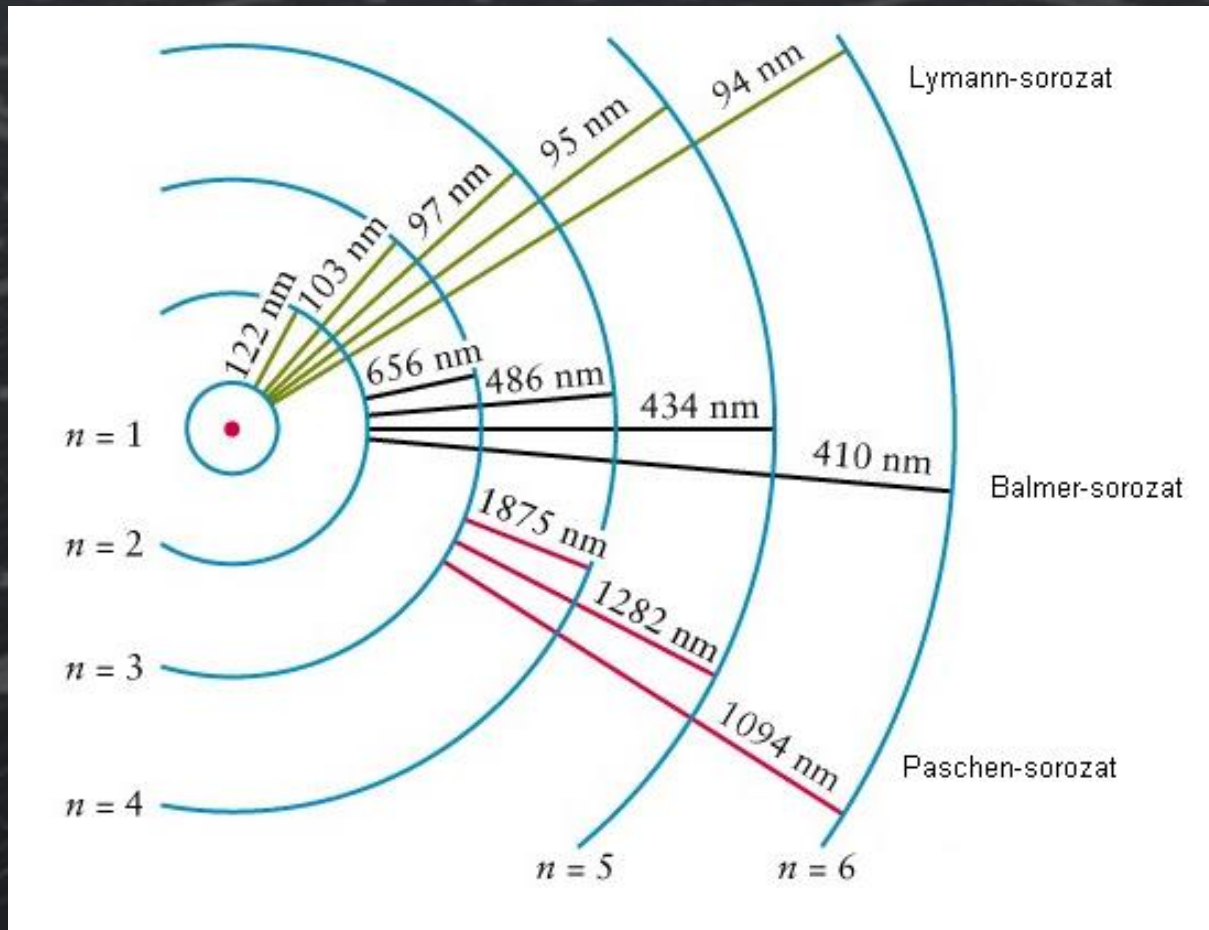
MATERIALS

Spectral decomposition of light



MATERIALS

Energy levels in hydrogen atom



An aerial photograph of a large-scale solar farm. The panels are arranged in a precise grid pattern, with rows extending towards the horizon. The perspective is from a high angle, looking down at the panels. The panels themselves are dark blue or black, with a grid of silver or white lines representing the electrical connections. The overall scene is a vast, organized expanse of renewable energy infrastructure.

Materials for photovoltaics

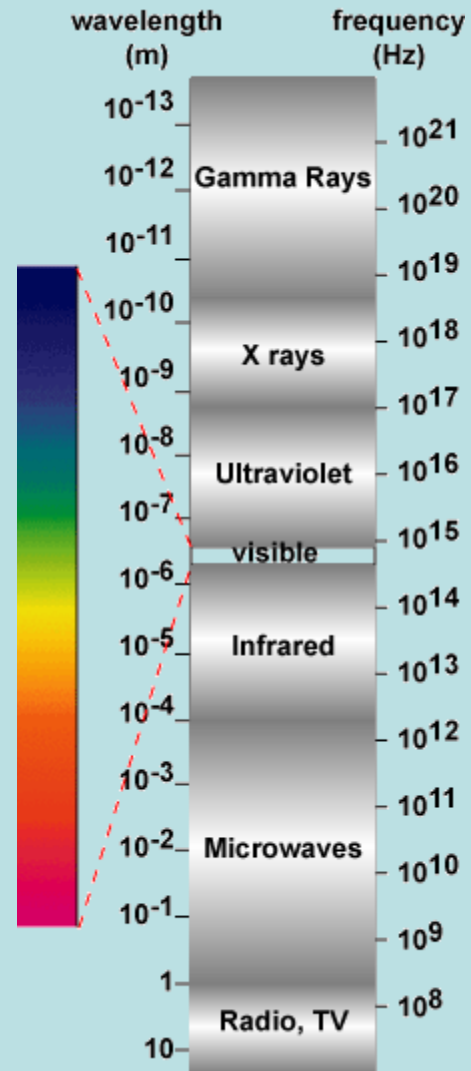
PHYSICS OF SOLAR CELLS

Properties of light

$$E = \frac{hc}{\lambda}$$

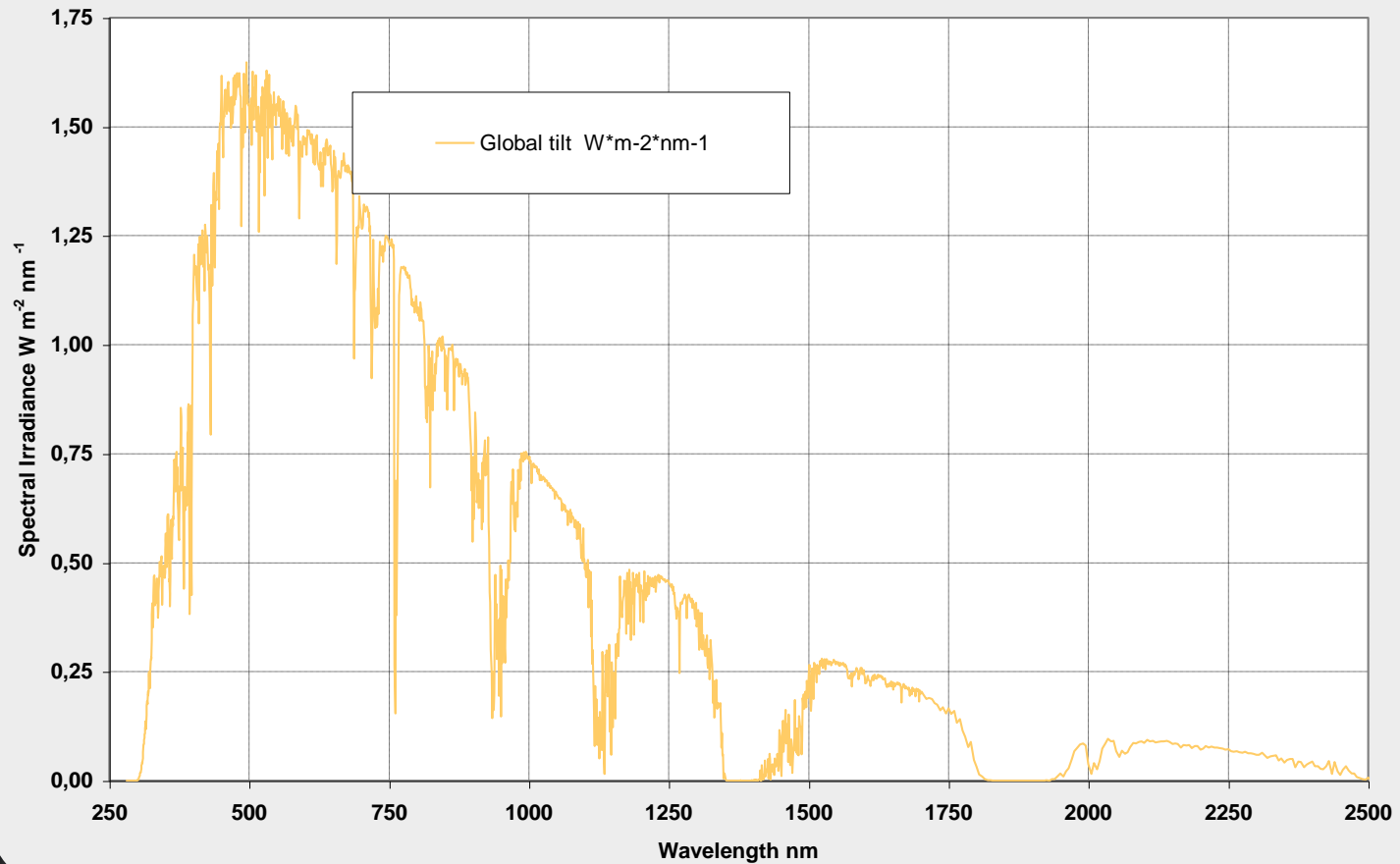
$$E(\text{eV}) = \frac{1.24}{\lambda(\mu\text{m})}$$

$$1\text{eV} = 1.6\text{E-}19\text{ J}$$



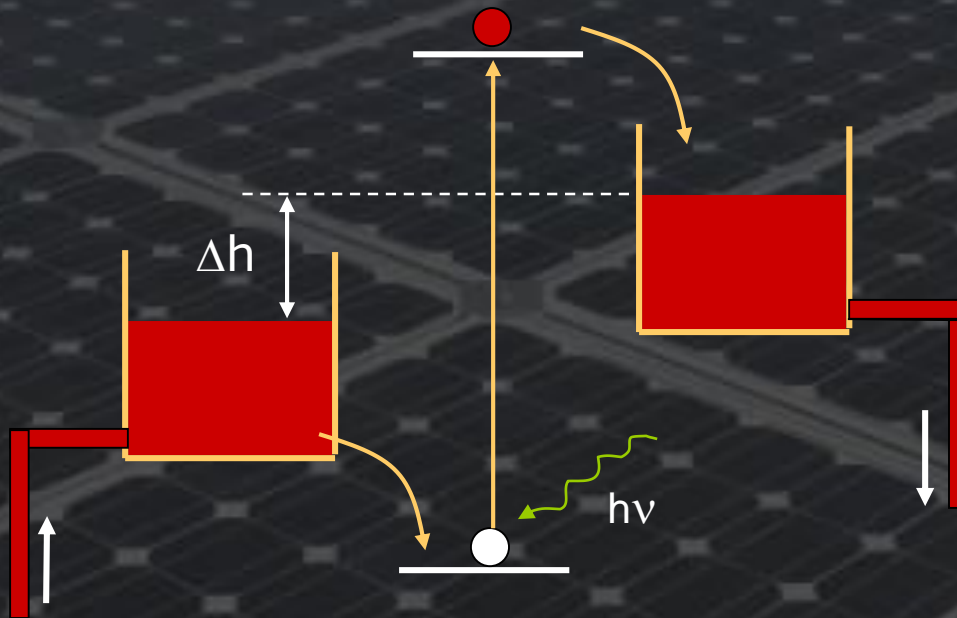
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AM1.5 spectrum



PHYSICS OF SOLAR CELLS

Generalized quantum converter



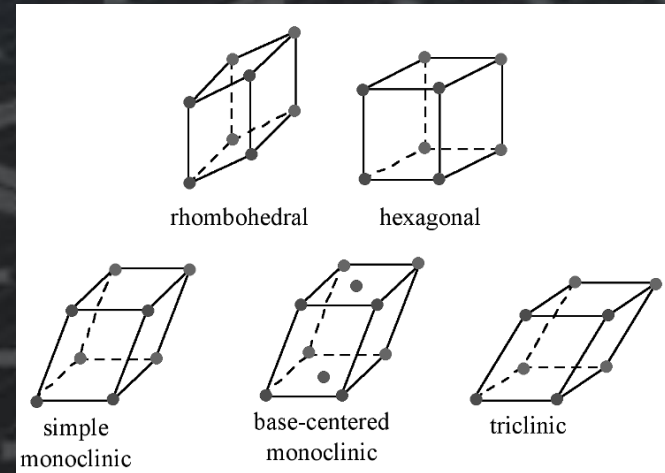
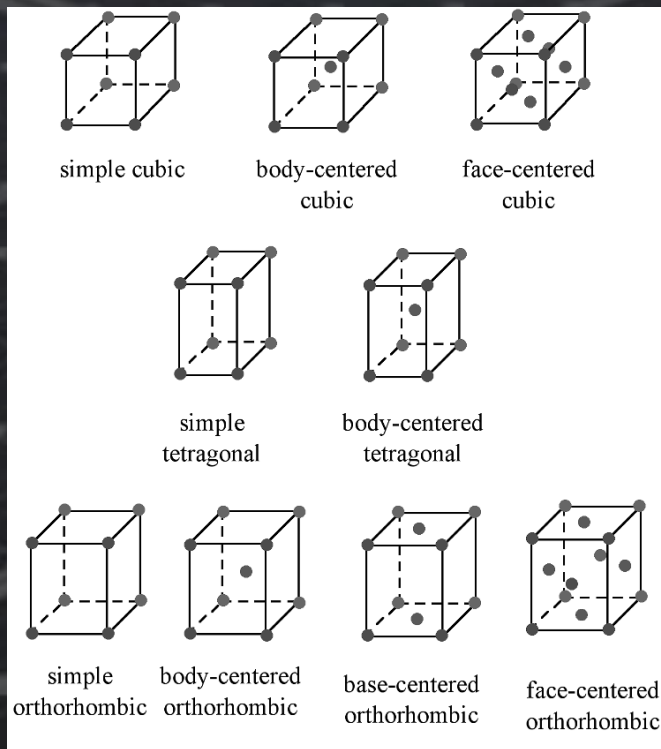
How light turns into electricity - creating charges
How does voltage and current appears – Charge Separation
How to collect charges - Collecting charges

An aerial photograph of a large solar farm. The solar panels are arranged in a grid pattern, with rows of panels extending across the landscape. The panels are dark blue or black, and the grid lines are light gray. The perspective is from a high angle, looking down at the panels.

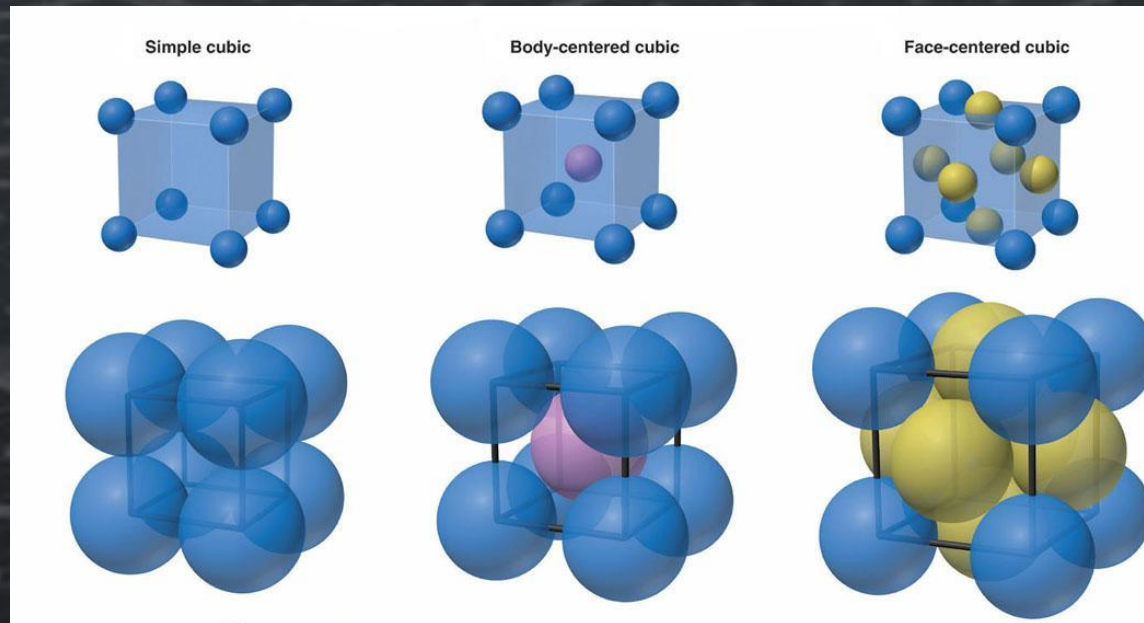
PART 1

From atoms to crystals

PHYSICS OF SOLAR CELLS



PHYSICS OF SOLAR CELLS



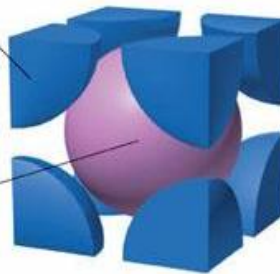
$\frac{1}{8}$ atom
at 8 corners



$$\text{Atoms/unit cell} = \frac{1}{8} \times 8 = 1$$

$\frac{1}{8}$ atom
at 8 corners

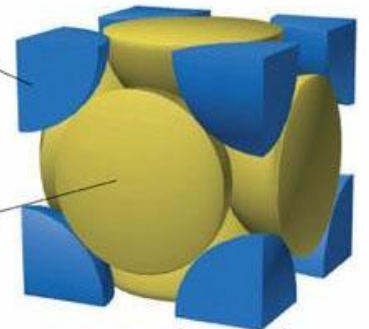
1 atom
at center



$$\text{Atoms/unit cell} = \left(\frac{1}{8} \times 8\right) + 1 = 2$$

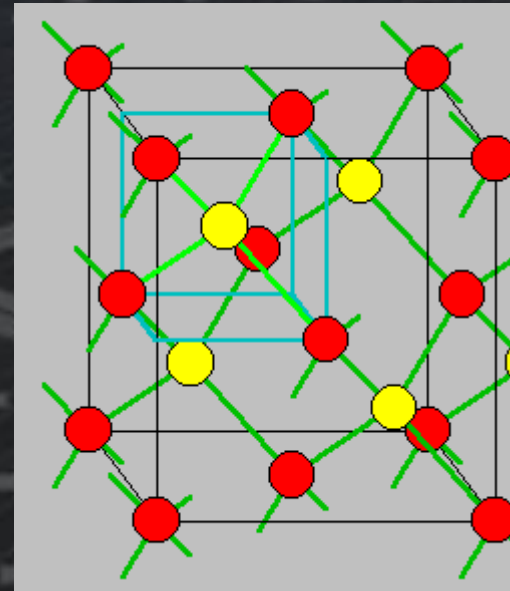
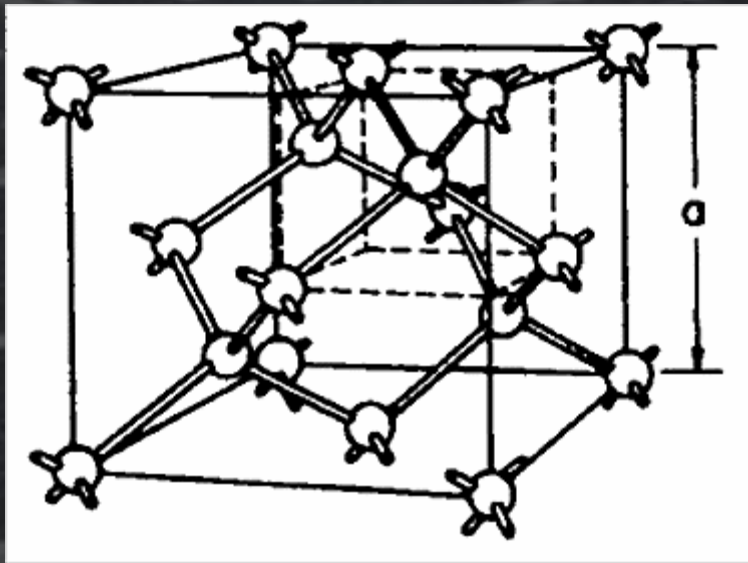
$\frac{1}{8}$ atom
at 8 corners

$\frac{1}{2}$ atom
at 6 faces

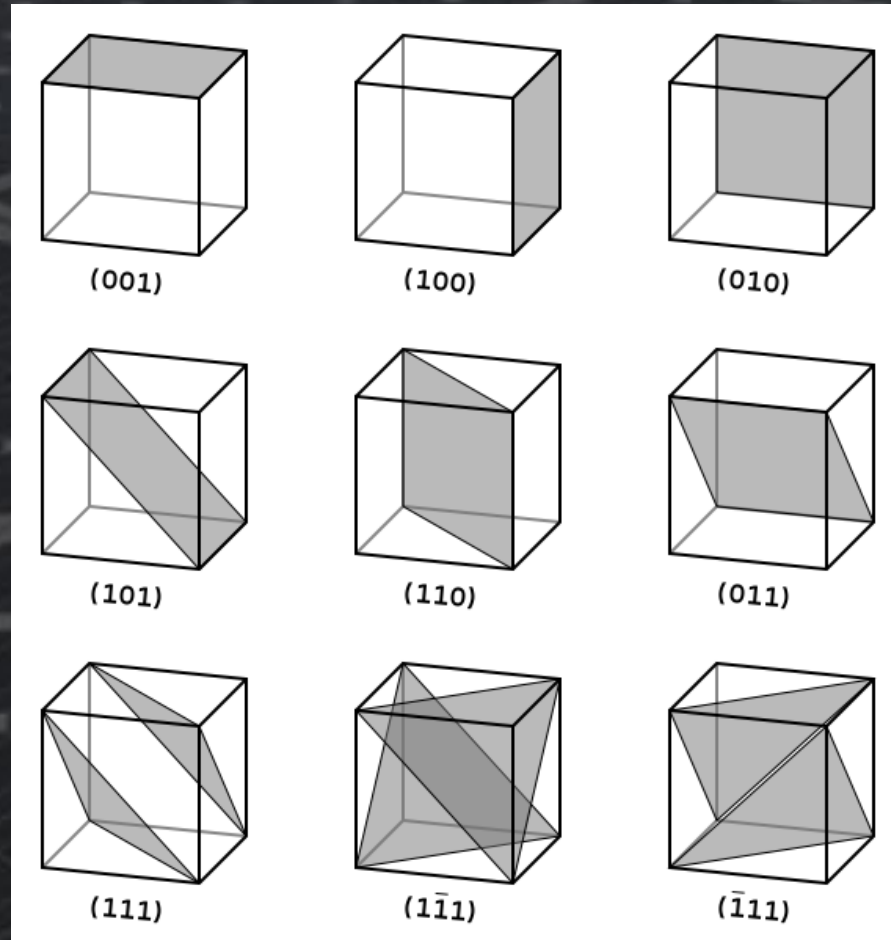


$$\text{Atoms/unit cell} = \left(\frac{1}{8} \times 8\right) + \left(\frac{1}{2} \times 6\right) = 4$$

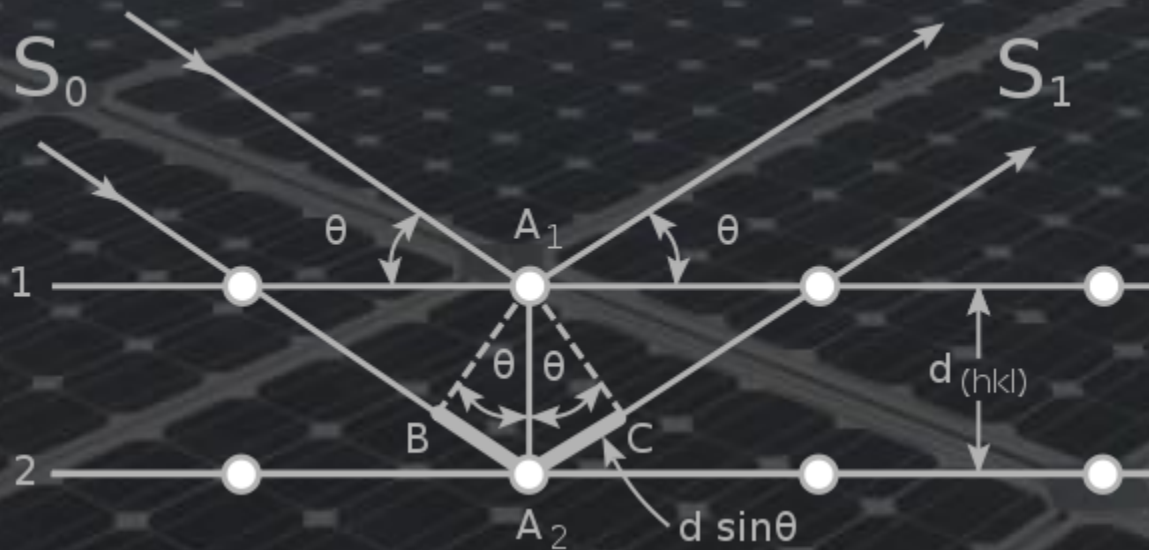
PHYSICS OF SOLAR CELLS



PHYSICS OF SOLAR CELLS

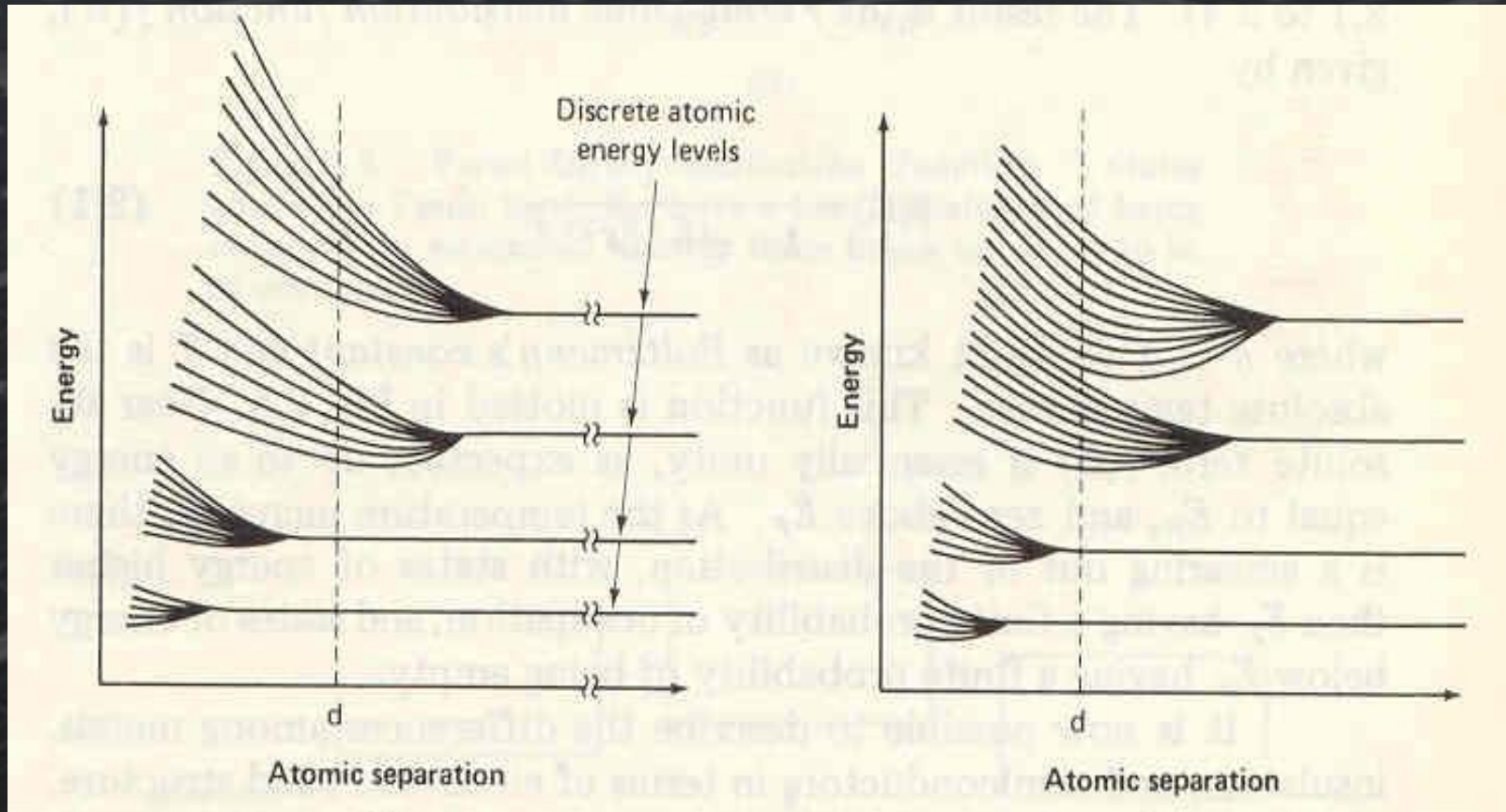


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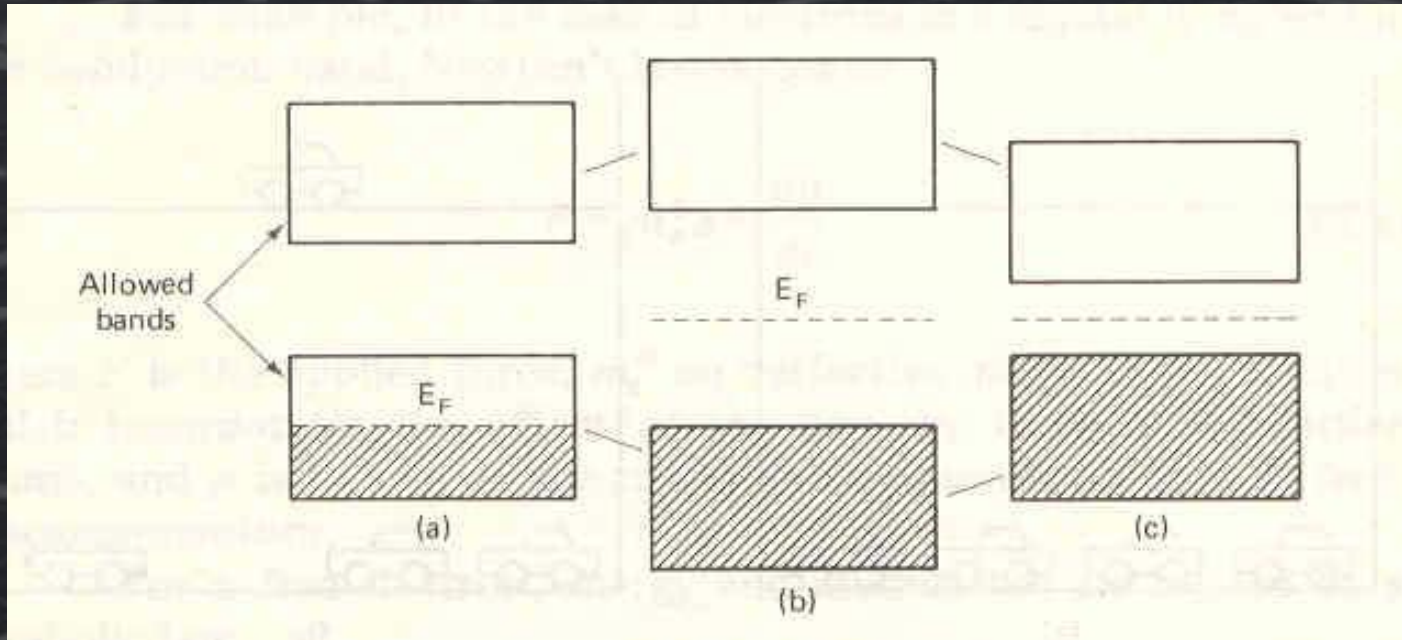
PHYSICS OF SOLAR CELLS

Formação das bandas de energia



PHYSICS OF SOLAR CELLS

Formação das bandas de energia



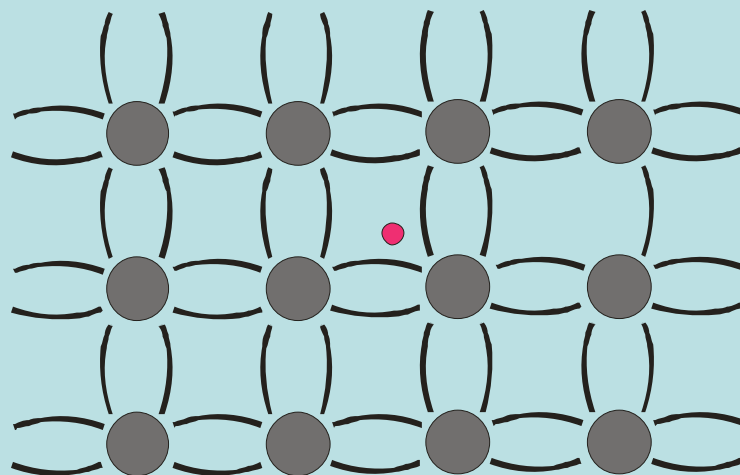
a) Metal

b) Insulator

c) Semiconductor

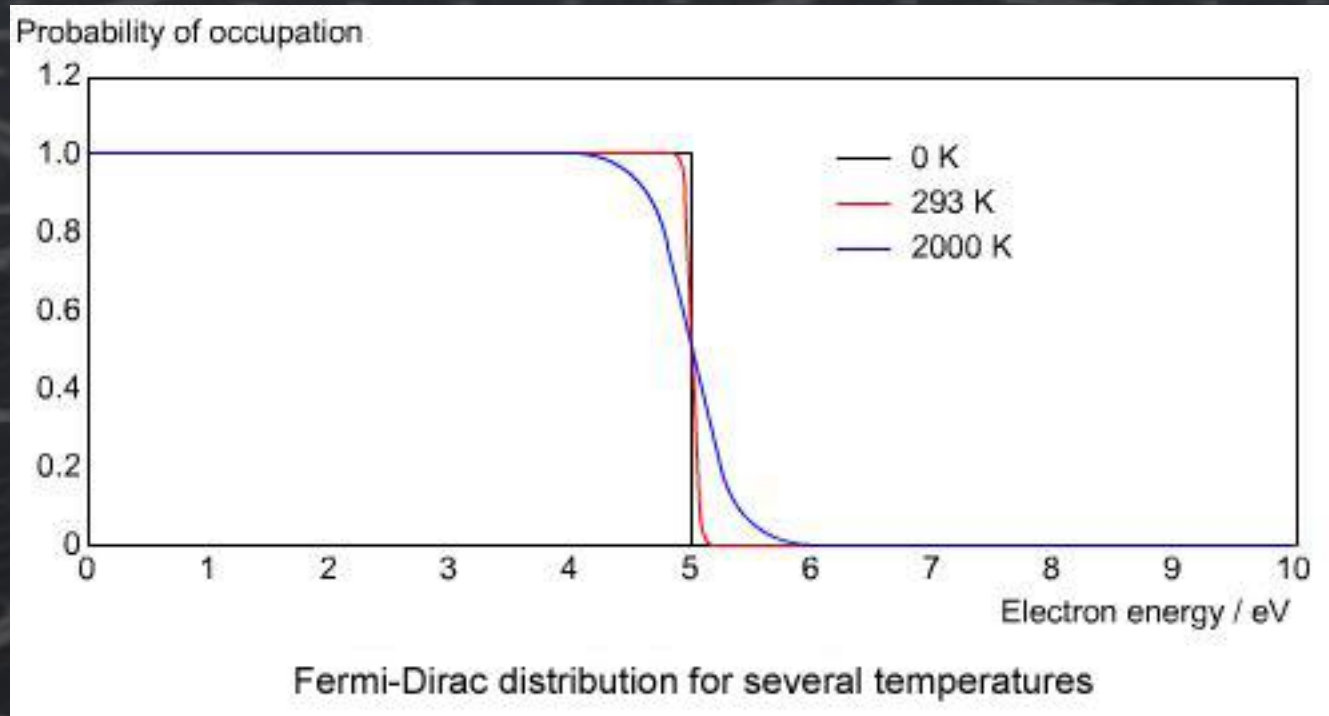
PHYSICS OF SOLAR CELLS

Formação de um par electrão-buraco



PHYSICS OF SOLAR CELLS

Formação de um par electrão-buraco



$$f(E) = \frac{1}{e^{(E - E_F)/kT} + 1}$$

PHYSICS OF SOLAR CELLS

