

Title: Quantum Mechanics 4 - OR vs. AND

Date: Aug 11, 2008 10:30 AM

URL: <http://pirsa.org/08080079>

Abstract: Highlighting the essential difference between the classical and quantum worlds.

Learning Outcomes:

• A recap of what we've learned so far.

• Understanding that in the classical world we have either • OR • particle moving to the left. •

• Understanding that, in the quantum world, OR can be replaced with AND: • AND • particle moving to the left. •

Recap : $F = ma$



Recap: $F=ma \rightarrow \lambda p = h$

Recap: $F=ma \rightarrow \lambda p = h$ de Broglie

Recap: $F = ma \rightarrow \lambda p = h$ de Broglie
↙ ↘
wave particule



Recap

$$F = ma \rightarrow$$

$$\lambda \quad p = h$$

↙ ↘
wave particelle

de Broglie



=

Recap: $F = ma \rightarrow \lambda p = h$ de Broglie

\nearrow
wave
 \searrow
particelle



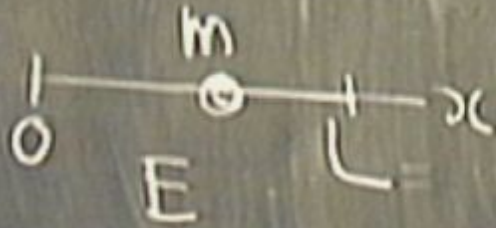
Recap

$$F = ma \rightarrow$$

$$\lambda \quad p = h$$

de Broglie

wave particule



de Broglie

Energy

0 | E_0 (zero point)

Energy



$$E_2 = 9E_0$$

$$E_1 = 4E_0$$

$$E_0 \text{ (zero point)}$$

Energy

$$\uparrow E_2 = 9E_0$$

$$E_1 = 4E_0$$

$$E_0 \text{ (zero point)}$$

$$\psi_0 = \text{[Diagram of a wavefunction]} \rho_0$$

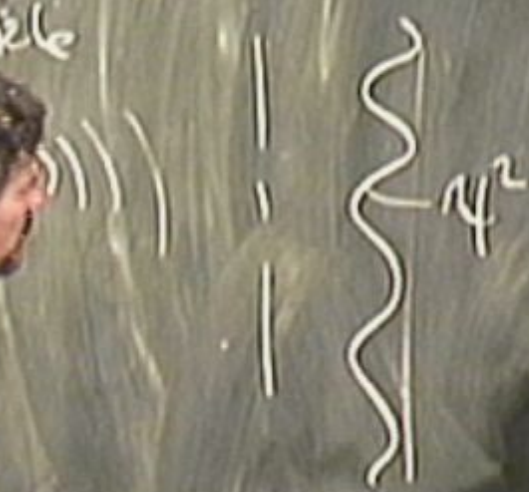
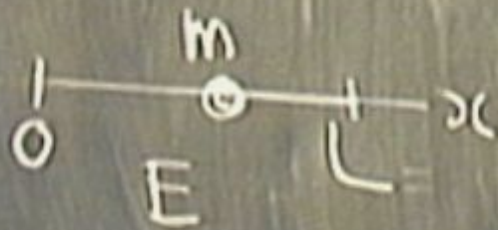
Recap

$$F = ma \rightarrow$$

$$\lambda p = h$$

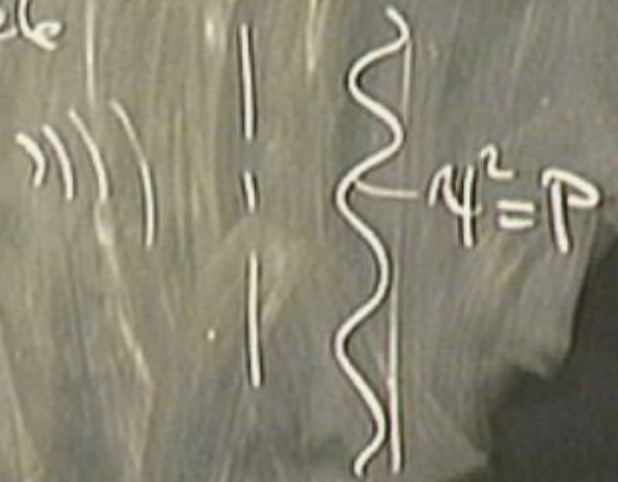
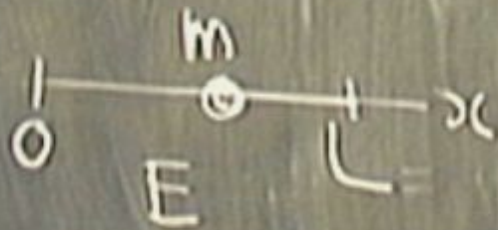
de Broglie

↗
wave
↘
particule



Recap: $F = ma \rightarrow \lambda p = h$ de Broglie

\nearrow wave
 \searrow particele

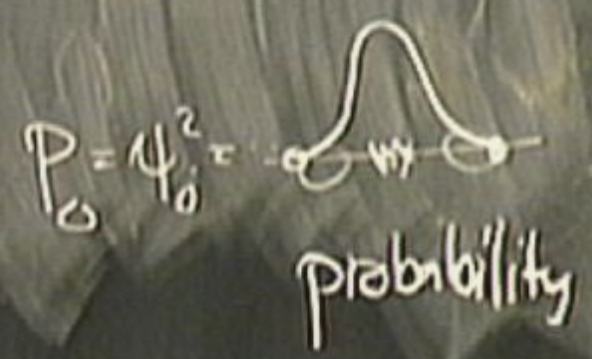


Energy

$$\uparrow E_2 = 9 E_0$$

$$E_1 = 4 E_0$$

$$E_0 \text{ (zero point)}$$



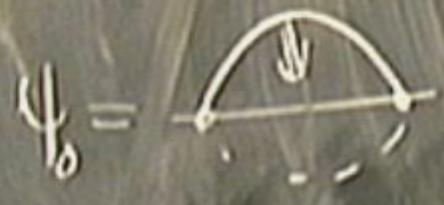
Energy

$E_2 = 9E_0$

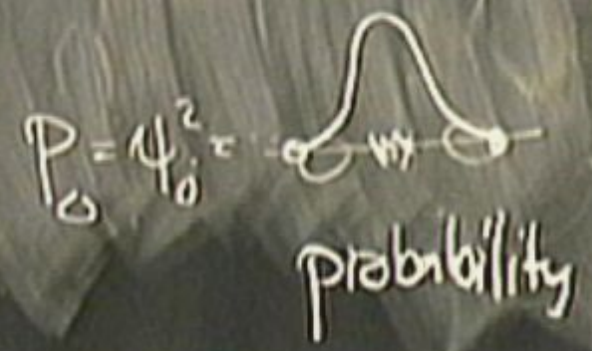
$E_1 = 4E_0$

E_0 (zero point)

ψ_1



ψ_0



Energy

$\uparrow E_2 = 9 E_0$

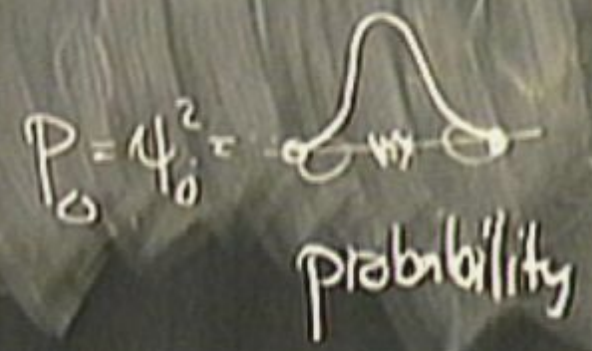
$E_1 = 4 E_0$

E_0 (zero point)

ψ_1

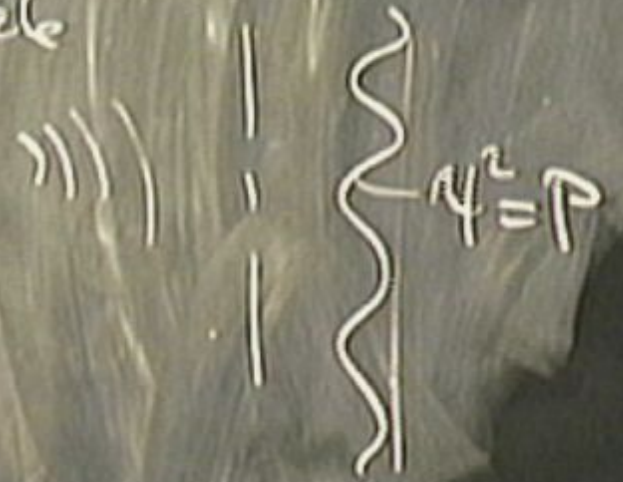
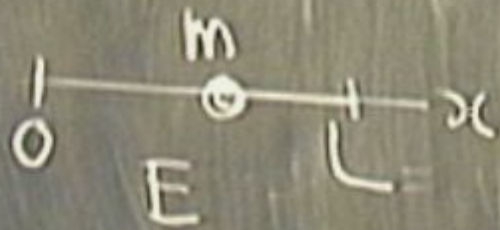


ψ_0



Recap: $F=ma \rightarrow \lambda p = h$ de Broglie

\swarrow wave
 \searrow particule

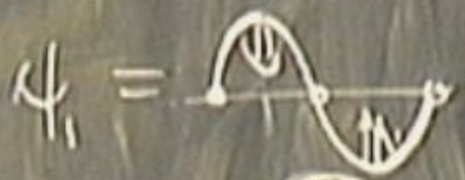


Energy

$E_2 = 9E_0$

$E_1 = 4E_0$

E_0 (zero point)



$P_1 = \psi_1^2$



$P_0 = \psi_0^2$



probability

Energy

$E_2 = 9E_0$



$E_1 = 4E_0$



$P_1 = \psi_1^2$



E_0 (zero point)



$P_0 = \psi_0^2$



probability

classical



$+p \underline{R} -p$

classical



$+p$ or $-p$

$$E = \frac{p^2}{2m}$$

quantum



Recap :

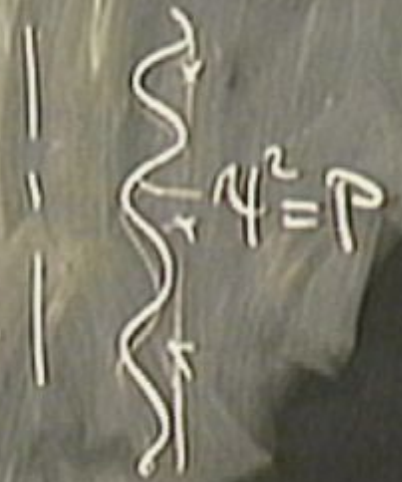
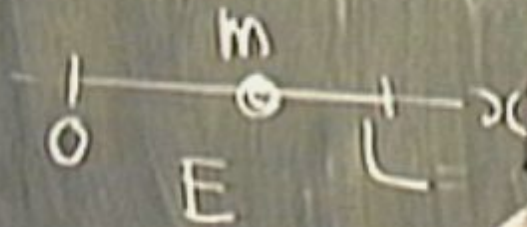
$$F = ma \rightarrow$$

$$\lambda \quad p = h$$

de Broglie

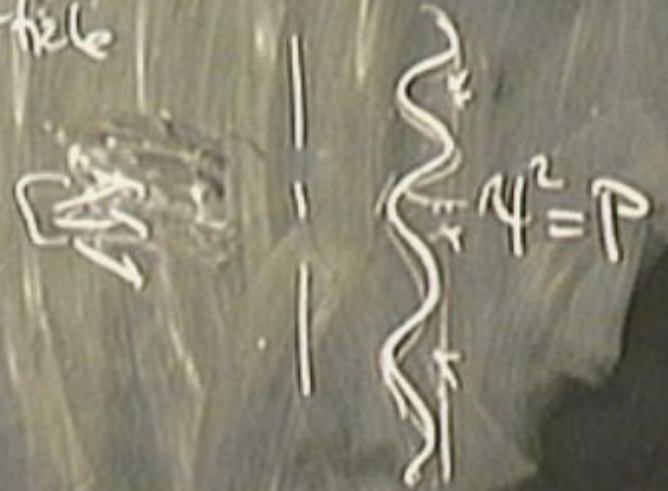
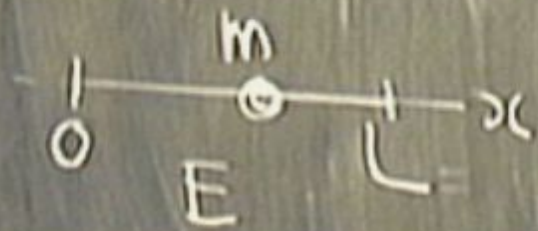
wave

particule



Recap: $F = ma \rightarrow \lambda p = h$ de Broglie

\swarrow
wave
 \searrow
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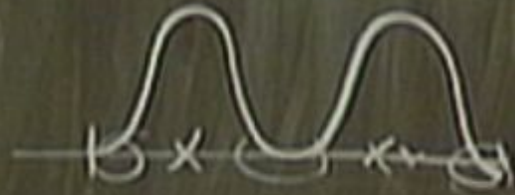
classical



$+p$ or $-p$

$$E = \frac{p^2}{2m}$$

quantum



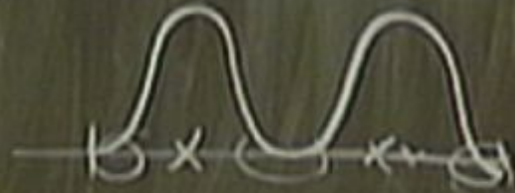
classical



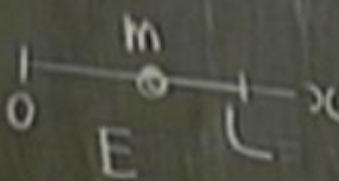
$+p$ or $-p$

$$E = \frac{p^2}{2m}$$


quantum






$F = ma \rightarrow \lambda p = h$ de Broglie
 ↗ ↘
 wave partikel



$\psi^2 = P$



Energy
 $E_2 = 9E_0$ $\psi_2 =$ 
 $E_1 = 4E_0$ $\psi_1 =$ 
 E_0 (zero point) $\psi_0 =$ 
 $\frac{h^2}{8mL^2}$

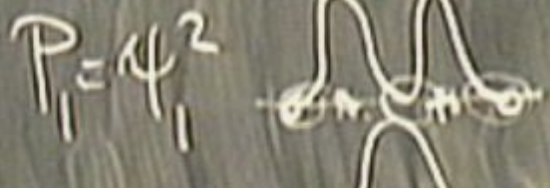


Energy

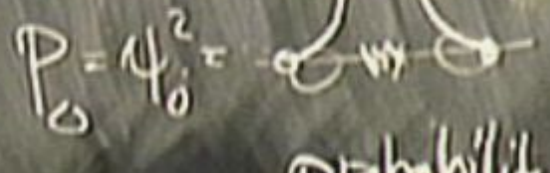
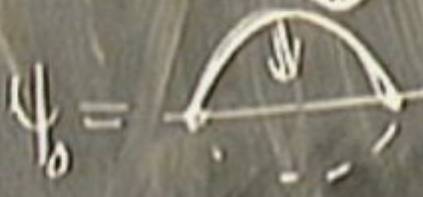
$E_2 = 9E_0$



$E_1 = 4E_0$



E_0 (zero point)
 $= \frac{h^2}{8mL^2}$



probability

Energy

$E_2 = 9E_0$



$E_1 = 4E_0$



$P_1 = \psi_1^2$



E_0 (zero point)



$P_0 = \psi_0^2$



probability

$\frac{h^2}{8mL^2}$

Energy

$$E_2 = 9E_0$$

$$\psi_2 = \text{[wave function]} \quad P_2 = \psi_2^2 = \text{[probability distribution]}$$



$$E_1 = 4E_0$$

$$\psi_1 = \text{[wave function]} \quad P_1 = \psi_1^2 = \text{[probability distribution]}$$

$$E_0 \text{ (zero point)} \\ \frac{h^2}{8mL^2}$$

$$\psi_0 = \text{[wave function]}$$

$$P_0 = \psi_0^2 = \text{[probability distribution]}$$

probability

class

quant

classical



$+\phi$ OR $-\phi$

$$E = \frac{\phi^2}{2m}$$

quantum



$+\phi$ AND $-\phi$

classical



$+p$ OR $-p$

$$E = \frac{p^2}{2m}$$

$$p = \pm \sqrt{2mE}$$

quantum



$+p$ AND $-p$

classical

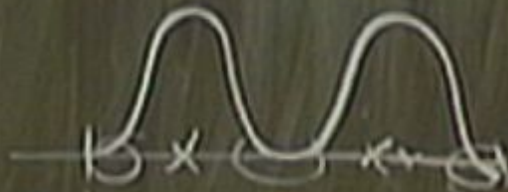


$+p$ OR $-p$

$$E = \frac{p^2}{2m}$$

$$p = \pm \sqrt{2mE}$$

quantum



$+p$ AND $-p$



classical

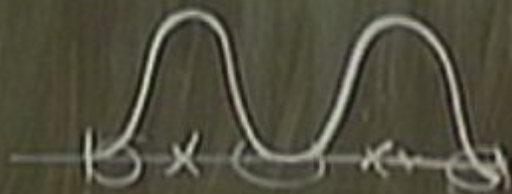


$+p$ OR $-p$

$$E = \frac{p^2}{2m}$$

$$p = \pm \sqrt{2mE}$$

quantum



$+p$ AND $-p$



classical



$+p$ OR $-p$

$$E = \frac{p^2}{2m}$$

$$p = \pm \sqrt{2mE}$$

quantum



$+p$ AND $-p$

