Lecture 20 Shadowitz 11.1

Does the vector potential exist or is it just a mathematical construct?

http://en.wikipedia.org/wiki/Ontology

"Ontology deals with questions concerning what entities exist or can be said to exist"

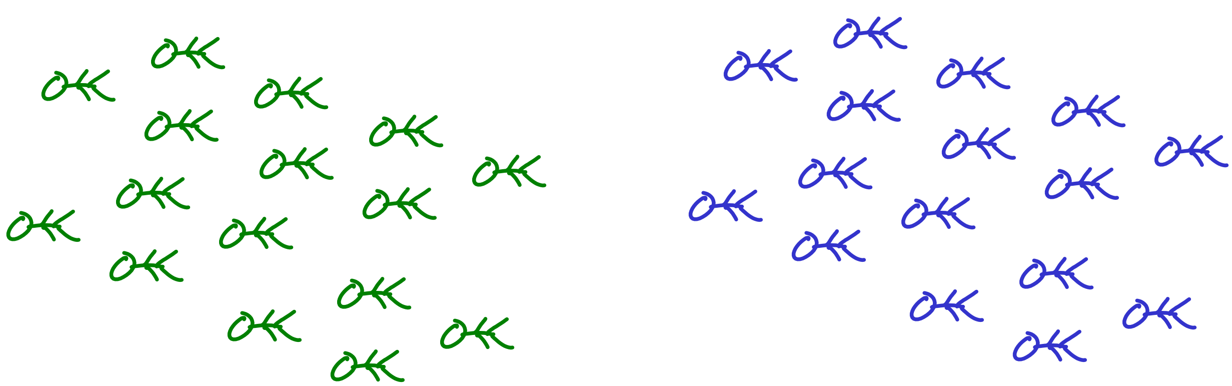
In the double slit expt. the wavefunction is near zero where there is B. Does this mean that B does not affect the motion of the wavefunction? A is not zero where the wavefunction is large. Does this mean the A affects the wavefunction?

http://en.wikipedia.org/wiki/Epistemology

"It questions what knowledge is and how it can be acquired, and the extent to which knowledge pertinent to any given subject or entity can be acquired."

Why does the skydiver analogy break down in E&M?

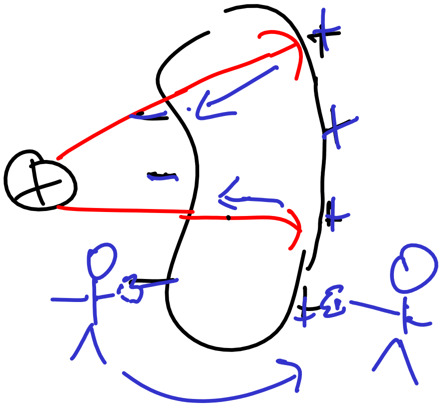
As far as we know there is no negative mass analogous to negative charge.



There has been some conjecture that antimatter falls differently from matter.

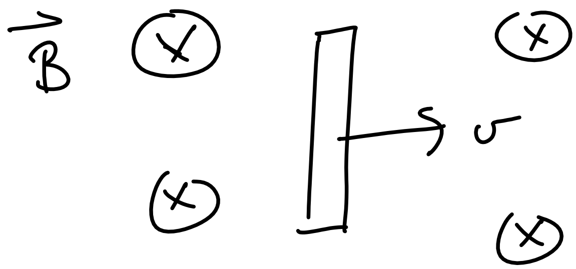
In addition there is no conductor of mass like a conductor of charge on whose surface the gravitational potential is constant.

How is E generated in a conductor with a battery?

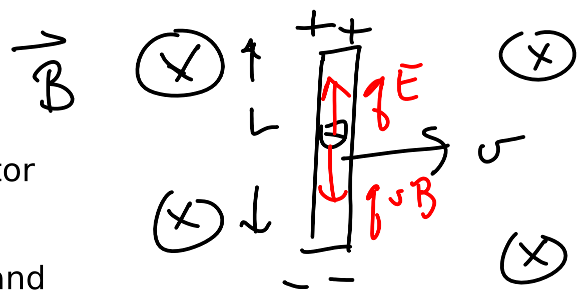


I pick up the charges and move them to the other side of the conductor causing a steady current to flow (acting as a battery)

Another tweezer method:



Like a battery it picks up charges and moves them to the other side of the conductor



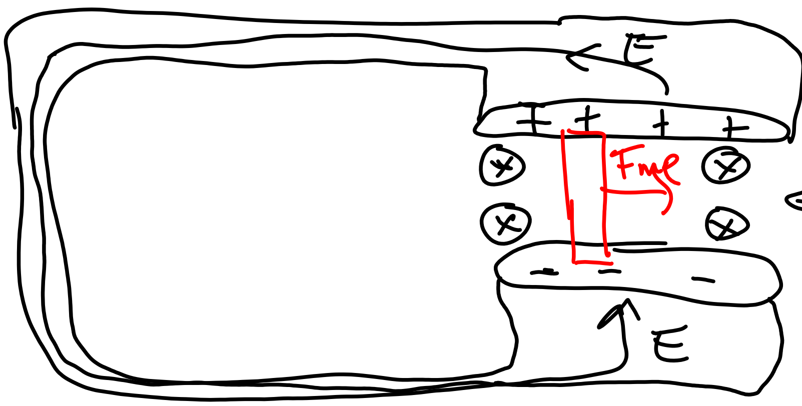
After equilibrium the charges generate an E which is equal and opposite to qvB. We can calculate the voltage this "battery" generates.

$$qvB = qE$$

$$E = vB$$

$$\Delta V = \left| -\int_0^L \vec{E} \cdot d\vec{r} \right| = EL$$

$$\Delta V = vBL$$



The wire moving in B slides along the metal surfaces.

const speed

What entity does work to move the charges and generate heat in the wire?

It requires work for me to move this wire and this goes into heating the circuit.

Faraday's law:

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

Questions about this model?

-(congruous)why does this have a non-zero curl?

-(congruous) will there be a time dependence in E?

--(congruous) Is E a neg time der of A.

-(congruous) what does the minus sign signify?

-(cong) continuity eqn.

-(congr) What does Stokes theorem tell us?

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

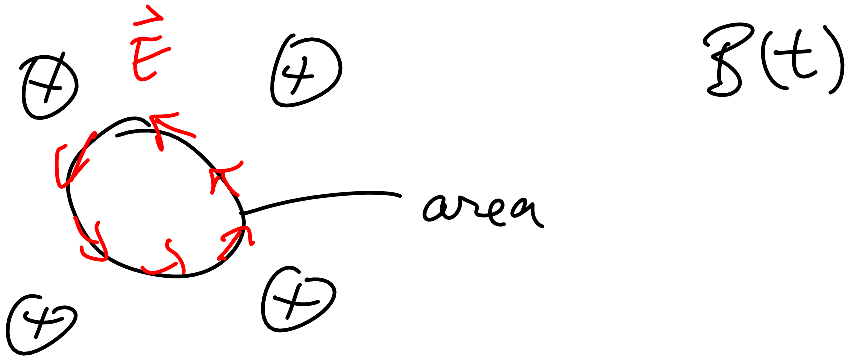
Since this a non-conservative field maybe we should call it G rather than E. Remember the curl of E is zero.

$$\vec{\nabla} \times \vec{G} = -\frac{\partial \vec{B}}{\partial t}$$

$$\int \vec{\nabla} \times \vec{E} \cdot d\vec{a} = -\frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a} = -\frac{\partial}{\partial t} \Phi_m$$

$$\parallel$$

$$\oint \vec{E} \cdot d\vec{r} = -\frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a}$$



This is not generated by charges as is our static E. It is generated by changing magnetic flux. If we called this E a G to distinguish it from the electrostatic E then would could easily separate the two. However, the force this field exerts is the same as an electric field so we will not use such a distinction.

$\vec{G}$

force $= q\vec{G} = q\vec{E}$

The cost of a ball and bat.

Knee-Jerk thinking

$1.00

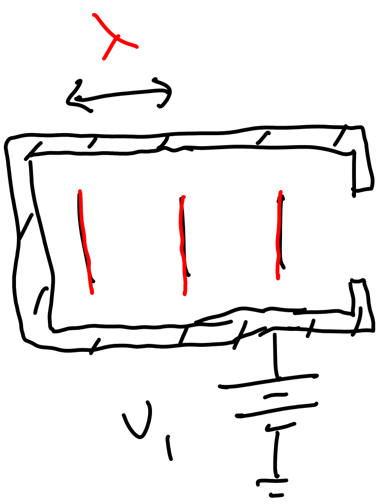
Analytic thinking

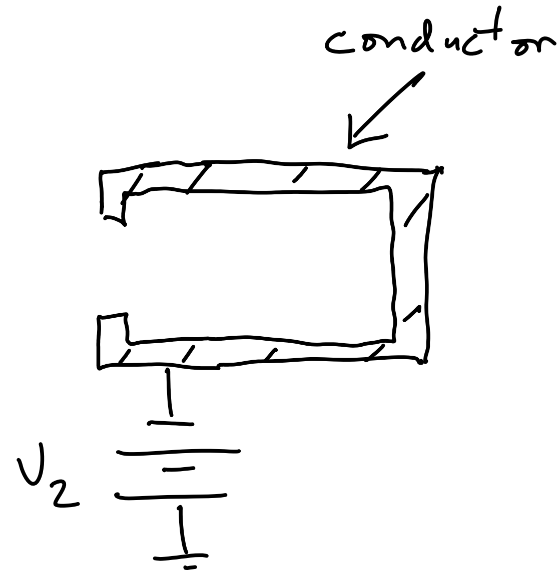
$x + y = \$1.10$

$x - y = \$1.00$

$x = 1.05 \quad y = .05$

How do we determine the motion of a quantum particle in this electric field?





$$-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\psi(x,t) + qV(x) = i\hbar\frac{\partial}{\partial t}\psi(x,t)$$

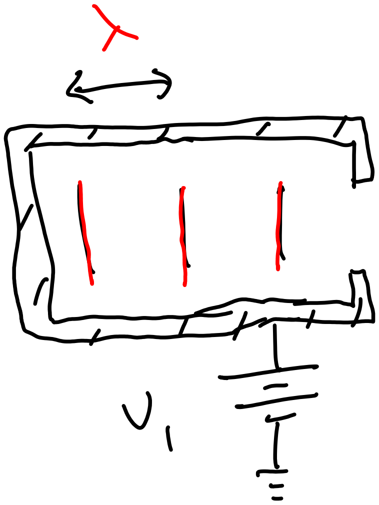
Questions:

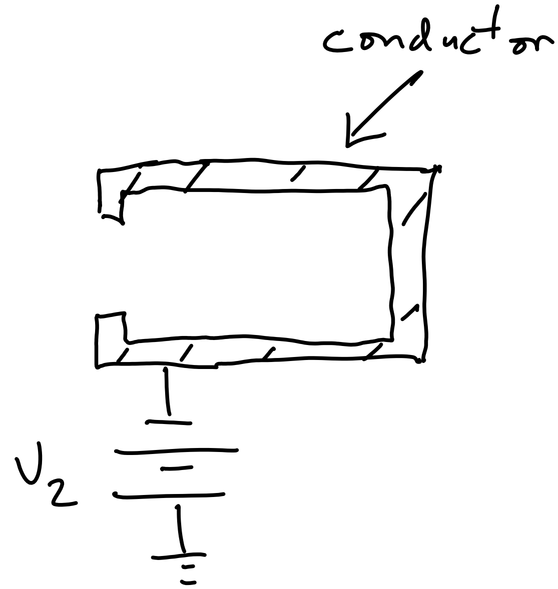
(congruous) How do you calculate V(x)?

(congrous) How do you calculate a solution to this Schrodinger eqn with boundary conditions?

(modify) What simplifying assumptions can I make?

(analogy) The Sch eqn is a statement of energy conservation. What is energy conservation classically?

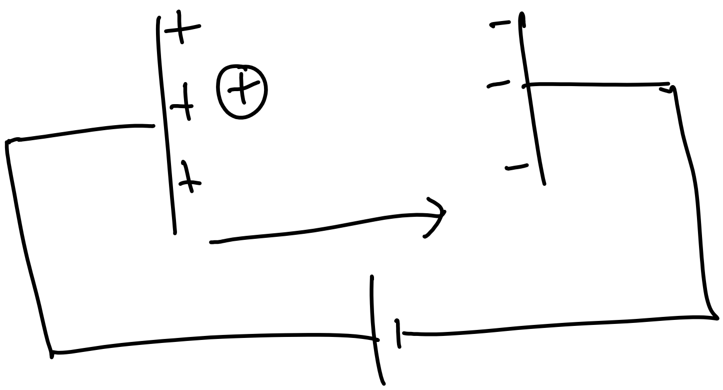


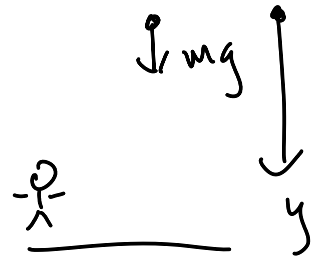


$$P = \frac{h}{\lambda}$$

Simplify

Analogy





$$PE = mgy$$

$$qV(x) = qE_0 x$$

$$E = -\frac{\partial V}{\partial x} = E_0$$

$$P = \frac{h}{\lambda} = \hbar k$$

$$E = \hbar \omega$$

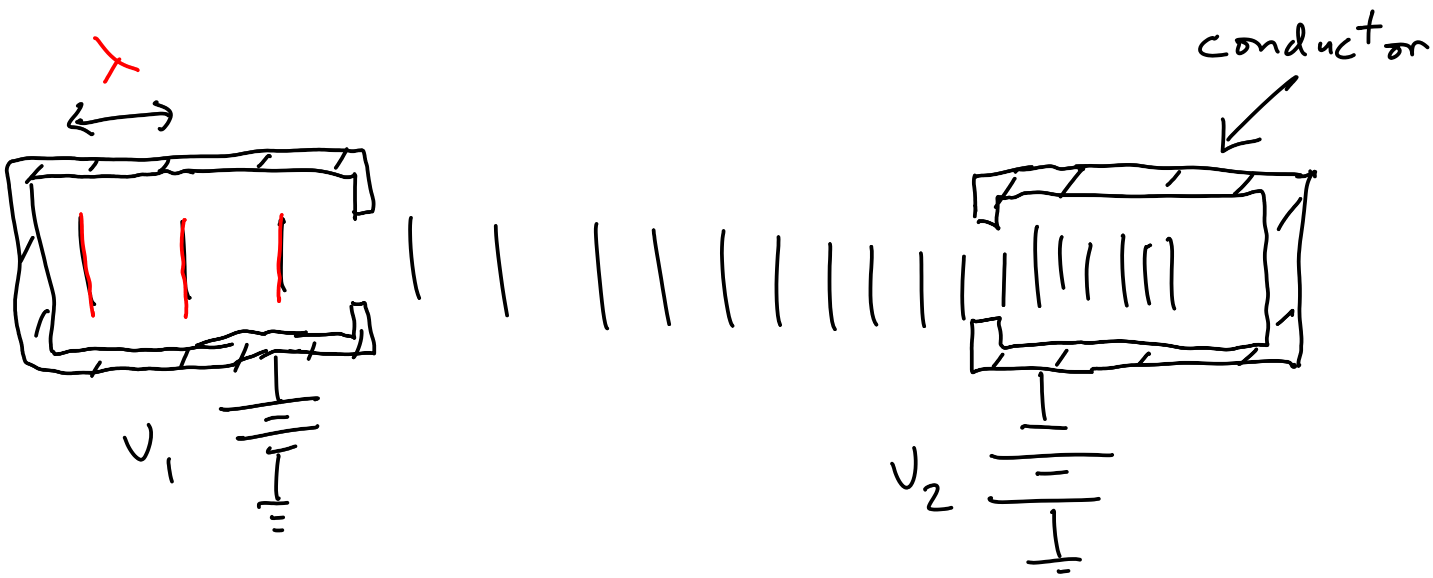
$$KE + PE = \frac{P^2}{2m} + qE_0 x = \text{Total Energy}$$

As the particle moves its momentum increases while its potential energy decreases but the total energy remains the same.

(informational) How are the classical parameters related to the quantum parameters?

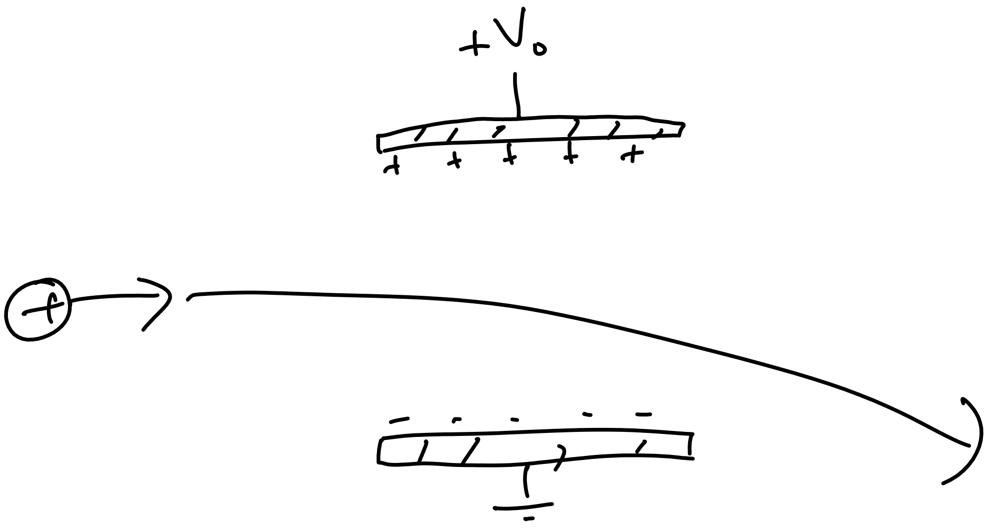
$p = \hbar k$ $\qquad$ $E_{tot} = \hbar \omega$

So $k = \frac{2\pi}{\lambda}$ increases but the total energy or frequency remains the same.



(analogy) Where have I seen a wave whose frequency doesn't change but its wavelength and speed change?

(causal/creative) How does the wavefunction bend due to an electric field?



Questions

(modify) What simplifying assumptions can I make?

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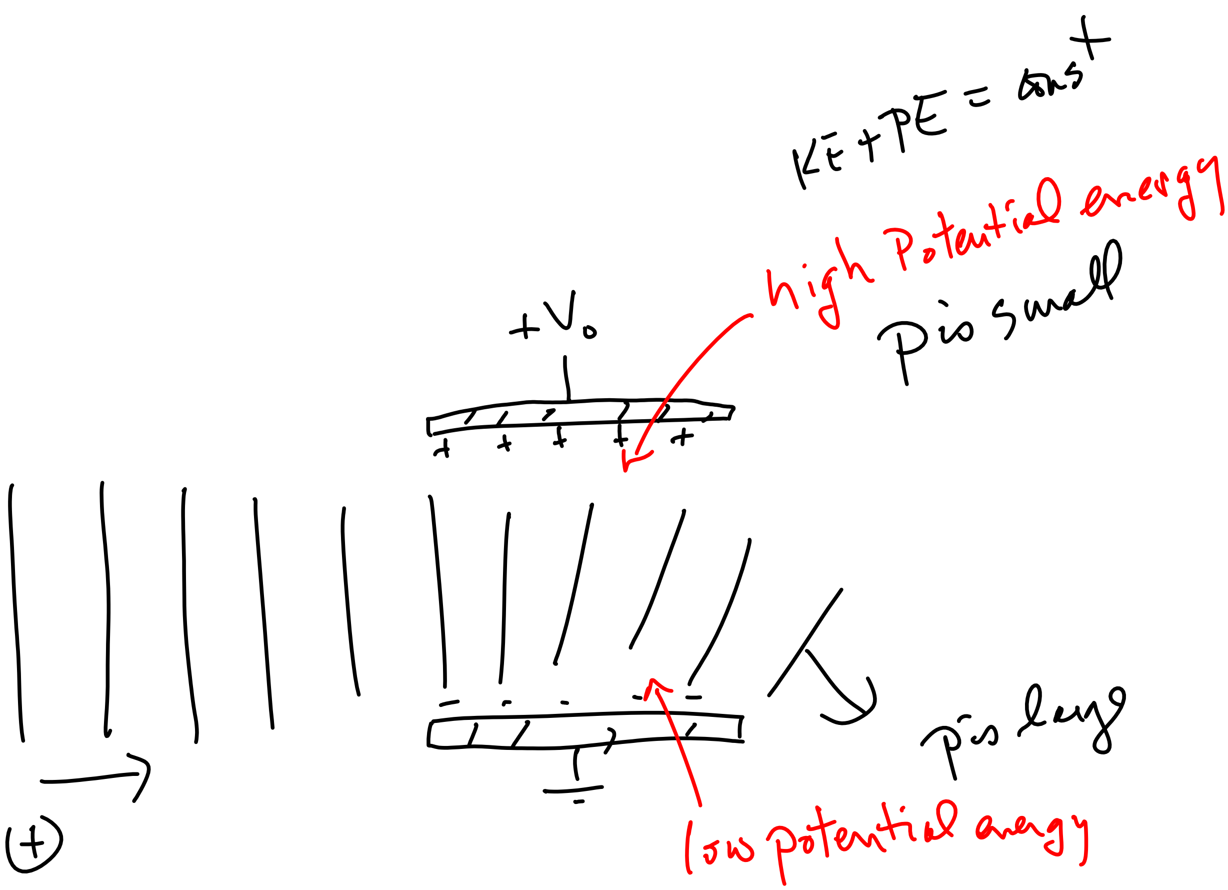

In a region of large potential energy the particle moves slowly.

$$p = \frac{h}{\lambda} \qquad \lambda \text{ large}$$

In a region of small potential energy the particle move fast.

$$p = \frac{h}{\lambda} \qquad \lambda \text{ small}$$