Lecture 31 iq27

Demo: Levitation of a cubic magnet
Jumping ring
Falling magnet within a metal tube
A simple Faraday's law demo
Comments from Faraday's learning module.

1. Demo with a magnet, a solenoid and a galvanometer
   - Galvanometer readings due to increasing/decreasing of the magnetic flux.
   - Increasing magnetic flux (out of the paper) leads to a CW curly induced E-pattern.

2. Lenz law: Current loop has magnetic inertia. Change of magnetic flux is canceled by the Bind (induced magnetic field) contribution.

3. Falling magnet (clicker 30-3)

4. Jumping ring

5. Levitation of a magnet IQ 31.3.1

6. Clicker 30.1 Evaluate <-d phi /dt>

7. One more exercise: IQ31.4.1

Concluding line in LM comments

Announcement:

Re: Adjustment on present lesson plan

Our lectures are slightly behind our original lesson plan. The updated lesson plan is as follows.

- Postpone the due date of ch23.h2 from this coming Sunday to next Tuesday.
- Due dates of ch23.h3 and ch24.h1 will be on the Wednesday of the following week. (Using present lesson plan notation, it is "W")
- Ch24.h2, ch24.h3 on Su.
- Ch24 h4, ch24.h5 on W
- Ch25-h1 on Su

Midterm3 will now cover the exam materials only through ch23-h2.Notice that the inductance and the LR circuit are covered in ch23-h2. They will be included in the exam. On the other hand problems which involve LC circuits only appear in ch23-h3. They will not be included in this exam.

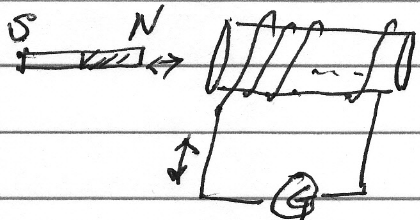
iq21 Lec 31-1

Demo: Levitation of a cubic magnet

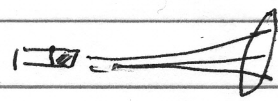
Jumping Ring

Falling magnet in a metal tube

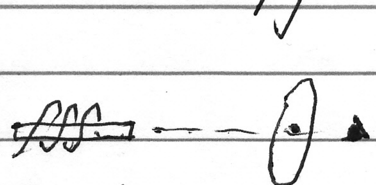
Simple Faraday's law demo



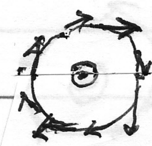
Flux Φ_B through 1 loop: $\phi = BA$



Change of magnetic flux defined by the solenoid $\Rightarrow$ induce em



Side view



Φ_B ⊙, ↑

Fig 23.4

Increasing mag. flux ⊙ $\Rightarrow$ CW E_{ind}.

Faraday's Law $\oint E \cdot dl = -\dfrac{d\Phi_B}{dt}$.

Direction: $\langle E_{ind} \rangle$: CW

RHS: $\langle -\frac{d\phi}{dt} \rangle = -\langle \Delta\phi \rangle$ = "Opposes the change".

Lenz law: Current loop has magnetic inertia

It has the tendency to maintain its flux state

Initial: 10 lines out Loop responds it generates B^{ind}, i.e.

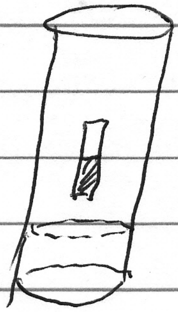
next: 12 lines out 2 lines in to main original 10 line out status.

∴ I_{ind} ⊗, E_{in} CW.

Application: Falling magnet in a metal tube.

Demo: The falling magnet moves slowly.

Clicker 30-3   Do the current below the magnet.



You will do the case where loop is above magnet

The loop has magnetic inertia:

Now: 3 lines ↓

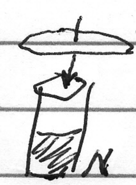
Next: 5 lines ↓

Loop generates B_{in}, 2 lines up to maintain original 3 line status. ∴ B_{in} ↑

Opposing the fall

I_{ind} CCW. Or E_{in} CCW pattern.

Your turn: Upper loop.



Now 3 lines ↓

Next: 1 line ↓

Ans = 3

Loop generates B_{in}: ↓ 2 lines   ∴ B_{in} ↓

↓

It attracts falling magnet

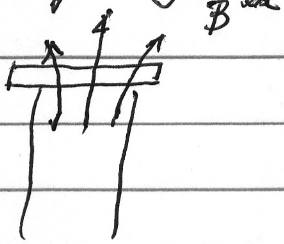
∴ Loop below opposes its fall (by repulsion)

Loop above " " (by attraction).

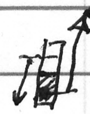
∴ It takes a long time to fall.

Jumping Ring show current (of) has magnetic inertia.
Initial flux = 0. After turn on B of the solenoid
the ring jumps away to maintain net flux status.

Understanding the force lifting the ring

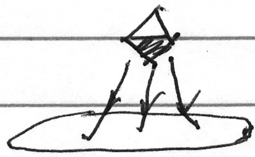


Induced magnet



Stronger lifting force

Levitation IQ 31.3.1

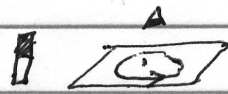


Direction of induced current –

Initial 5 lines ↓

Next 6 lines ↓

B in greater ↑

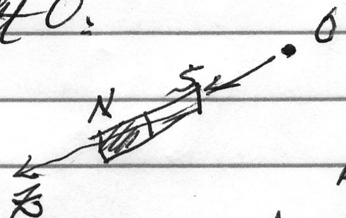


CCW

Fig 30.1

Read: $\langle -\frac{d\phi}{dt} \rangle$

At O:



Initial 3 lines ↙

Next 4 lines ↙

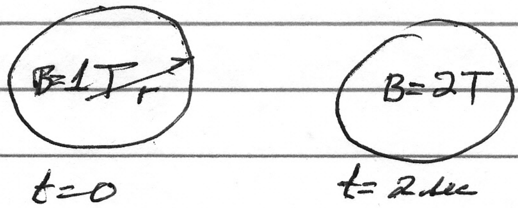
B in: ↗

$\therefore +\hat{z}$

Dir of induced current at A – ↗

Magnitude of $\left|\frac{d\phi}{dt}\right|$

At $t_1 = 0$, $B_1 = 1T$; $t_2 = 2$ sec, $B_2 = 2T$.



$r = 1\ m$

Find: $\left|\frac{d\phi}{dt}\right| = \left|\frac{B_2 A - B_1 A}{t_2 - t_1}\right| = \frac{(2 * \pi * 1^2 - 1 * \pi * 1^2)}{2 - 0}$

$A = \pi r^2$, $= \frac{\pi}{2}$ volts,

$2\pi r E = \frac{\pi}{2}$, $E = \frac{\pi/2}{2\pi \cdot 1} = \frac{1}{4}$ volts/m

Dir: initial: π $\otimes$

final: 2π $\otimes$

B_{in}: π $\odot$ I_{in} ccw.

Lenz law makes use of current loop

Faraday's Law is more general it works for imaginary loop with the wire drops the special case.