deduce from Faraday's experiments on electromagnetic induction or other appropriate experiments: (i) that a changing magnetic field can induce an e.m.f. in a circuit

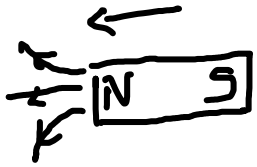
Changing Field

Dr K M Hock

Coil of wire :

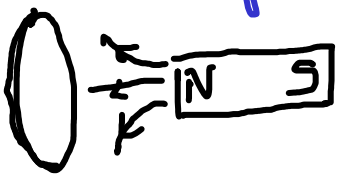
When magnet moves near :

Current flows



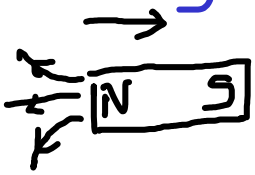
When magnet stops :

Current stops



When magnet moves away :

Current flows



When magnet stops :

Current stops

Changing magnetic field induces e.m.f. in circuit.

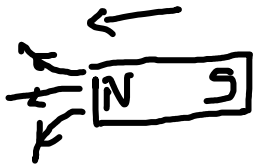
deduce from Faraday's experiments on electromagnetic induction or other appropriate experiments: (ii) that the direction of the induced e.m.f. opposes the change producing it

Lenz's Law

Dr K M Hock

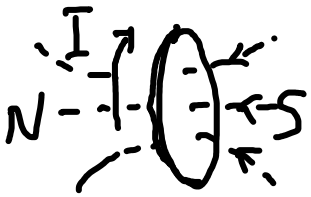
When magnet moves near:

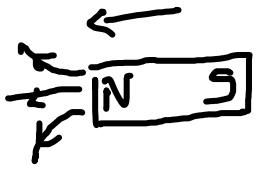
Current flows



But which way?

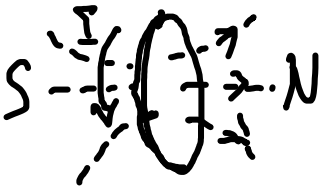
If this way:

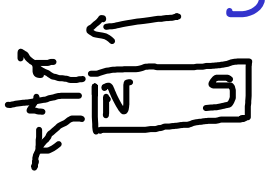




S attracts N - magnet moves and current flows on their own
- energy created from nothing ✗

So must be the other way:





← work

N, N repel - must do work to push magnet
- current produced - energy conserved ✓

Lenz's law:

> Current induced must be in such a direction as to oppose the change producing it.

deduce from Faraday's experiments on electromagnetic induction or other appropriate experiments: (iii) the factors affecting the magnitude of the induced e.m.f.

Induced e.m.f.

Dr K M Hock

Can induce stronger e.m.f. if :

1. Use stronger magnet

2. Move magnet faster

3. Use bigger coil

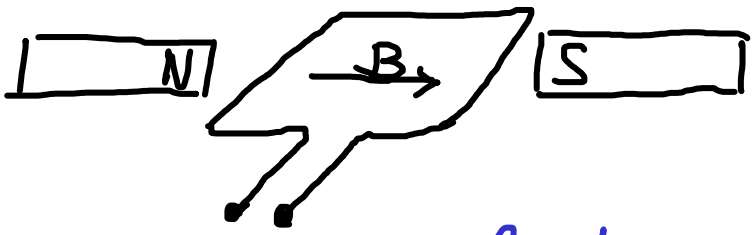
4. Have more turns in coil

describe a simple form of a.c. generator (rotating coil or rotating magnet) and the use of slip rings (where needed)

a.c. generator

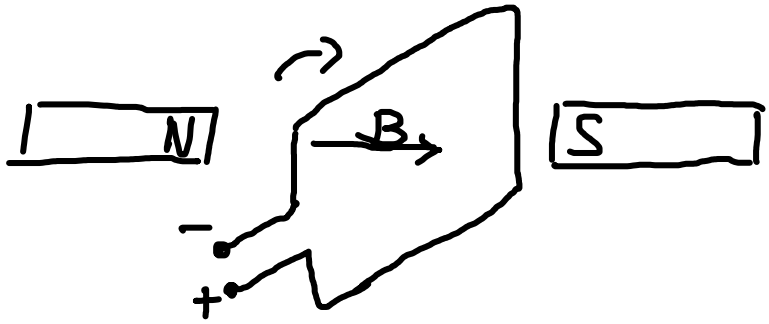
Dr K M Hock

When coil parallel to field B, no field thru' coil:

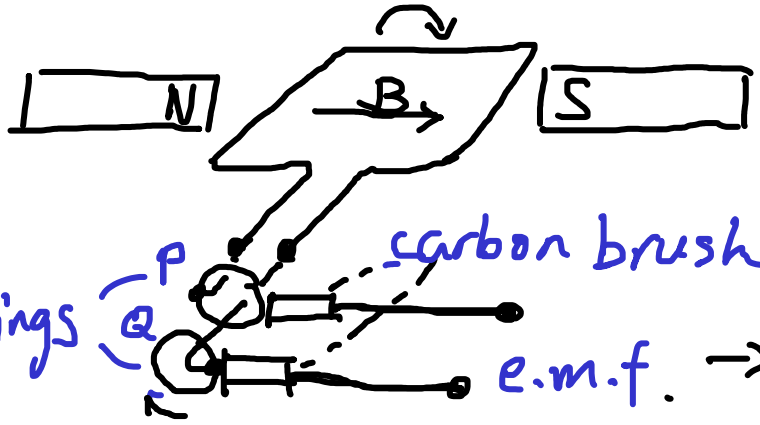


When coil rotates, field can go thru' coil:

Field change induces e.m.f. in coil.



To get emf. out, fix 'slip rings' to coil:



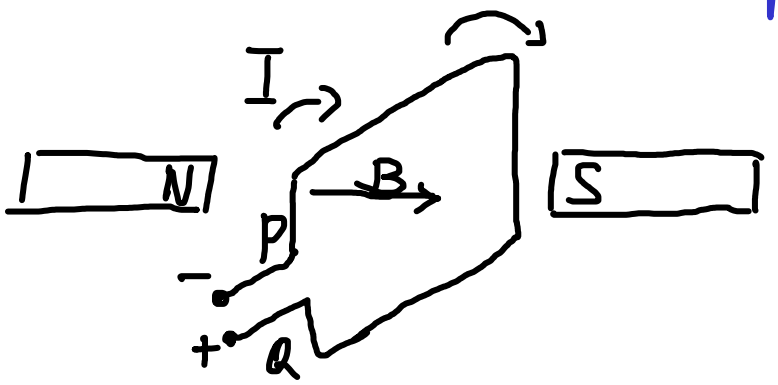
Slip rings - rotate with coil
- contact carbon brushes → circuit

To generate electricity, must do work to rotate coil. (NOT a motor!)

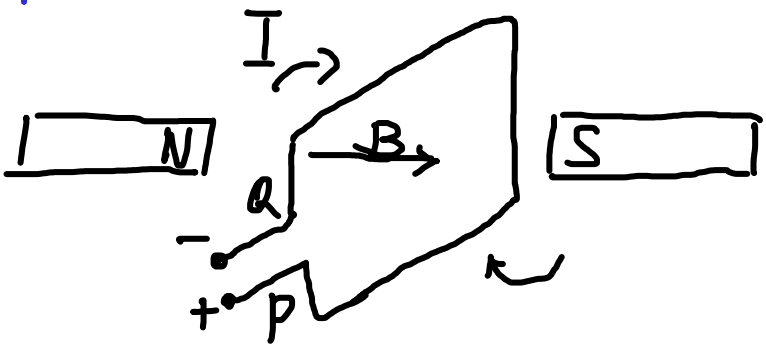
Generator output

Dr K M Hock

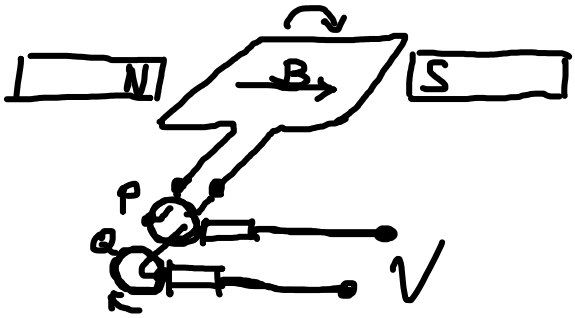
Lenz's law → field from I opposes B :



after 180°:

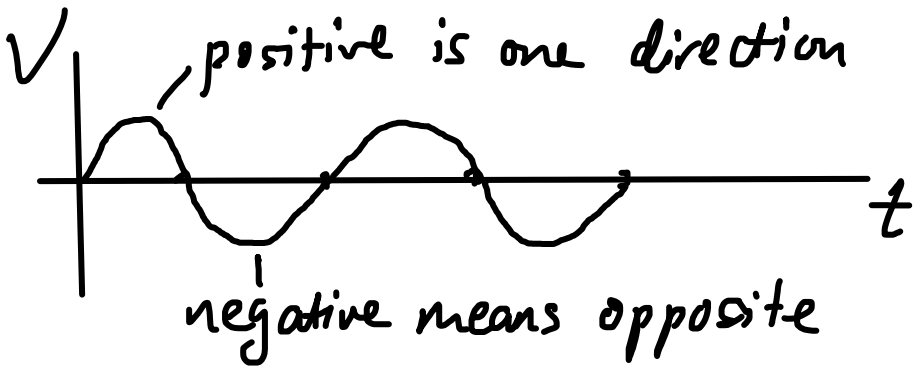


coil flips, so current changes direction inside coil.



So output voltage V keeps changing direction as coil rotates.

Alternating voltage
(" current
a.c.)

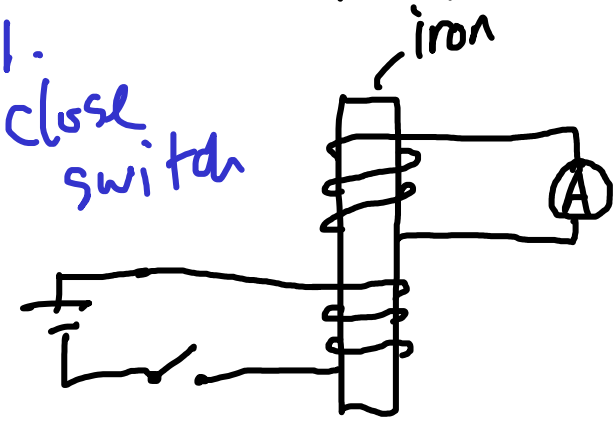


describe the structure and principle of operation of a simple iron-cored transformer as used for voltage transformations

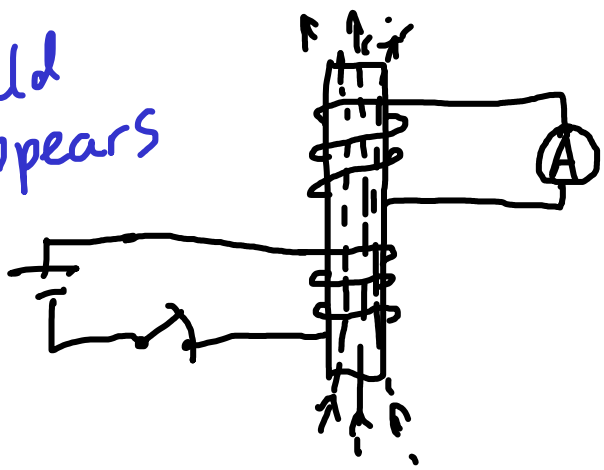
Transformer

Dr K M Hock

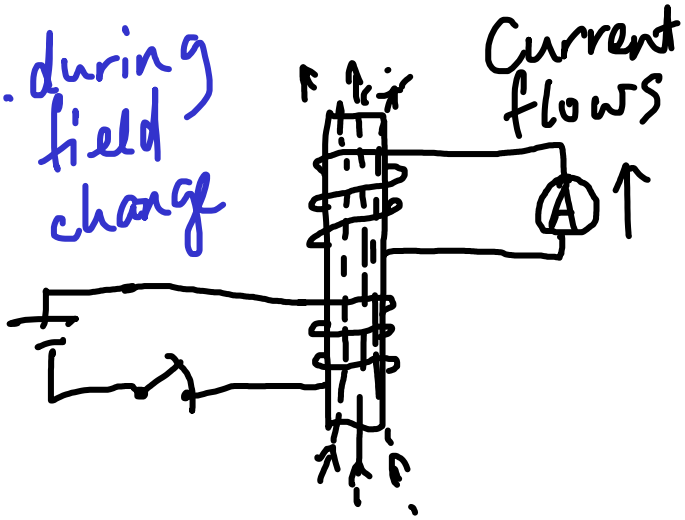
1. close switch



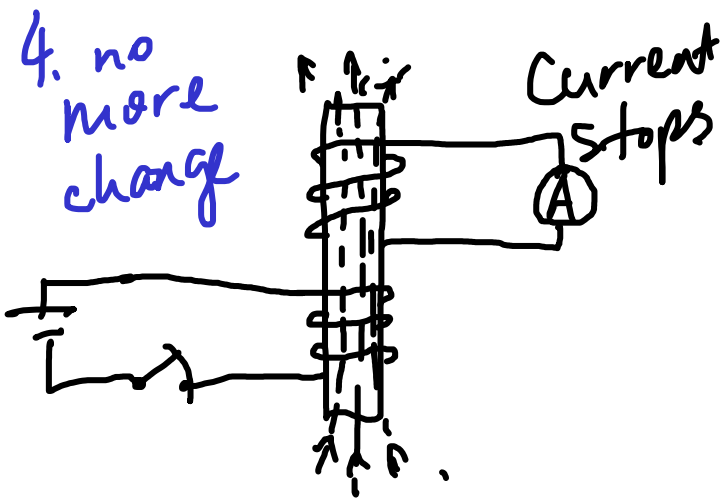
2. field appears



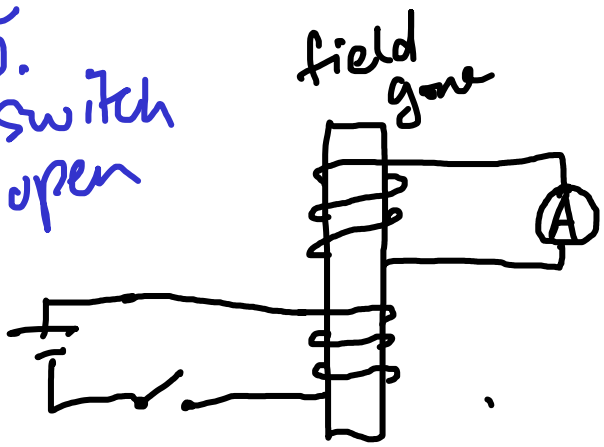
3. during field change



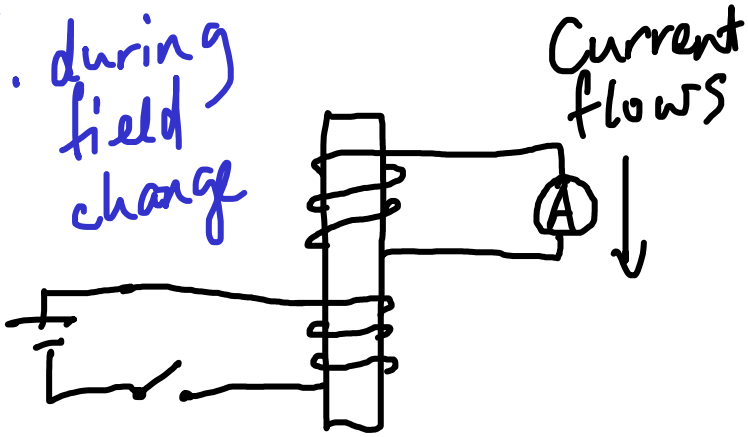
4. no more change



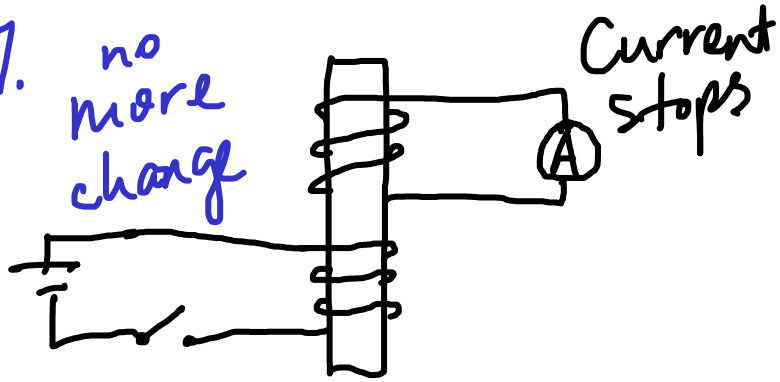
5. switch open



6. during field change



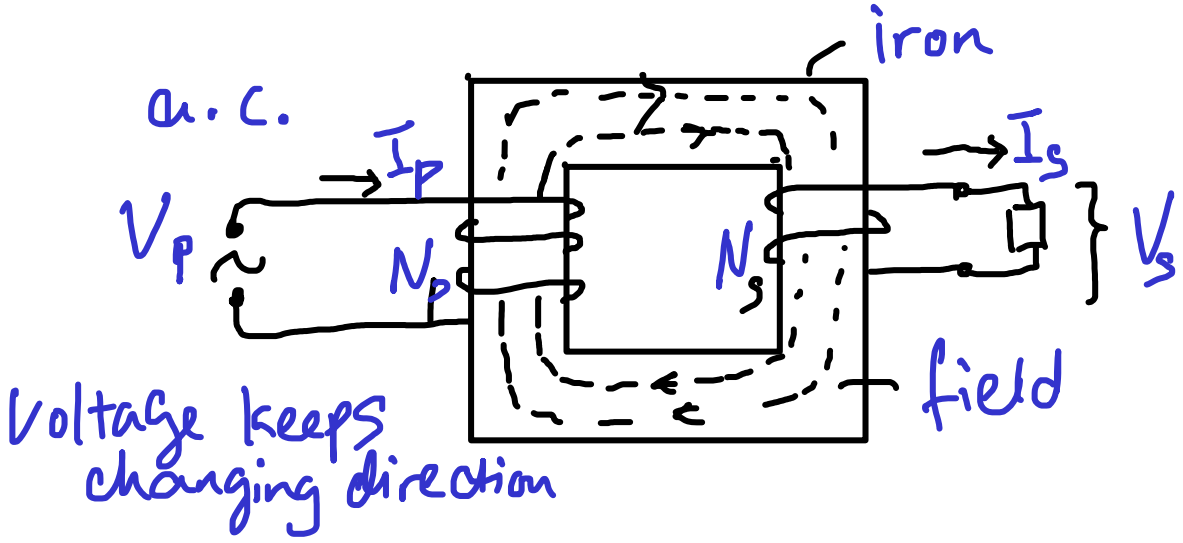
7. no more change



recall and apply the equations V_p / V_s = N_p / N_s and V_p I_p = V_s I_s to new situations or to solve related problems (for an ideal transformer)

Transformer equations

Dr K M Hock



Voltage induced all the time

Voltage keeps changing direction

1- Can change induced V_s by changing no. of turns N_s.

2- Can give stronger field by increasing no. of turns N_p.

Equation $\boxed{\frac{V_p}{V_s} = \frac{N_p}{N_s}}$.

p: primary
s: secondary

Energy is conserved:

power into primary coil = power out from secondary coil

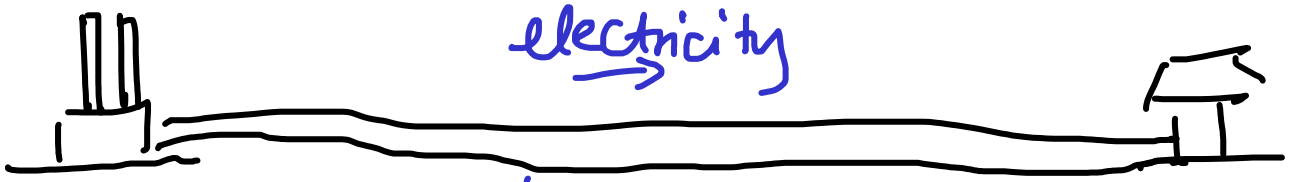
$$\boxed{V_p I_p = V_s I_s}$$

(assuming no heat loss)

describe the energy loss in cables and deduce the advantages of high voltage transmission

High Voltage Transmission

Dr K M Hock



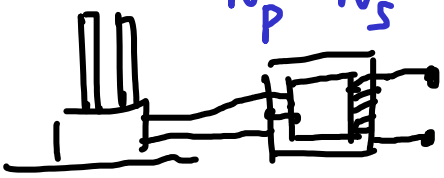
Power station — long distance — my house

↓

huge heat loss !

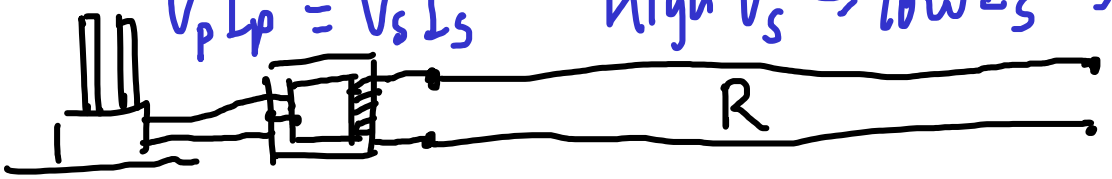
Solution.

1. $N_p < N_s$ "Step up" voltage first

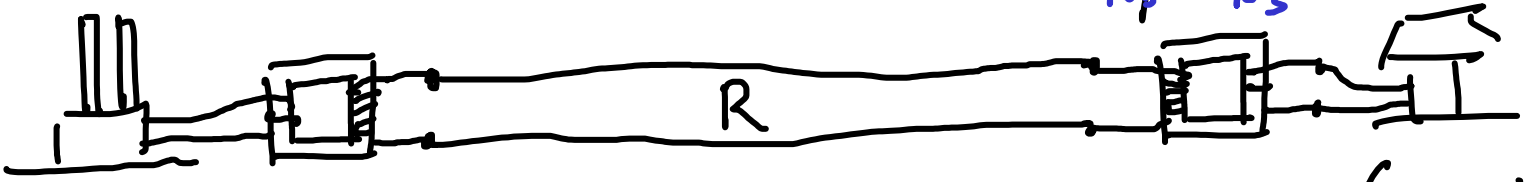


2. (~10 000 V)

$V_p I_p = V_s I_s$ high V_s → low I_s → low heat loss ($P = I^2R$)



3. "Step down" voltage for ↓ $N_p > N_s$



(240V)

Save energy !