SPH3U 11.1 Electrical Energy and Power Plants

1. Electrical power

Electricity:	
Electrical power:	
equation	

Calculate the power to charge a cellphone if 740 J of energy is transferred in 1.0 min.

Kilowatt hour:	

Calculate the energy needed by a 35 W halogen light bulb that operates for 240 h. Give your answer in both joules and kilowatt hours.

Homework: page 507: #2-4

SPH3U 11.3 Electric Potential Difference

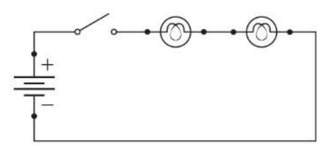
1. Electric potential difference

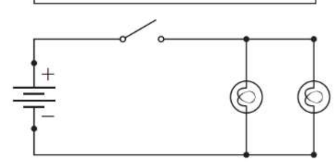
Electric potential:	
Electric potential difference:	
equation	
Quantity of electrons:	

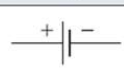
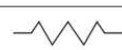
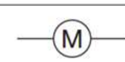
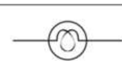
Calculate the electric potential difference between the negative and positive terminals of a battery if 1500 J of electric potential energy is transformed to move 125 C of charge between the terminals.

2. Series and parallel circuits

Series circuit:	
Parallel circuit:	
Voltmeter:	





Part of circuit	Circuit symbol				
battery		resistor		motor	
		lamp		open switch	
variable DC power supply		connecting wire		closed switch	

Homework: page 513: #1-5, 7

SPH3U 11.5 Electric Current

1. Electric current

Electric current:	
equation	
Direct current (DC):	
Alternating current (AC):	

Calculate the amount of current through a wire that has 0.85 C of electrons passing a point in 2.5 min.

Effects of current on your body:	
Ammeter	

Homework: page 518: #2-6

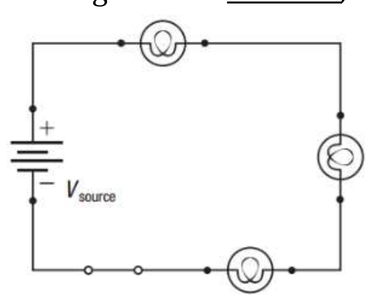
SPH3U 11.6 Kirchhoff's Laws

1. Kirchhoff's Laws

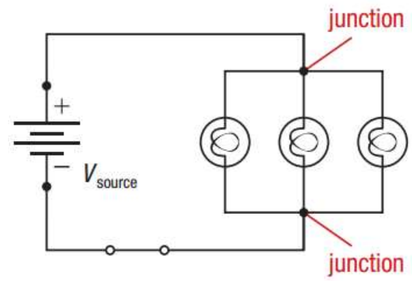
Kirchhoff's Voltage Law (KVL):	
series	
parallel	

Kirchoff's Current Law (KCL):	
series	
parallel	

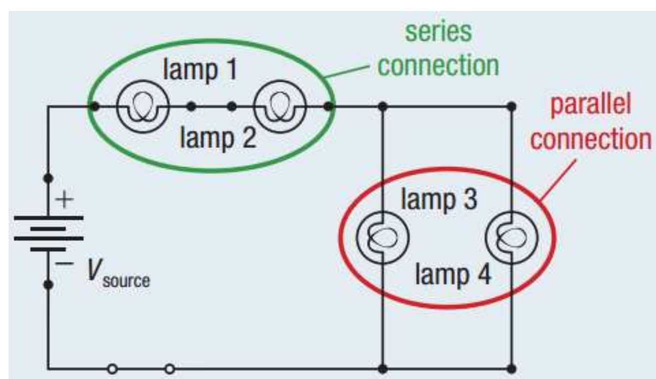
If a 6.0 V battery with 0.20 A of current is connected to three identical light bulbs <u>in series</u>, what is the voltage and current of each light bulb?



If a 6.0 V battery with 0.30 A of current is connected to three identical light bulbs <u>in parallel</u>, what is the voltage and current of each light bulb?



Analyze this mixed circuit. Find each unknown voltage and current, given the following information: V_{source} = 40 V, V_1 = 10 V, V_3= 20 V; I_{source} = 0.40 A, I_3 = 0.10 A.



Homework: page 522: #1-2

<u>SPH3U 11.7 Electrical Resistance</u>

2. Electrical resistance

Electrical resistance:	
Resistor:	
Ohm's Law:	
equation	

Calculate the resistance of a load with a voltage of 25 V and a current of 410 mA.

Ohmmeter:	

Homework: page 526: #2-6, 12

SPH3U 11.8 Resistors in Circuits

3. Series and parallel

Equivalent resistance:	

Series:	
equation	

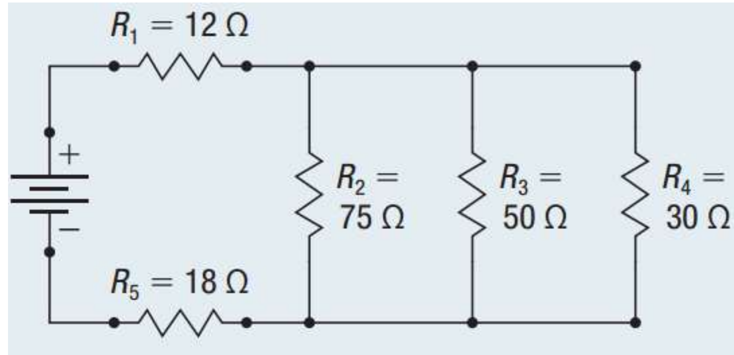
Four resistors are connected in series in a circuit. The resistances are as follows: R_1 = 41 Ω, R_2 = 51.75 Ω, R_3 = 11.1 Ω, R_4 = 102.008 Ω. Calculate the equivalent resistance.

Parallel:	
equation	

Three resistors are connected in parallel in a circuit. The resistances are as follows: R_1 = 15 Ω, R_2 = 12 Ω, R_3 = 10 Ω. Calculate the equivalent resistance.

4. Mixed circuits

Calculate the equivalent resistance for the circuit shown.

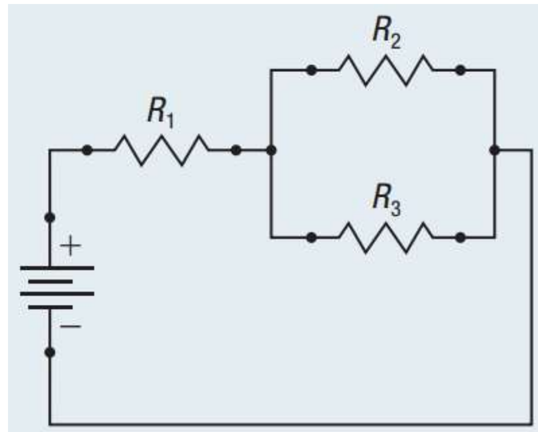


Homework: page 530: #4-5

SPH3U 11.9 Circuit Analysis

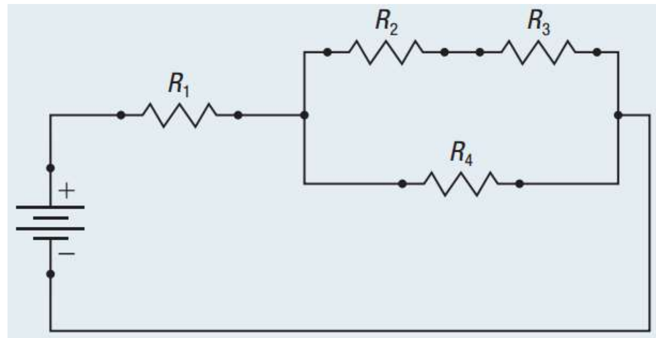
1. **Circuit analysis when resistance values are given**

The circuit below has a source voltage of 12.0 V and resistance values of R_1 = 15.0 Ω, R_2 = 25.0 Ω, R_3 = 35.0 Ω. Find values for I_{source}, I_1, I_2, I_3, V_1, V_2, V_3, and R_{total}.



2. **Circuit analysis when only some resistance values are given**

The circuit below has a V_{source} = 12.0 V, I_1 = 0.50 A, V_3= 2.5 V, V_4 = 5.0 V, and R_3 = 10.0 Ω. Find values for I_{source}, I_2, I_3, I_4, V_1, V_2, R_1, R_2, R_4, and R_{total}.

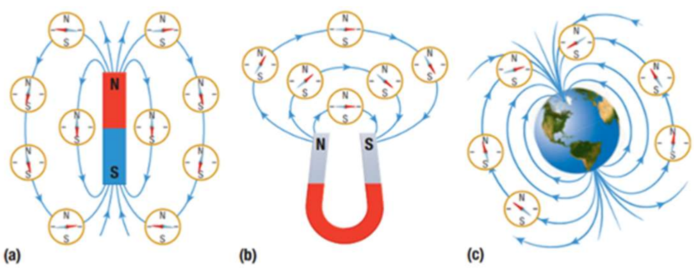


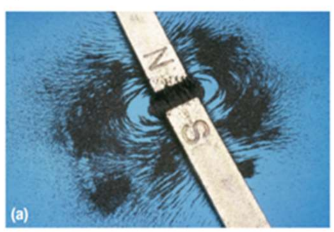
Homework: page 535: #1-4

SPH3U 12.1 Magnetic Fields

5. Magnetic fields

Magnets:	
Magnetic field:	
direction	
magnetic field lines	





Draw a bar magnet (north and south poles) and its magnetic field lines, including compass indications of the direction of the field at various points.

Homework: page 552: #5-6

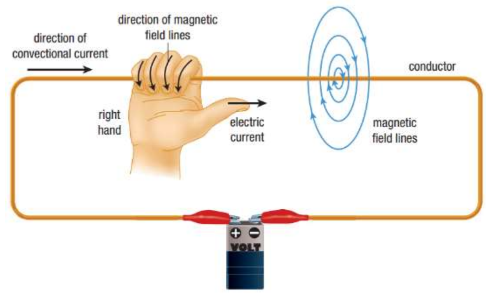
SPH3U 12.2 Oersted's Discovery

6. Oersted's principle

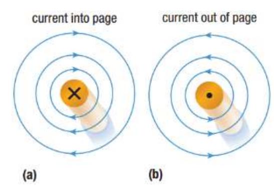
Oersted's principle:	
Right-hand rule:	

Right-Hand Rule for a Straight Conductor

If your right thumb is pointing in the direction of conventional current, and you curl your fingers forward, your curled fingers point in the direction of the magnetic field lines.



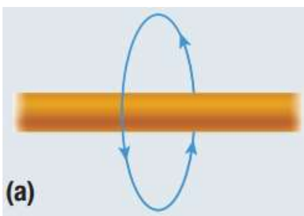
Current into /out of page:	

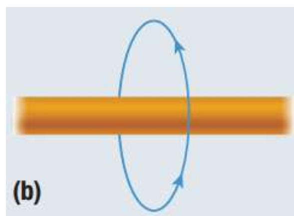


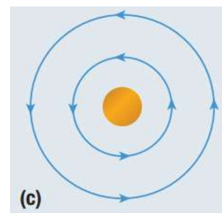
Conventional current:	
Electron flow model:	

Draw the magnetic field for each diagram.

Draw the direction of the conventional current for each diagram.







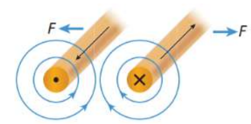
WE WERE GOING TO USE THE TIME MACHINE TO PREVENT THE ROBOT APOCALYPSE, BUT THE GUY WHO BUILT IT WAS AN ELECTRICAL ENGINEER.

Homework: page 556: #1-2, 5, 7

SPH3U 12.4 Solenoids

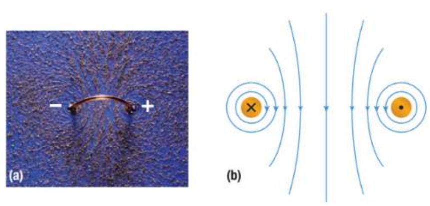
7. Interacting magnetic fields

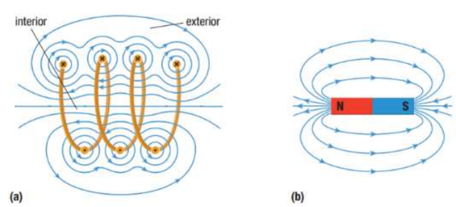
Magnetic fields interacting:	
example	



8. Solenoids

Coiled conductors:	
Electromagnet:	
Solenoid:	

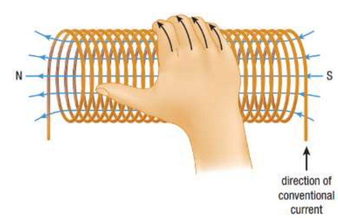




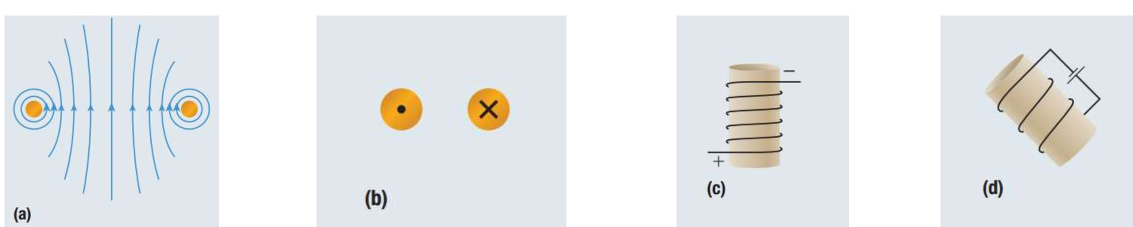
Right-hand rule #2:	

Right-Hand Rule for a Solenoid

If you coil the fingers of your right hand around a solenoid in the direction of the conventional current, your thumb points in the direction of the magnetic field lines in the centre of the coil.



Draw the magnetic field lines and/or the direction of conventional current for each:

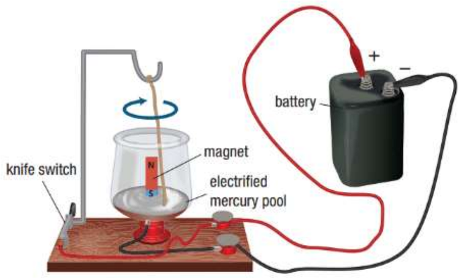


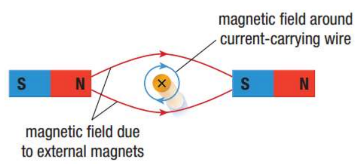
Homework: page 562: #1-4

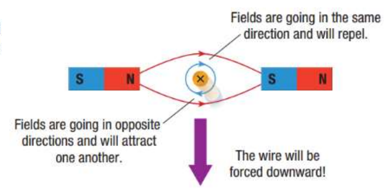
SPH3U 12.5 The Motor Principle

9. The motor principle

Faraday's experiment:	



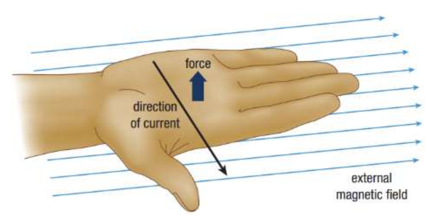




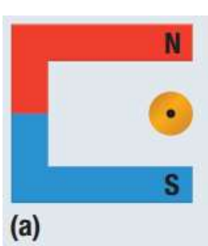
The motor principle:	
Right-hand rule #3:	

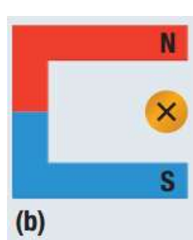
Right-Hand Rule for a Moving Charge in a Magnetic Field

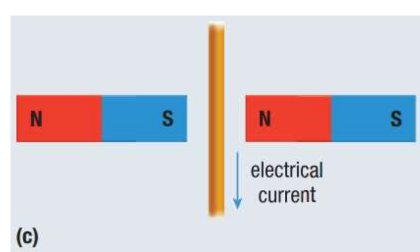
If you point your right thumb in the direction of the velocity of the charge ($\vec{v}$), and your straight fingers in the direction of the magnetic field ($\vec{B}$), then your palm will point in the direction of the resulting magnetic force ($\vec{F}_M$).



Draw the magnetic field lines of both the magnet and the conductor. Then determine the direction of the force on the conductor.

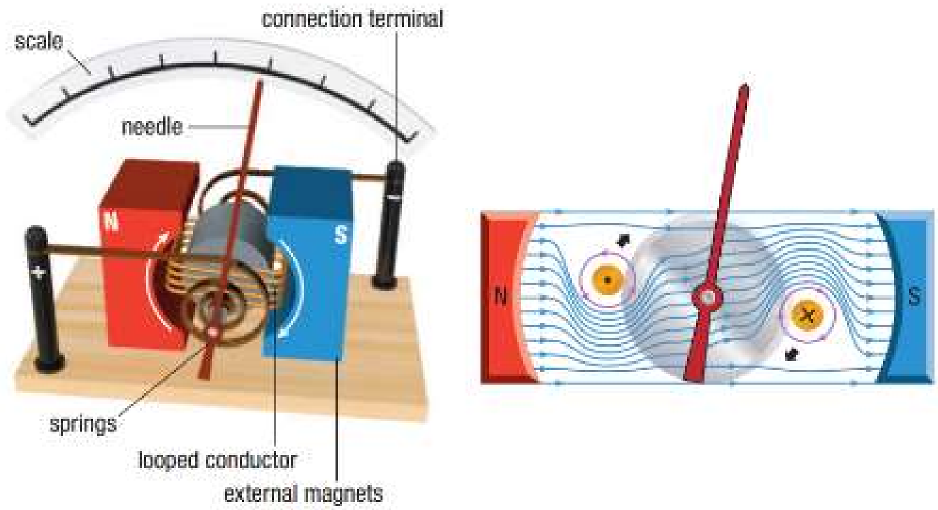




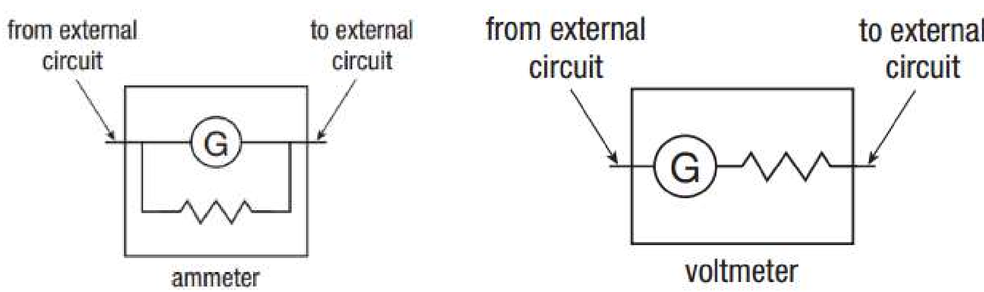


10. The analog meter

The galvanometer:	



Ammeter:	
Voltmeter:	



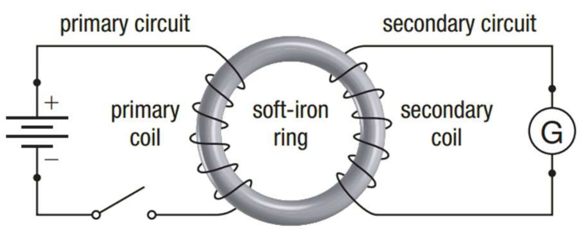
Homework: page 566: #1-3, 5-6

SPH3U 13.1 Electromagnetic Induction

11. Discovery

Induction:	
Chapter 12:	
Chapter 13:	
stationary magnet	
moving magnet	
Law of electromagnetic induction:	

Faraday's ring:	



12. Factors affecting induction

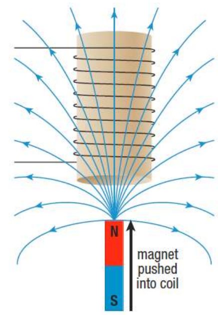
Coiled conductor:	
Number of loops:	
Change in magnetic field:	
Magnetic field strength:	

13. Applications of electromagnetic induction

Induction cooking:	
Metal detectors:	
Induction chargers:	

Homework: page 591: #2-3

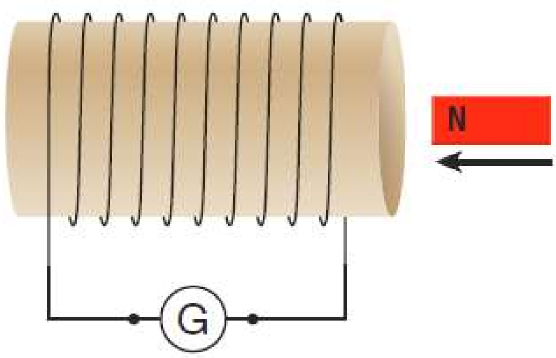
SPH3U 13.2 Lenz's Law

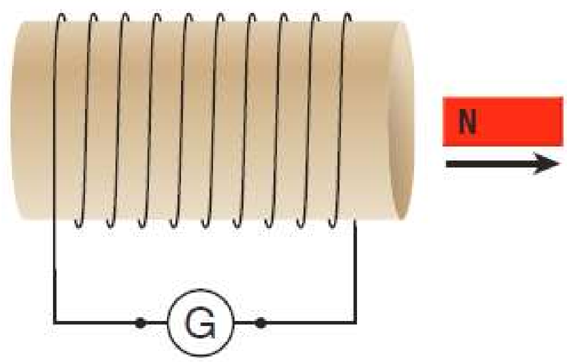


1. Direction of induced current

Lenz's question:	

Newton's 3rd law:	
applied to induced currents	
Lenz's Law:	





2. Drop-tower rides

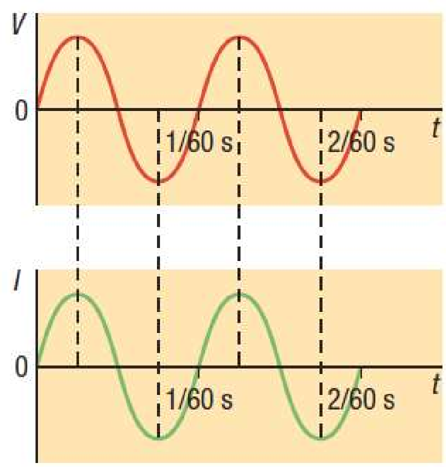
Drop-tower rides:	
brakes	
solution	

Homework: page 594: #1-3

SPH3U 13.3 Alternating Current

3. Alternating current

Continuous current:	
solution	
Alternating current:	
DC vs. AC:	
Canada's electricity:	
RMS voltage:	

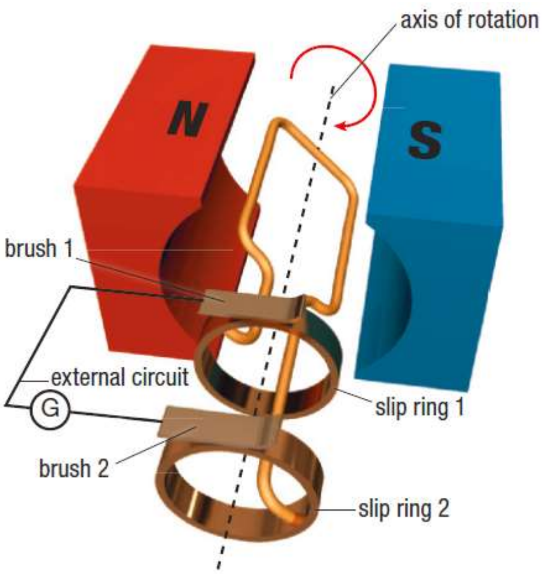


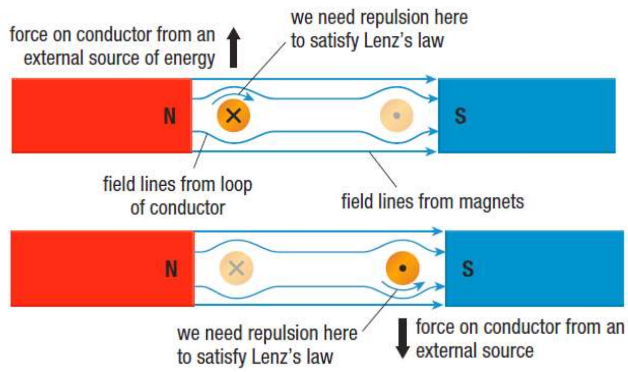
Homework: page 598: #1-2, 5

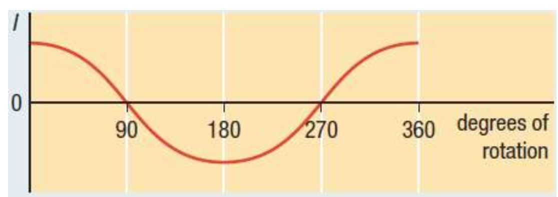
SPH3U 13.4 Electricity Generation

4. The AC generator

Design:	

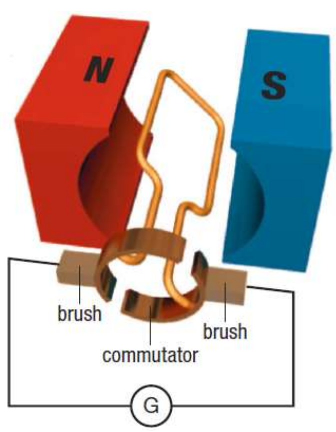






5. The DC generator

Design:	

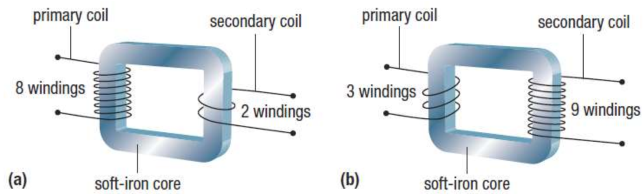


Homework: page 604: #2-3

SPH3U 13.5 Transformers

6. How transformers work

Transformer:	
AC	
how it works	



Step-down transformer:	
Step-up transformer:	
Conservation of energy:	
Equations:	

A step-down transformer used in an adapter for a laptop has a primary voltage of 120 V. There are 250 windings in the primary coil and 25 windings in the secondary coil. Calculate the voltage in the secondary coil.

A step-down transformer used in the adapter for a cellphone charger has a primary voltage of 120 V and a secondary voltage of 5.0 V. The current in the primary coil is 0.10 A. Calculate the current in the secondary coil.

Homework: page 609: #2, 7-9

SPH3U 13.6 Power Plants and the Electrical Grid

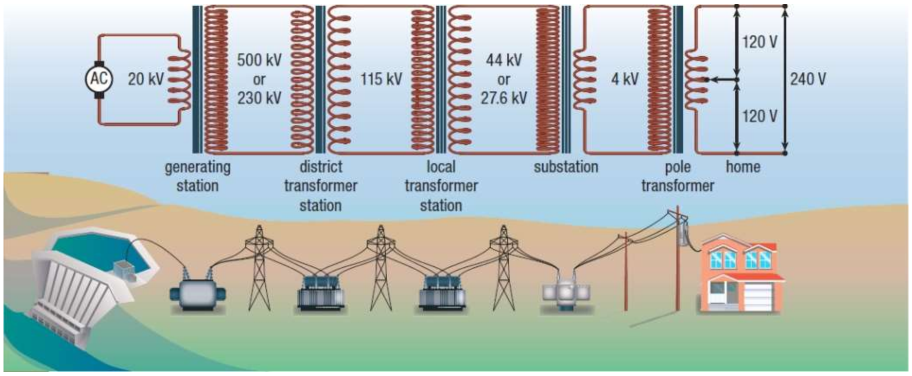
7. Transmission efficiency

Power loss:	
equation	
efficiency	

A generator produces 300 MW (3×10^8 W) of power at a current of 30 kA and a voltage of 10 kV. That power travels through a transmission wire with a resistance of 0.1 Ω. How much power is lost (in MW and in % of the total)?

Now a step-up transformer is used to increase the voltage to 100 kV before sending it over the wire. This lowers the current to 3 kA ($V_PI_P = V_SI_S$). What is the new power loss?

8. The power grid



AC generators:	

Homework: page 612: #1-2