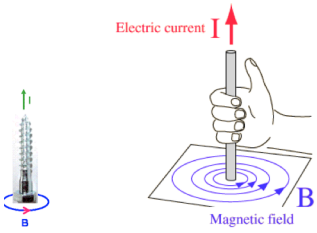
11th Physics 6 : Magnetism

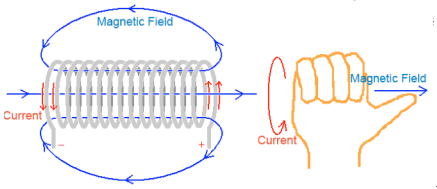
2018-19



$$B = \frac{\mu_0}{2\pi}\frac{I}{r}$$

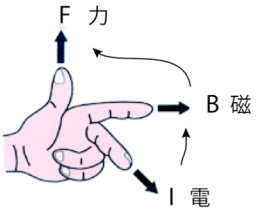
Right Screw Rule Right-Hand Thumb Rule

$\mu_0 = 4\pi \times 10^{-7} T \cdot m/A$

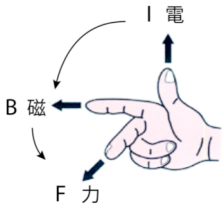


$$B = \mu_0 nI$$

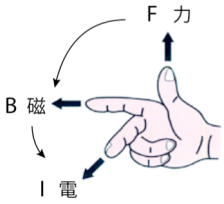
Right-Hand Thumb Rule



Fleming's Left-Hand Rule (Motor)



Tohei's Right-Hand Rule (Motor)



Fleming's Right-Hand Rule (Generator)

The magnetic force exerted on a current

$$F = I L B$$

The magnetic force on a moving charge

$$F = qvB$$

Electromagnetic waves

T: Period、 f: Frequency, λ : Wavelength

$$T = \frac{1}{f} \qquad c = f\lambda$$

Speed of light in the vacuum

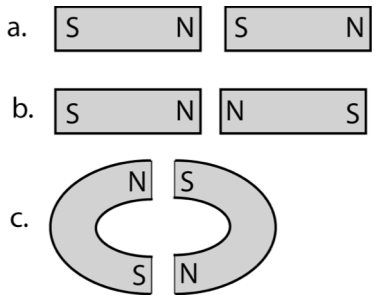
$$c = 3.00 \times 10^8 \ m/s$$

Transformer

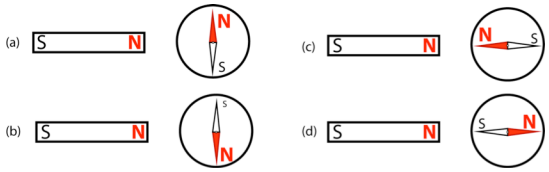
$$\frac{V_1}{n_1} = \frac{V_2}{n_2} \qquad V_1 I_1 = V_2 I_2$$

1. Magnets and Magnetic Field
(Chap22, p782-788)

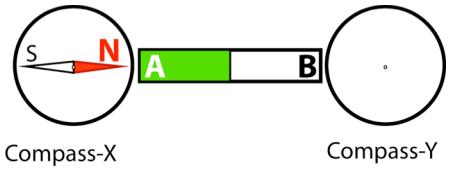
[Q1] For each of the cases in the figure at the right, identify whether the magnets will attract or repel one another.



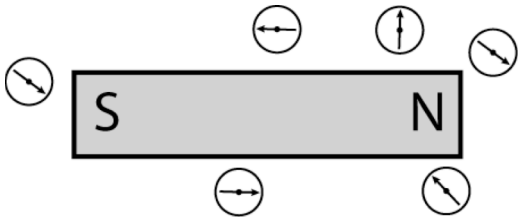
[Q2] The figure shows a compass place near the north pole, N, of a bar magnet. Which diagram best represents the position of the compass needle?



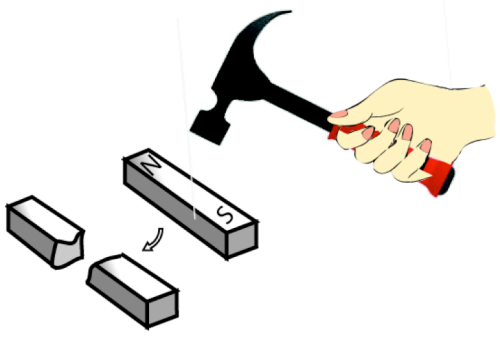
[Q3] The figure shows two compasses located near the end of a bar magnet. The north pole of compass X points toward end A of the magnet. On the diagram draw the correct orientation of the needle of compass Y and label its polarity.



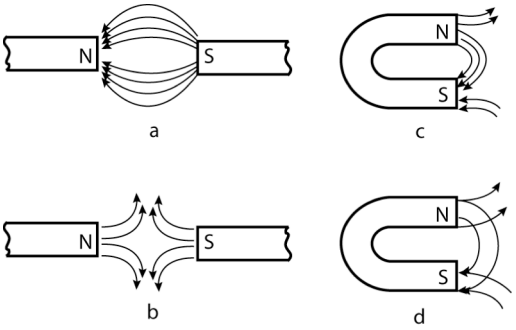
[Q4] Which of the compass-needle orientations in the figure might correctly describe the magnet's field at the point?



[Q5] When you break a bar magnet in half, how many poles does each piece have?

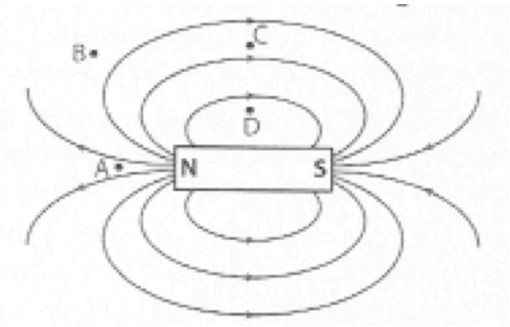


[Q6] Which diagram in Fig. 3 correctly shows a magnetic field configuration?

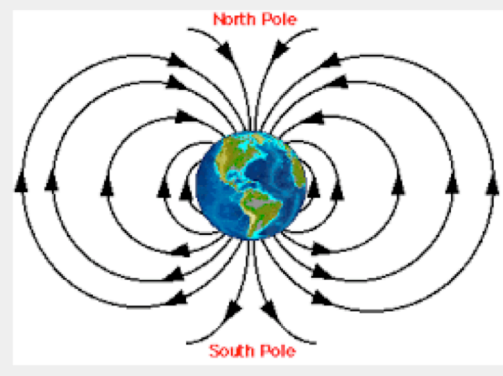


[Q7] The figure represents the magnetic lines of force around a bar magnet. At which point is the magnitude of the magnetic field strength of the bar magnet greatest?

◦



[Q8] Earth magnetic field has a configuration similar to a bar magnet. Which magnetic pole is near the geographic North Pole, the magnetic north pole or south pole?

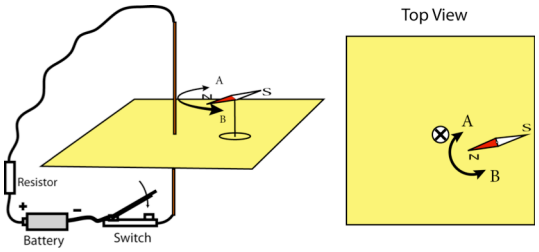


[Q9] (a) How is the direction of magnetic field determined?
(b) How is the direction of electric field determined?

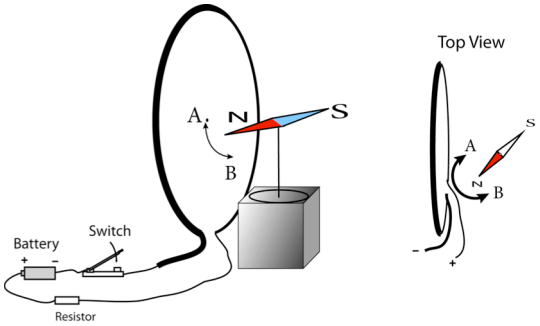
2. Magnetic Field of a Current-Carrying Wire (Chap22, p789-795)

[Q11] The connection between electricity and magnetism was discovered unexpectedly by Hans Christian Oersted in 1820. How did he do?

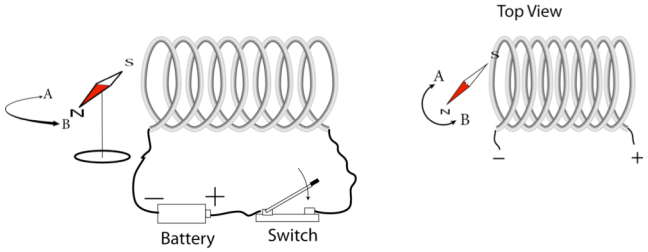
[Q12] When the current is flown in the figure, how does the north pole of the compass rotate, in the direction A or B?



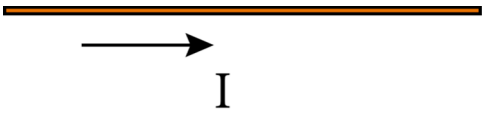
[Q13] When the switch is closed in the circuit shown in the figure, is the north pole of the compass attracted to the coil or repelled from the coil?



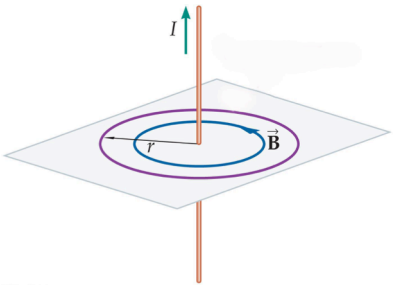
[Q14] When the switch is closed in the circuit shown in the figure, is the north pole of the compass attracted to the coil or repelled from the coil?



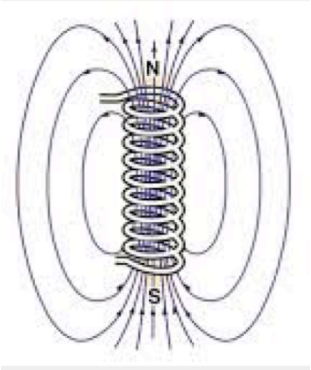
[Q15} What is the shape of the magnetic field produced by a straight current-carrying wire?



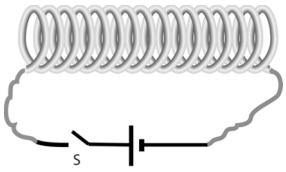
[Q16] Find the magnitude of the magnetic field 1 m from a long, straight wire carrying a current of 1A.



[Q17] Why is the magnetic field inside a solenoid stronger than magnetic field outside?

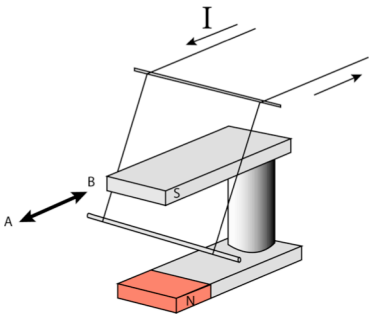


[Q18] If I desire that a solenoid (coil) 38 cm long and with 430 turns produces a magnetic field within it equal to the Earth's magnetic field (5.0×10^{-5} T). What current is required?

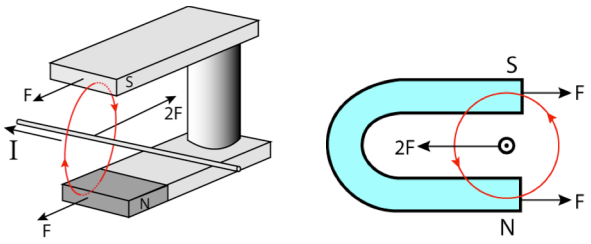


3. Magnetic Force Exerted on a Current-Carrying Wire (Chap22, p796-806)

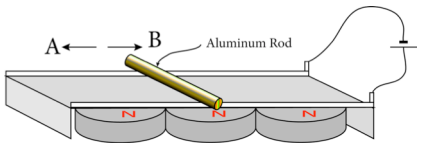
[Q21] When the current is flown in the figure, how does the conductive rod in the U-shaped magnet swing, in the direction A or B?



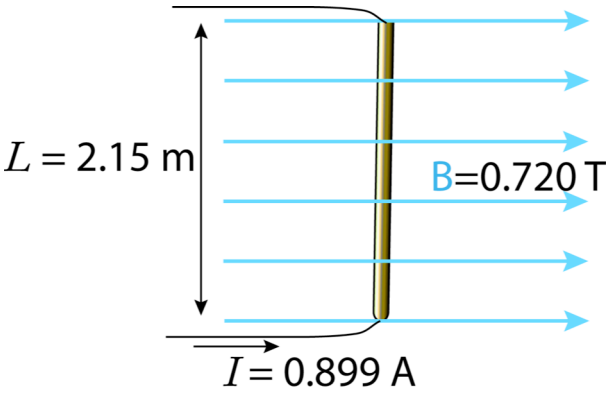
[Q22] Concerning the direction of the force exerted on the current inside a magnetic field, deduce the "Fleming's left-hand rule" or the "Tohei's right-hand rule" from the "right-hand thumb rule."



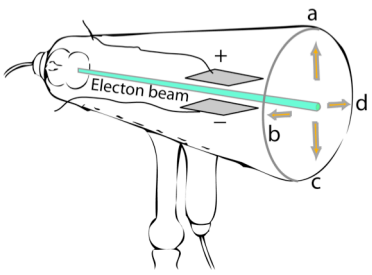
[Q23] The figure is an apparatus called "Magnetic Force Accelerator." When the current is flown, how does the aluminum rod move, in the direction a or b?



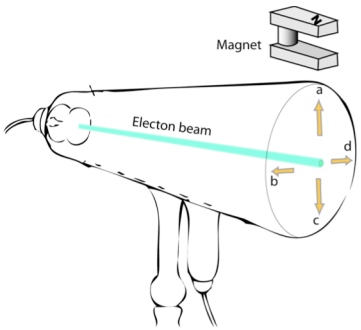
[Q24] What is the magnitude of magnetic force exerted on a L= 2.15 m length of wire carrying a current of I= 0.899 A perpendicular to a magnetic field of B= 0.720 T?



[Q25] The figures, (a) and (b) show an electron beam is in the Crooks Tube. (a) Electric field is applied as shown. In which direction does the electron beam move, a, b, c or d? (b) A magnet showing the character "N" on its upper part is brought near the tube as shown. In which direction does the electron beam move, a, b, c or d?

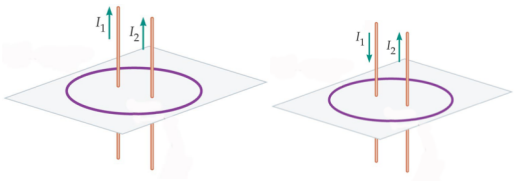


(a)



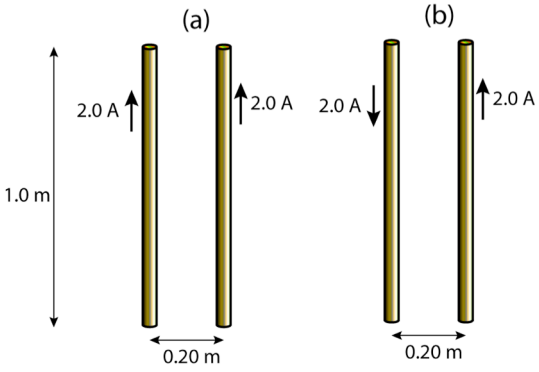
(b)

[Q26] The figures, (a) and (b), show two wires. Find the direction of force (a) if the currents are in the same direction, and (b) if the current is in the opposite directions.



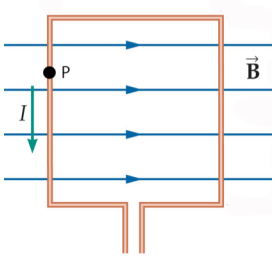
(a) (b)

[Q27] Two 1.0 m wires are placed with parallel 2.0 A currents and separation of O.20 m, as shown the figures, (a) in the same direction and (b) in the opposite direction. Find the direction and magnitude of the forces exerted on the wires..

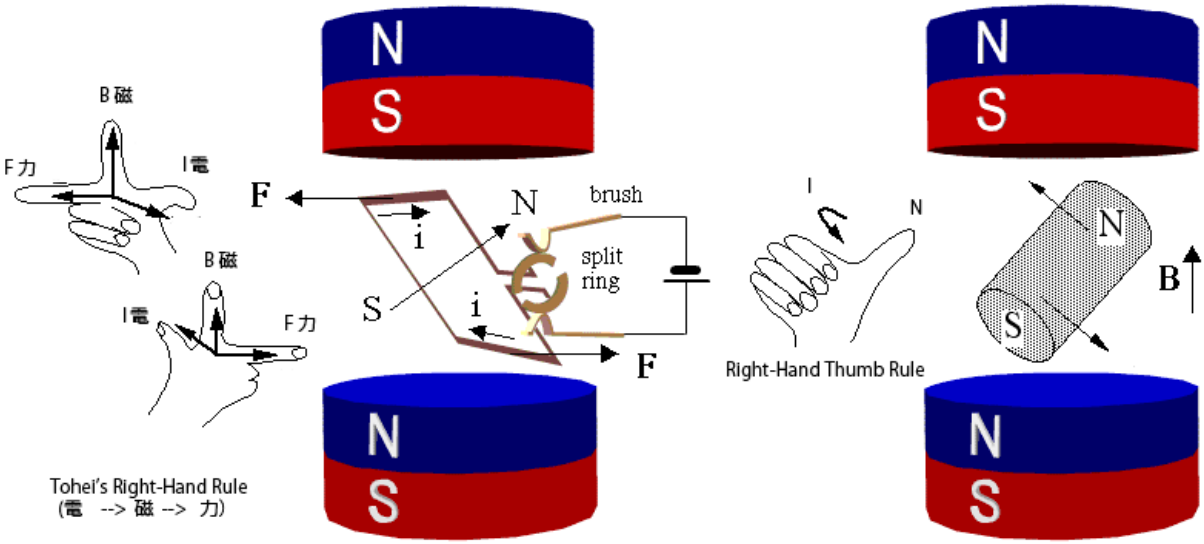


4. Principle of Electric Motors
(Chap22, p796-806) (Chap23, p830-831)

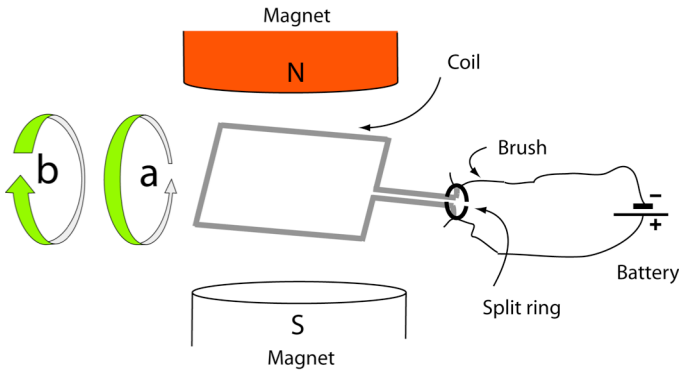
[Q31] The figure shows a rectangular coil in a magnetic field. When the current is flown, how does the point P move?



[Q32] The figures below show the principle of a DC motor. Explain.

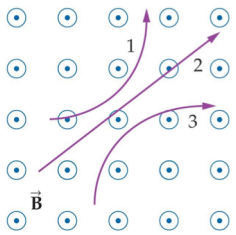


[Q33] The figure shows a DC (direct current) motor. How does it rotate, in the direction **a** or in the direction **b**?

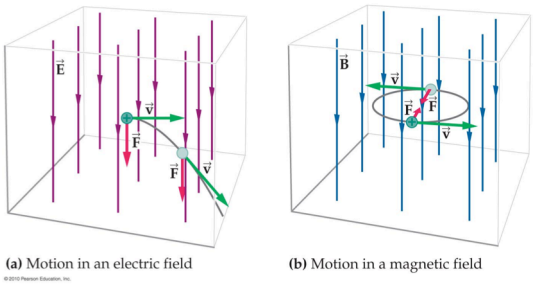


5. Magnetic Force on Moving Charges (Chap22, p796-806)

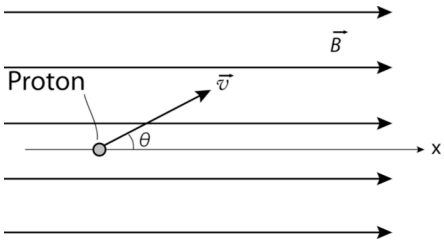
[Q43] Three particles travel through a region of space where the magnetic field out of the page, as shown in Fig. 45. For each of the three particles, state whether the particle's charge is positive, negative, or zero.



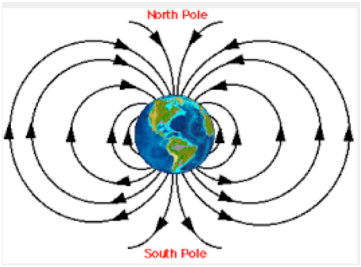
[Q46] (a) A positive charged particle moving into a region with an electric field. (b) A positively charged particle entering a magnetic field. Investigate how different the motion in the two situations.



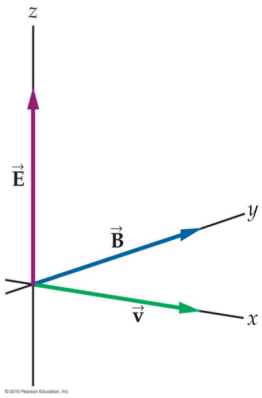
[Q47] A magnetic field points to the x- axis in the vacuum, as shown in the figure. An electron with a a mass m and a charge –e is launched from the origin with a speed v and an angle θ from the x-axis. When $0^\circ < \theta < 90^\circ$, how does the proton move?



[Q48] Explain the mechanism how aurora or northern lights are formed near the poles.

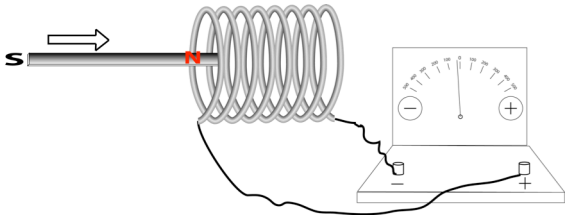


[Q49] A particle with a charge of 7.70 μ C and a speed of 435 m/s, is acted on by both and electric and a magnetic field. The particle moves along the x axis in the positive direction, the magnetic field has a strength of 3.20 T and points in the positive y direction, and the electric field points in the positive z direction with a magnitude of 8.10 x 10^3 N/C. Find the magnitude and direction of the net force acting on the particle.

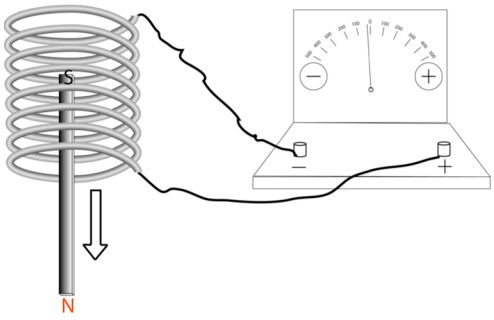


6 . Electromagnetic Induction
Principle of Electric Generators
(Chap23, p816-830)

[Q41] When the magnet is moved as shown, does the galvanometer show a positive current or negative current?

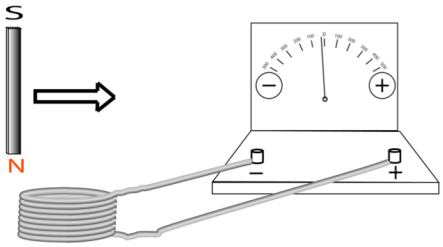


(a)



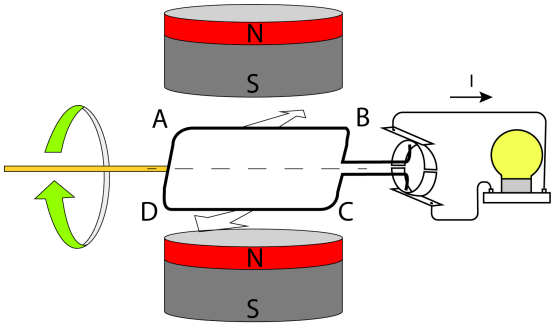
(b)

[Q42] When the magnet is moved as shown, does the galvanometer show a positive current or negative current?

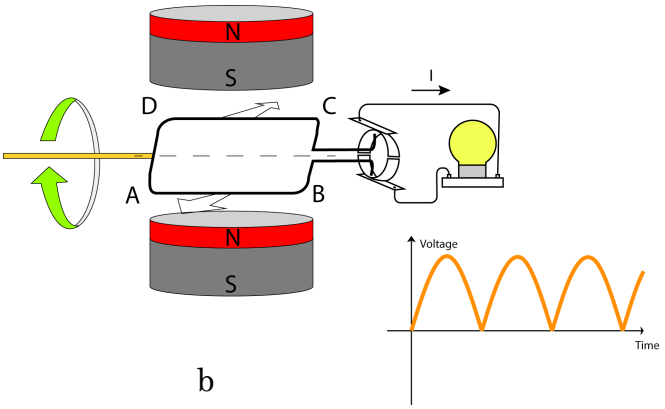


[Q43] The Figures show the principle of a DC and AC generators. Explain.

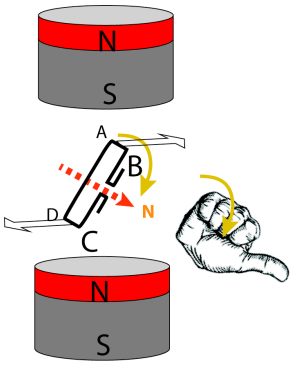
DC Generator



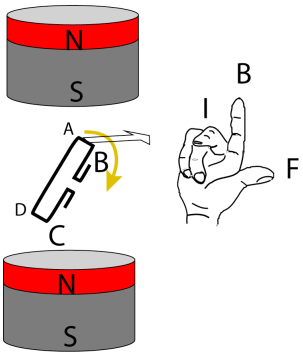
a



b

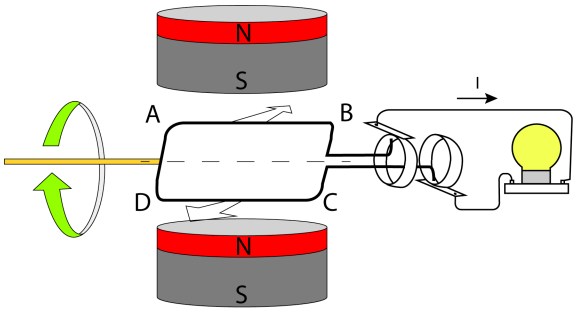


c

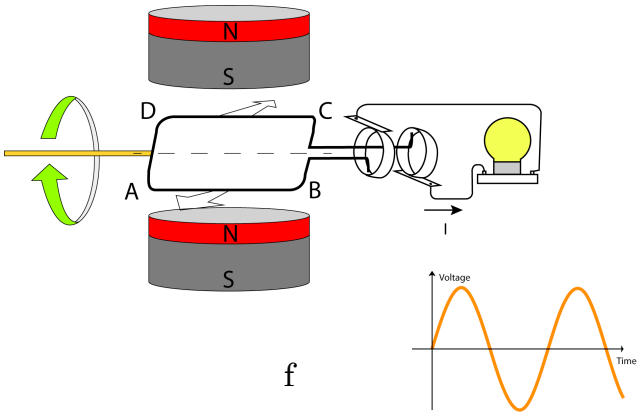


d

AC Generator

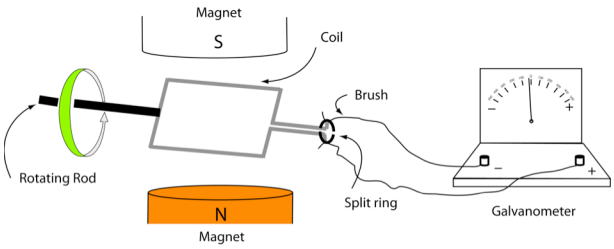


e

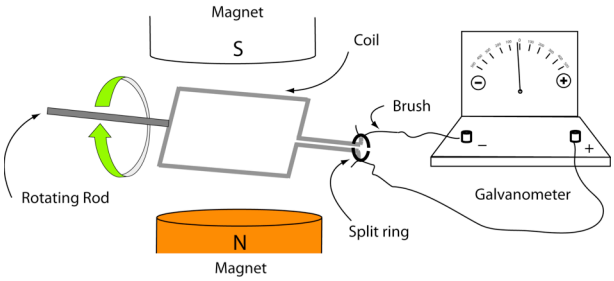


f

[Q44] The figures show generators. The coil rotates around the rotating rod in the direction shown. Does the galvanometer show a positive current or negative current?



(a)

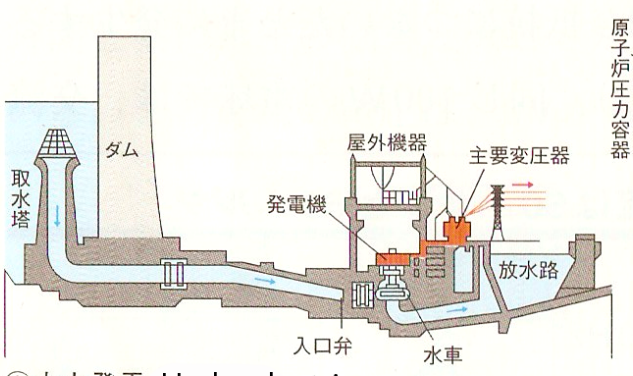


(b)

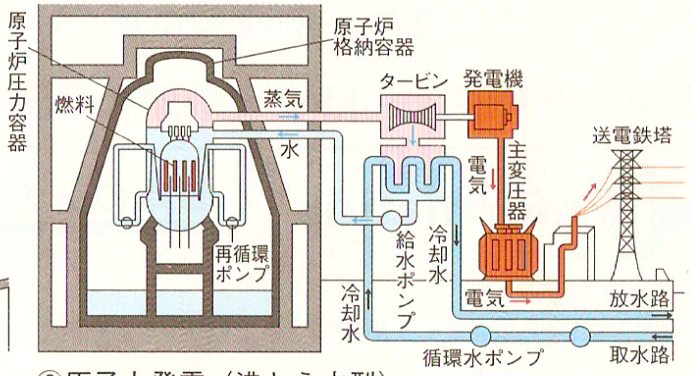
[Q45]In the above (b) generator, which does not affect the magnitude of current in the following modifications? Write "none" if there is no right answer. One or more answers should be chosen if there are.

a) Increasing the rotating speed of the coil.
b) Increasing the length of wire to the galvanometer.
c) Increasing the turn numbers of the coil.
d) Increasing the strength of the magnets.

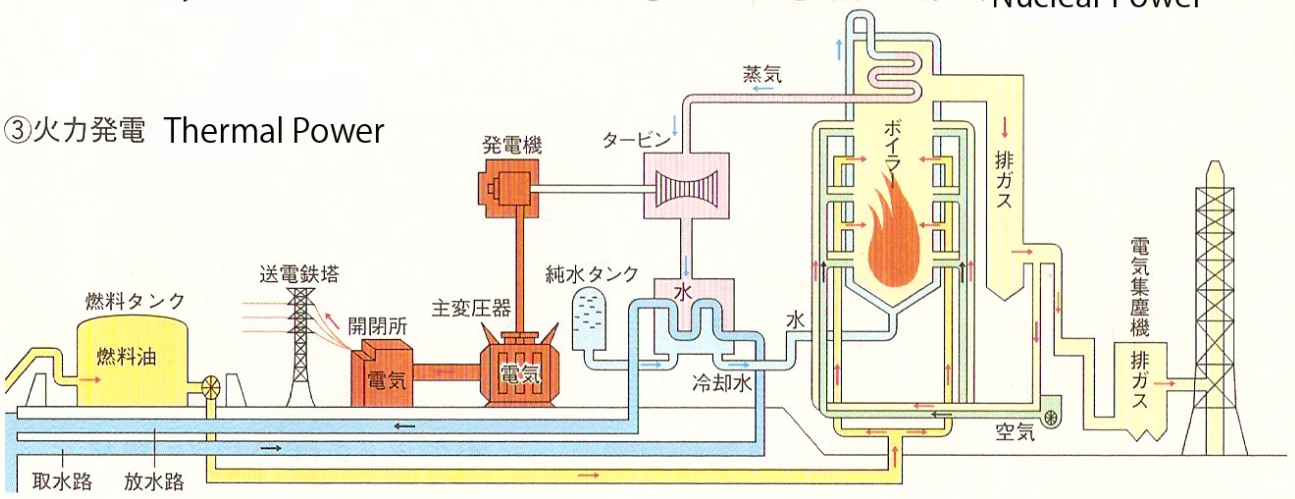
[Q46] Does the above generator (b) give direct current or alternating current?

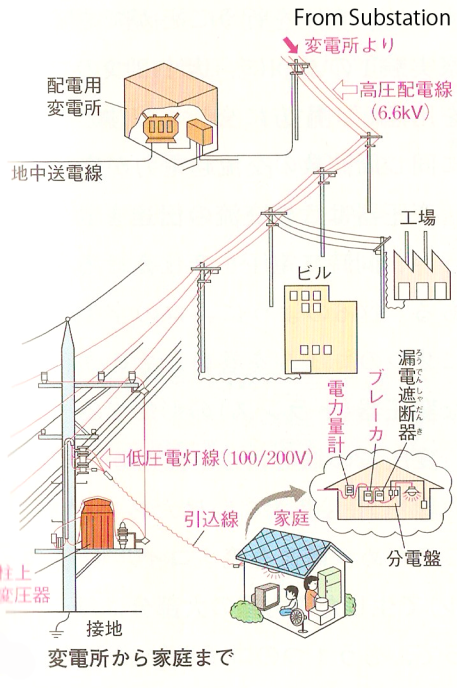


①水力発電 Hydroelectric

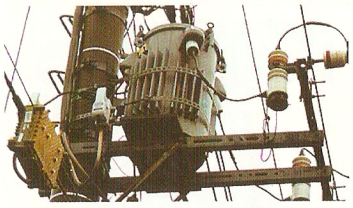


②原子力発電（沸とう水型）Nuclear Power

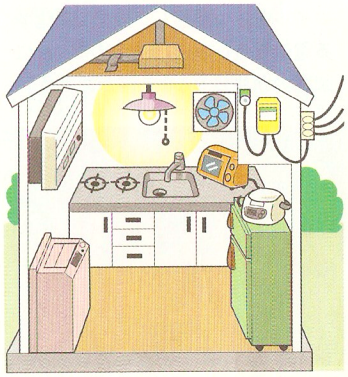




変電所から家庭まで

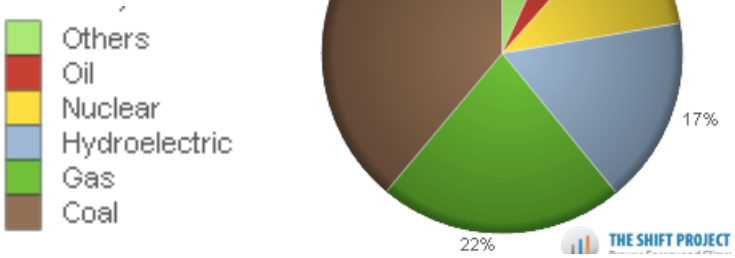


柱上変圧器 Transformer

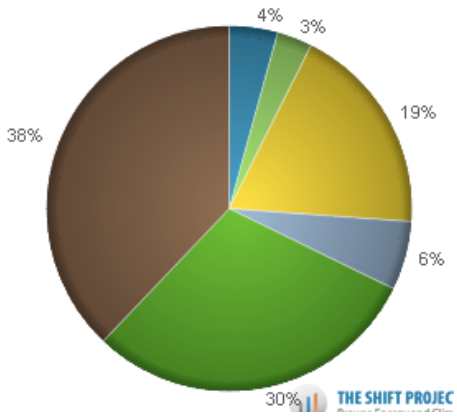


家の中での電気の利用

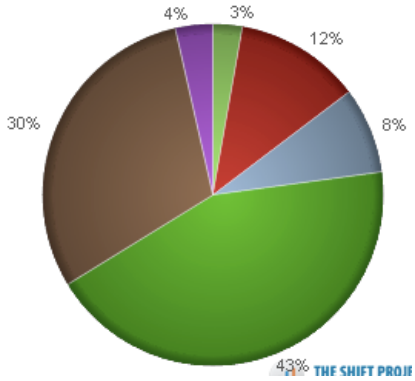
Breakdown of Electricity Generation by Energy Source



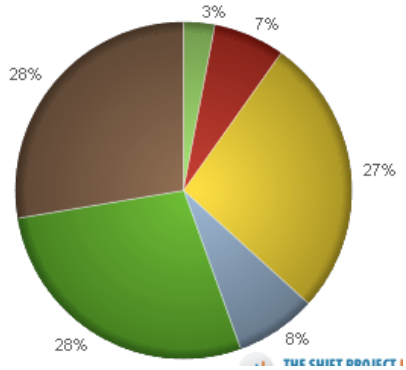
World 2014



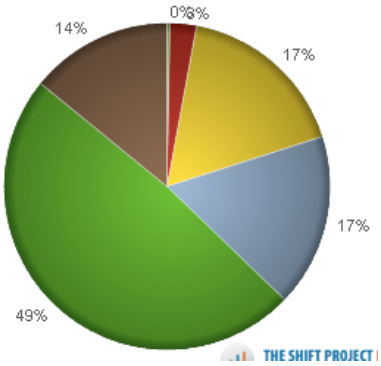
USA 2014



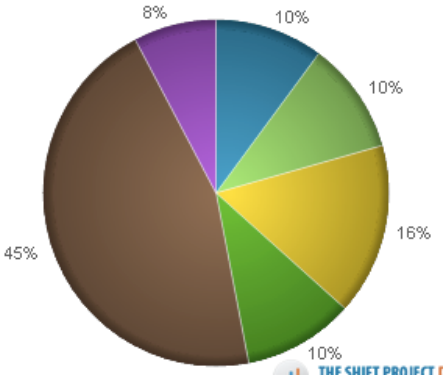
Japan 2014



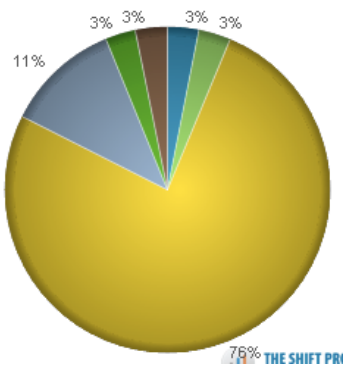
Japan 2010



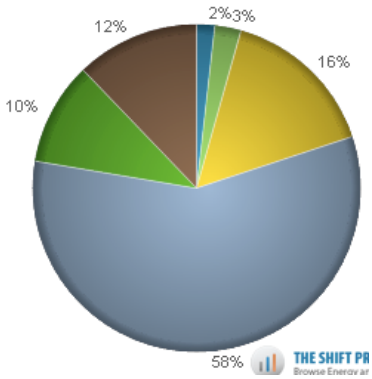
Russia 2014



Germany 2014

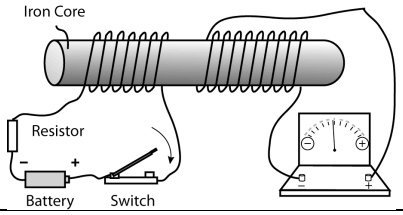
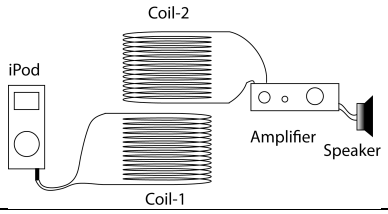
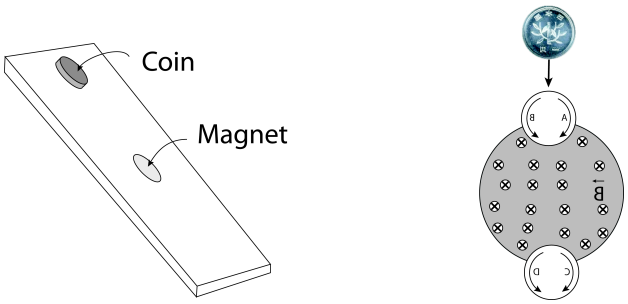
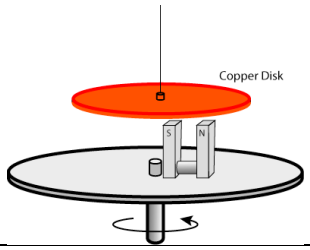
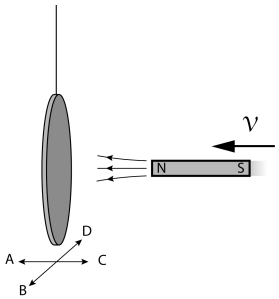
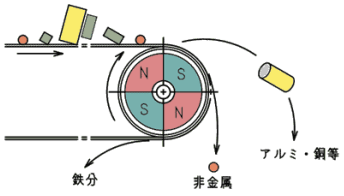


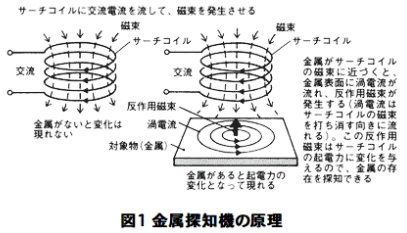
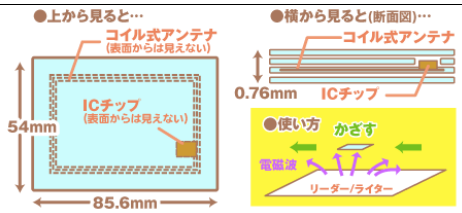
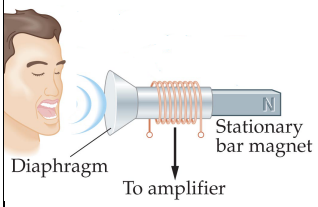
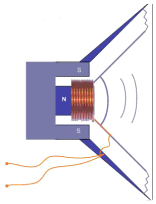
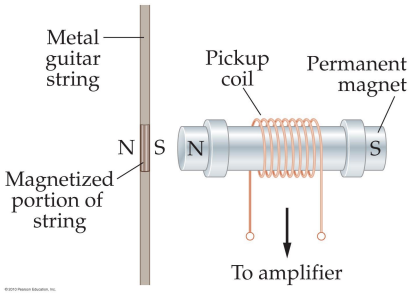
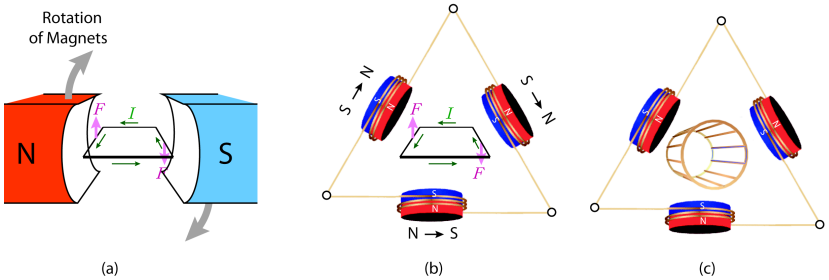
France 2014



Canada 2014

7． Applications of Electromagnetic Induction

1	Faraday's Experiment (Mutual Inductance)	
2	Mutual induction Communication	
3	Induction Braking	
4	Arago's Disk	
5		
6	Can Selector	

7	Metal Detector	  図1 金属探知機の原理
8	IC Card	
9	IH, Induction Heater	
10	Microphone & Speaker	  
11	Electric Guitar	
12	Induction Motor	

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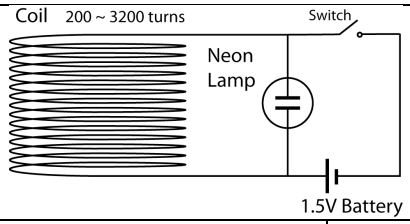

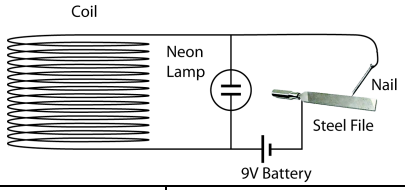

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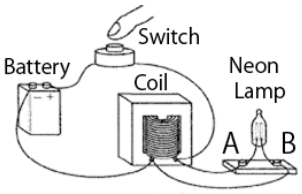

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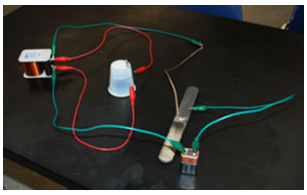
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Induction Coil
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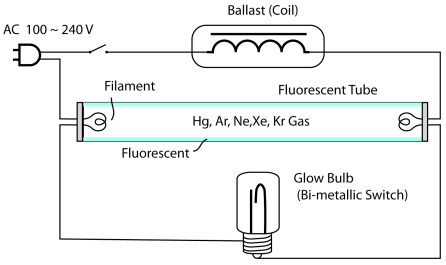

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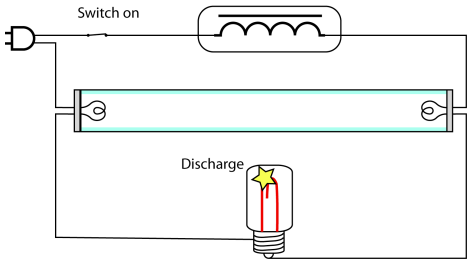

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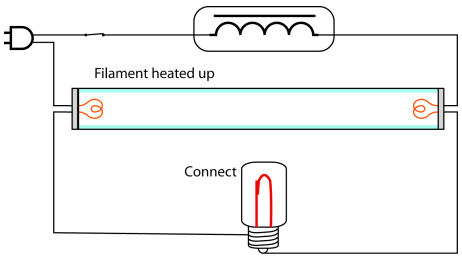

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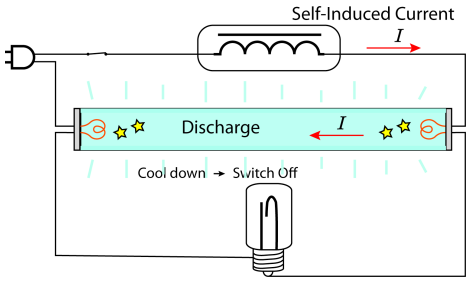

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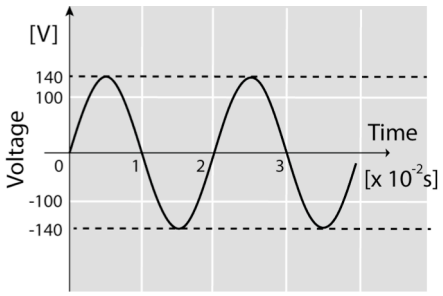
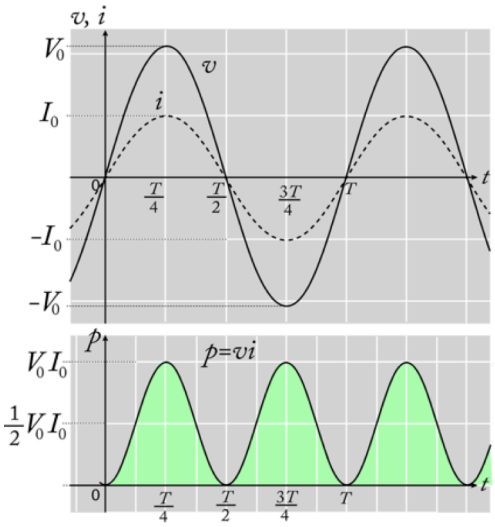
8. Alternating Current (AC)

(Chap23, p832-840)

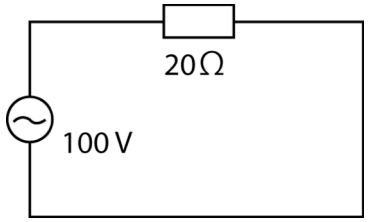
[Q51] The figure shows the voltage change of an alternating current. Find its period and frequency. Although the voltage changes periodically with the maximum voltage of 140V, it is called "100 V AC." Explain why.



[Q52] In the circuit having an AC generator and a resistor R in the figure, the voltage v, current i and power dissipation p for the resistor change with a time as shown in the graph. Explain about rms values of voltage and current.



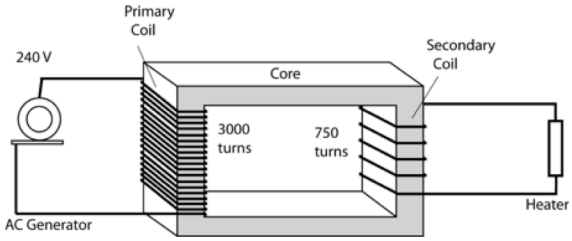
[Q53] An AC generator with an rms voltage of 100 V is connected to a resistor of 20 Ω. Find (a) the maximum voltage, (b) the maximum current and (c) the average power dissipation in the resistor.



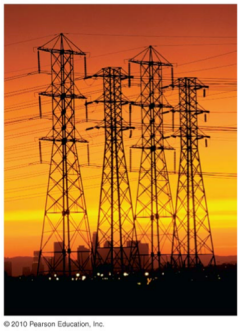
[Q54] A neon sign that requires a voltage of 11,000 V is plugged into a 120-V wall outlet. What turn ratio (secondary / primary) must a transformer have to power up the sign.

[Q55] An alternating EMF of 240 V is applied to a transformer having 3000 turns on its primary and 750 turns on its secondary. On the secondary side, a heater for 120V and 800W is connected. Find the followings assuming no losses.

(1) What is the resistance of the heater?
(2) What is the voltage of the secondary part?
(3) What is the secondary current?
(4) What is the primary current?
(5) What is the power consumed by the heater?

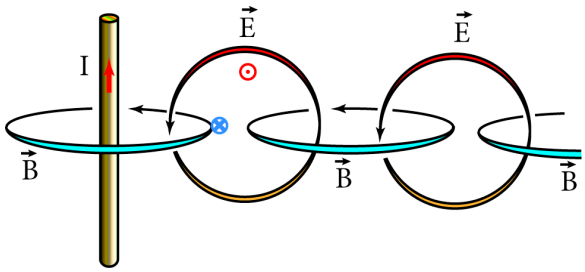


[Q56] There are two kinds of currents, direct current and alternative, and the former is commonly used for most electrical tools at home. In spite of that, alternating current is broadly produced in electric plants. Explain why?

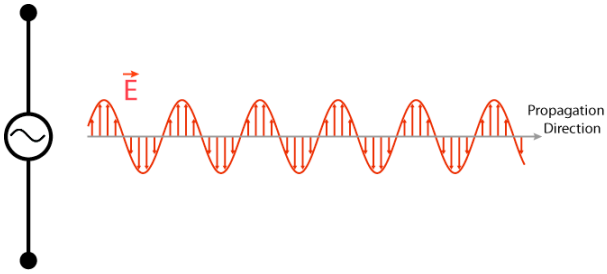


8. Electric Waves

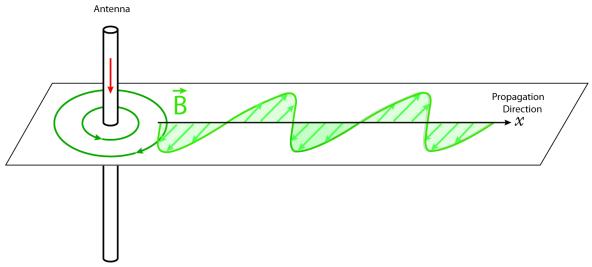
1) Generation of electric wave



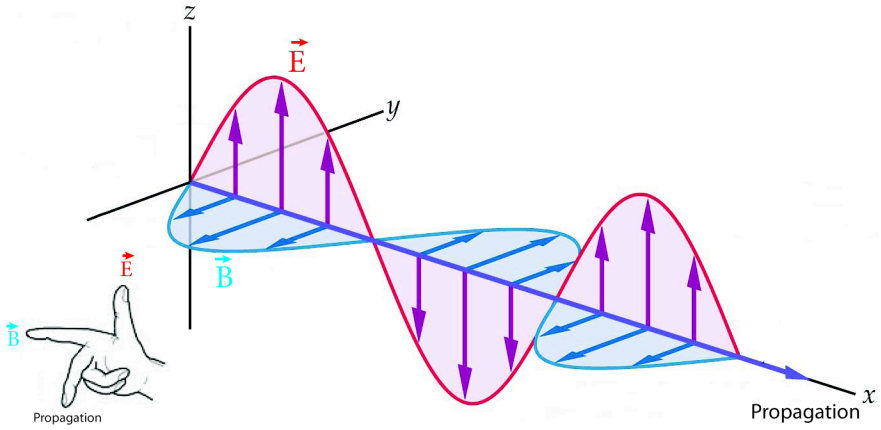
2) The wave of electric field



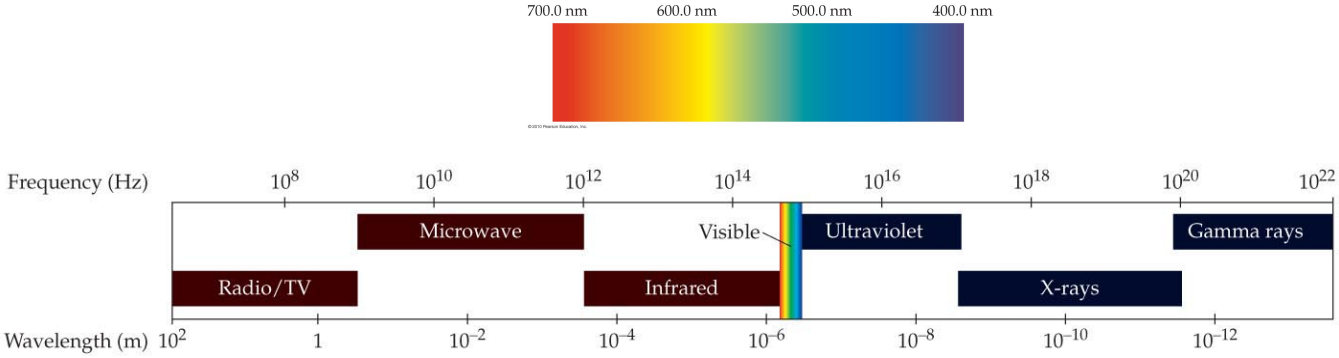
3) The wave of magnetic field



4) Electromagnetic Waves



3. The EM Spectrum



	周波数 Hz	波長 m	
Radio Waves	$10^6 \sim 10^9$	300 m ~ 0.3 m	
Microwaves	$10^9 \sim 10^{12}$	0.3 m ~ 0.3 mm	
Infrared Waves	$10^{12} \sim 4.3\text{x}10^{14}$	0.3 mm ~ 700 nm	
Visible Light	$4.3\text{x}10^{14} \sim 7.5\text{x}10^{14}$	700 nm ~ 400 nm	
Ultraviolet Light	$7.5\text{x}10^{14} \sim 10^{17}$	400 nm ~ 3 nm	
X-rays	$10^{17} \sim 10^{20}$	3 nm ~ 0.003 nm	
Gamma Rays γ ray	10^{20} and Higher	0.003 nm and smaller	

[Q62] What is the wavelength of an electromagnetic wave of 3 x 10^6 MHz.

[Q63] Find the frequencies of the following radio waves.
(a) A radio wave of the wavelength of 500 m
(b) A radio wave of the wavelength of 5.0 m

1. Magnets 磁石
   Magnetic Poles, N-Pole, S-Pole 磁極, N 極、S 極
   Magnetic Force 磁気力
   Magnetic Field 磁場（磁界）B
   Magnetic Field Lines 磁力線
   Geomagnetism 地磁気

2. Magnetic Field around a Current 電流の作る磁場
   Hans Christian Oersted エルステッド

   Right Screw Rule 右ねじの法則
   Right-Hand Thumb Rule 右手親指の法則

   Magnetic Field by a Current-Carrying Wire 直線電流による磁場
   Magnetic Field. by a Current Loop 円形電流による磁場
   Magnetic Field. by a Coil コイルによる磁場

3. Force on a Current in a Magnetic Field 磁場中の電流が受ける力
   Force on a Coil in a Magnetic Field 磁場中のコイルが受ける力
   Fleming's Left-Hand Rule フレミングの左手の法則
   Principe of a Motor モーターの原理
   Brushes, Split ring ブラシ、整流子

4. Electromagnetic Induction 電磁誘導
   Michael Faraday ファラデー
   Induced Current 誘導電流
   Lenz's Law レンツの法則
   Fleming's Right-Hand Rule フレミングの右手の法則
   Generators 発電機
   Generation of Alternating Current (AC) 交流の発電

5. Properties of Alternating Current (AC) 交流の性質
   Electric Power Plants 発電所
   Transformer Substations 変電所
   Transformer 変圧器

6. Electric Waves 電波
   Electromagnetic Waves 電磁波
   Microwave マイクロ波
   Infrared, Visible Light, Ultraviolet 赤外線、可視光線、紫外線
   X-ray, Gamma ray X 線、ガンマ線