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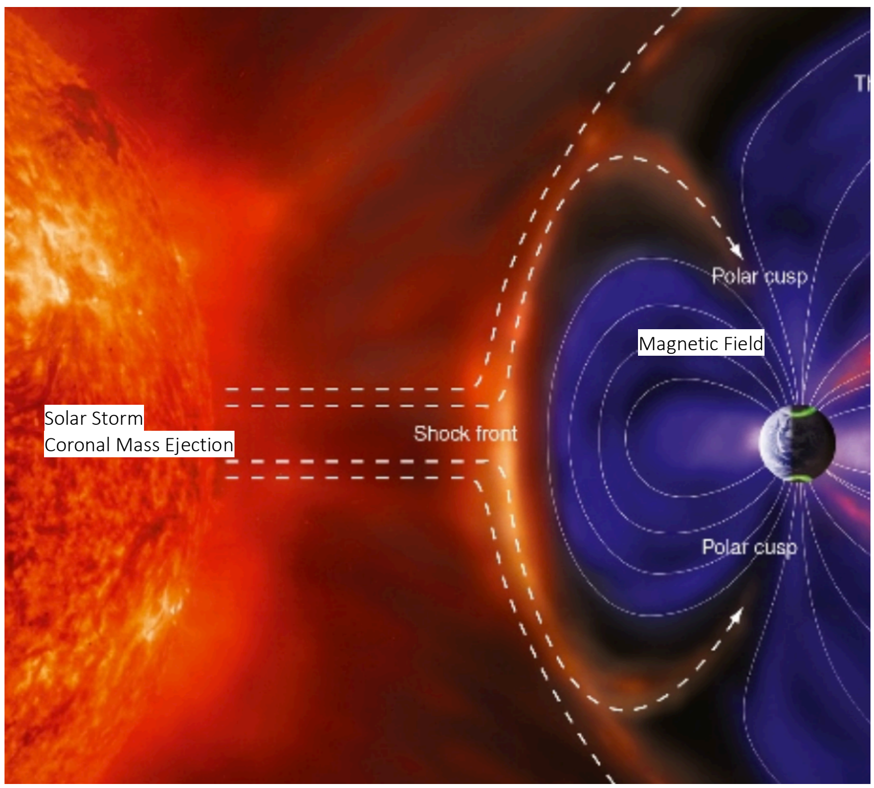
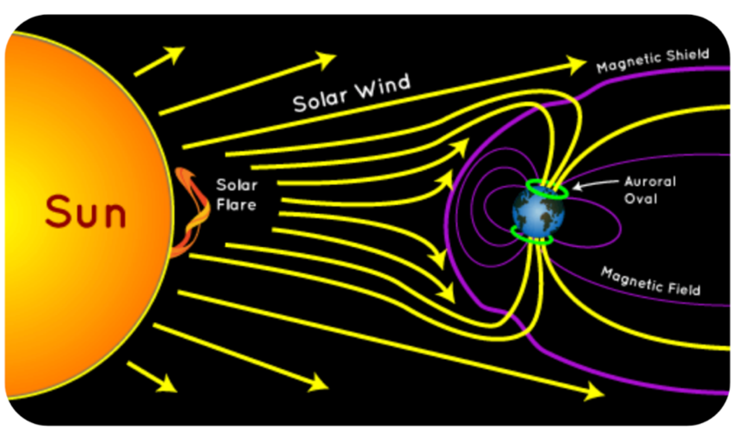
Unit 3 Chapter 8: Magnetic fields
Lesson 3.8: Magnetic Field and magnetic force on moving charges (8.1 – 8.2)





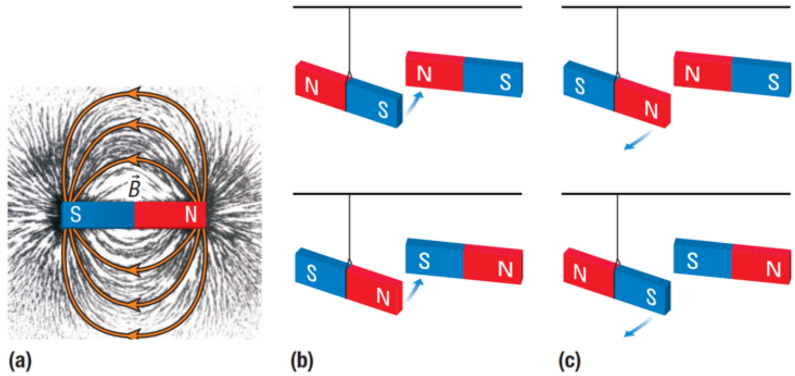


Figure 2 (a) The iron filings around the bar magnet show that the magnetic field $\vec{B}$ extends from the north pole of a magnet to the south pole. (b) The interaction of the magnetic fields of two magnets causes unlike poles to attract each other. (c) The interaction of the magnetic fields causes like poles to repel each other.

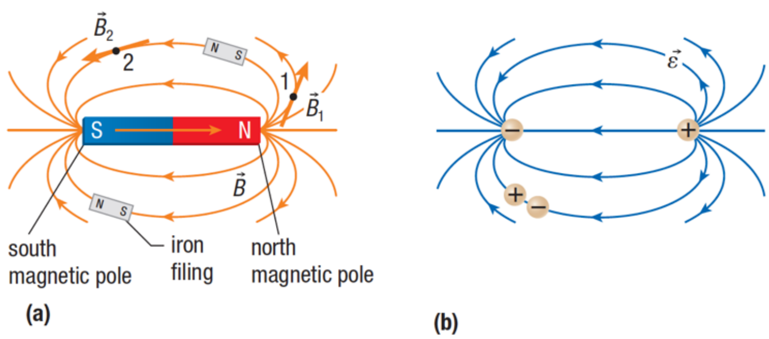


Figure 3 The magnetic field lines of a bar magnet are similar to the electric field lines of an electric dipole. (a) The iron filings align with $\vec{B}$. (b) The electric dipoles align with $\vec{\varepsilon}$.

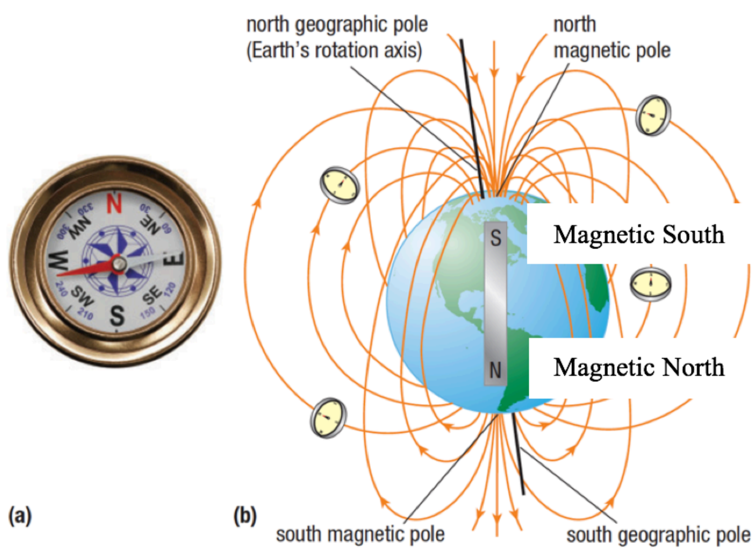


Figure 5 (a) A compass. (b) If we were to place compasses at different spots in Earth's magnetic field, each compass needle would be aligned parallel to the field.

Right-Hand Rule for a Straight Conductor: If you 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.

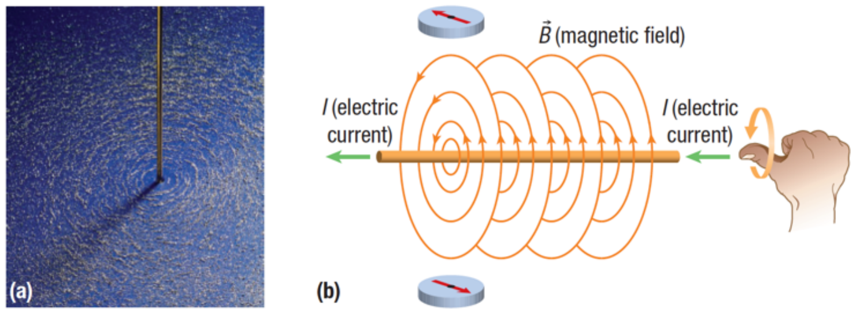


Figure 8 (a) Iron filings indicate the circular magnetic field around a conducting wire. (b) The right-hand rule for a straight conductor indicates the direction of the magnetic field.

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.

Note from the diagram b) and c) that the field outside of a solenoid is weaker and non-uniform especially when the number of loops increases. However the magnetic field inside the solenoid is stronger and uniform.

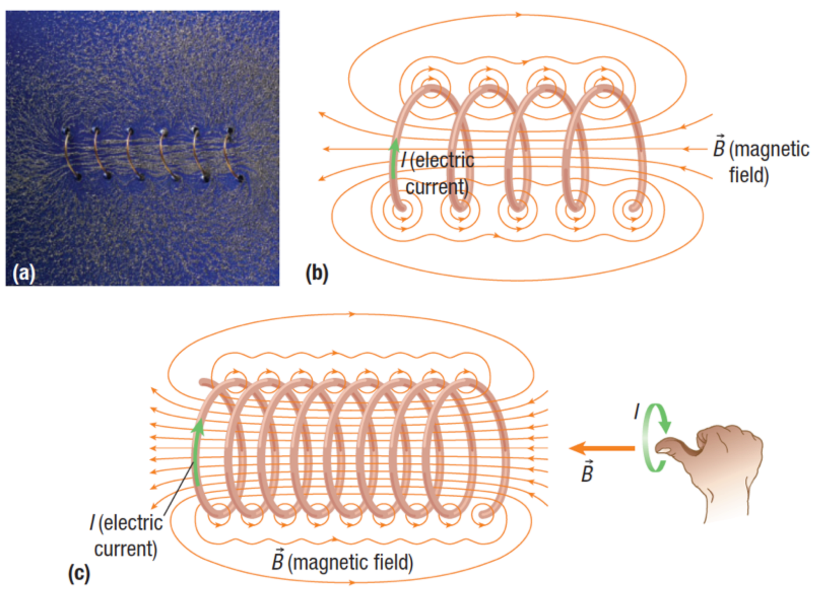


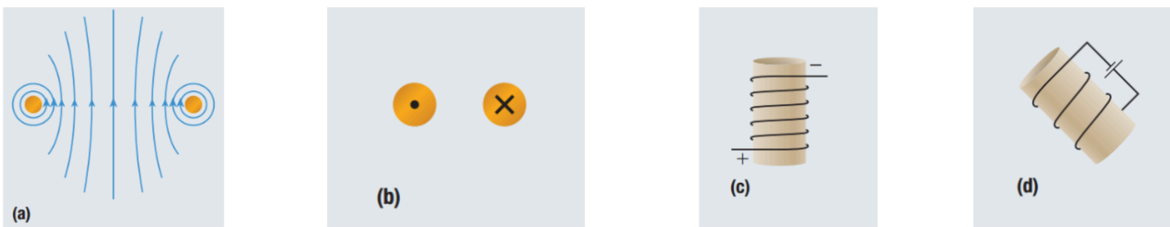
Figure 10 Magnetic field, $\vec{B}$, of a solenoid. (a) The iron filings indicate the direction of the solenoid's magnetic field. (b) The field lines are curved when the coil of the solenoid is loosely wound. (c) The field lines are straight for a tightly wound solenoid. The right-hand rule indicates the direction of the magnetic field through the solenoid.

The strength of the uniform field can be calculated: $\vec{B} = u_0 I n$

- $\vec{B}$ = Magnetic Field Strength in Tesla (T), $1\text{T} = 1\frac{kg}{C \cdot s}$
- u_0 = Permeability of free space $= 4\pi \times 10^{-7}$
- I = Current in A
- n = Loops per meter (total loops over length)

Example 1: A hollow solenoid is 25 cm long and has 1000 loops. If the solenoid has a diameter of 4.0 cm and a current of 9.0 A, what is the magnetic field in the solenoid?

Example 2: Draw the magnetic field lines and/or the direction of conventional current for each:



Magnetic Force on Moving charges (8.2)

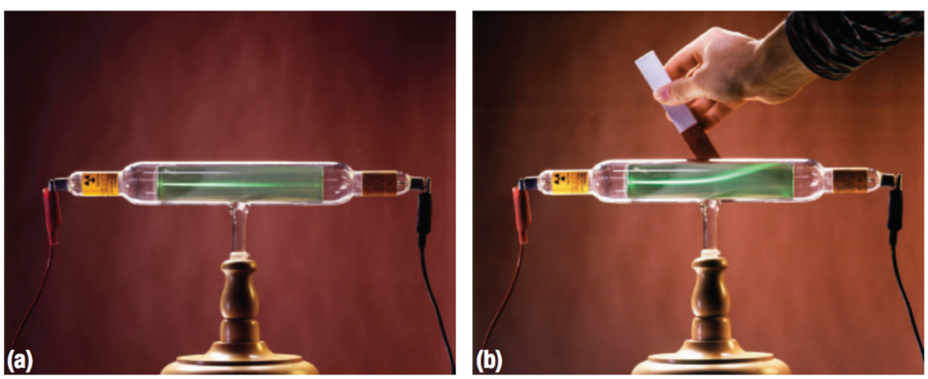
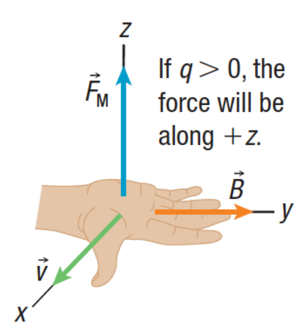


Figure 2 (a) Electrons move straight through the cathode ray tube. (b) When a bar magnet is placed near the electrons, the magnetic force deflects their path.

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 ($\vec{v}$), i.e., the direction of **conventional current**, 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 ($\overrightarrow{F_M}$).

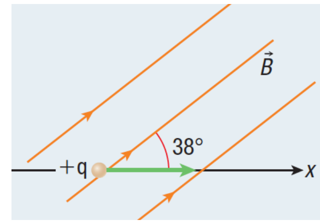


The magnitude of the magnetic force can be calculated by:

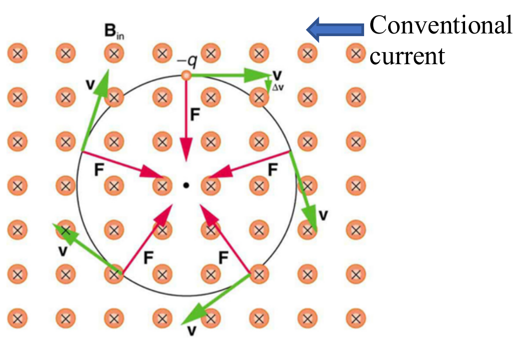
$F_M = qvBsin\theta$, where θ is the angle between $\vec{v}$ and $\vec{B}$.

Note: From $sin\theta$, no work done when the particles are moving ________________ to the magnetic field. And Magnetic force ONLY depends on the velocity of the charge.

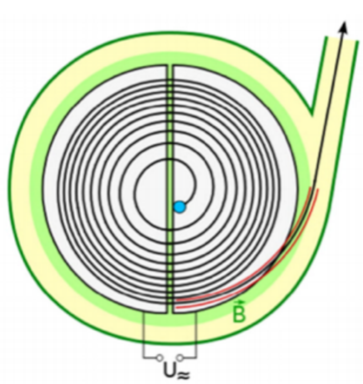
Example 3: A proton is moving along the x-axis at a speed of 78 m/s. It enters a magnetic field of strength 2.7 T. The angle between the proton's velocity vector and the magnetic field is 38 degrees. The mass of a proton is $1.67 \times 10^{-27}\ kg$. Determine the initial magnitude and the direction of the magnetic force on the proton and its initial acceleration.



Example 4: Let's consider the following cases

If a negatively charged electron enters a magnetic field traveling perpendicular to the field, it will deflect continuously and travel in a circle.	Now replaces by a proton moving through the same magnetic field. Draw your own diagram.
	

Example 5: Circular particle accelerators use magnetic fields to bend beams of charged particles. This allows them reach phenomenal speeds in relatively small spaces. The cyclotron at UBC's TRIUMF contains the largest of its kind in the world. It accelerates a beam of hydrogen anions (H^-) to 75% the speed of light and uses 0.42 T magnetic field. Note that at these speeds the relativistic mass of a hydrogen anion is $2.524 \times 10^{-27} kg$. Determine the radius of accelerators.



Practice: Textbook pg390. #1 – 4 & pg 391.# 5 – 10