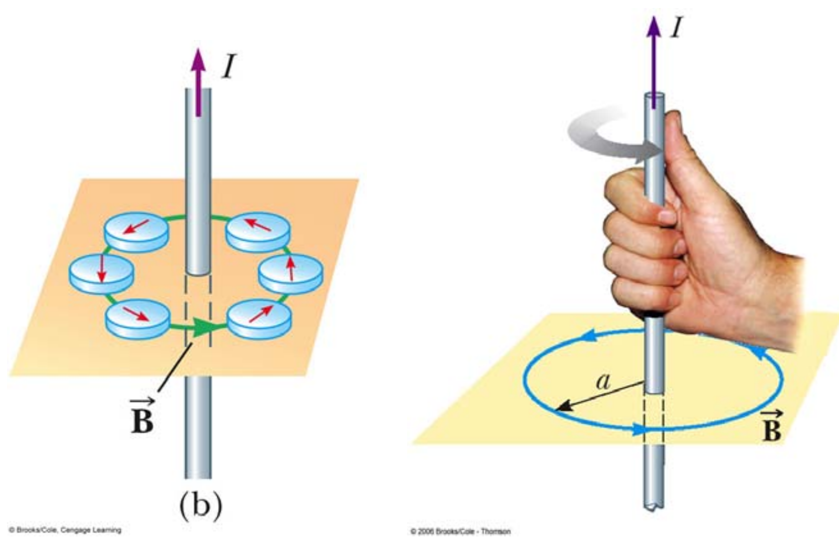
1. B $\propto$ v,q
2. B reverses direction if v reverses direction or q changes sign
3. The field varies as sinφ where φ is the angle relative to the direction of v
4. B is tangent to circles drawn about v in planes perpendicular to v and the direction is given by the right hand rule.
5. B decreases as $1/r^2$ where r is the perpendicular distance from the direction of v.



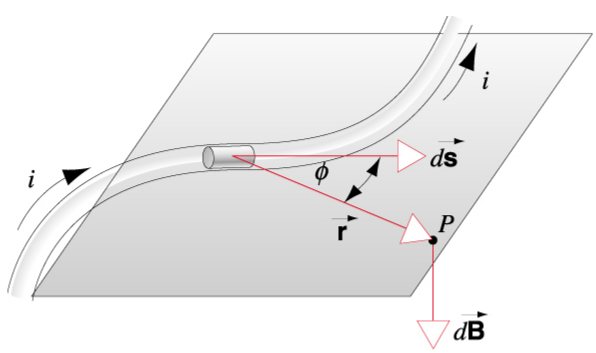
$$\vec{B} = K\frac{q\vec{v}\times\hat{r}}{r^2}$$

$$\Rightarrow \vec{B} = K\frac{q\vec{v}\times\vec{r}}{r^3}$$

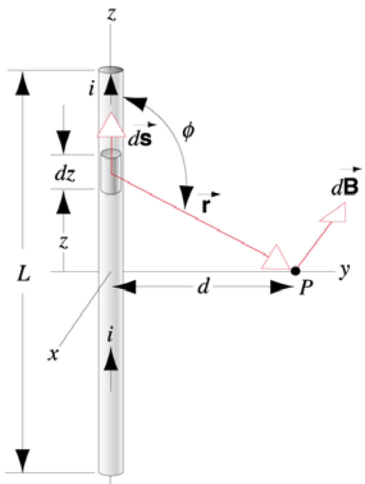
$K = \dfrac{\mu_0}{4\pi}$ = 10^{-7} T.m/A

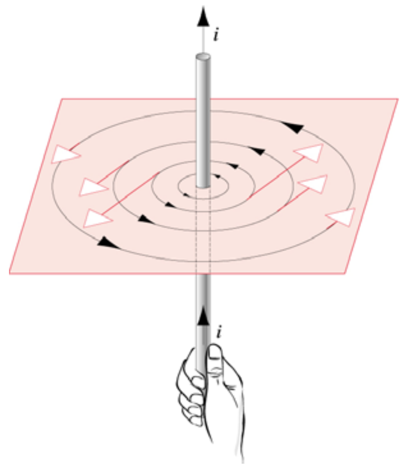
$$\Rightarrow \vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\vec{r}}{r^3} \qquad \Rightarrow B = \frac{\mu_0}{4\pi}\frac{|q|v\sin\phi}{r^2}$$

$$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{id\vec{s}\times\vec{r}}{r^3}}$$ Biot-Savart law

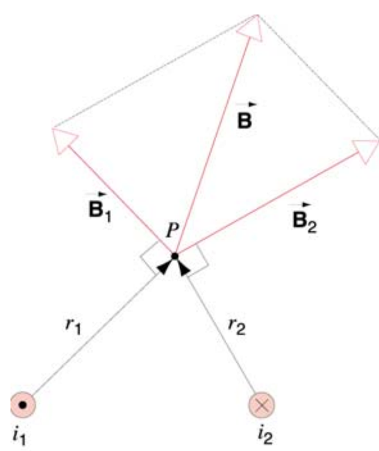


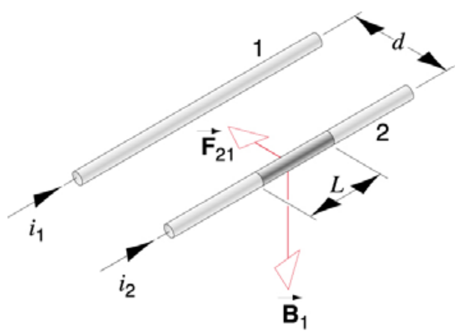
B due to a straight current carrying wire





Two parallel currents

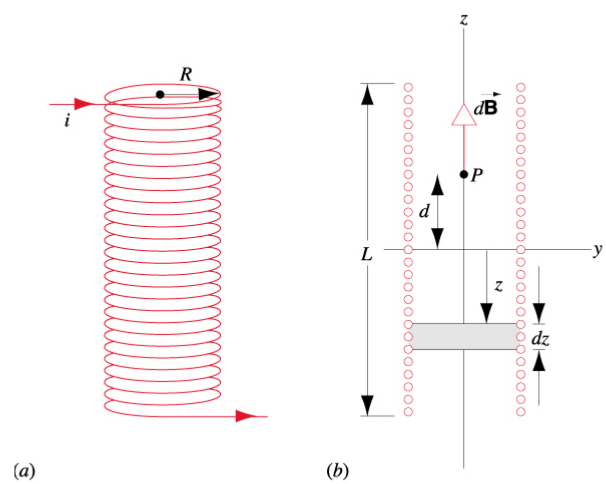


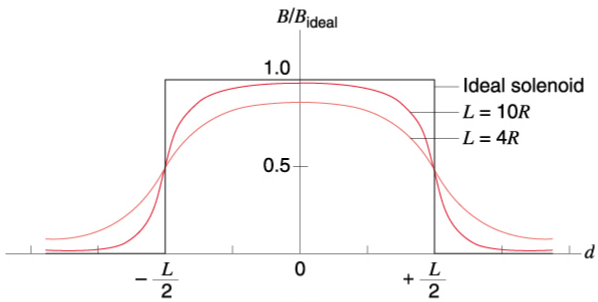


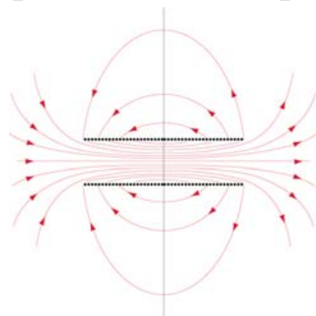
Defining Ampere and Coulomb

- The force between parallel conductors can be used to define the Ampere (A)
  - If two long, parallel wires 1 m apart carry the same current, and the magnitude of the magnetic force per unit length is 2×10^{-7} N/m, then the current is defined to be 1 A
- The SI unit of charge, the Coulomb (C), can be defined in terms of the Ampere
  - If a conductor carries a steady current of 1 A, then the quantity of charge that flows through any cross section in 1 second is 1 C

Solenoid







Coulomb

$$\boxed{\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}}$$

Gauss

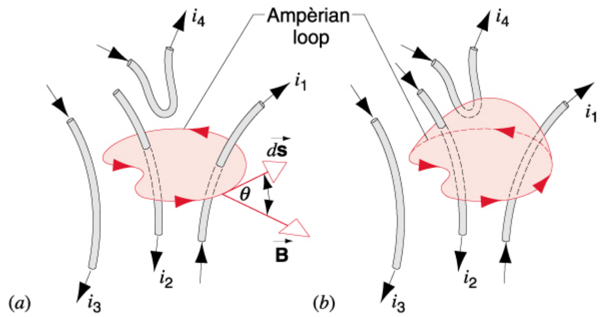
$$\oint \vec{E} \bullet d\vec{A} = \frac{q}{\varepsilon_0}$$

Biot-Savart

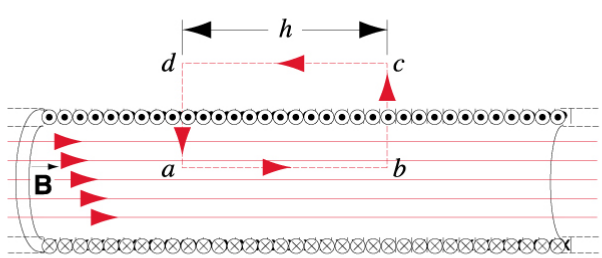
$$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{id\vec{s} \times \hat{r}}{r^2}}$$

Ampere

$$\oint \vec{B} \bullet d\vec{s} = \mu_0 i$$



Ampere’s law and a solenoid



Ampere’s law and a toroid