Scalar and Vector Products

Consider two vectors. We know how to add and subtract them.
When it comes to multiplication, things become tricky. First we already introduced scalar product , which is just a number, not a vector:

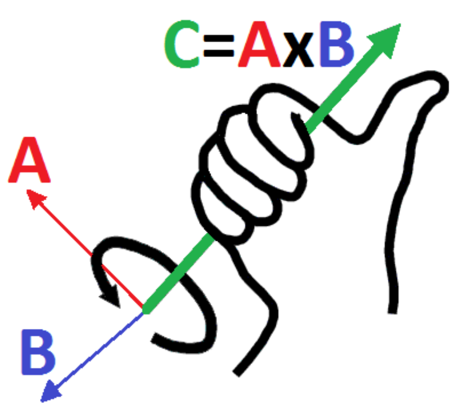
* Scalar product of two vectors (aka **'dot product'**):

$$S = \vec{A} \cdot \vec{B} = AB\cos\alpha$$

Here A and B are magnitudes of the two vectors, and α is the angle between them.
We already saw its use in Physics. Work is the dot product of Force and Displacement:

$$W = \vec{F} \cdot \vec{d} = Fd\cos\alpha$$

* In 3D (only!) one can also introduce Vector Product (aka "**Cross product**" between two vectors). Its result is a vector, not scalar:



$$\vec{C} = \vec{A} \times \vec{B}$$

here $\left|\vec{C}\right| = AB\sin\alpha$

$\vec{C}$ is directed perpendicular to both $\vec{A}$ and $\vec{B}$,

its positive direction is determined by right hand rule.

Lorentz Force

Magnetic field **B** acts on a charge **q** moving at velocity **v** with the force known as Lorentz force:

$$\vec{F} = q\vec{v} \times \vec{B}$$

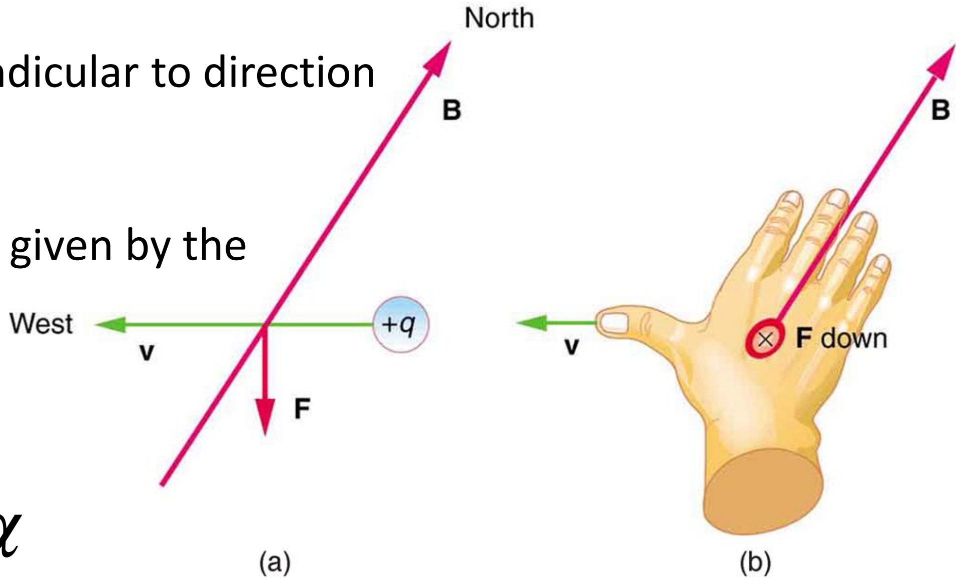
Here 'x' is the vector product. Therefore

- Lorentz force is always directed perpendicular to direction of motion and to the magnetic field.

- Direction of force for positive charge is given by the right hand rule:

- Magnitude of the Lorentz force is

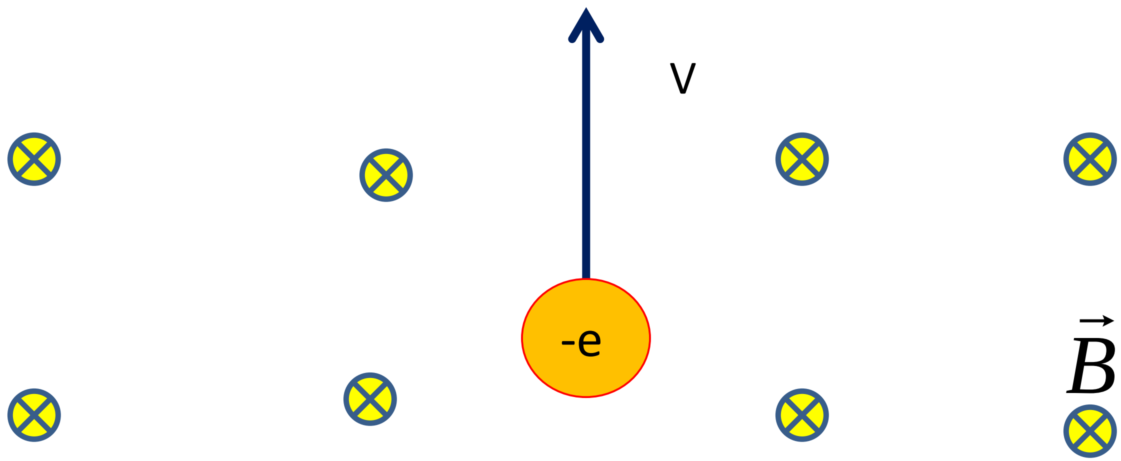
$$F = qvB\sin\alpha$$



Here a is the angle between v and B. According to this result, there is no Lorentz force when charge moves along magnetic field!

Homework

Magnetic field B is directed perpendicular to the plane of the figure, pointing away from you (this is shown by 'dart' symbol $\otimes$). An electron is moving in the plane with original velocity v, as shown:



a) Which way the acceleration is originally directed?
b) Will the speed decrease/increase/stay the same in presence of magnetic field?
c) Sketch the trajectory of the electron, including direction of its motion.
d) Find the time after which the electron will return to the starting point.
   For doing this part you will need to refresh your memory about centripetal acceleration.