Homework 1 - Tensors

Q1.1. Draw diagrams illustrating

(a) $\vec{v}$, $2\vec{v}$ and $-\vec{v}$

(b) $\vec{\vec{v}}$, $2\vec{\vec{v}}$ and $-\vec{\vec{v}}$

(c) $\underline{\omega}$, $2\underline{\omega}$ and $-\underline{\omega}$

(d) $\underline{\underline{\omega}}$, $2\underline{\underline{\omega}}$ and $-\underline{\underline{\omega}}$

in two dimensions.

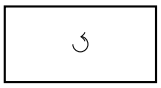
A1.1. (a) $\vec{v}$

$2\vec{v}$

$-\vec{v}$

(b) $\vec{\vec{v}}$

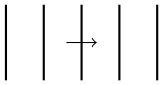
$2\vec{\vec{v}}$



$-\vec{\vec{v}}$

(c) $\underline{\omega}$

$2\underline{\omega}$



$-\underline{\omega}$

(d) $\underline{\underline{\omega}}$

$2\underline{\underline{\omega}}$

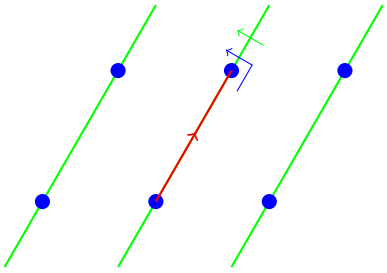
$-\underline{\underline{\omega}}$

Q1.2. Draw diagrams illustrating

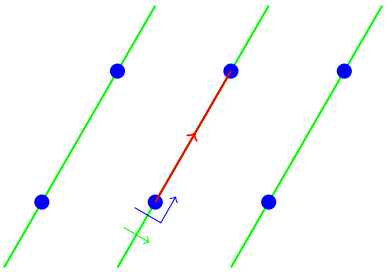
(a) $\vec{v} \cdot \underline{\underline{\omega}}$
(b) $\underline{\underline{\omega}} \cdot \vec{v}$
(c) $\underline{\omega} \cdot \vec{\vec{v}}$
(d) $\vec{\vec{v}} \cdot \underline{\omega}$

in two dimensions.

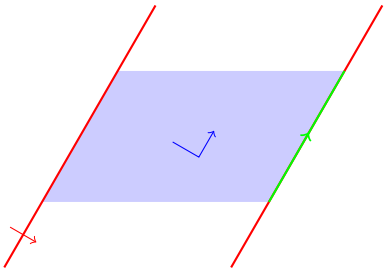
A1.2. (a) $\vec{v} \cdot \underline{\underline{\omega}} = \underline{\sigma}$



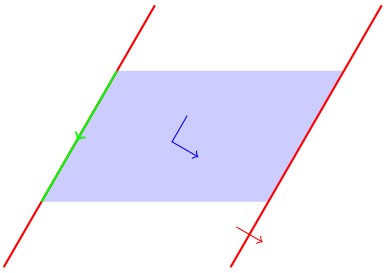
(b) $\underline{\underline{\omega}} \cdot \vec{v} = -\underline{\sigma}$



(c) $\underline{\omega} \cdot \vec{\vec{v}} = \vec{u}$



(d) $\vec{\vec{v}} \cdot \underline{\omega} = -\vec{u}$



Q1.3. Write down the Lorentz force law, expressing every tensor in its natural form. Draw a diagram illustrating your answer.

A1.3.

$$\underline{F} = q\left(\underline{E} + \underline{\underline{B}} \cdot \vec{v}\right) \tag{A1.3.1}$$

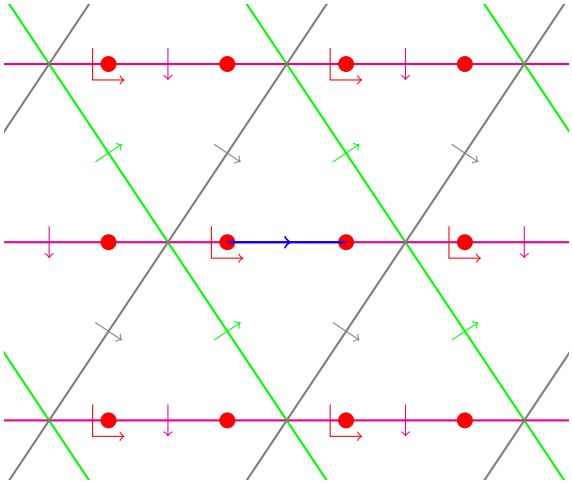


Figure A1.3.1: $\underline{F}/q = \underline{E} + \left(\underline{\underline{B}} \cdot \vec{v}\right)$