## 4 Section 13.4

- Cross product: $\overrightarrow{a} =< a_1, a_2, a_3 >$, $\overrightarrow{b} =< b_1, b_2, b_3 >$,

$$\overrightarrow{a} \times \overrightarrow{b} =< a_2b_3 - a_3b_2, a_3b_1 - b_3a_1, a_1b_2 - a_2b_1 >$$

- Determinant formula:

$$\overrightarrow{a} \times \overrightarrow{b} = \begin{vmatrix} \overrightarrow{i} & \overrightarrow{j} & \overrightarrow{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

- Properties:

$$\overrightarrow{a} \times \overrightarrow{a} = \overrightarrow{0}, \quad \overrightarrow{a} \times \overrightarrow{b} = -\overrightarrow{b} \times \overrightarrow{a}, \quad \overrightarrow{a} \perp \overrightarrow{b} \Leftrightarrow \overrightarrow{a} \times \overrightarrow{b} = 0$$

- Area of parallelogram:

$$|\overrightarrow{a} \times \overrightarrow{b}| = |\overrightarrow{a}||\overrightarrow{b}|\sin\theta$$

- Scalar triple product: $\overrightarrow{a} =< a_1, a_2, a_3 >$, $\overrightarrow{b} =< b_1, b_2, b_3 >$, $\overrightarrow{c} =< c_1, c_2, c_3 >$,

$$\overrightarrow{a} \cdot (\overrightarrow{b} \times \overrightarrow{c}) = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$$

  Volume of parallelepiped=$|\overrightarrow{a} \cdot (\overrightarrow{b} \times \overrightarrow{c})|$

  $\overrightarrow{a}, \overrightarrow{b}, \overrightarrow{c}$ coplanar $\Leftrightarrow \overrightarrow{a} \cdot (\overrightarrow{b} \times \overrightarrow{c}) = 0$.

## 5 Section 13.5

Equations of lines: $\overrightarrow{r} =< x, y, z >, \overrightarrow{r_0} =< x_0, y_0, z_0 >$, $P(x_0, y_0, z_0)$ point on the line.

- Vector equation:

$$\overrightarrow{r} = \overrightarrow{r_0} + t\overrightarrow{v} \Leftrightarrow < x, y, z >=< x_0, y_0, z_0 > +t < a, b, c >$$

- Parametric equations:

$$\begin{cases} x = x_0 + at \\ y = y_0 + bt \\ z = z_0 + ct \end{cases}$$

- Symmetric equation: $\overrightarrow{v} =< a, b, c >$ a direction vector of the line

$$\frac{x - x_0}{a} = \frac{y - y_0}{b} = \frac{z - z_0}{c}$$