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PART I: Mechanics of Rigid Bodies

Chapter 1

Properties of Forces and Force Systems

COMPONENTS OF A FORCE

The *components* (or *scalar components*) of a force F in the x and y directions are denoted by F_x and F_y , respectively (Fig. 1-1), and are

$$F_x = |F| \cos \theta \quad F_y = |F| \sin \theta \quad (1.1)$$

where the vertical bars denote the magnitude of the vector F .

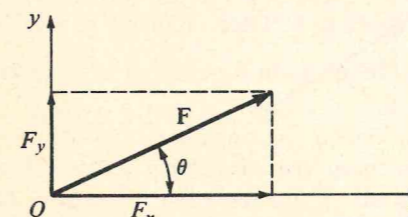


Fig. 1-1

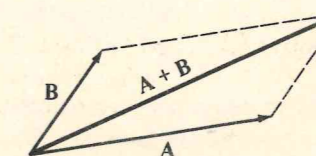


Fig. 1-2

VECTOR ADDITION

Two vectors A and B may be added by taking A and B as adjacent sides of a parallelogram, as indicated in Fig. 1-2. The vector sum (or *resultant*) of A and B is then the vector from the origin of A and B along the diagonal to the opposite corner. This defines the *parallelogram rule* for vector addition. We sometimes refer to A and B of Fig. 1-2 as *vector components* of $A + B$.

DOT PRODUCT

The *dot product* (or *scalar product*) of two vectors A and B is the product of the magnitudes of the two vectors multiplied by the cosine of the acute angle α between them, as shown in Fig. 1-3:

$$A \cdot B = |A||B| \cos \alpha \quad (1.2)$$

It is frequently convenient to work with unit vectors (i.e., vectors of unit length) directed along the x , y , and z axes, as shown in Fig. 1-4. These are denoted i , j , and k , respectively. From (1.2) we obviously have

$$\begin{aligned} i \cdot i &= j \cdot j = k \cdot k = 1 \\ i \cdot j &= j \cdot k = i \cdot k = 0 \end{aligned} \quad (1.3)$$

Figure 1-5 shows the extension of these ideas to three-dimensional space.