

CHAPTER 1 SUMMARY

Physical quantities and units: Three fundamental physical quantities are mass, length, and time. The corresponding fundamental SI units are the kilogram, the meter, and the second. Derived units for other physical quantities are products or quotients of the basic units. Equations must be dimensionally consistent; two terms can be added only when they have the same units. (See Examples 1.1 and 1.2.)

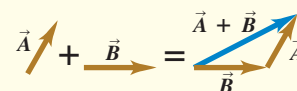
Significant figures: The accuracy of a measurement can be indicated by the number of significant figures or by a stated uncertainty. The significant figures in the result of a calculation are determined by the rules summarized in Table 1.2. When only crude estimates are available for input data, we can often make useful order-of-magnitude estimates. (See Examples 1.3 and 1.4.)

Significant figures in magenta

$$\pi = \frac{C}{2r} = \frac{0.424 \text{ m}}{2(0.06750 \text{ m})} = 3.14$$

$$123.62 + 8.9 = 132.5$$

Scalars, vectors, and vector addition: Scalar quantities are numbers and combine according to the usual rules of arithmetic. Vector quantities have direction as well as magnitude and combine according to the rules of vector addition. The negative of a vector has the same magnitude but points in the opposite direction. (See Example 1.5.)



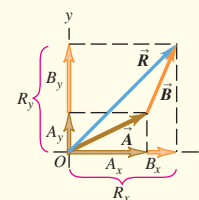
Vector components and vector addition: Vectors can be added by using components of vectors. The x -component of $\vec{R} = \vec{A} + \vec{B}$ is the sum of the x -components of \vec{A} and \vec{B} , and likewise for the y - and z -components. (See Examples 1.6 and 1.7.)

$$R_x = A_x + B_x$$

$$R_y = A_y + B_y$$

$$R_z = A_z + B_z$$

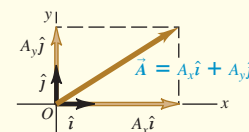
(1.9)



Unit vectors: Unit vectors describe directions in space. A unit vector has a magnitude of 1, with no units. The unit vectors \hat{i} , \hat{j} , and \hat{k} , aligned with the x -, y -, and z -axes of a rectangular coordinate system, are especially useful. (See Example 1.8.)

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

(1.14)



Scalar product: The scalar product $C = \vec{A} \cdot \vec{B}$ of two vectors \vec{A} and \vec{B} is a scalar quantity. It can be expressed in terms of the magnitudes of \vec{A} and \vec{B} and the angle ϕ between the two vectors, or in terms of the components of \vec{A} and \vec{B} . The scalar product is commutative; $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$. The scalar product of two perpendicular vectors is zero. (See Examples 1.9 and 1.10.)

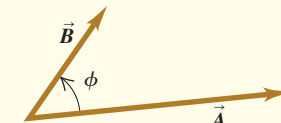
$$\vec{A} \cdot \vec{B} = AB \cos \phi = |\vec{A}| |\vec{B}| \cos \phi$$

(1.16)

Scalar product $\vec{A} \cdot \vec{B} = AB \cos \phi$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$$

(1.19)



Vector product: The vector product $\vec{C} = \vec{A} \times \vec{B}$ of two vectors \vec{A} and \vec{B} is a third vector \vec{C} . The magnitude of $\vec{A} \times \vec{B}$ depends on the magnitudes of \vec{A} and \vec{B} and the angle ϕ between the two vectors. The direction of $\vec{A} \times \vec{B}$ is perpendicular to the plane of the two vectors being multiplied, as given by the right-hand rule. The components of $\vec{C} = \vec{A} \times \vec{B}$ can be expressed in terms of the components of \vec{A} and \vec{B} . The vector product is not commutative; $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$. The vector product of two parallel or antiparallel vectors is zero. (See Example 1.11.)

$$C = AB \sin \phi$$

(1.20)

$$C_x = A_y B_z - A_z B_y$$

$$C_y = A_z B_x - A_x B_z$$

$$C_z = A_x B_y - A_y B_x$$

(1.25)

