

Halliday ♦ Resnick ♦ Walker

**FUNDAMENTALS OF PHYSICS  
SIXTH EDITION**

Selected Solutions

Chapter 3

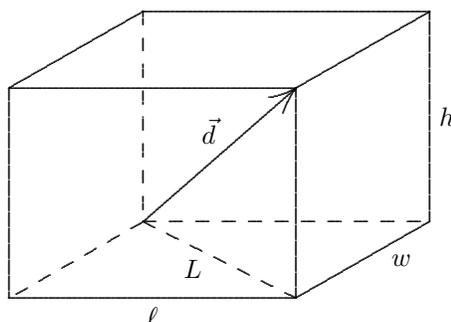
3.9

3.21

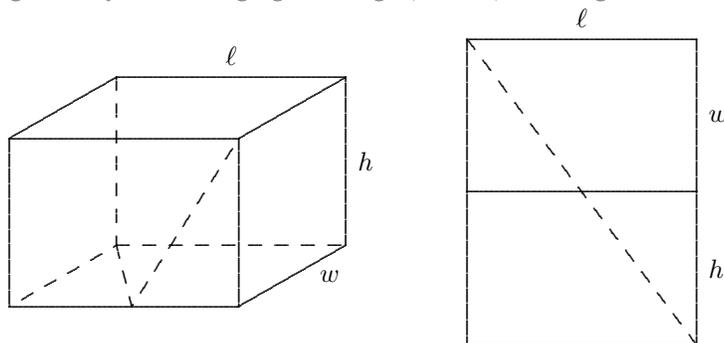
3.31

9. The length unit meter is understood throughout the calculation.

- (a) We compute the distance from one corner to the diametrically opposite corner:  $d = \sqrt{3.00^2 + 3.70^2 + 4.30^2} = 6.42$ .



- (b) The displacement vector is along the straight line from the beginning to the end point of the trip. Since a straight line is the shortest distance between two points, the length of the path cannot be less than the magnitude of the displacement.
- (c) It can be greater, however. The fly might, for example, crawl along the edges of the room. Its displacement would be the same but the path length would be  $\ell + w + h$ .
- (d) The path length is the same as the magnitude of the displacement if the fly flies along the displacement vector.
- (e) We take the  $x$  axis to be out of the page, the  $y$  axis to be to the right, and the  $z$  axis to be upward. Then the  $x$  component of the displacement is  $w = 3.70$ , the  $y$  component of the displacement is  $4.30$ , and the  $z$  component is  $3.00$ . Thus  $\vec{d} = 3.70 \hat{i} + 4.30 \hat{j} + 3.00 \hat{k}$ . An equally correct answer is gotten by interchanging the length, width, and height.



- (f) Suppose the path of the fly is as shown by the dotted lines on the upper diagram. Pretend there is a hinge where the front wall of the room joins the floor and lay the wall down as shown on the lower diagram. The shortest walking distance between the lower left back of the room and the upper right front corner is the dotted straight line shown on the diagram. Its length is

$$L_{\min} = \sqrt{(w+h)^2 + \ell^2} = \sqrt{(3.70 + 3.00)^2 + 4.30^2} = 7.96 \text{ m} .$$

21. It should be mentioned that an efficient way to work this vector addition problem is with the cosine law for general triangles (and since  $\vec{a}$ ,  $\vec{b}$  and  $\vec{r}$  form an isosceles triangle, the angles are easy to figure). However, in the interest of reinforcing the usual systematic approach to vector addition, we note that the angle  $\vec{b}$  makes with the  $+x$  axis is  $135^\circ$  and apply Eq. 3-5 and Eq. 3-6 where appropriate.

(a) The  $x$  component of  $\vec{r}$  is  $10 \cos 30^\circ + 10 \cos 135^\circ = 1.59$  m.

(b) The  $y$  component of  $\vec{r}$  is  $10 \sin 30^\circ + 10 \sin 135^\circ = 12.1$  m.

(c) The magnitude of  $\vec{r}$  is  $\sqrt{1.59^2 + 12.1^2} = 12.2$  m.

(d) The angle between  $\vec{r}$  and the  $+x$  direction is  $\tan^{-1}(12.1/1.59) = 82.5^\circ$ .

31. Since  $ab \cos \phi = a_x b_x + a_y b_y + a_z b_z$ ,

$$\cos \phi = \frac{a_x b_x + a_y b_y + a_z b_z}{ab} .$$

The magnitudes of the vectors given in the problem are

$$\begin{aligned} a = |\vec{a}| &= \sqrt{(3.0)^2 + (3.0)^2 + (3.0)^2} = 5.2 \\ b = |\vec{b}| &= \sqrt{(2.0)^2 + (1.0)^2 + (3.0)^2} = 3.7 . \end{aligned}$$

The angle between them is found from

$$\cos \phi = \frac{(3.0)(2.0) + (3.0)(1.0) + (3.0)(3.0)}{(5.2)(3.7)} = 0.926 .$$

The angle is  $\phi = 22^\circ$ .