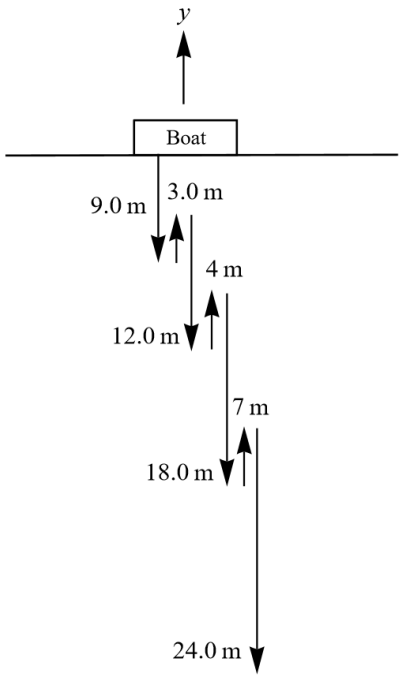
Problem 25

A scuba diver makes a slow descent into the depths of the ocean. His vertical position with respect to a boat on the surface changes several times. He makes the first stop 9.0 m from the boat but has a problem with equalizing the pressure, so he ascends 3.0 m and then continues descending for another 12.0 m to the second stop. From there, he ascends 4 m and then descends for 18.0 m, ascends again for 7 m and descends again for 24.0 m, where he makes a stop, waiting for his buddy. Assuming the positive direction up to the surface, express his net vertical displacement vector in terms of the unit vector. What is his distance to the boat?

Solution

Draw a schematic of the diver's position with respect to the boat. Let the vertical distance be y and be positive going upward. Then the unit vector in this direction is $\hat{\mathbf{y}}$.



The diver's net displacement $\mathbf{d}_{\text{net}}$ is the sum of the displacement vectors.

$$\mathbf{d}_{\text{net}} = \sum_i \mathbf{d}_i$$

$$= (-9.0\text{ m})\hat{\mathbf{y}} + (3.0\text{ m})\hat{\mathbf{y}} + (-12.0\text{ m})\hat{\mathbf{y}} + (4\text{ m})\hat{\mathbf{y}} + (-18.0\text{ m})\hat{\mathbf{y}} + (7\text{ m})\hat{\mathbf{y}} + (-24.0\text{ m})\hat{\mathbf{y}}$$

$$= (-9.0 + 3.0 - 12.0 + 4 - 18.0 + 7 - 24.0)\text{ m }\hat{\mathbf{y}}$$

$$= -49\text{ m }\hat{\mathbf{y}}$$

The diver's distance from the boat is the magnitude of this net displacement vector.

$$d_{\text{net}} = |\mathbf{d}_{\text{net}}| = \sqrt{(-49\text{ m})^2} = 49\text{ m}$$