10. We use Eq. 4-15 with $\vec{v}_1$ designating the initial velocity and $\vec{v}_2$ designating the later one.

(a) The average acceleration during the $\Delta t = 4$ s interval is

$$\vec{a}_{\text{avg}} = \frac{\left(-2\,\hat{\text{i}} - 2\,\hat{\text{j}} + 5\,\hat{\text{k}}\right) - \left(4\,\hat{\text{i}} - 22\,\hat{\text{j}} + 3\,\hat{\text{k}}\right)}{4} = -1.5\,\hat{\text{i}} + 0.5\,\hat{\text{k}}$$

in SI units (m/s^2).

(b) The magnitude of $\vec{a}_{\text{avg}}$ is $\sqrt{(-1.5)^2 + 0.5^2} = 1.6\ \text{m/s}^2$. Its angle in the xz plane (measured from the $+x$ axis) is one of these possibilities:

$$\tan^{-1}\left(\frac{0.5}{-1.5}\right) = -18^\circ \quad \text{or} \quad 162^\circ$$

where we settle on the second choice since the signs of its components imply that it is in the second quadrant.

18. We adopt the positive direction choices used in the textbook so that equations such as Eq. 4-22 are directly applicable.

(a) With the origin at the initial point (edge of table), the y coordinate of the ball is given by $y = -\frac{1}{2}gt^2$. If t is the time of flight and $y = -1.20$ m indicates the level at which the ball hits the floor, then

$$t = \sqrt{\frac{2(1.20)}{9.8}} = 0.495 \text{ s} .$$

(b) The initial (horizontal) velocity of the ball is $\vec{v} = v_0\,\hat{\text{i}}$. Since $x = 1.52$ m is the horizontal position of its impact point with the floor, we have $x = v_0 t$. Thus,

$$v_0 = \frac{x}{t} = \frac{1.52}{0.495} = 3.07 \text{ m/s} .$$

59. Since the raindrops fall vertically relative to the train, the horizontal component of the velocity of a raindrop is $v_h = 30\,\mathrm{m/s}$, the same as the speed of the train. If v_v is the vertical component of the velocity and θ is the angle between the direction of motion and the vertical, then $\tan\theta = v_h/v_v$. Thus $v_v = v_h/\tan\theta = (30\,\mathrm{m/s})/\tan 70^\circ = 10.9\,\mathrm{m/s}$. The speed of a raindrop is $v = \sqrt{v_h^2 + v_v^2} = \sqrt{(30\,\mathrm{m/s})^2 + (10.9\,\mathrm{m/s})^2} = 32\,\mathrm{m/s}$.