From the diagram we know that:

\[ y - y_0 = \frac{1}{2} g (2.0)^2 = 19.6 \text{ m} \quad \text{for the dropped apple (} v_0 = 0\text{)} \]

\[ \begin{array}{c}
\int \\
\downarrow \\
\int mg \\
\downarrow \\
v
\end{array} \]

Hence, for the thrown apple we have:

\[ 0 = 19.6 \text{ m} - v_0 (1.25 \text{ sec}) - \frac{1}{2} (4.8 \text{ m/s}^2) (1.25 \text{ s})^2 \quad t = 2.25 \text{ s} \]

\[ \frac{1}{2} (1.25 \text{ s}) (19.6 \text{ m} - v_0 - 4.8 \text{ m/s}^2 \cdot (1.25 \text{ s})^2) = 9.55 \text{ m/sec} \]

\[ \Rightarrow v_0 = -9.6 \text{ m/s} \]

(Note since you get \( t \) from reading a graph you are really only entitled to 2 sig. figs, but the grader should let you cut by 0.05)

\[ x_1 = 6.00t^2 + 10t + 2.00 \quad \Rightarrow \quad v_1 = 12.0t + 3.0 \]

\[ a_2 = -8.0 \text{ m/sec}^2 \quad v_2 = -4.0t^2 + 20 \text{ m/sec} \]

\[ \Rightarrow v_2 = -4.0t^2 + v_0 \text{ but we can take } v_0 = 20 \text{ m/sec} \]

The velocities are equal when \( v_1 = v_2 \)

\[ (12.0t + 3.0) \text{ m/sec} = (-4.0t^2 + 20 \text{ m/sec}) \]

\[ a = (4.0t^2 + 12.0t - 17) \text{ m/sec} = 0 \]

\[ \Rightarrow t = \frac{-12 \pm \sqrt{144 + 4.417}}{8.0} = \frac{1.05 \text{ sec}}{4.8 \text{ sec}} = -4.05 \]
The velocity caught at t = 1.05s and are equal to 15.6 m/s

(rounding this to 16 m/s would, strictly speaking, be the right thing to do since they told 20 m/s not 20.0 m/s, but given all the other figures I think the authors were just a bit sloppy.) The police should accept 15.6 m/s or 16 m/s.

Note: All the equations are meant to be solved for all time, not the velocities were also equal at t = 4.05 sec, as which point their velocities were -45.6 m/s (close 46 m/s)

2.74

\[
\begin{align*}
\text{h} & \quad v_0 = 0 \\
\text{a} & \quad g \downarrow \quad \text{air} \\
\text{d} & \quad a = 0 \quad \text{water}
\end{align*}
\]

a) To find d we need to know \( v_1 \), the speed when it hits the water, and \( t_1 \), the time it is in the water. To find these we need first clear at the free fall:

\[
-5.20 \text{ m} = 0 - v_1 \cdot 9.8 \text{ m/s}^2 \cdot t_1^2
\]

\[
\Rightarrow t_1 = 1.03 \text{ sec}
\]

\[
(1) t_1 = \sqrt{\frac{2h}{g}}
\]

\[
(2) v_1 = -9 \cdot t_1, \quad \text{(since } v_0 = 0) \]

\[
(3) d = v_1 \cdot t - t_1 = \sqrt{2gh} \left( 4.80 \text{ s} - 1.03 \text{ sec} \right) = 38.1 \text{ m}
\]
b) \[ \overline{V} = \frac{x-x_0}{\Delta t} = \frac{-35.1m+5.10m}{4.80s} = -9.01 \text{ m/s} \]

c) (ie 9.01 m/s downward)

d) For this problem we have:

\[ 0m = 43.3m + V_0 \cdot (4.80s) - \frac{1}{2} \cdot 9.8m/s^2 \cdot (4.80s)^2 \]

\[ V_0 = \frac{-43.3m + \frac{1}{2} \cdot 9.8m/s^2 \cdot (4.80s)^2}{4.80s} = +14.5m/s \]

e) Clearly this must be incorrect since without

the water present the ball would traverse the

distance of much faster in this case, so it

must have spent some time while at the stated

time in the same
3-27

A) Each segment is 2.0 cm long

\[ x_A = 0 + a \cos 60^\circ + 0 - a \cos 60^\circ + 0 = 0 \text{ cm} \]

\[ y_A = 0 + a \sin 60^\circ + a + a \sin 60^\circ + a = 2a + 2a \sin 60^\circ \]

\[ = 2a(1 + 0.866) \]

\[ = 7.46 \text{ cm} \quad \text{and} \quad a = 2.0 \text{ cm} \]

\[ \vec{r}_A = (0 \hat{i} + 7.46 \hat{j}) \]

\[ |\vec{r}_A| = 7.5 \text{ cm} \quad \text{along the y-axis (} \theta = 90^\circ \text{)} \]

B) \[ x_B = 0 + a \cos 60^\circ + 0 + a \cos 60^\circ + a \cos 30^\circ + a = \]

\[ = a (1 + 2 \cos 60^\circ + \sin 60^\circ) \quad (\sin 60^\circ = \cos 30^\circ) \]

\[ = 2.866a \]

\[ y_B = 0 + a \sin 60^\circ + a + a \sin 60^\circ + a \sin 30^\circ + 0 \]

\[ = a (1 + 2 \sin 60^\circ + \sin 30^\circ) \]

\[ = 3.732a \]

\[ |\vec{r}_B| = \sqrt{(2.866a)^2 + (3.732a)^2} = 8.64 \text{ cm} \]

\[ |\vec{r}_B| = 8.6 \text{ cm} \quad \tan \theta = \frac{3.732a}{2.866a} \]

\[ \theta = 48^\circ \]
a) \( \mathbf{a} \cdot (\mathbf{b} \times \mathbf{c}) = (3.0\mathbf{i} + 3.0\mathbf{j} - 2.0\mathbf{k}) \cdot (-8\mathbf{i} + 5\mathbf{j} + 6\mathbf{k}) \)

\[ = -24 + 15 - 12 \]

\[ = -21 \]

b) \( \mathbf{a} \cdot (\mathbf{b} + \mathbf{c}) = (3.0\mathbf{i} + 3.0\mathbf{j} - 2.0\mathbf{k}) \cdot (1.0\mathbf{i} - 2.0\mathbf{j} + 3.0\mathbf{k}) \)

\[ = 3.0 - 6.0 - 6.0 \]

\[ = -9.0 \]

c) \( \mathbf{a} \times (\mathbf{b} + \mathbf{c}) = (3.0\mathbf{i} + 3.0\mathbf{j} - 2.0\mathbf{k}) \times (1.0\mathbf{i} - 2.0\mathbf{j} + 3.0\mathbf{k}) \)

\[ = \begin{bmatrix} 3 \cdot 3 - (-2)(-2) \end{bmatrix} \mathbf{i} + \begin{bmatrix} (-2)(1) - (3)(3) \end{bmatrix} \mathbf{j} + \begin{bmatrix} (3)(1) - (3.0)(10) \end{bmatrix} \mathbf{k} \]

\[ = 5\mathbf{i} - 11\mathbf{j} - 9\mathbf{k} \]
\[ \begin{align*} 
X_F &= 250 \text{ m} \sin 30^\circ + 175 \text{ m} = 300 \text{ m} \\
Y_F &= 250 \text{ m} \cos 30^\circ + 0 = 216.5 \text{ m} 
\end{align*} \]

a) The displacement magnitude is:
\[ |\Delta r| = \sqrt{(300 \text{ m})^2 + (216.5 \text{ m})^2} = 370 \text{ m} \]

b) \[ \tan \theta = \frac{216.5 \text{ m}}{300 \text{ m}} \Rightarrow \theta = 35.8^\circ \quad \theta = 36^\circ \]

c) The total distance she walked is 250 m + 175 m:
\[ \text{Distance} = 425 \text{ m} \]

d) The distance walked is obviously greater than the displacement.