Problems / Chapter 2

2. Let's take left to right to be the positive direction.
Vector diagram

\[ \Delta x = (+4) + (-1) + (+6.5) + (-8.3) = \boxed{1.2 \text{ m to the right}} \]

7. Choose South to the right

a) Starting Point

Let's show them on the x-axis:

\[ x_1 = 20 \text{ km} \]
\[ x_2 = 20 + 96 = 116 \text{ km} \]
\[ x_3 = 12 \text{ km} \]
Continues

\[ \Delta x = x_3 - x_1 = 12 - 20 = -8 \text{ km} \]

or 8 km north of its position at 3 P.M.

b) \[ \Delta x = x_2 - x_0 \]
\[ \Delta x = (20 + 96) - 0 = 116 \text{ km} \]

Starting Point (which = 0)

\[ \Delta x = x_2 - x_1 = 12 - 116 = -104 \]

104 km north of its position at 4:00 P.M.

When Yani's catches the jeep, the distance traveled

\[ \Delta x_{\text{Yani}} = 186 + \Delta x_{\text{Jeep}} \]
\[ (24.4 \text{ m/s}) \Delta t = 186 + (18.6 \text{ m/s}) \Delta t \]

Solve for \( \Delta t \) \( \Rightarrow \Delta t = 32 \text{ s} \)
Choose upward direction as positive:

Each displacement = area under the velocity graph.

Thus from \( t = 0 \) to \( t = 2 \) s, \( \Delta y_1 = \)

\[
\int_0^2 v(t) \, dt = \frac{(2 \times 2)}{2} = 2 \text{ m}
\]

Now follow this idea for other time intervals:

\( \Delta y_1 = 2 \text{ m} \) \( t = 0 \) to \( t = 2 \)

\( \Delta y_2 = 12 \text{ m} \) \( t = 2 \) to \( t = 8 \)

\( \Delta y_3 = 2 \text{ m} \) \( t = 8 \) to \( t = 10 \)

\( \Delta y_4 = 20 \) \( t = 10 \) to \( t = 14 \)

\( \Delta y_5 = -2 \text{ m} \) \( t = 14 \) to \( t = 16 \)

\( \Delta y_6 = -4 \text{ m} \) \( t = 16 \) to \( t = 18 \)

\( \Delta y_7 = -2 \text{ m} \) \( t = 18 \) to \( t = 20 \)

\( \Delta y = \Delta y_1 + \cdots + \Delta y_7 = 8 \text{ m} \)
20. \[ V(m/s) \] 

\[ \begin{aligned} 4 m/s \\
2 m/s \\
0.5 m/s \\
-2 m/s \\
-4 m/s \end{aligned} \]

\[ t(s) \]

26. \( a_x = \text{Slope of the velocity graph} = \frac{\Delta V}{\Delta t} = \frac{14 - 4}{11 - 6} = \frac{10}{5} = 2 \text{ m/s}^2 \)

b) \[ V_{\text{ave},x} = \frac{V_1 + V_2}{2} = \frac{4 + 14}{2} = 9 \text{ m/s} \]

c) For this, we use \( V_{\text{ave},x} = \frac{\Delta x}{\Delta t} \). We need \( \Delta x \).

\[ \Delta x = \text{Area under } V_x \text{ curve} = ... = 19.5 \text{ m} \]

\[ V_{\text{ave},x} = \frac{19.5 \text{ m}}{20 \text{ s}} = 0.975 \text{ m/s} \]

d) At \( t = 10 \text{ s} \), \( V_1 = 12 \text{ m/s} \)

At \( t = 15 \text{ s} \), \( V_2 = 14 \text{ m/s} \)

\[ \boxed{\Delta V = 2 \text{ m/s}} \]

e) \( \Delta x = \text{Area under } V_x \text{ from } t=10 \text{ to } t=15 \text{.} \)

\[ \Delta x = \text{area} = 69 \text{ m} \]
\( 30 \) \( u_x = 0 \quad u_{f_x} = 45 \text{ m/s} \)
\( a_x = 5 \text{ m/s}^2 \quad \Delta t = ? \)

\[ u_{f_x} = u_x + a_x \Delta t \]
\[ 45 = 0 + 5 \Delta t \quad \Rightarrow \quad \Delta t = 9 \text{ s} \]

The length of the runway does not enter into the calculations. In other words, the plane is not at the end of the runway after reaching speed 45 m/s.

\[
\Delta x = u_{ix} \Delta t + \frac{1}{2} a_x \Delta t^2
\]
\[ = 0 + \frac{1}{2} (5)(9)^2 = 202.5 \text{ m} \]

Which is less than the length of the runway.
\[ v_{ix} = 24 \text{ m/s} \quad v_{fx} = 6 \text{ m/s} \quad \Delta t = 9 \]

\[ a_x = \frac{-24 + 6}{9} = -2 \text{ m/s}^2 \]

\[ \Delta x = v_{ix} \Delta t + \frac{1}{2} a_x \Delta t^2 \]

\[ \Delta x = (24)(9) + \frac{1}{2}(-2)(9)^2 \]

\[ = 135 \text{ m} \]
\[ dy = 369 \text{ m} \quad a_y = 9.8 \text{ m/s}^2 \quad v_{fy} = ? \]

\[ v_{i,y}^2 = v_{f,y}^2 + 2 a_y dy \]

\[ v_{f,y}^2 - v_{i,y}^2 = 2 a_y dy \]

\[ v_{f,y}^2 = 0 = 2(9.8)(-369) \rightarrow v_{f,y} = 85 \text{ m/s} \]

\[ v_i = 10 \text{ m/s} \]

for the boy:

\[ \begin{cases} 
    v_i = 10 \text{ m/s} \\
    a_y = 9.8 \text{ m/s}^2 \quad \text{(downward)} \\
    \Delta y = 40.8 \text{ m} \\
    v_{fy} = ? \\
\end{cases} \]

\[ v_{f,y}^2 - v_{i,y}^2 = 2 a_y \Delta y \rightarrow v_{f,y}^2 = v_{i,y}^2 + 2 a_y \Delta y = 2(-9.8)(40.8) \]

\[ v_{f,y} = -30 \text{ m/s} \]