Problem 2.1.1

A race car can be slowed with a deceleration of \(-11 \text{ m/s}^2\). (a) If it is going +55 \text{ m/s}, how many meters will it take to stop? (b) Repeat part (a) for a car going 110 \text{ m/s}.

\[ v_f^2 = v_i^2 + 2ad \]

\( v \) final = 0m/s  
\( v \) initial = 55m/s  
\( a = -11m/s^2 \)  
\( d = ? \)

\[(0 \text{ m/s})^2 = (55 \text{ m/s})^2 + 2(-11 \text{ m/s}^2)d \]

\[ 0 = (3025 \text{ m}^2/\text{s}^2) - 22 \text{ m/s}^2 * d \]

\[ (-3025 \text{ m}^2/\text{s}^2) = - 22 \text{ m/s}^2 * d \]

\[ (-3025 \text{ m}^2/\text{s}^2) / (-22 \text{ m/s}^2) = \rightarrow 137.5 \text{ m} = d \rightarrow \]

\[ d = 1.4 \times 10^2 \text{ m} \]

(b) \( v_f^2 = v_i^2 + 2ad \)

\( v \) final = 0m/s  
\( v \) initial = 110m/s  
\( a = -11m/s^2 \)  
\( d = ? \)

\[(0 \text{ m/s})^2 = (110 \text{ m/s})^2 + 2(-11 \text{ m/s}^2)d \]

\[ 0 = (12100 \text{ m}^2/\text{s}^2) - 22 \text{ m/s}^2 * d \]
(-12100 m^2/s^2) = -22 m/s^2 * d

(-12100 m^2/s^2) = d → 550 m = d → d = \textcolor{red}{5.5 \times 10^2 \text{ m}}

Prob. 2.1.2
An astronaut dropped a feather from 1.2 m above the surface of the moon. If the acceleration of gravity on the moon is 1.6 m/s^2, how long did it take to hit the surface?

d = v_0t + \frac{1}{2}at^2

d = 1.2 \text{ m}

v_0 = 0 \text{ m/s}

a = 1.6 \text{ m/s}^2

t = ?

1.2 \text{ m} = (0 \text{ m/s})t + \frac{1}{2}(1.6 \text{ m/s}^2) \cdot t^2

1.2 \text{ m} = \frac{1}{2}(1.6 \text{ m/s}^2) \cdot t^2

(1.2 \text{ m})^2 = (1.6 \text{ m/s}^2) \cdot t^2

(2.4 \text{ m}) = (1.6 \text{ m/s}^2) \cdot t^2

2.4 \text{ m} = t^2

(1.6 \text{ m/s}^2)

1.5 \text{ s}^2 = t^2

1.2247 \text{ s} = t → t = \textcolor{red}{1.2 \times 10^0 \text{ s}}
Prob. 2.1.3
Find the uniform acceleration that will cause an object's speed to change from 32. m/s to 96. m/s in an 8.0 s period.

\[ v_f = v_i + at \]

\[ v \text{ final} = 96 \text{ m/s} \]
\[ v \text{ initial} = 32 \text{ m/s} \]
\[ t = 8.0 \text{ s} \]
\[ a = ? \]

\[ 96 \text{ m/s} = 32 \text{ m/s} + a(8.0 \text{ s}) \]

\[ 96 \text{ m/s} - 32 \text{ m/s} = a(8.0 \text{ s}) \]

\[ 64 \text{ m/s} = a(8.0 \text{ s}) \]

\[ \frac{64 \text{ m/s}}{8.0 \text{ s}} = a \rightarrow a = 8.0 \times 10^0 \text{ m/s}^2 \]

Prob. 2.1.4
A rocket traveling at +155. m/s is decelerated at a rate of −31. m/s². (a) How long will it take before the instantaneous speed is 0 m/s? (b) How far will it travel during this time? (c) What will be its velocity after 8.0 s?

a) \[ v_f = v_i + at \]
\[ v \text{ initial} = 155 \text{ m/s} \]
\[ v \text{ final} = 0 \text{ m/s} \]
\[ a = -31 \text{ m/s}^2 \]
\[0 \text{ m/s} = 155 \text{ m/s} + (-31 \text{ m/s}^2) \cdot t\]

\[-155 \text{ m/s} = (-31 \text{ m/s}^2) \cdot t\]

\[155 \text{ m/s} = t\]

\[(-31 \text{ m/s}^2)\]

\[5 \text{ s} = t \rightarrow \boxed{t = 5.0 \times 10^1 \text{ s}}\]

\textbf{b) } \text{d} = \frac{v_i + v_f \cdot t}{2}

\[v \text{ initial} = 55 \text{ m/s}\]

\[v \text{ final} = 0 \text{ m/s}\]

\[t = 5.0 \text{ s}\]

\[d = \frac{(155 \text{ m/s}) + (0 \text{ m/s}) \cdot 5.0 \text{ s}}{2}\]

\[d = \frac{(155 \text{ m/s}) \cdot 5.0 \text{ s}}{2}\]
\[ d = 77.5 \text{ m/s} \times 5.0 \text{ s} \]
\[ d = 387.5 \text{ m} \]
\[ \text{d} = 3.9 \times 10^2 \text{ m} \]

\( \text{c) } v_f = v_i + at \)

\[ v \text{ initial} = 155 \text{ m/s} \]
\[ a = -31 \text{ m/s}^2 \]
\[ t = 8.0 \text{ s} \]

\[ v \text{ final} = 155 \text{ m/s} + (-31 \text{ m/s}^2)(8.0 \text{ s}) \]
\[ v \text{ final} = 155 \text{ m/s} - 248 \text{ m/s} \]
\[ v \text{ final} = -9.3 \times 10^1 \text{ m/s} \]

\text{prob. 2.1.5}

A car with a velocity of 22. m/s is accelerated uniformly at the rate of 1.6 m/s^2 for 6.8 s. What is its final velocity?

\[ v_f = v_i + at \]
\[ v \text{ initial} = 22 \text{ m/s} \]
\[ a = 1.6 \text{ m/s}^2 \]
\[ t = 6.8 \text{ s} \]
v final = 22 m/s + (1.6 m/s^2)(6.8 s)

\[ v \text{ final } = 22 \text{ m/s } + 10.88 \text{ m/s} \]

\[ v \text{ final } = 32.88 \text{ m/s} \]

Prob. 2.1.6
Determine the displacement of a plane that is uniformly accelerated from 66. m/s to 88. m/s in 12.0 s.

First solve for the acceleration with the formula \( v_f = v_i + at \)
\[ v \text{ final } = 88. \text{ m/s} \]
\[ v \text{ initial } = 66. \text{ m/s} \]
\[ t= 12.0 \text{ s} \]

\[ 88 \text{ m/s } = 66 \text{ m/s } + a(12.0 \text{ s}) \]

\[ 22 \text{ m/s} = a(12.0 \text{ s}) \]

\[ 1.8 \text{ m/s}^2 \]
Use the acceleration that was solved for in the previous section in the following formula: \( d = v_i \times t + \frac{1}{2} at^2 \)

\[
v_{\text{initial}} = 66.\text{m/s}
\]
\[
t = 12.0\ \text{s}
\]
\[
a = 1.8\ \text{m/s}^2
\]

\[
d = (66. \text{m/s})(12.0\ \text{s}) + \frac{1}{2}(1.8\ \text{m/s}^2)(12.0\ \text{s})^2
\]

\[
d = 792\ \text{m} + 129.6\ \text{m}
\]

\[
d = 921.6\ \text{m} \rightarrow \boxed{d = 9.2 \times 10^2\ \text{m}}
\]

**Prob. 2.1.7**

A car comes to rest after uniform deceleration at the rate of 9.0 m/s\(^2\) for 8.0 s. What distance does it travel during this time?

In order to solve for distance, \( v_{\text{initial}} \) needs to be solved for first by using the formula: \( v_f = v_i + at \)

\[
v_{\text{final}} = 0\ \text{m/s}
\]
\[
a = 9.0\ \text{m/s}^2
\]
\[
t = 8.0\ \text{s}
\]
0 m/s = v initial + (-9.0 m/s^2)(8.0 s)

\[ v \text{ initial} = -(-9.0 \text{ m/s}^2)(8.0 \text{ s}) \]

\[ v \text{ initial} = 72 \text{ m/s} \]

Now that I have \( v \text{ initial} \); I will use it in the formula: \( d = v_i \times t + \frac{1}{2} at^2 \)

To solve for distance

\[ d = (72 \text{ m/s})(8.0 \text{ s}) + \frac{1}{2}(-9.0 \text{ m/s}^2)(8.0 \text{ s})^2 \]

\[ d = 576 \text{ m} - (-4.5 \text{ m/s}^2)(64 \text{ s}^2) \]

\[ d = 576 \text{ m} - 288 \text{ m} \]

\[ d = 288 \text{ m} \]

\[ d = 2.9 \times 10^2 \text{ m} \]
Prob. 2.1.8

A plane travels a distance of $5.0 \times 10^2$ m while being accelerated uniformly from rest at the rate of $+5.0$ m/s$^2$. What final speed does it attain?

\[ v_f^2 = v_i^2 + 2ad \]

$v$ initial = 0 m/s
$a$ = $+5.0$ m/s$^2$
$d$ = $5.0 \times 10^2$ m

\[ v_f^2 = (0 \text{ m/s})^2 + 2(5.0 \text{ m/s}^2)(5.0 \times 10^2 \text{ m}) \]

\[ v_f^2 = (10.0 \text{ m/s}^2)(5.0 \times 10^2 \text{ m}) \]

\[ v_f^2 = 50.0 \times 10^2 \text{ m}^2/\text{s}^2 \]

$v$ final = 70.7107 m/s $\rightarrow$ \[ V \text{ final } = 7.1 \times 10^1 \text{ m/s} \]

Prob. 2.1.9

A stone falls freely from rest for 8.0 s. (a) Calculate its final velocity. (b) What distance does the stone fall during this time?

\[ a) \quad v_f = v_i + at \]

$v$ initial = 0 m/s
$a$ = $9.8$ m/s$^2$
$t$ = 8.0 s
Prob. 2.1.10
A weather balloon is floating at a constant height above the earth when it releases a pack of instruments. (a) If the pack hits the ground with a speed of -73.5 m/s, how far does the pack fall? (b) How long does the pack fall?

a) \( v_f^2 = v_i^2 + 2ad \)
v initial = 0 m/s
v final = 73.5 m/s
a = 9.8 m/s^2

\[(0 \text{ m/s})^2 = -(73.5 \text{ m/s})^2 + 2(-9.8 \text{ m/s}^2)d\]

\[5402.25 \text{ m}^2/\text{s}^2 = (-19.6 \text{ m/s}^2)d\]

\[d = -2.76 \times 10^2 \text{ m}\]

c) \[v_f = v_i + at\]
\[-73.5 \text{ m/s} = 0 \text{ m/s} + (-9.8 \text{ m/s}^2)t\]

\[-73.5 \text{ m/s} = (-9.8 \text{ m/s}^2)t\]

\[-73.5 \text{ m/s} = t\]

\[-9.8 \text{ m/s}^2\]

\[7.5 \text{ s} = t \rightarrow t = 7.50 \times 10^0 \text{ s}\]