1. The particle travels along a straight track such that the position is described by the s-t graph shown below.
   a. Calculate the velocity of this particle at t = 4 sec.
   b. Calculate the acceleration of this particle at t = 4 sec.
   c. Calculate the velocity of this particle at t = 8 sec.
   d. Calculate the acceleration of this particle at t = 8 sec.

Part a)
\[ v = \frac{ds}{dt} = 1.5t^2 \]
\[ v(t) = 1.5t^2 \]
\[ v(t=4) = 24 \text{ m/s} \]

Part b)
\[ a = \frac{dv}{dt} = 3t \]
\[ a(t) = 3t \]
\[ a(t=4) = 12 \text{ m/s}^2 \]

Part c) Since s = constant = 108 m at 8 sec, \( v = 0 \)

Part d) Since s = constant = 108 m at 8 sec, \( a = 0 \)
2. A particle is traveling along a straight path at a speed of 20 ft/s when it encounters a drag force that **decelerates** the particle as \( a = 0.05v^2 \) ft/sec\(^2\).

   a. Calculate the distance covered by the particle by the time its velocity has dropped to 5 ft/sec. Assume that \( s_0 = 0 \).

   b. Calculate the time it takes to bring the velocity down to 5 ft/sec.

\[
\begin{align*}
v_0 &= 20 \text{ ft/s} \\
a &= -0.05v^2 \quad \text{(function of velocity)}
\end{align*}
\]

**Part a)\)**

\[
\begin{align*}
a &= \frac{dv}{dt} \\
ds &= v \, dv \\
ds &= v \, \frac{dv}{a} \\
\int ds &= \int _{20} ^{5} \frac{dv}{\frac{-0.05v^2}{v}} \\
\int ds &= -20 \int _{20} ^{5} \frac{dv}{v^2} \\
S &= -20 \left\{ \ln(5) - \ln(20) \right\} \\
S &= 27.7 \text{ ft}
\end{align*}
\]

**Part b)\)**

\[
\begin{align*}
a &= \frac{dv}{dt} \\
dt &= \frac{dv}{a} \\
\int dt &= \int _{20} ^{5} \frac{dv}{\frac{-0.05v^2}{v}} \\
t &= -20 \int _{20} ^{5} \frac{dv}{v^2} = -20 \int _{20} ^{5} v^{-2} \, dv \\
t &= -20 \left\{ \frac{1}{v} \right\} _{20} ^{5} = 20 \left\{ \frac{1}{5} - \frac{1}{20} \right\} \\
t &= 20 \left\{ \frac{1}{5} - \frac{1}{20} \right\} \\
t &= 3 \text{ sec}
\end{align*}
\]
3. A car starts at rest and accelerates as a function of position $s$ as shown in the graph below.

a. Derive the equation relating the car's velocity to its position $v = f(s)$.
b. Calculate the car’s speed when $s = 30$ m.
c. Calculate the time that it takes for the car to reach $s = 30$ m.

\[
\int 0.01 \, da = \int 0 \, dv
\]

\[
\int (0.01 \Delta^2 + 6 \Delta) \, da = \int v \, dv
\]

\[
\left. \left[ \frac{0.01 \Delta^3}{3} + 6 \Delta \right] \right|_0^\infty = \left. \frac{v^2}{2} \right|_0^\infty
\]

\[
0.00333 \Delta^3 + 6 \Delta = \frac{v^2}{2} - 0
\]

\[
\frac{v^2}{2} = 0.00333 \Delta^3 + 12 \Delta
\]

\[
v = \sqrt{0.00333 \Delta^3 + 12 \Delta}
\]

**Part b)**

\[
v(s=30) = \sqrt{0.00333 (30)^3 + 12 (30)}
\]

\[
v(s=30) = 23.2 \text{ m/s}
\]