1. (1 point) Use a calculator to find the definite integral

\[ \int_{1}^{3} 2^x \, dx \]

accurate to three decimal places.

\[ f(1 \text{ Int } (2^x, x, 1, 3) \approx 8.656 \]

2. (3 points) The velocity of a particle is given in the table below. The units of time \( t \) are seconds, and the units of velocity \( v(t) \) are meters per second.

<table>
<thead>
<tr>
<th>( t )</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v(t) )</td>
<td>2</td>
<td>18</td>
<td>20</td>
</tr>
</tbody>
</table>

(a) Give a lower estimate for the change in the particle’s position, and give units.

(b) Give an upper estimate for the change in position.

a) Using smaller number on each interval:

\[ (2 \text{ m/s} / 5 \text{ s}) + (18 \text{ m/s} / 5 \text{ s}) = 100 \text{ m} \]

b) Using larger number on each interval:

\[ (18 \text{ m/s} / 5 \text{ s}) + (20 \text{ m/s} / 5 \text{ s}) = 190 \text{ m} \]
3. (6 points) Consider the function $y = 2t$ for $0 \leq t \leq 3$.

(a) (2 points) Use left hand sums with $n = 3$ to estimate the area under the graph, and draw the rectangles whose areas represent this sum.

\[ \begin{align*}
0 \cdot 1 \\
+ 2 \cdot 1 \\
+ 4 \cdot 1 \\
\hline
6 \text{ units squared}
\end{align*} \]

(b) (2 points) Use right hand sums with $n = 3$ to estimate the area under the graph, and draw the rectangles whose areas represent this sum.

\[ \begin{align*}
2 \cdot 1 \\
+ 4 \cdot 1 \\
+ 6 \cdot 1 \\
\hline
12 \text{ units squared}
\end{align*} \]

(c) (2 points) Find the exact value of the area under the curve.

\[ \text{Triangle: } \frac{1}{2} \cdot 3.6 = 9 \text{ units}^2 \]
1. (1 point) Use a calculator to find the definite integral

\[ \int_{1}^{3} 3x \, dx \]

accurate to three decimal places.

On a TI-83 it is:

\[ \text{fn Int}(3^x, x, 1, 3) \approx 21.846 \]

2. (3 points) The velocity of a particle is given in the table below. The units of time \( t \) are seconds, and the units of velocity \( v(t) \) are meters per second.

<table>
<thead>
<tr>
<th>( t )</th>
<th>0</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v(t) )</td>
<td>3</td>
<td>12</td>
<td>22</td>
</tr>
</tbody>
</table>

(a) Give a lower estimate for the change in the particle's position, and give units.

(b) Give an upper estimate for the change in position.

a) \((\text{velocity increasing})\) Using smaller number for each interval:

\[ (5 \text{ s})(3 \text{ m/s}) + (5 \text{ s})(12 \text{ m/s}) = 75 \text{ m} \]

b) Using larger number:

\[ (5 \text{ s})(12 \text{ m/s}) + (5 \text{ s})(22 \text{ m/s}) = 170 \text{ m} \]
3. (6 points) Consider the function \( y = 3t \) for \( 0 \leq t \leq 3 \).

(a) (2 points) Use left hand sums with \( n = 3 \) to estimate the area under the graph, and draw the rectangles whose areas represent this sum.

\[
\begin{align*}
0 \cdot 1 \\
+ 3 \cdot 1 \\
+ 6 \cdot 1 \\
\underline{9 \text{ units squared}}
\end{align*}
\]

(b) (2 points) Use right hand sums with \( n = 3 \) to estimate the area under the graph, and draw the rectangles whose areas represent this sum.

\[
\begin{align*}
3 \cdot 1 \\
+ 6 \cdot 1 \\
+ 9 \cdot 1 \\
\underline{18 \text{ units squared}}
\end{align*}
\]

(c) (2 points) Find the exact value of the area under the curve.

\[
\text{Triangle: } \quad \frac{1}{2} \cdot 3 \cdot 9 = 13.5 \text{ units}^2
\]