**IEEE 754 Standard Floating Point Representation**

<table>
<thead>
<tr>
<th>Sign bit</th>
<th>Exponent</th>
<th>Mantissa</th>
<th>Sign bit</th>
<th>Exponent</th>
<th>Mantissa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8-bit</td>
<td>23-bit</td>
<td>0</td>
<td>11-bit</td>
<td>52-bit</td>
</tr>
<tr>
<td>1</td>
<td>(bias 127)</td>
<td>(for normalized values, leading 1 not stored)</td>
<td>1</td>
<td>(bias 1023)</td>
<td>(for normalized values, leading 1 not stored)</td>
</tr>
</tbody>
</table>

- **Single Precision**
  - Exponent: 1-254
  - Mantissa: any value

- **Double Precision**
  - Exponent: 1-2046
  - Mantissa: any value

- **Object**
  - Represented: normalized #
  - Denormalized #
  - Infinity
  - NaN (not a #)

1) Convert the value $23.625_{10}$ to its binary representation.

2) Normalize the above value so that the most significant 1 is immediately to the left of the radix point. Include the corresponding exponent value to indicate the motion of the radix point.

3) Write the corresponding 32-bit IEEE 754 floating point representation for $23.625_{10}$.
4) Write the corresponding 64-bit IEEE 754 floating point representation for $23.625_{10}$.

5) What would be the smallest positive normalized 32-bit IEEE 754 floating point value?

6) How would you add two IEEE 754 floating point numbers?

7) How would you multiply two IEEE 754 floating point numbers?

8) Consider adding $1.011 \times 2^{40}$ and $1.01 \times 2^5$.
   a) How many places does the second number's mantissa get shifted?

   b) After we add these two numbers and store the results back into a 32-bit IEEE 754 value, what would be the result?