Problem Solving, Units and Numerical Accuracy

Problem Solution Method:

1. Inputs
   Outputs
   “Critical Path”

2. Draw simple diagram of body/bodies & forces acting on it/them.

3. Choose a reference system for the forces.

4. Identify key geometry and constraints.

5. Write the basic equations for force components.

6. Count the equations & unknowns.

7. SOLVE

8. “Feel” the validity of the answer. (Use common sense. Check units…)

Example: Two forces, A & B, act on a particle. What is the resultant?

1. **GIVEN:** Two forces on a particle and a diagram with size and orientation

2. **FIND:** The “resultant” of the two forces

**SOLUTION:**

2. Draw what you know (the diagram, any other numbers in the problem statement that could be put on the drawing….)

3. Choose a reference system. What would be the easiest? Cartesian, radian?

4. Key geometry: the location of the particle as the origin of all the forces
   Key constraints: the particle is “free” in space

5. Write equations:
   \[
   \text{size of } A^2 + \text{size of } B^2 = \text{size of resultant} \\
   \sin \alpha = \frac{\text{size of } B}{\text{size of } A + B}
   \]

6. Count: Unknowns: 2, magnitude and direction ≤ Equations: 2 \(\therefore\) can solve

7. Solve: graphically or with equations

8. “Feel”: Is the result bigger than A and bigger than B? Is it in the right direction? (like A & B)
## Units

<table>
<thead>
<tr>
<th>Units</th>
<th>Mass</th>
<th>Length</th>
<th>Time</th>
<th>Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>kg</td>
<td>m</td>
<td>s</td>
<td>( N = \frac{kg \cdot m}{s^2} )</td>
</tr>
<tr>
<td>Absolute English</td>
<td>lb</td>
<td>ft</td>
<td>s</td>
<td>( \text{Poundal} = \frac{lb \cdot \text{ft}}{s^2} )</td>
</tr>
<tr>
<td>Technical English</td>
<td>slug</td>
<td>ft</td>
<td>s</td>
<td>( \text{lb}_{\text{force}} )</td>
</tr>
<tr>
<td>Engineering English</td>
<td>lb</td>
<td>ft</td>
<td>s</td>
<td>( \text{lb}_{\text{force}} )</td>
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</table>

\[ \text{slug} = \frac{\text{lb} \cdot s^2}{\text{ft}} \]

\[ \text{lb}_{\text{force}} = \text{lb}_{\text{mass}} \times 32.17 \frac{\text{ft}}{\text{s}^2} \]

gravitational constant:

\[ g_c = 32.17 \frac{\text{ft}}{\text{s}^2} \quad \text{(English)} \]

\[ g_c = 9.81 \frac{\text{m}}{\text{s}^2} \quad \text{(SI)} \]

conversions:

\( 1 \text{ in} = 25.4 \text{ mm} \)

\( 1 \text{ lb} = 4.448 \text{ N} \)

## Numerical Accuracy

Depends on  
1) accuracy of data you are given  
2) accuracy of the calculations performed

The solution CANNOT be more accurate than the less accurate of #1 and #2 above!

**DEFINITIONS:**

- **precision** the number of significant digits
- **accuracy** the possible error

**Relative error** measures the degree of accuracy:

\[ \frac{\text{relative error}}{\text{measurement}} \times 100 = \text{degree of accuracy} (\%) \]

For engineering problems, accuracy rarely is less than 0.2%.