**Problem Solving, Units and Numerical Accuracy**

**Problem Solution Method:**

1. **Inputs**
   - Given: on graph paper
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
   - 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:
        - $\text{sizeof } A^2 + \text{sizeof } B^2 = \text{sizeof resultant}$
        - $\sin \alpha = \frac{\text{sizeof } B}{\text{sizeof } A + B}$
     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>
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</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>$Poundal = \frac{lb \cdot ft}{s^2}$</td>
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<tr>
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<td>$slug = \frac{lb \cdot s^2}{ft}$</td>
<td>ft</td>
<td>s</td>
<td>$lb_{force}$</td>
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<tr>
<td>Engineering English</td>
<td>lb</td>
<td>ft</td>
<td>s</td>
<td>$lb_{force}$</td>
</tr>
</tbody>
</table>

gravitational constant

$g_c = 32.17 \frac{ft}{s^2}$ (English)

$g_c = 9.81 \frac{m}{s^2}$ (SI)

conversions (pg. vii)

$1 \text{ in} = 25.4 \text{ mm}$

$1 \text{ lb} = 4.448 \text{ N}$

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%.