Problem Solving, Units and Numerical Accuracy

Problem Solution Method:

1. Inputs
Outputs
"Critical Path" $\Rightarrow$ GIVEN:
FIND:
SOLUTION } *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.

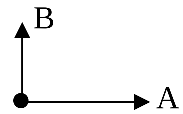
5. Write the basic equations for force components.

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:

$$\mathit{size\ of}\ A^2 + \mathit{size\ of}\ B^2 = \mathit{size\ of\ resultant}$$

$$\sin\alpha = \frac{\mathit{size\ of}\ B}{\mathit{size\ of}\ A + B}$$

6. Count: Unknowns: 2, magnitude and direction $\leq$ 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

Units	Mass	Length	Time	Force
SI	kg	m	s	$N = \frac{kg \cdot m}{s^2}$
Absolute English	lb	ft	s	$Poundal = \frac{lb \cdot ft}{s^2}$
Technical English	$slug = \frac{lb_f \cdot s^2}{ft}$	ft	s	lb_{force}
Engineering English	lb	ft	s	lb_{force}

$$lb_{force} = lb_{(mass)} \times 32.17\ {ft}/{s^2}$$

gravitational constant

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

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

conversions (pg. vii)

$1\,in = 25.4\,mm$

$1\,lb = 4.448\,N$

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:

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

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