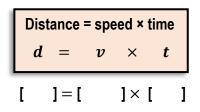
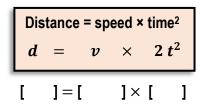
## **CONCEPT: DIMENSIONAL ANALYSIS**

- Equations work only if they are *dimensionally consistent*, meaning the units on both sides are \_\_\_\_\_\_
  - Easy way to check if equations make sense *without* calculations.

EXAMPLE: You walk a constant speed v = 5m/s for a time t of 2s. Which equation from below would be appropriate for determining the distance d in meters?



OR



## **DIMENSIONAL CONSISTENCY**

- 1) Replace variables with units
- 2) Ignore signs & numbers (2, ½, etc..)
- 3) Multiply & divide to cancel out units
- 4) Check if units on left = units on right

[ CONSISTENT | INCONSISTENT ]

[ CONSISTENT | INCONSISTENT ]

## **DETERMINING UNITS OF UNKOWN VARIABLES**

• You'll also need Dimensional Analysis to figure out the units of unknown variables.

<u>EXAMPLE</u>: Hooke's Law states that a restoring Force  $\mathbf{F}$ , measured in Newtons [N], in springs is related to the distance from equilibrium  $\mathbf{x}$  by the equation  $\mathbf{F} = -\mathbf{k}\mathbf{x}$ . What are the units of the force constant  $\mathbf{k}$ ?

## **SOLVING UNITS OF VARIABLES**

- 1) Replace variables with units
- 2) Ignore signs & numbers (2, ½, etc..)
- 3) Isolate unknown variable
- 4) Solve

<u>PRACTICE</u>: A box moving with an initial speed  $\mathbf{v}$  is accelerated horizontally. If  $\mathbf{x}$  is measured in [m],  $\mathbf{v}$  in [m/s],  $\mathbf{a}$  in [m/s²],  $\mathbf{t}$  in [s] which of the following equations is correct for solving the distance  $\mathbf{x}$ ?

- **A)**  $x = \frac{a}{t^2}$
- **B)**  $x = v + \frac{1}{2}$  at
- **C)**  $x = vt + \frac{1}{2} at^2$

PRACTICE: Newton's Law of Gravitation describes the attraction force between two masses. The equation is

 $F = G \frac{m_1 m_2}{r^2}$ , where F is in  $[\frac{kg \cdot m}{s^2}]$ ,  $m_1$  and  $m_2$  are masses in [kg], and r is the distance in [m] between them.

Determine the units of the Universal Constant G.

$$\mathbf{A)}\,\frac{kg\cdot s^2}{m^3}$$

$$\mathbf{B)}\,\frac{m^3}{kg\cdot s^2}$$

C) 
$$\frac{m}{s^2}$$

**D)** 
$$\frac{m^3}{s^2}$$