

# Introduction

# 1

## Mechanics

Rigid Body

### Statics (Part A)

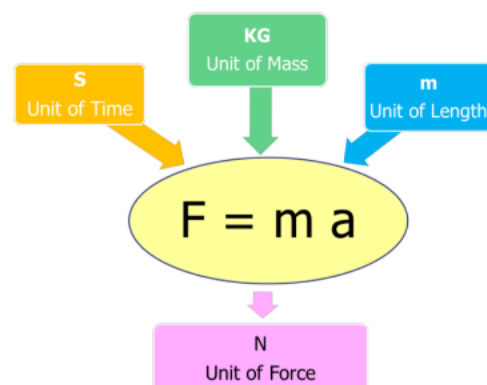
- Equilibrium of bodies at **REST**

### Dynamics (Part B)

- Accelerated **MOTION** of bodies

### 1.3. Systems of Units

Systems of Units



| Name                   | Length       | Time          | Mass                            | Force         |
|------------------------|--------------|---------------|---------------------------------|---------------|
| <b>SI</b>              | meter<br>(m) | second<br>(s) | kilogram<br>(kg)                | newton<br>(N) |
| <b>US</b><br>Customary | foot<br>(ft) | second<br>(s) | slug<br>(lb s <sup>2</sup> /ft) | pound<br>(lb) |

## Unit Conversions

**TABLE 1.3 U.S. Customary Units and Their SI Equivalents**

| Quantity           | U.S. Customary Unit      | SI Equivalent            |
|--------------------|--------------------------|--------------------------|
| Acceleration       | ft/s <sup>2</sup>        | 0.3048 m/s <sup>2</sup>  |
|                    | in./s <sup>2</sup>       | 0.0254 m/s <sup>2</sup>  |
| Area               | ft <sup>2</sup>          | 0.0929 m <sup>2</sup>    |
|                    | in <sup>2</sup>          | 645.2 mm <sup>2</sup>    |
| Energy             | ft · lb                  | 1.356 J                  |
| Force              | kip                      | 4.448 kN                 |
|                    | lb                       | 4.448 N                  |
| Impulse            | oz                       | 0.2780 N                 |
|                    | lb · s                   | 4.448 N · s              |
| Length             | ft                       | 0.3048 m                 |
|                    | in.                      | 25.40 mm                 |
|                    | mi                       | 1.609 km                 |
| Mass               | oz mass                  | 28.35 g                  |
|                    | lb mass                  | 0.4536 kg                |
|                    | slug                     | 14.59 kg                 |
|                    | ton                      | 907.2 kg                 |
| Moment of a force  | lb · ft                  | 1.356 N · m              |
|                    | lb · in.                 | 0.1130 N · m             |
| Moment of inertia  | Of an area               | in <sup>4</sup>          |
|                    | Of a mass                | lb · ft · s <sup>2</sup> |
| Momentum           | lb · s                   | 4.448 kg · m/s           |
| Power              | ft · lb/s                | 1.356 W                  |
|                    | hp                       | 745.7 W                  |
| Pressure or stress | lb/ft <sup>2</sup>       | 47.88 Pa                 |
|                    | lb/in <sup>2</sup> (psi) | 6.895 kPa                |
| Velocity           | ft/s                     | 0.3048 m/s               |
|                    | in./s                    | 0.0254 m/s               |
|                    | mi/h (mph)               | 0.4470 m/s               |
|                    | mi/h (mph)               | 1.609 km/h               |
|                    | ft <sup>3</sup>          | 0.02832 m <sup>3</sup>   |
| Volume             | in <sup>3</sup>          | 16.39 cm <sup>3</sup>    |
|                    | Liquids                  | gal                      |
|                    | qt                       |                          |
| Work               | ft · lb                  | 1.356 J                  |

## Prefixes for SI units

|                    | Exponential form | Prefix | SI symbol |
|--------------------|------------------|--------|-----------|
| <b>Multiple</b>    |                  |        |           |
| 1,000,000,000      | $10^9$           | giga   | G         |
| 1,000,000          | $10^6$           | mega   | M         |
| 1,000              | $10^3$           | kilo   | k         |
| <b>Submultiple</b> |                  |        |           |
| 0.001              | $10^{-3}$        | milli  | m         |
| 0.000001           | $10^{-6}$        | micro  | $\mu$     |
| 0.00000001         | $10^{-9}$        | nano   | n         |

EX  $10 \text{ MPa} = 10 \times 10^6 \text{ Pa}$

$1000 \text{ kN} = 1000 \times 10^3 \text{ N}$

#  $1 \text{ N} = \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$

#  $g = 9.8 \text{ m/s}^2$   
 $g = 32.2 \text{ ft/s}^2$  } acceleration of gravity

### Problem 1:

Imagine that you are driving your car in Canada. As you're driving along, you notice that the speed limit signs says **120 km/hr**. Unfortunately, your speedometer only reads in **mi/hour**. Figure out how fast you're allowed to go on your speedometer: Given **1 km = 0.6214 mi**



$$120 \text{ km/hr} = \frac{120 \times 0.6214 \text{ mi}}{\text{hr}}$$

$$= 74.6 \text{ mi/hr}$$

### Problem 2:

A rock has a density of  $171 \text{ lb/ft}^3$ . Convert your rock's density to  $\text{g/cm}^3$ .

$$\frac{171 \text{ lb}}{1 \text{ ft}^3} = \frac{\text{g}}{\text{cm}^3}$$

pounds to grams:  
 $1 \text{ lb} = 453.3924 \text{ g}$   
 feet to cm:  
 $1 \text{ foot} = 30.48 \text{ cm}$

$$171 \frac{\text{lb}}{\text{ft}^3} = \frac{171 \times 453.3924 \text{ g}}{(30.48)^3 \text{ cm}^3}$$

$$= 2.74 \frac{\text{g}}{\text{cm}^3}$$