

Section 2.2: Difference Between Weight and Mass

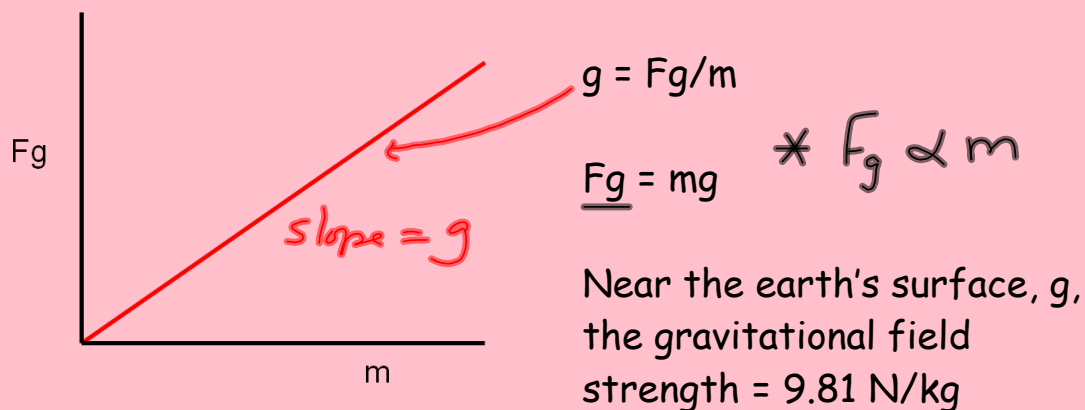
http://www.youtube.com/watch?v=grWG_U4sgS8

Mass

- the quantity of matter (or "stuff") in an object.
- measured using a triple beam balance
- Does not vary with position. Amount is constant
- measured in kilograms

Weight

- is the force of gravity pulling down on an object. For us, weight is caused by the planet earth "pulling down" on us.
- measured using a spring (or weight) scale.
- Varies with position and the force of gravity. E.g. Your weight on the moon would be less than on Earth.
- measured in Newtons, in the metric system (not pounds)



$$F_g = mg$$

where F_g is the weight of the object in Newtons
 m is the mass of the object in kg
 g is the gravitational field strength in N/kg or m/s^2
 On earth, it is 9.8 N/kg or 9.8 m/s^2

g - gravitational field strength = 9.81 $\frac{N}{kg}$
 a_g - acceleration due to gravity = -9.8 $\frac{m}{s^2}$



A Spring Scale

- used to measure downward force
- weight



A Balance

- used to compare one mass to another known mass

Examples:

- 1 What is the weight of a 950.0 kg car? (Same Question: What is the force of gravity acting on the car?)

$$\begin{aligned} m &= 950.0 \text{ kg} & F_g &= mg \\ g &= 9.8 \text{ N/kg or } 9.8 \text{ m/s}^2 & F_g &= (950.0 \text{ kg})(9.8 \text{ m/s}^2) \\ & & F_g &= 9.3 \times 10^3 \text{ N} \end{aligned}$$

- 2 A spring balance determines that an unknown mass has a weight of 24.5 N. Find the mass.

$$\begin{aligned} F &= 24.5 \text{ N} & F_g &= mg \\ g &= 9.8 \text{ N/kg} & F_g &= m \\ m &= ? & \frac{F_g}{g} & \\ & & \frac{24.5 \text{ N}}{9.8 \text{ N/kg}} &= m \\ & & 2.5 \text{ kg} &= m \end{aligned}$$

- 3 A 7.50 kg object is placed on a spring scale. If the spring scale reads 78.4 N, what is the acceleration of gravity at that location?

$$\begin{aligned} F &= 78.4 \text{ N} & F_g &= mg \\ g &= a = ? & F_g &= g \\ m &= 7.50 \text{ kg} & \frac{F_g}{m} & \\ & & \frac{78.4 \text{ N}}{7.50 \text{ kg}} &= g \\ & & 10.5 \text{ N/kg} &= g \\ \text{Therefore,} & & 10.5 \text{ m/s}^2 &= a \end{aligned}$$

- 4 A car has a mass of 1200 kg. How much would the car weigh on the moon where the acceleration due to gravity is approximately 1/6 that of Earth's.

$$\begin{aligned} m &= 1200 \text{ kg} \\ g &= 9.8 \text{ N/kg on earth} \\ \text{therefore } g &\text{ on the moon is} \\ (1/6)(9.8 \text{ m/s}^2) &= 1.63 \text{ m/s}^2 \end{aligned}$$

$$\begin{aligned} F_g &= mg \\ F_g &= (1200 \text{ kg})(1.63 \text{ m/s}^2) \\ F_g &= 11\,760 \text{ N} \\ F_g &= 12\,000 \text{ N} \end{aligned}$$

- 5 An astronaut has a weight of 630 N on Saturn where gravity has a value of 10.5 N/kg. What would the astronaut's mass be on earth where gravity has a value of 9.8 N/kg?

$$\begin{aligned} F_g &= 630 \text{ N} \\ g &= 10.5 \text{ N/kg} \\ m &= ? \end{aligned}$$

$$\begin{aligned} F_g &= mg \\ \frac{F_g}{g} &= m \\ \frac{630 \text{ N}}{10.5 \text{ N/kg}} &= m \end{aligned}$$

$$6.0 \times 10^1 \text{ kg} = m \text{ on Saturn}$$

On Earth the mass is also $6.0 \times 10^1 \text{ kg}$

- 6 Mindy has a weight of 539 Newtons on Earth, while on the planet Ork she has a weight of 506 Newtons.
(a) What is the value of gravity on Ork?

$$\begin{aligned} \text{Earth} \\ F_g &= 539 \text{ N} \\ g &= 9.8 \text{ N/kg} \\ m &= ? \end{aligned}$$

$$\begin{aligned} \text{Saturn} \\ F_g &= 506 \text{ N} \\ g &= ? \\ m &= ? \end{aligned}$$



$$\begin{aligned} m_E &= m_S \\ \frac{F_g}{g} &= \frac{F_g}{g} \\ \frac{539 \text{ N}}{9.8 \text{ N/kg}} &= \frac{506 \text{ N}}{g} \end{aligned}$$

$$g = 9.2 \text{ N/kg}$$

$$\begin{aligned} \textcircled{1} m &= \frac{F_g}{g} \\ &= \frac{539 \text{ N}}{9.8 \text{ N/kg}} \\ &= 55 \text{ kg} \end{aligned}$$

$$\begin{aligned} \textcircled{2} g &= \frac{F_g}{m} \\ &= \frac{506 \text{ N}}{55 \text{ kg}} \\ &= 9.2 \text{ N/kg} \end{aligned}$$

- (b) Did Mindy lose weight or mass when she travelled from Earth to Ork? EXPLAIN.

Mindy lost weight not mass. Her mass did not change but her weight did because the gravitational field strength on Ork is less than that on Earth.