

Law of Universal Gravitation

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- $F = Gm_1m_2/r^2$ (N)
- $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$
- m_1 and m_2 are positive so F is positive
- By Newton's Third Law each mass experiences the same Force of Universal Gravitation (N).

Example

- What is the Force of Universal Gravitation between the earth and the moon?
- Mass of earth = 5.98×10^{24} kg
- Mass of moon = 7.35×10^{22} kg
- Mean distance between earth-moon = 3.84×10^8 m
- $F = (6.67 \times 10^{-11})(5.98 \times 10^{24})(7.35 \times 10^{22}) / (3.84 \times 10^8)^2 = 2.0 \times 10^{20}$ N

Example

- What is the Force of Universal Gravitation between a man and a woman near each other?
- Man mass = 80 kg
- Woman mass = 50 kg
- $F = (6.67 \times 10^{-11})(80)(50)/(0.3)^2$
- $F = 2.96 \times 10^{-6} \text{ N}$

Calculate g knowing mass and radius

- Weight = $F_g = mg = F(\text{gravity}) = Gm_1m_2/r^2$
- But we can cancel m (mass of object) from both sides.
- $g = Gm_2/r^2$
- On earth $m = 5.98 \times 10^{24}$ kg
- On earth $r = 6.37 \times 10^6$ m
- $G = (6.67 \times 10^{-11})(5.98 \times 10^{24})/(6.37 \times 10^6)^2$

Group Activity

- Calculate g for each of the following four bodies given mass and radius.
- 1. moon $m = 7.35 \times 10^{22}$; $r = 1.74 \times 10^6$
- 2. Mars $m = 6.42 \times 10^{23}$; $r = 3.397 \times 10^6$
- 3. Venus $m = 4.87 \times 10^{24}$; $r = 6.051 \times 10^6$
- 4. Jupiter $m = 1.90 \times 10^{27}$; $r = 7.15 \times 10^7$