Physics A - PHY 2048C

Gravitation

11/13/2019

My Office Hours:

Thursday 2:00 - 3:00 PM

212 Keen Building

Warm-up Questions

1. Did you read Chapter 13 on Newton's Theory of Gravity?
2. Consider a binary star system. The mass of star 2 is twice the mass of star 1. Compared to $\vec{F}_{1 \text{ on } 2}$, the magnitude of the force $\vec{F}_{2 \text{ on } 1}$ is ...
3. A space station astronaut is working outside the station as it orbits the Earth. If he drops a hammer, will it fall to Earth? Explain.

Outline

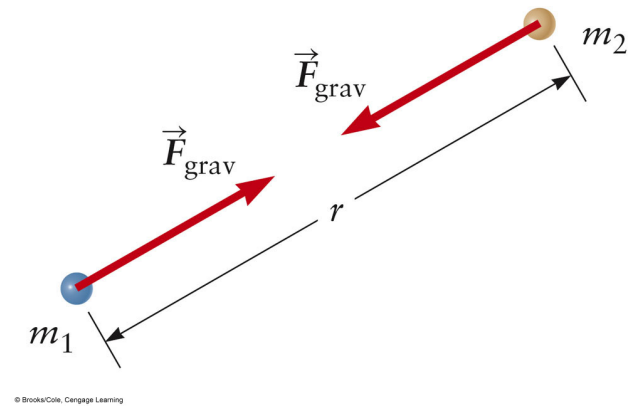
Newton's Law of Gravitation

There is a gravitational attraction between any two objects. If the objects are point masses m_1 and m_2, separated by a distance r the magnitude of the force is:

$$F_{\text{grav}} = \frac{G\, m_1\, m_2}{r^2}$$

1. The gravitational force is always attractive.
2. The magnitude of the gravitational force exerted by mass 1 on mass 2 is equal in magnitude to the force exerted by mass 2 on mass 1.
3. Universal Gravitational Constant:

$$G = 6.67 \times 10^{-11}\ \text{N}\,\text{m}^2/\text{kg}^2$$



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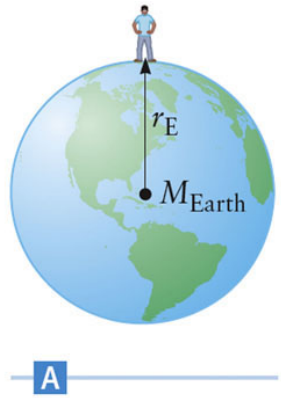
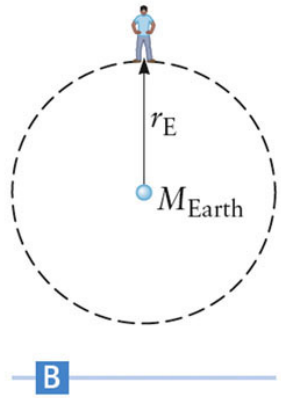


1. The gravitational force is always attractive.
2. The two forces form an action-reaction pair.
3. We can now calculate the value of g:

$$m_{\text{person}}\, g = \frac{G\, m_{\text{person}}\, m_{\text{Earth}}}{r^2_{\text{Earth}}}$$

$$g = \frac{G\, m_{\text{Earth}}}{r^2_{\text{Earth}}} \approx 9.81\ \text{m/s}^2$$



Gravitation and the Moon's Orbit

The Moon follows an approximately circular orbit around the Earth:

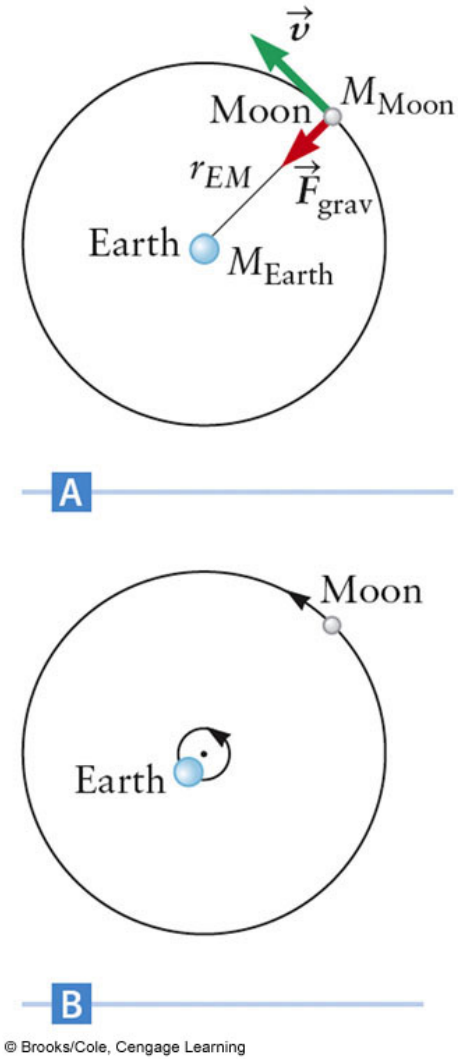
- Since the Moon travels in a circle, it experiences a centripetal force.
- This force is provided by gravity:

$$F_{\text{grav}} = \frac{G M_{\text{Earth}} M_{\text{Moon}}}{r_{\text{ME}}^2}$$

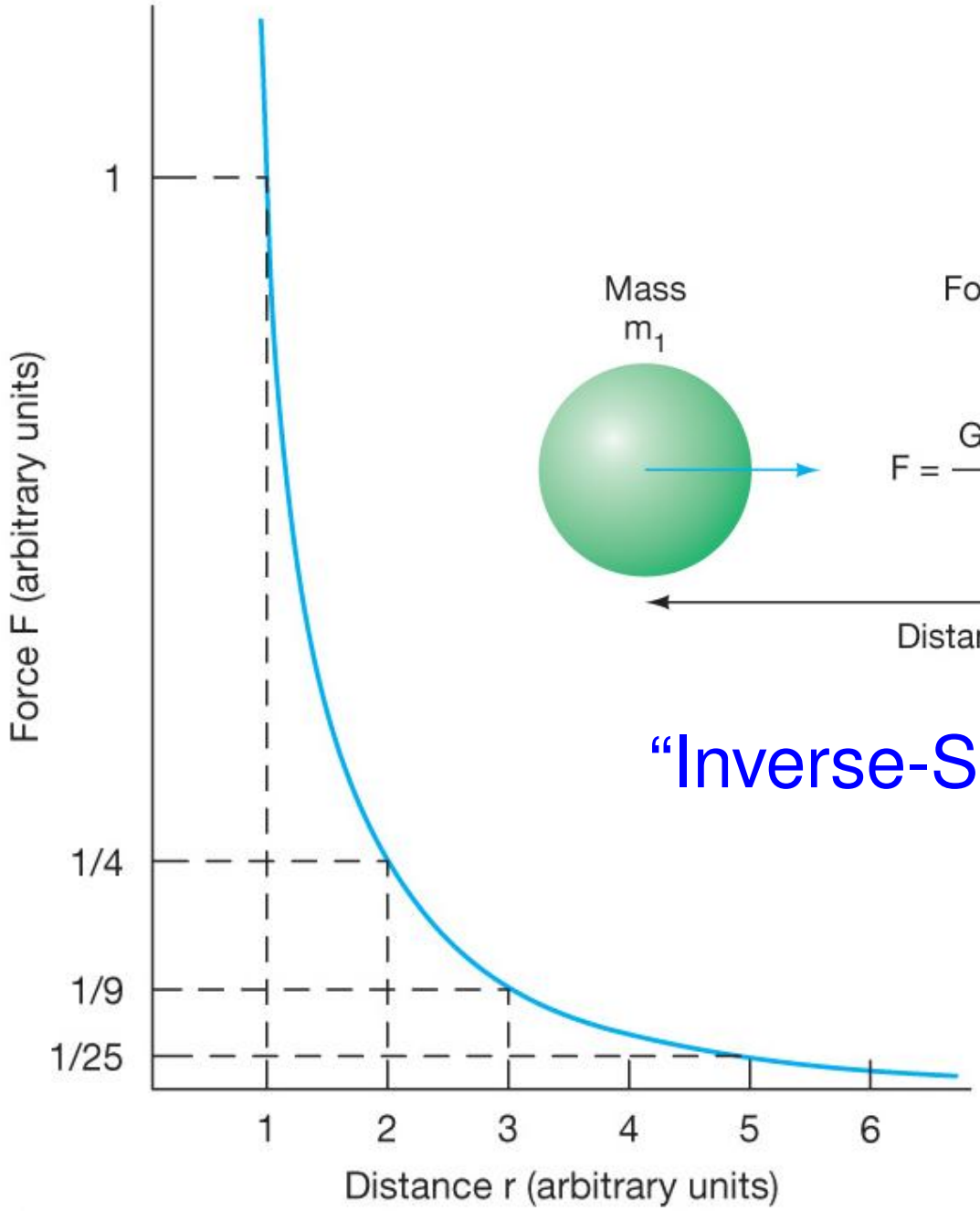
$$= 2.0 \times 10^{20}\ \text{N}$$

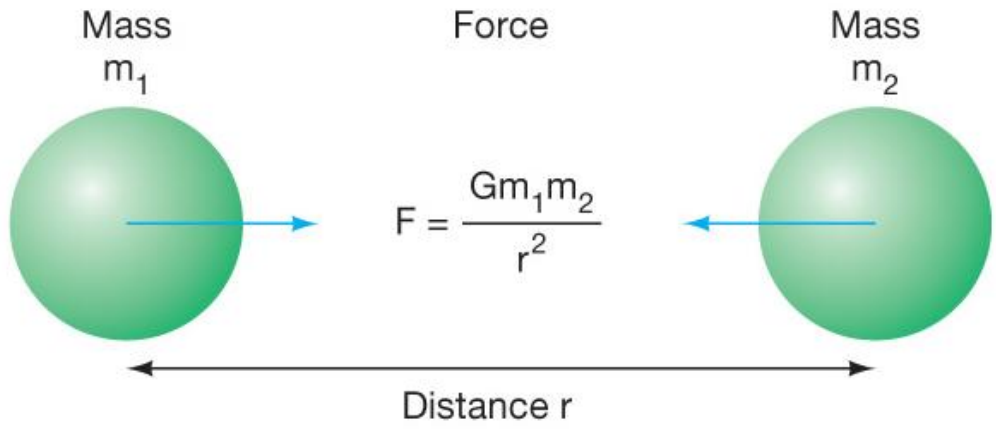
- The force required to make the Moon move in a circle:

$$F = \frac{M_{\text{Moon}} v^2}{r_{\text{EM}}} \approx 2.0 \times 10^{20}\ \text{N}$$



Gravity





"Inverse-Square Law"

Law of Gravity

Every particle of matter in the universe attracts every other particle with a force that is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them.