

Gravitation

①

Gravity is a force that exists between two or more objects that have mass.

- compared to other fundamental forces gravity is weak
- depends on mass and separation
- attractive force

$$F_g = \frac{G \cdot m_1 \cdot m_2}{r^2}$$

$$G = 6.67 \times 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$$

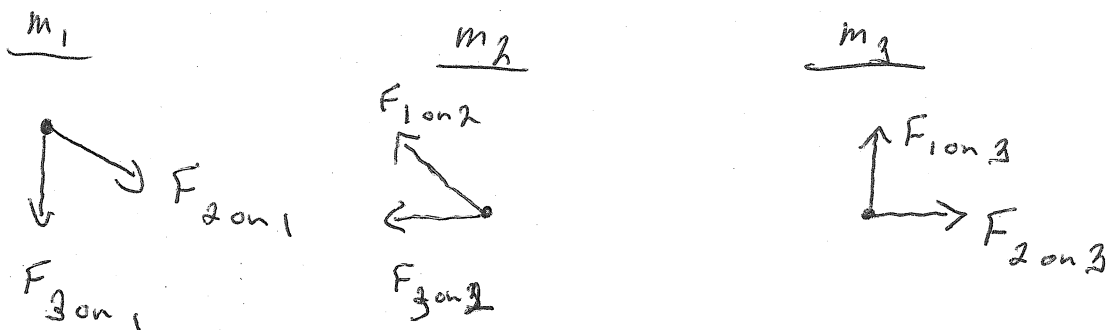
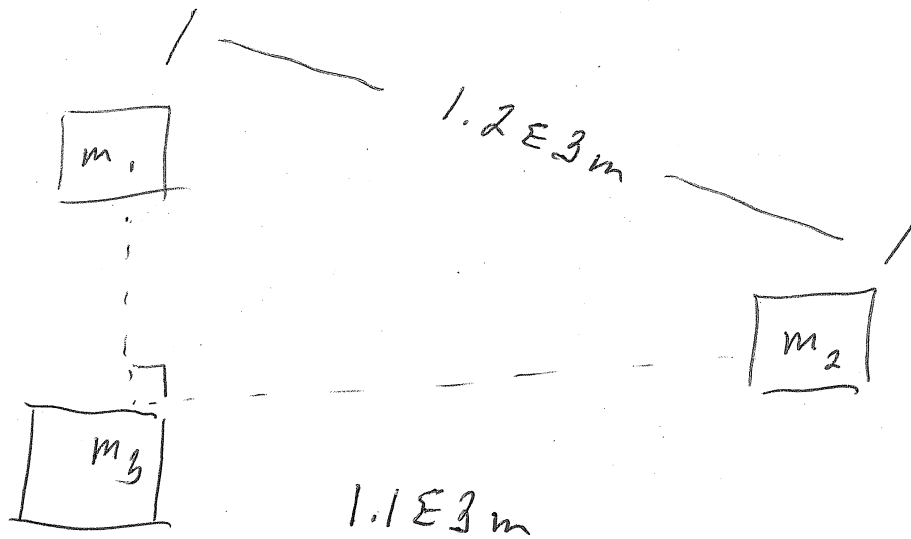
m_1 = mass of object 1 (kg)

m_2 = mass of object 2 (kg)

r = separation of object centers of mass (m)

Net Gravitational Force

- the net force acting on an object due to gravity alone.
- Any system with multiple masses will have a net gravitational force on any given part of the system.



Notice that in our case each part of the system has a net gravitational force that is not zero.

The gravitational force law introduced applies to point objects.

* For a uniform sphere the point where all gravity can be said to act is the center.

4

Gravitational Potential Energy

$$E_g = G \frac{mM}{r}$$

For large objects separated by large distances it is ~~easy~~ convenient to let $E_g = 0$ at ∞ just like it is convenient to let $E_g = 0$ at the Earth's surface for terrestrial problems.

Escaping the Earth

For an object to escape from the Earth it must be traveling with enough kinetic energy at the surface to transfer to all potential at ∞ .

5

$$|E_k| = |E_g|$$

$$\frac{1}{2} m v^2 = \frac{G M M_E}{r}$$

Since $E_g = 0$ @ ∞

$E_g = -$ large # at
the surface

$$v = \sqrt{\frac{2 G M_E}{r_E}}$$

↑
Escape
Velocity

The assumption above means that the object would be at rest when it is at an infinite distance from the Earth.