

▪ Newton's Law of Gravitation

A particle of mass  $3m$  is located  $1.00$  m from a particle of mass  $m$ .

- a) Where should you put a third mass  $M$  so that the net gravitational force on  $M$  due to the two masses is exactly zero?
- b) Is the equilibrium of  $M$  at this point stable or unstable
  - i. for points along the line connecting  $m$  and  $3m$ , and
  - ii. for points along the line passing through  $M$  and perpendicular to the line connecting  $m$  and  $3m$ ?

▪ Aura Mission

On July 15, 2004, NASA launched the Aura spacecraft to study the earth's climate and atmosphere. This satellite was injected into an orbit  $705$  km above the earth's surface. Assume a circular orbit.

- a) How many hours does it take this satellite to make one orbit?
- b) How fast (in km/s) is the Aura spacecraft moving?

▪ Hot Jupiter

In 2004 astronomers reported the discovery of a large Jupiter-sized planet orbiting very close to the star HD 179949 (hence the term "hot Jupiter"). The orbit was just  $1/9$  the distance of Mercury from our sun, and it takes the planet only  $3.09$  days to make one orbit (assumed to be circular).

- a) What is the mass of the star? Express your answer in kilograms and as a multiple of our sun's mass.
- b) How fast (in km/s) is this planet moving?

▪ Comet Tempel

On July 4, 2005, the NASA spacecraft Deep Impact fired a projectile onto the surface of Comet Tempel 1. This comet is about  $9.0$  km across. Observations of surface debris released by the impact showed that dust with a speed as low as  $1.0$  m/s was able to escape the comet.

- a) Assuming a spherical shape, what is the mass of this comet? (Hint: escape speed  $v = \sqrt{\frac{2GM}{R}}$ .)
- b) How far from the comet's center will this debris be when it has lost
  - i. 90.0% of its initial kinetic energy at the surface and
  - ii. all of its kinetic energy at the surface?

▪ Oceans on Mars

Scientists have found evidence that Mars may once have had an ocean  $0.500$  km deep. The acceleration due to gravity on Mars is  $3.71$  m/s<sup>2</sup>.

- a) What would be the gauge pressure at the bottom of such an ocean, assuming it was freshwater?
- b) To what depth would you need to go in the earth's ocean to experience the same gauge pressure?