PHYSICS 12

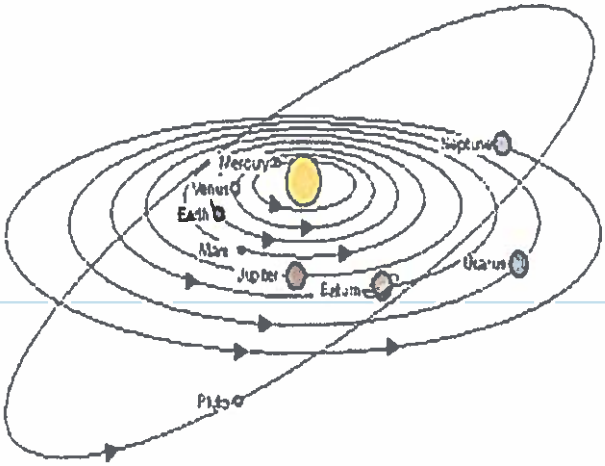
ORBITS

The object is specifically stated to be in orbit or it is located in space.

To find force, Newton's Law of Universal Gravitation must be used:

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

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



$$F_g = F_c$$

- Be careful not to substitute object's altitude = surface-to-surface distance but always center-to-center

Example: Find the speed of Apollo 13 when it is in orbit about the Moon at an altitude of 3000km.

1. a) Find the altitude of a satellite orbiting the Earth at 5000 m/s. Mass of the Earth is 5.98×10^{24}kg.

b) Find the period of the probe.

POTENTIAL ENERGY ASSOCIATED WITH GRAVITY

(for objects high above the Earth's surface)

GPE = gravitational potential energy

- This energy is found by evaluating work required to move an object from Earth's surface to infinity. This work is done by applied force that counters gravity.

$$GPE = \frac{-G\,m\,M}{r}$$

- GPE = 0 in infinity as objects separated by infinitely large radius do not interact.

Recall: Total energy of an object is given by the sum of the potential and kinetic energy of the object.

- For an object to escape Earth, the total energy has to be zero.
- Total energy of an orbiting satellite is always negative as the satellite is not free to move away.

Derive the formula for escape velocity:

Escape Velocity

2. Read textbook p. 144-145 Chapter 5.5

3. a) What is the speed a satellite needs to maintain an orbit with a fixed radius?

b) How does the magnitude of this speed depend on the mass of the satellite?

4. What is a geosynchronous satellite?

5. How is time needed for one revolution about the orbit related to the speed of a satellite?

6. Calculate the magnitude of escape velocity of the Earth.

7. If you wanted to calculate escape speed from another planet, what variables would change in the formula?