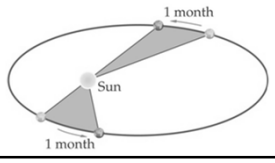
Kepler's Three Laws of Planetary Motion

- 1st Law
  –
- 2nd Law
  –



1

Kepler's Three Laws of Planetary Motion

- 3rd Law
  – The square of the period of any planet is proportional to the cube of the planet's mean distance from the sun

Can be used for any object revolving around another.

T = period of the satellite **in seconds**

G = Gravitational Constant (6.67×10^{-11})

M = Mass of the object that is being orbited

r = distance between the center of the planet and the center of the sun

2

Kepler's Three Laws of Planetary Motion

- 3rd Law
  - For any objects orbiting the same planet or star:

Earth's Period around the sun = 365.25 days

Average distance from the sun to the Earth = 1.5×10^{11} m
or 1 AU

3

Kepler's Three Laws of Planetary Motion

- 3rd Law (Example)
  - If it takes 686.95 days for Mars to revolve around the sun, what is its mean distance from the sun?

4

Newton's Universal Law of Gravity

- Any two objects of mass, m_1 and m_2 are accelerated towards each other by a force due to gravity.

$G = 6.67 \times 10^{-11}\ N \cdot m^2 / kg^2$
$M_E = 5.98 \times 10^{24}\ kg$
$R_E = 6.38 \times 10^{6}\ m$

5

Newton's Universal Law of Gravity

- For any object of mass, m, that is a certain distance from the surface of the Earth.

$G = 6.67 \times 10^{-11}\ N \cdot m^2 / kg^2$
$M_E = 5.98 \times 10^{24}\ kg$
$R_E = 6.38 \times 10^{6}\ m$

6

Gravitational Field

- The acceleration felt on a mass due to a gravitational force
- In general, the acceleration due to gravity is:
-

where r is the distance from the center of the earth

- For any distance above the earth, $r = R_E + h$

7

Gravitational Field

- How far above the surface of the earth must you be to have an acceleration due to gravity that is 85% of the gravity at the surface?

8