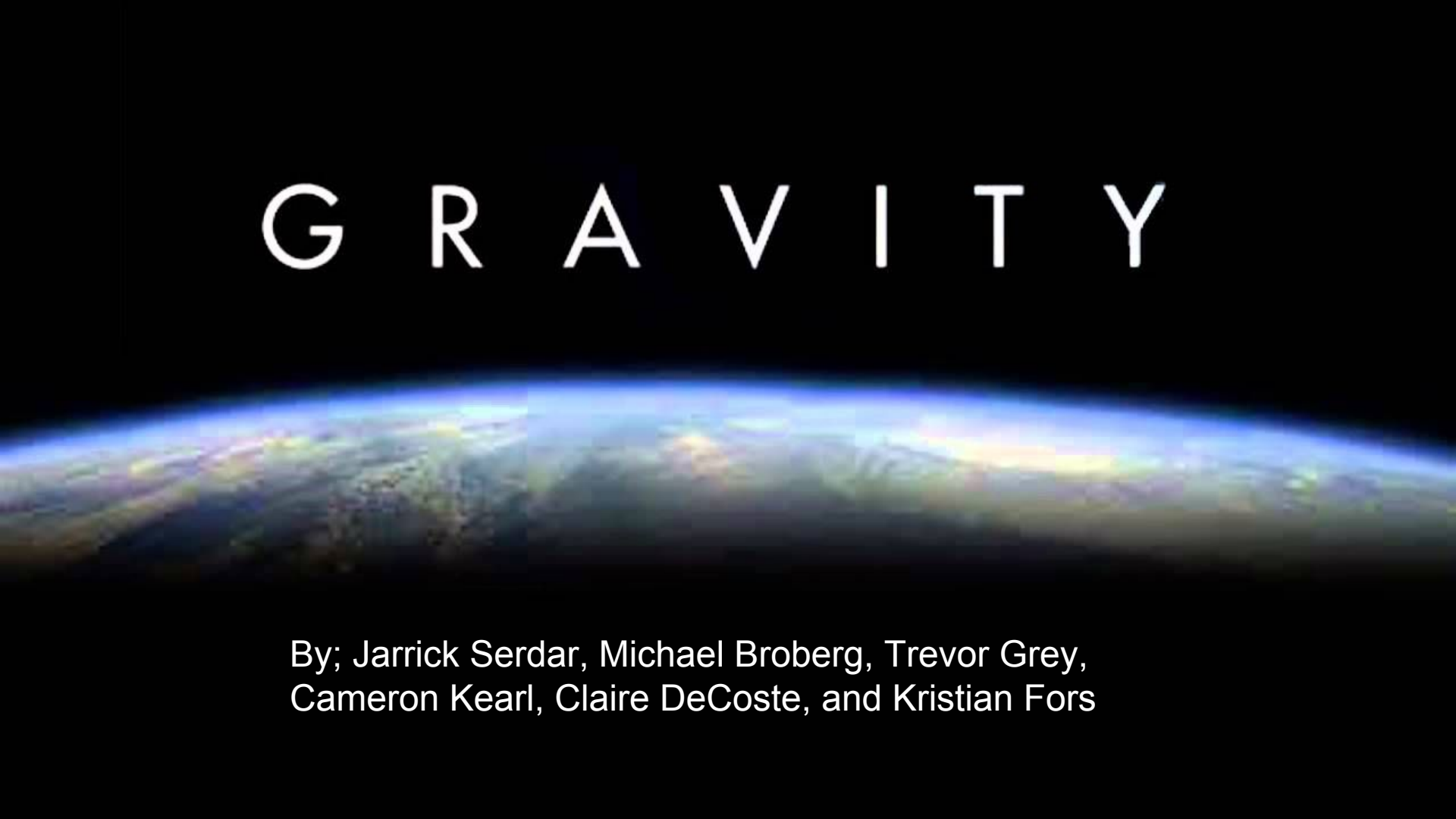


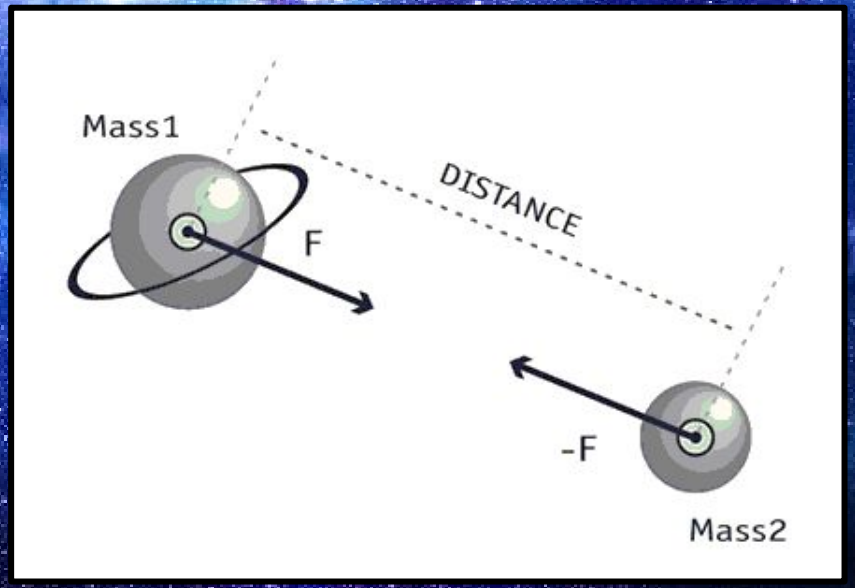
By; Jarrick Serdar, Michael Broberg, Trevor Grey,
Cameron Kearl, Claire DeCoste, and Kristian Fors

What is gravity?

- Gravity is defined as the force of attraction by which terrestrial bodies tend to fall toward the center of the earth.
- Means by which all things with mass are attracted to each other, including planets, stars, and galaxies.
- $F_g = \frac{G m_1 m_2}{r^2}$
- G = 6.67×10^-11 Nm2/kg2
- The Gravitational constant is always the same no matter where you are in the Universe.

The force of gravity between two objects depends on 3 quantities:

1. Distance between the two objects: r
2. How big the first object is: m_1
3. How big the second object is: m_2



Gravitational Potential Energy

- $PE_g = \frac{-Gm_1m_2}{r}$
- WHY it's negative?
  - Because a negative amount of work is done to bring an object closer to the Earth.
- The gravitational potential is the energy that an object has, based on where it is in a gravitational field
- The gravitational acceleration on the surface of the earth is 9.8 m/s^2

Orbital Velocity

- Objects that already have velocity come into the gravity field of an object begin to fall into their orbit
- ex.) When a satellite is put into space, it maintains a current speed while it travels in earths orbit, just as the moon does
- The equation for Orbital Velocity relies on the mass of the object, the gravitational pull, and the radius of the planet

$$V_{orbit} = \sqrt{\frac{GM}{R}}$$

Escape Velocity

- Escape Velocity is the lowest velocity that a body must have in order to escape the gravitational attraction of a particular planet or other object.
- ex.)In order for NASA to put satellites into space, they must first find the escape velocity of the satellite so they can overcome earth's gravity
- The equation of escape velocity depends on the gravitational pull of the planet, the mass of the planet and the radius of the planet
- $V_{esc} = \sqrt{(2GM/R)}$

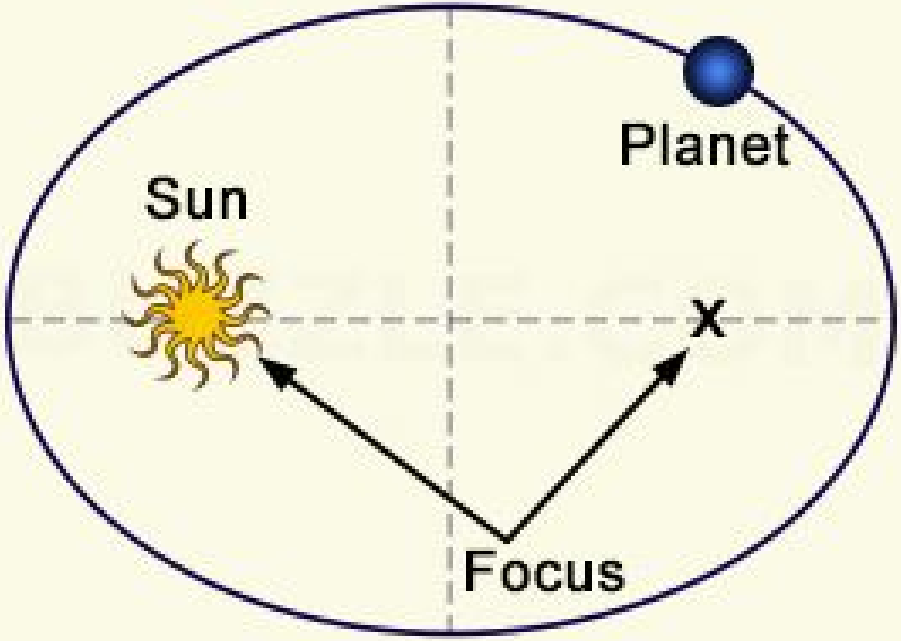
Kepler's 3 Laws of Planetary Motion

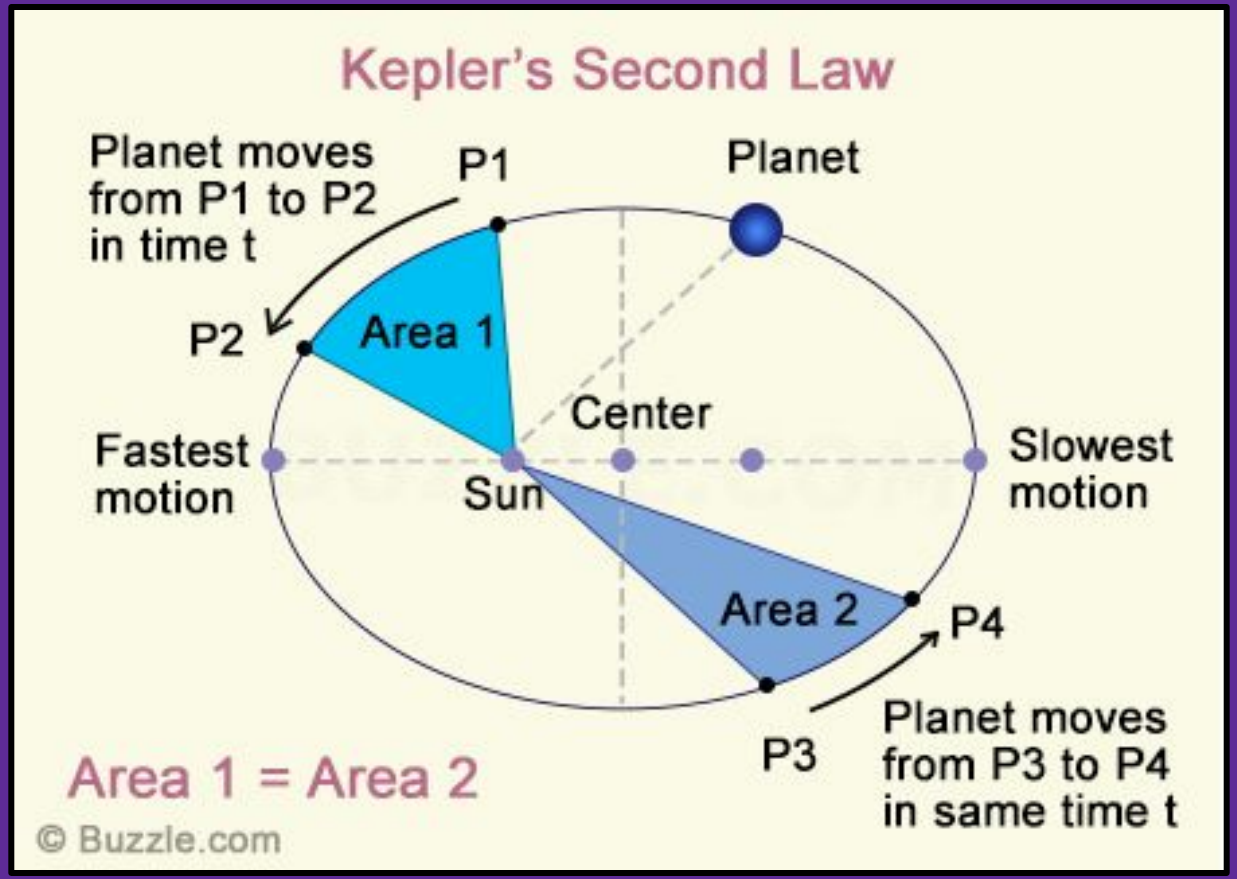
1. The orbit of a planet is an ellipse with the sun at one of the two focus points.
2. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time.
3. The square of the orbital period of a planet is proportional to the cube of its average distance from the Sun.

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

r = the average distance from the Sun

Kepler's First Law




Kepler's Second Law
Planet moves from P1 to P2 in time t
P1
Planet
P2
Area 1
Center
Fastest motion
Sun
Slowest motion
Area 2
P4
P3
Planet moves from P3 to P4 in same time t
Area 1 = Area 2
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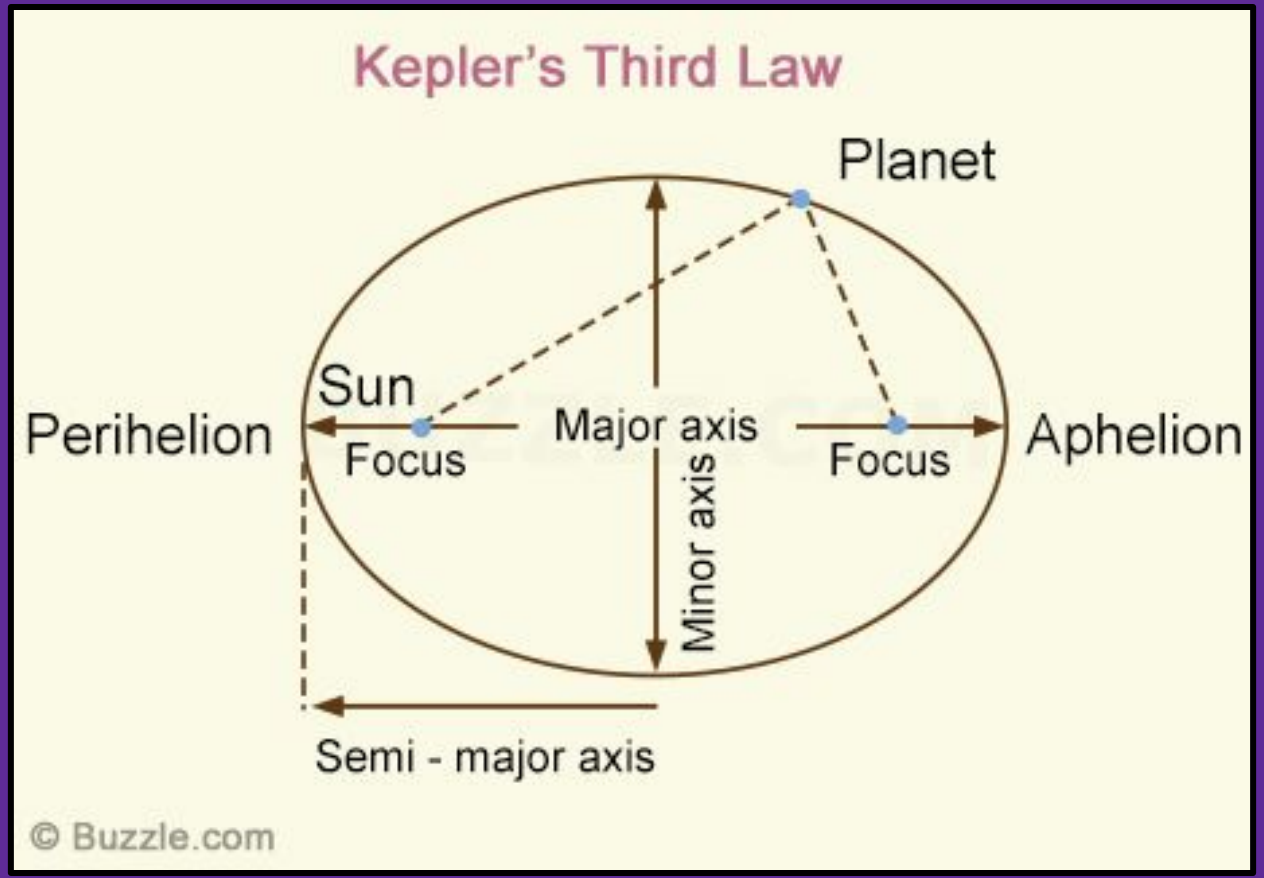
Kepler's Third Law
Planet
Sun
Perihelion
Focus
Major axis
Focus
Aphelion
Minor axis
Semi - major axis
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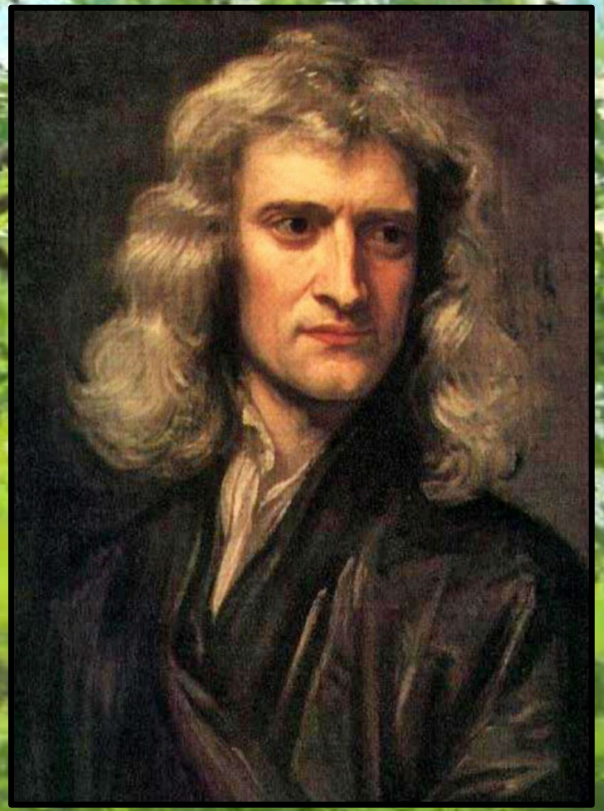
Major Contributions

- **Eratosthenes** was the first to measure the circumference of Earth.
- **Ptolemy** created the idea of a Geocentric Universe.
- **Nicolaus Copernicus** was the father of the Heliocentric Theory, and often thought to spark the Scientific Revolution.
- **Tycho Brahe** discovered that our universe is dynamic and ever changing.
- **Galileo Galilei** discovered that in the absence of air resistance, all objects accelerate toward the Earth at the same rate, regardless of mass.
- **Albert Einstein** proposed that gravity is the universal attraction between all mass, and, since E = mc2, all forms of energy
  - Gravity is the curvature of spacetime — the four dimensional fabric of the universe
- **Edwin Hubble** believed that the Universe goes beyond the Milky Way, and that is was expanding ever so rapidly.

Newton's Theory of Gravity

- Explained the motion of falling objects
- In 1821, Alexis Bouvard observed disturbances in the orbit of Uranus
- Newton's theory of gravity predicted these disturbances were due to the presence of an unknown gravitational source and eventually led to the discovery of Neptune



Common Misconceptions

- The shape of an orbit is an ellipse, not a circle
- Weight changes, mass is constant.
- Make sure to convert to the appropriate units before making any calculations.
- Gravitational potential energy is negative
- Doesn't have constant velocity, has constant speed
- In acceleration due to gravity, all objects fall in free fall, this means that no matter what the mass is, in a vacuum they would fall at the same velocity, the only reason some objects fall faster is due to air resistance.
- Remember when calculation how strong the force of gravity is to measure the distance from the CORE not from the surface of the Earth i.e. “If an apple tree is doubled in height”
- Isaac Newton did not discover gravity because of an apple tree
- Earth is not a perfect sphere and that’s why Eratosthenes messed up when calculating the circumference of the Earth


Multiple Choice Review

Question 1

What is the force of gravity between Jupiter and it's moon that are 670, 000 kilometers apart? The mass of Jupiter is 1.9 x 10^27 kg, and the mass of moon is 4.8 x 10^22 kg.

A. 1.36 x 10^22

B. 9.1 x 10^22

C. 9.0 x 10^30

D. 1.36 x 10^30

Question 1 Answer

Answer:

A. 1.36 x 10^22 N

Question 2)

Question 2) Kepler's 1st law

The orbit of a planet is an _____ with the sun at one of the two focus points.

A. Sphere

B. circle

C. Ellipse

D. Oval

Question 2 Answer

Answer:

C. Ellipse

Question 3

The sun weighs 1.989 × 10^30 kg. If it takes 365 days to orbit the sun, on average how far is the earth from the sun?

a) 1.62 x 10^11

b) 1.49 x 10^11

c) 1.45 x 10^11

d) 1.28 x 10^11

Question 3 Answer

Answer:

b) 1.49 x 10^11

Question 4

How is your mass on Earth compared to your mass on the moon?

A. 2x greater

B. Same

C. 2x smaller

D. 4x greater

Question 4 Answer

B. Same

Question 5

Calculate the escape velocity of Planet B, which has a mass of 1.38 x 10^25 kg, and a radius of 6.32 x 10^7 m.

a) 6453.2 m/s

b) 4312.1 m/s

c) 5397.1 m/s

d) 5285.1 m/s

Question 5 Answer

Answer:

c) 5397.1 m/s