Astronomy

Fall 2026

Weeks 11 - 12

Tuesday, October 20th

- T: **(7) Science concepts. The student knows our relative place in the solar system. The student is expected to:**
  7B model the scale, size, and distances of the Sun, Earth, and Moon system and identify the limitations of physical models; and
  (11) Science concepts. The student uses models to explain the formation, development, organization, and significance of solar system bodies. The student is expected to:
  11A relate Newton's law of universal gravitation and Kepler's laws of planetary motion to the formation and motion of the planets and their satellites;
- O: I will discover and be able to understand surface gravity and escape velocity
- D: by taking notes, discussing with my group, and completing a textbook assignment.

- EdPuzzle Escape Velocity
- Textbook Questions Escape Velocity

Surface Gravity

- *Surface gravity* is the acceleration a mass undergoes at the surface of a celestial object (e.g., an asteroid, planet, or star).
- Surface gravity:
- Determines the weight of a mass at a celestial object's surface.
- Influences the shape of celestial objects.
- Influences whether or not a celestial object has an atmosphere.

Surface Gravity Calculations

- Surface gravity is determined from Newton's Second Law and the Law of Gravity:

$$ma = \frac{GMm}{R^2}$$

where M and R are the mass and radius of the celestial object, and m is the mass of the object whose acceleration *a* we wish to know

- The surface gravity, denoted by *g*, is then:

$$g = \frac{GM}{R^2}$$

Notice dependence of g on M and R, but not m

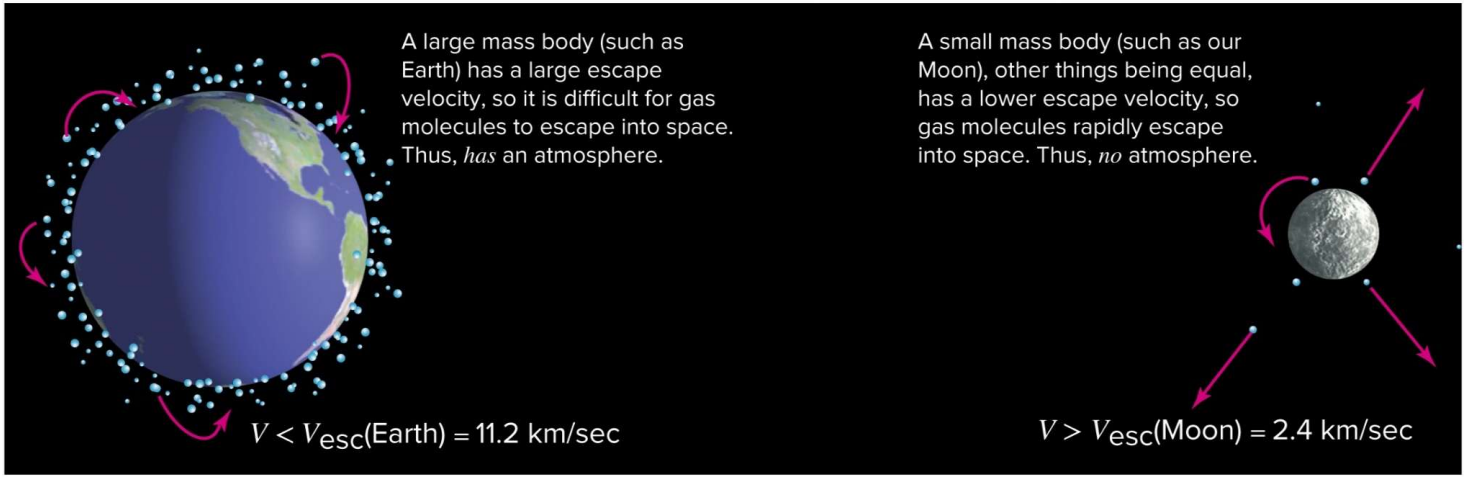
- $g_{Earth} = 9.8 m/s^2$
- $\frac{g_{Earth}}{g_{Moon}} = 5.6$ and $\frac{g_{Jupiter}}{g_{Earth}} = 3$

Escape Velocity

- To overcome a celestial object's gravitational force and escape into space, a mass must obtain a critical speed called the *escape velocity.*
- Escape velocity:
- Determines if a spacecraft can move from one planet to another.
- Influences whether or not a celestial object has an atmosphere.
- Relates to the nature of black holes.

Uses of Escape Velocity Concept

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Escape Velocity Calculation

- The escape velocity, v_{esc}, is determined from Newton's laws of motion and the Law of Gravity and is given by:

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

where M and R are the mass and radius of the celestial object from which the mass wishes to escape.

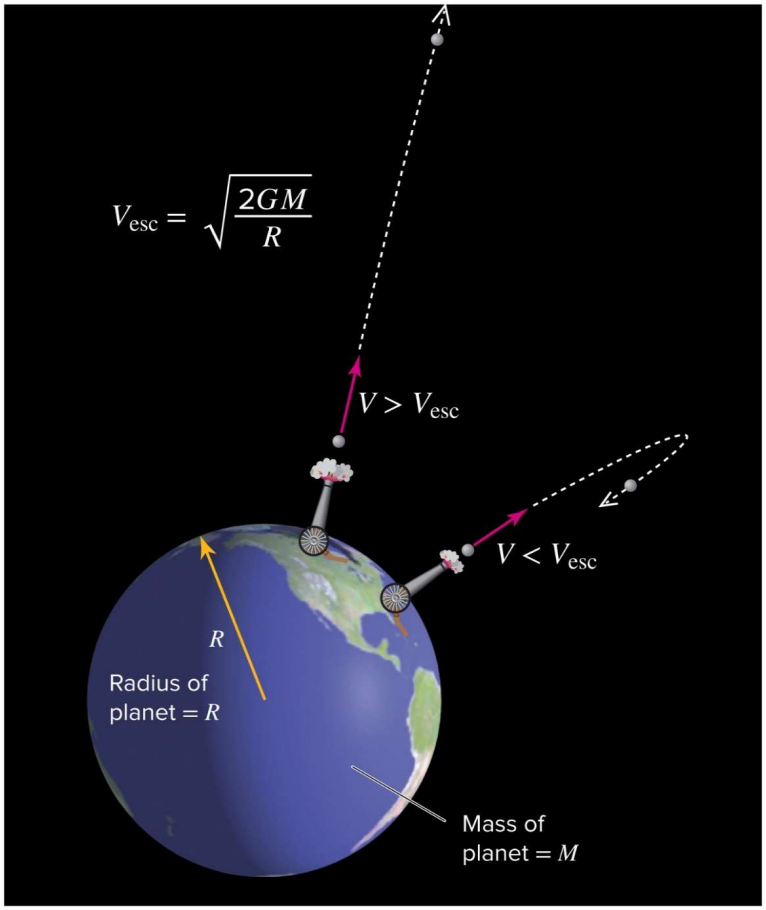
- Notice dependence of V_{esc} on M and R, but not m.

- $V_{esc,\,Earth} = 11 km/s.$

- $V_{esc,\,Moon} = 2.4 km/s.$

The Escape Velocity Formula

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Textbook Questions

- Virtual Book Pg 33
- Questions for Review # 9 - 10
- Thought Questions # 6 - 11
- Test Yourself #1 - 9

Tuesday, October 27

- Unit 3 Test

Thursday, October 29

- T: **Science concepts. The student uses models to explain the formation, development, organization, and significance of solar system bodies. The student is expected to:**

1D compare the factors essential to life on Earth such as temperature, water, gases, and gravitational and magnetic fields to conditions on other planets and their satellites.

(16) Science concepts. The student understands the benefits and challenges of expanding our knowledge of the universe. The student is expected to:

16C evaluate the evidence of the existence of habitable zones and potentially habitable planetary bodies in extrasolar planetary systems;

- O: I will begin to understand the complexity of Earth
- D: by discussing the composition of Earth and beginning my Earth Project

Earth

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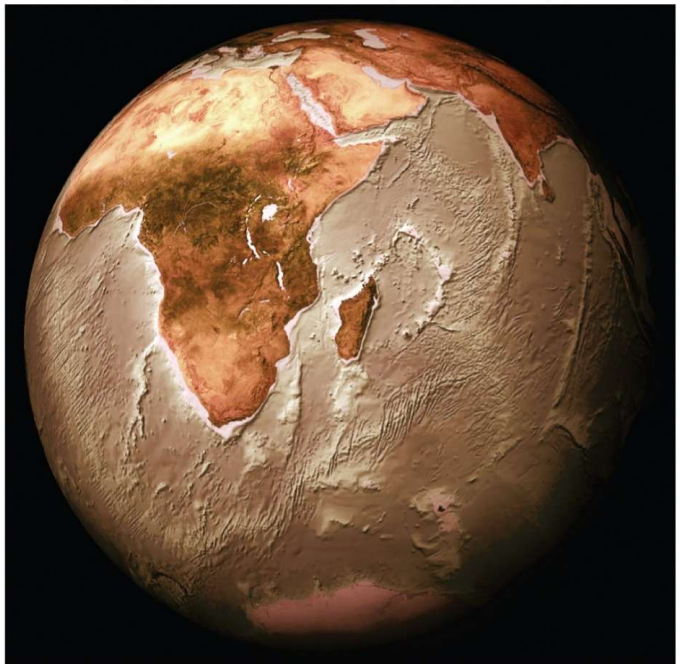


- NASA

Size and Shape of Earth

- In simple terms, Earth is a huge, rocky sphere spinning in space and moving around the Sun at a speed of about 100 miles every few seconds.
- Earth also has a blanket of air and a magnetic field that protects the surface from the hazards of interplanetary space.

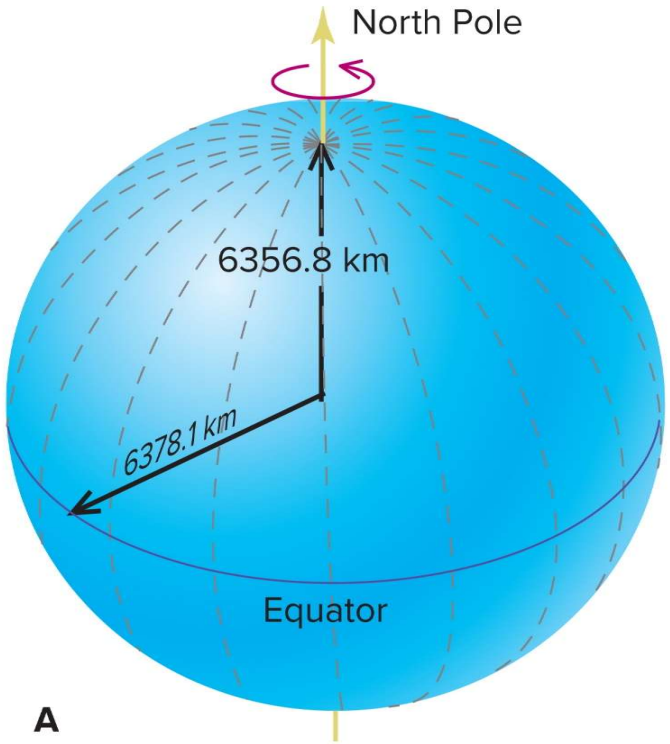
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Earth's Equatorial Bulge

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- Earth is large enough for gravity to have shaped it into a sphere.
- More precisely, Earth's spin makes its equator bulge into a shape referred to as an oblate spheroid – a result of inertia.

Composition of Earth

- The most common elements of Earth's surface rocks are:
- Oxygen (45.5% by mass),
- Silicon (27.2%),
- Aluminum (8.3%),
- Iron (6.2%),
- Calcium (4.66%), and.
- Magnesium (2.76%).
- Silicon and oxygen usually occur together as ***silicates.***
- Ordinary sand is the silicate mineral quartz and is nearly pure silicon dioxide.

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Density of Earth

- ***Density*** is a measure of how much material (mass) is packed into a given volume.
- Typical unit of density is grams per cubic centimeter.
- Water has a density of $1\text{g}/\text{cm}^3$, • ordinary <u>surface</u> rocks are $3\text{g}/\text{cm}^3$,
  - while iron is $8\text{g}/\text{cm}^3$.
- For a spherical object of mass *M* and radius *R*, its <u>average density</u> is given by

$$\rho = \frac{M}{\frac{4}{3}\pi R^3}$$

- For Earth, this density is found to be $5.5\text{g}/\text{cm}^3$.
- Consequently, Earth's interior (core) probably is iron (which is abundant in nature and high in density)

Friday, October 30

- Project Day 2
- T: **Science concepts. The student uses models to explain the formation, development, organization, and significance of solar system bodies. The student is expected to:**

1D compare the factors essential to life on Earth such as temperature, water, gases, and gravitational and magnetic fields to conditions on other planets and their satellites.

(16) Science concepts. The student understands the benefits and challenges of expanding our knowledge of the universe. The student is expected to:

16C evaluate the evidence of the existence of habitable zones and potentially habitable planetary bodies in extrasolar planetary systems;

- O: I will expand my understand of Earth
- D: by participating in a gallery walk and start designing my presentation.