AST 301
Introduction to Astronomy

John Lacy
RLM 16.332
471-1469
lacy@astro.as.utexas.edu

Myoungwon Jeon
RLM 16.216
471-0445
myjeon@astro.as.utexas.edu

Bohua Li
RLM 16.212
471-8443
bohuali@astro.as.utexas.edu

web site: www.as.utexas.edu
Go to Department of Astronomy courses,
AST 301 (Lacy), course website

Topics for this week

Describe how the planets appear to move during a night and from night to night relative to the stars.

How did Aristotle explain the motions of the planets?

How did Copernicus explain the motions of the planets?

Was his explanation more accurate than Aristotle's?

How did Kepler improve on Copernicus' model?

State (and define the term in) Kepler's laws.

What makes a model a scientific theory?

Motions of the planets

During a night (or day) the planets appear to move across the sky along with the stars, due to the rotation of the Earth.

But from night to night the planets slowly move relative to the stars.

Usually, they move west to east relative to the stars.

That is, they move east to west across the sky slightly slower than the stars do.

This is called prograde motion.

Occasionally, they reverse their motion, moving east to west relative to the stars.

This is called retrograde motion.

Prograde and retrograde motion

Remember: all objects in the sky move east-to-west during a night due to the west-to-east rotation of the Earth.

Prograde motion is when a planet moves west-to-east relative to the stars.

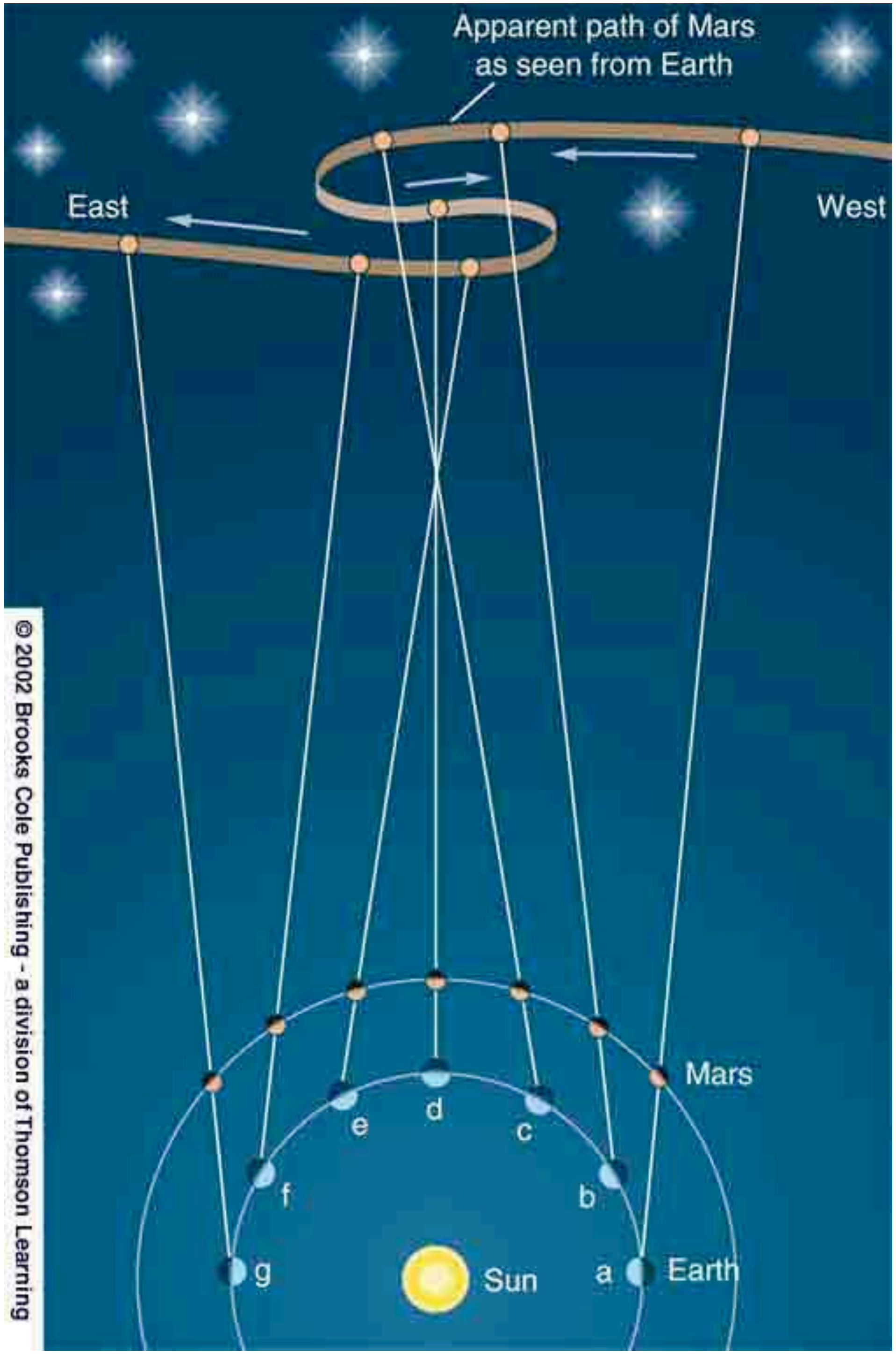
The Sun and Moon always move prograde.

Retrograde motion is when a planet moves east-to-west relative to the stars.

Looking down on the solar system from the north, prograde motion occurs when the line from the Earth to the object rotates counterclockwise (in the same way the planets actually move).

Retrograde motion occurs when the line rotates clockwise because the Earth passes the planet.

The heliocentric explanation of the motions of the planets relative to the stars



Form groups of four
Two from one row and two from the next

Pick a leader and a scribe.

The explanation I gave for retrograde motion works for Mars, but Venus is a bit different.

Draw the orbits of Venus and the Earth around the Sun, and figure out when Venus is moving prograde and retrograde.

Remember: the prograde direction is the direction the Sun appears to move.

Hand in your papers with names, noting who was the discussion leader and the scribe.

Copernicus, Tycho, and Kepler

Copernicus (500 yr ago) put the Sun at the center of his model, but wanted to keep the planets moving on circular paths at constant speed.

His model was no more accurate than those of Aristotle and Ptolemy.

Tycho (450 yr ago) showed that neither model could reproduce the observed paths of the planets in the sky.

Kepler (400 yr ago) allowed the planets to move on elliptical paths with varying speeds, according to his 3 rules.

His model predicted planetary positions very accurately.

Kepler's laws (or rules)

1. The planets move on elliptical paths with the Sun at one focus of the ellipse for each planet.

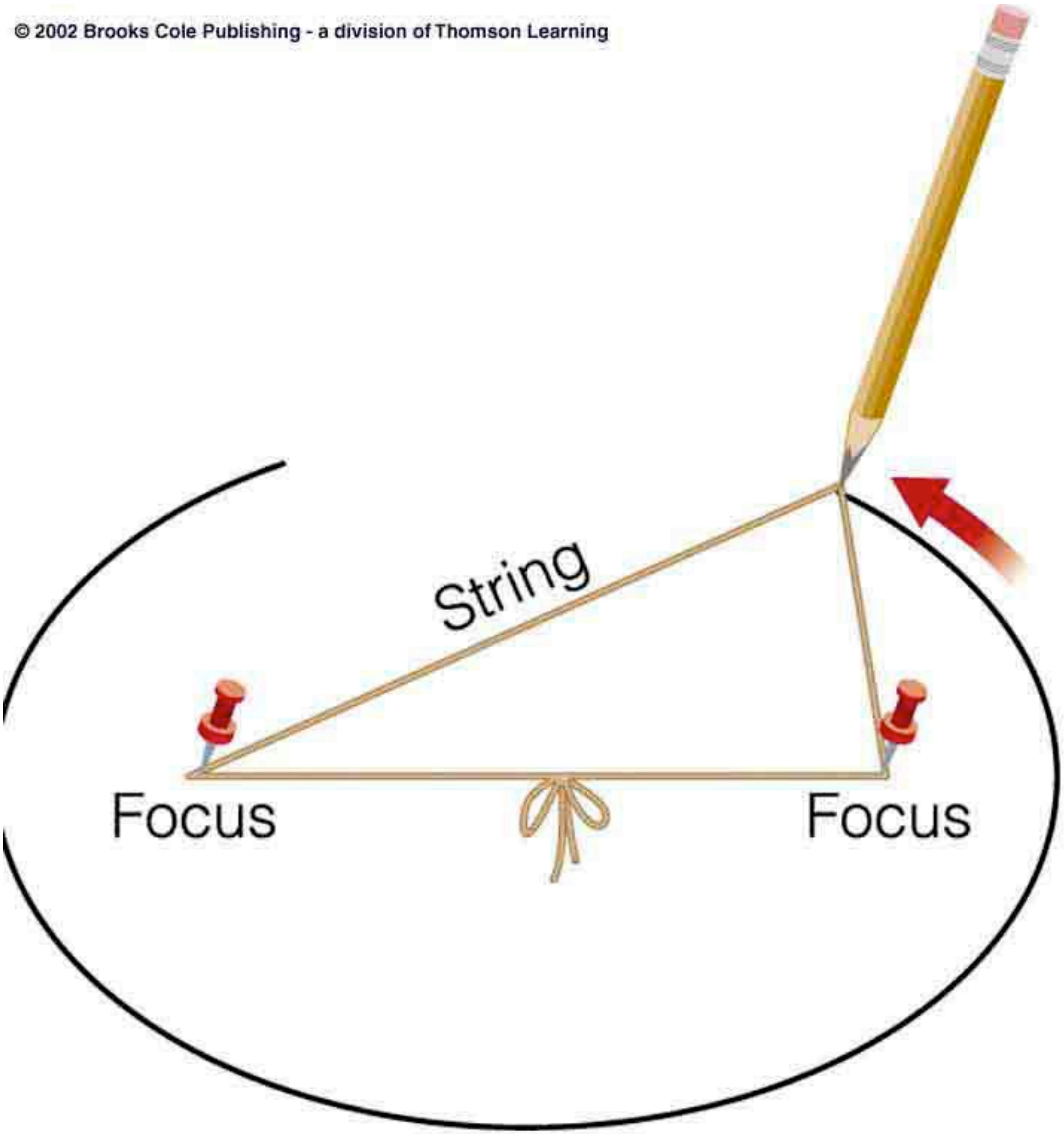
2. The speed of a planet changes during its orbit, moving fastest when it is closest to the Sun and slowest when it is farthest from the Sun.

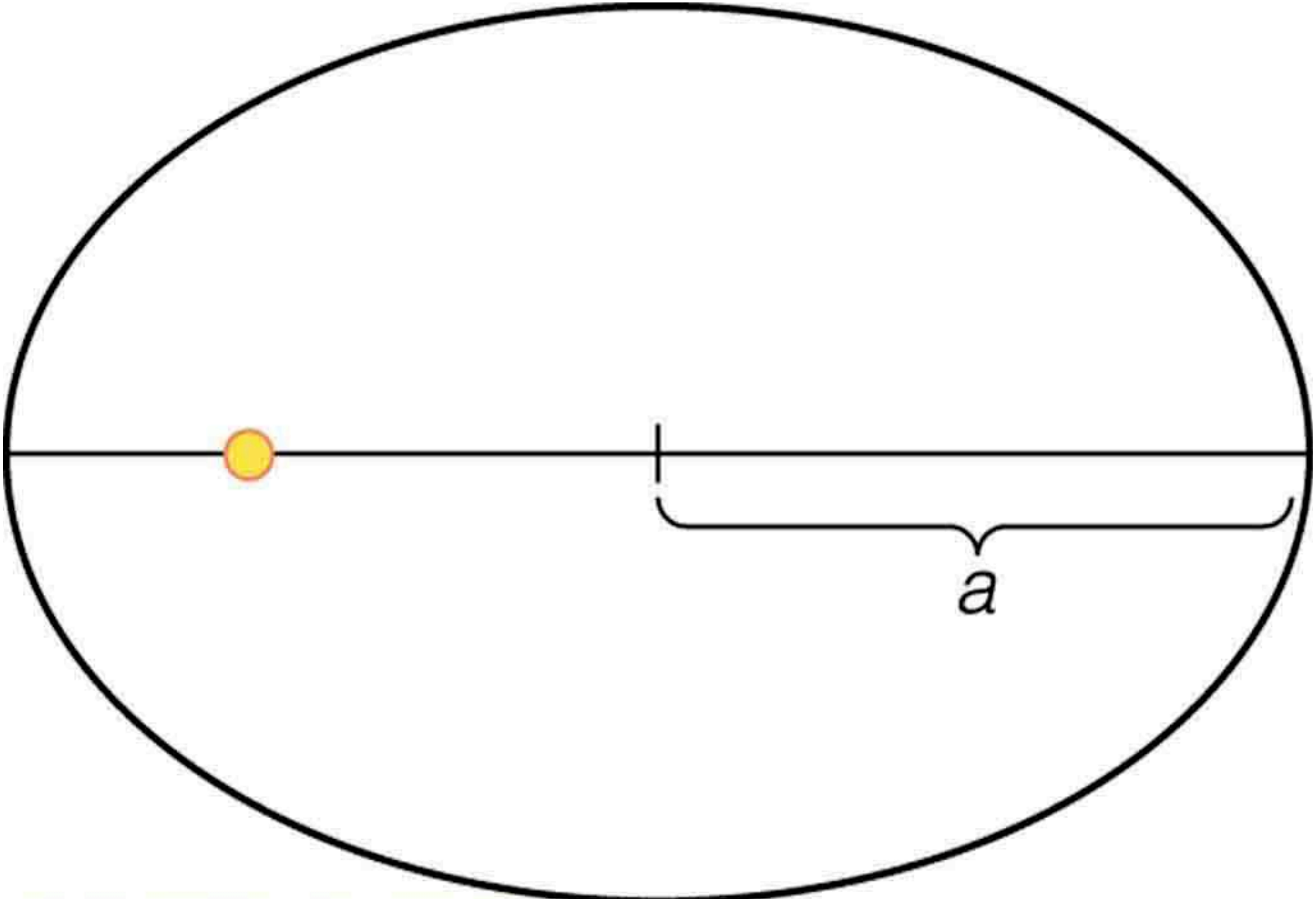
   A line from the Sun to the planet sweeps out equal areas in equal times.

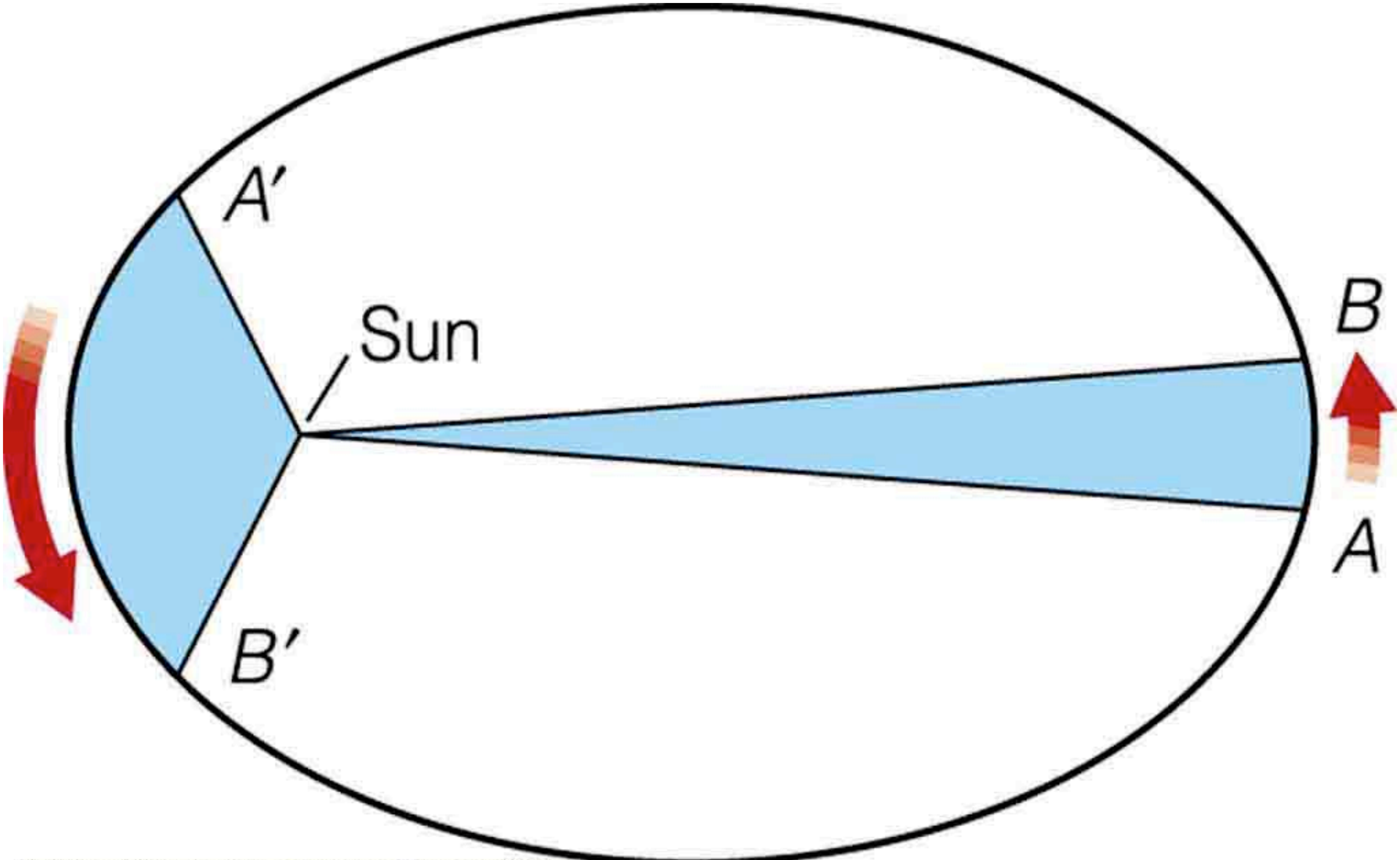
3. Different planets move at different speeds, with a planet in a smaller orbit moving faster than one in a larger orbit.

   The time for a planet to orbit the Sun depends on the size of it orbit according to the rule:

   $P^2 = a^3$, where P is in years and a is in AU


String
Focus
Focus


a


A′
Sun
B
A
B′

Kepler’s 2nd law

A simpler, although not exact, way to state Kepler’s second law is to say:

The distance traveled by a planet in a given time is inversely proportional to the planet’s distance from the Sun during that time.

Or the speed of a planet is inversely proportional to its distance from the Sun.

This means that if at one time a planet is twice as far from the Sun as at a second time, it is moving ½ as fast.

Or: closer to Sun means faster.

twice as close means twice as fast

twice as far means ½ as fast

Quiz

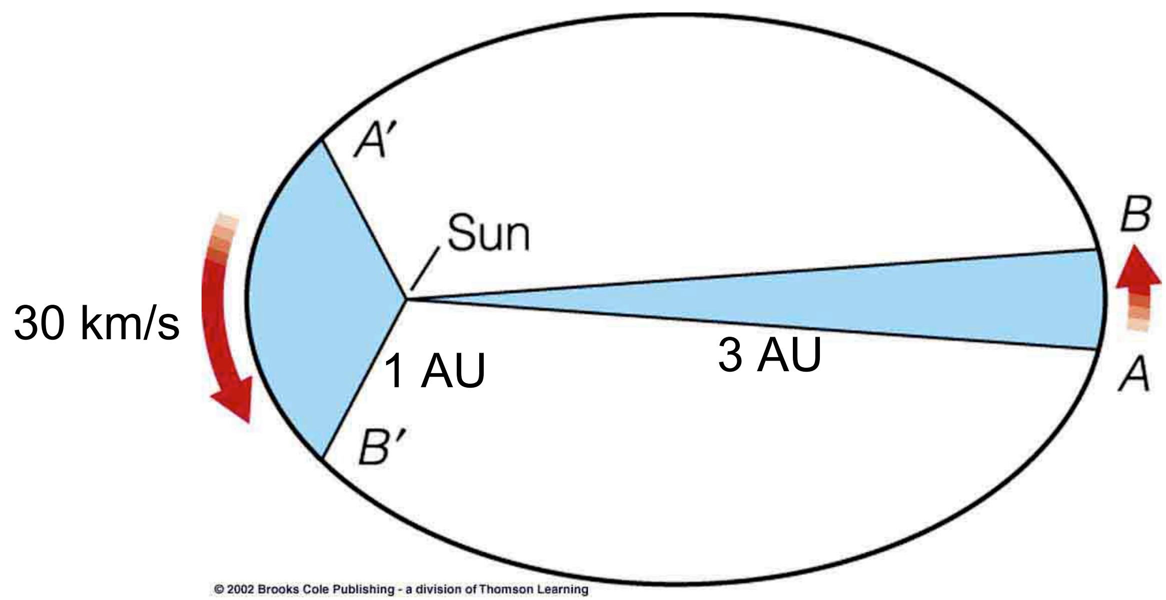
If the speed of the planet between A` and B` is 30 km/s, what is its speed between A and B?

A. 10 km/s

B. 28 km/s

C. 32 km/s

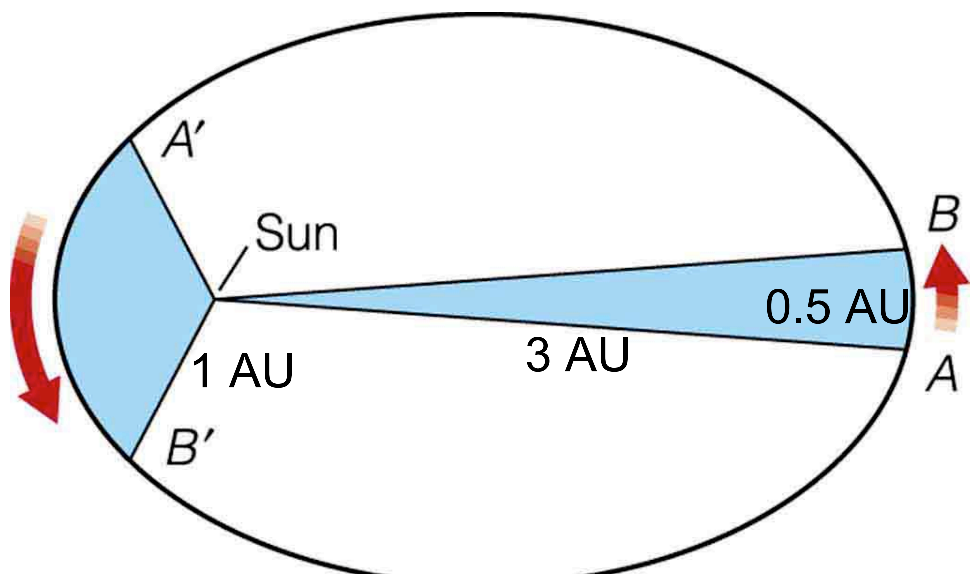
D. 90 km/s

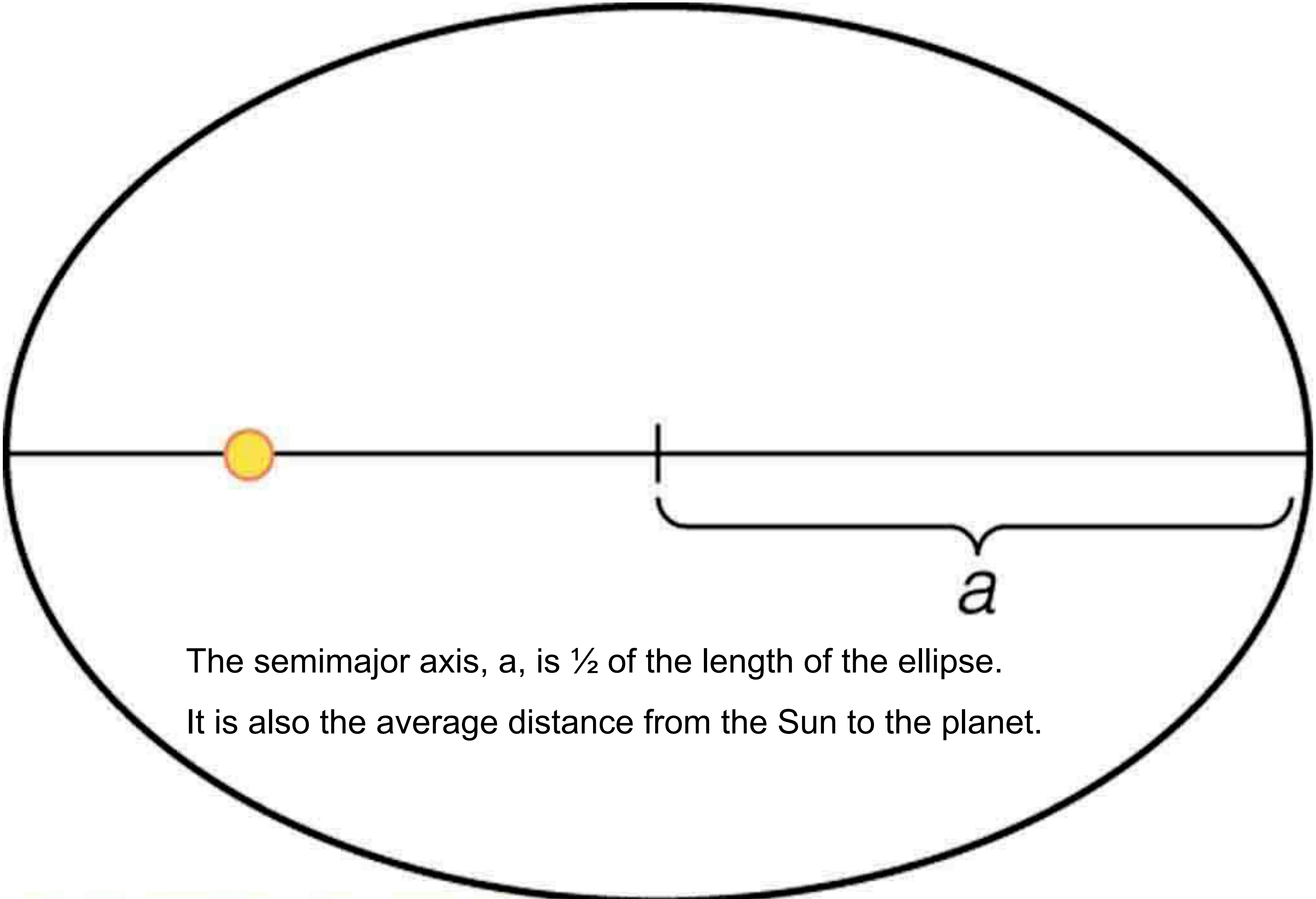


Quiz

In the figure below, given that the distance from the Sun to points A and B is 3 AU, the distance to points A` and B` is 1 AU, and the distance from A to B is 0.5 AU, what is the distance from A` to B` (along the orbit)?

A. 0.5 AU
B. 1 AU
C. 1.5 AU
D. 3 AU





The semimajor axis, a, is ½ of the length of the ellipse.

It is also the average distance from the Sun to the planet.