Q13.1

The mass of the moon is 1/81 of the mass of the earth. Compared to the gravitational force that the earth exerts on the moon, the gravitational force that the moon exerts on the earth is

A. $81^2 = 6561$ times greater.

B. 81 times greater.

C. equally strong.

D. 1/81 as great.

E. $(1/81)^2 = 1/6561$ as great.

A13.1

The mass of the moon is 1/81 of the mass of the earth. Compared to the gravitational force that the earth exerts on the moon, the gravitational force that the moon exerts on the earth is

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B. 81 times greater.

C. equally strong.

D. 1/81 as great.

E. $(1/81)^2 = 1/6561$ as great.

Q13.2

The planet Saturn has 100 times the mass of the earth and is 10 times more distant from the sun than the earth is. Compared to the earth's acceleration as it orbits the sun, the acceleration of Saturn as it orbits the sun is

A. 100 times greater.

B. 10 times greater.

C. the same.

D. 1/10 as great.

E. 1/100 as great.

A13.2

The planet Saturn has 100 times the mass of the earth and is 10 times more distant from the sun than the earth is. Compared to the earth's acceleration as it orbits the sun, the acceleration of Saturn as it orbits the sun is

A. 100 times greater.

B. 10 times greater.

C. the same.

D. 1/10 as great.

E. 1/100 as great.

Q13.3

Compared to the earth, planet X has twice the mass and twice the radius. This means that compared to the earth's surface gravity, the surface gravity on Planet X is

A. four times as much.

B. twice as much.

C. the same.

D. half as much.

E. one-quarter as much.

A13.3

Compared to the earth, planet X has twice the mass and twice the radius. This means that compared to the earth's surface gravity, the surface gravity on Planet X is

A. four times as much.

B. twice as much.

C. the same.

D. half as much.

E. one-quarter as much.

Q13.4

Compared to the earth, planet X has twice the mass and twice the radius. This means that compared to the amount of energy required to move an object from the earth's surface to infinity, the amount of energy required to move that same object from planet X's surface to infinity is

A. four times as much.

B. twice as much.

C. the same.

D. half as much.

E. one-quarter as much.

A13.4

Compared to the earth, planet X has twice the mass and twice the radius. This means that compared to the amount of energy required to move an object from the earth's surface to infinity, the amount of energy required to move that same object from planet X's surface to infinity is

A. four times as much.

B. twice as much.

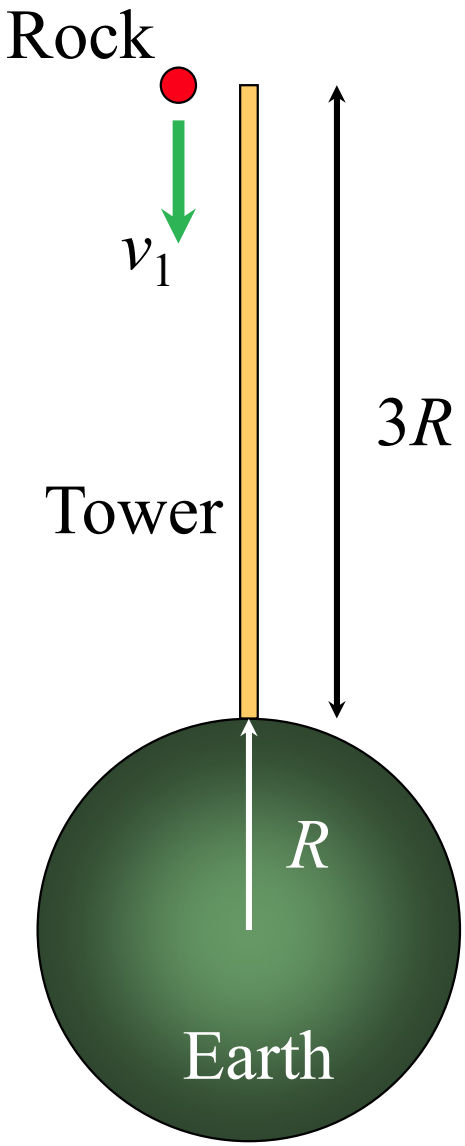
C. the same.

D. half as much.

E. one-quarter as much.

Q13.5

A rock is initially at rest with respect to earth and located very far away. The rock is released and accelerates toward earth. An observation tower is built three earth radii high to observe the rock as it falls to earth. When the rock passes the top of the tower, its speed is v_1. Neglecting air resistance, what is the rock's speed when it hits earth's surface?



A. $2v_1$

B. $3v_1$

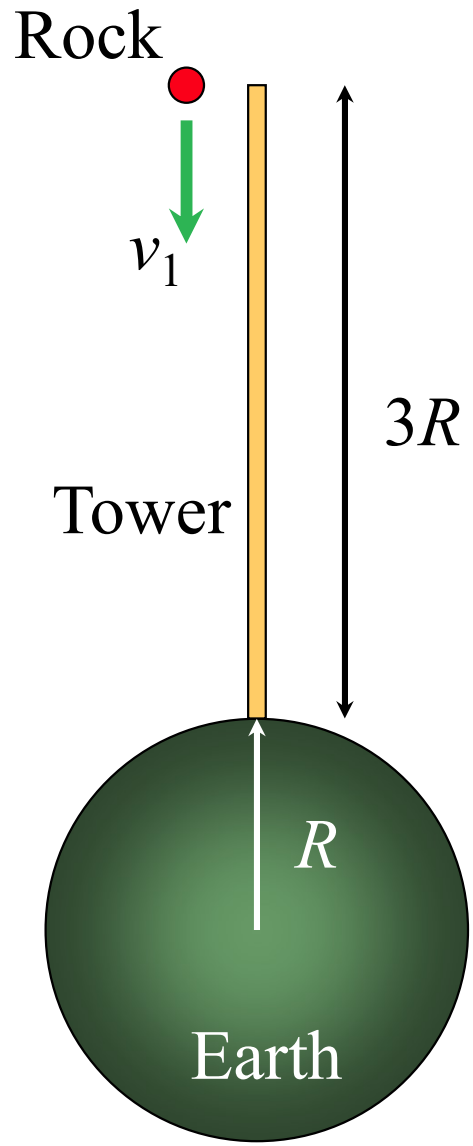
C. $4v_1$

D. $8v_1$

E. $16v_1$

A13.5

A rock is initially at rest with respect to earth and located very far away. The rock is released and accelerates toward earth. An observation tower is built three earth radii high to observe the rock as it falls to earth. When the rock passes the top of the tower, its speed is v_1. Neglecting air resistance, what is the rock's speed when it hits earth's surface?



A. $2v_1$

B. $3v_1$

C. $4v_1$

D. $8v_1$

E. $16v_1$

Q13.6

You put your spacecraft into a circular orbit around planet Z, which has half the radius of earth and has one-quarter earth's mass. Compared to being in an orbit of the same size around earth, when in orbit around planet Z your spacecraft will have

A. the same acceleration and the same orbital period.

B. half the acceleration and half the orbital period.

C. one-quarter the acceleration and one-quarter the orbital period.

D. one-quarter the acceleration and the same orbital period.

E. none of the above.

A13.6

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A. the same acceleration and the same orbital period.

B. half the acceleration and half the orbital period.

C. one-quarter the acceleration and one-quarter the orbital period.

D. one-quarter the acceleration and the same orbital period.

✔ E. none of the above.

Q13.7

You put your spacecraft into a circular orbit around planet Z, which has half the radius of earth and has one-quarter earth's mass. Compared to being in an orbit of the same size around earth, how are the kinetic energy K and gravitational potential energy U for your spacecraft different when in orbit around planet Z?

A. K is greater and U is less (more negative).

B. K is less and U is greater (less negative).

C. K is less and U is less (more negative).

D. K is greater and U is greater (less negative).

E. none of the above

A13.7

You put your spacecraft into a circular orbit around planet Z, which has half the radius of earth and has one-quarter earth's mass. Compared to being in an orbit of the same size around earth, how are the kinetic energy K and gravitational potential energy U for your spacecraft different when in orbit around planet Z?

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B. K is less and U is greater (less negative).

C. K is less and U is less (more negative).

D. K is greater and U is greater (less negative).

E. none of the above

Q13.8

Star X has twice the mass of the sun. One of star X's planets moves in a circular orbit around star X. This orbit has the same radius as the earth's orbit around the sun. The orbital *speed* of this planet of star X

A. is faster than the earth's orbital speed.

B. is the same as the earth's orbital speed.

C. is slower than the earth's orbital speed.

D. depends on the mass of the planet.

E. depends on the mass and radius of the planet.

A13.8

Star X has twice the mass of the sun. One of star X's planets moves in a circular orbit around star X. This orbit has the same radius as the earth's orbit around the sun. The orbital *speed* of this planet of star X

A. is faster than the earth's orbital speed.

B. is the same as the earth's orbital speed.

C. is slower than the earth's orbital speed.

D. depends on the mass of the planet.

E. depends on the mass and radius of the planet.

Q13.9

Suppose the sun were to shrink to half of its present radius while maintaining the same mass. What effect would this have on the radius r and the period T of earth's orbit around the sun?

A. r would decrease and T would decrease.

B. r would increase and T would increase.

C. r would decrease and T would increase.

D. r would increase and T would decrease.

E. r and T would both be unchanged.

A13.9

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B. r would increase and T would increase.

C. r would decrease and T would increase.

D. r would increase and T would decrease.

E. r and T would both be unchanged.

Q13.10

A satellite is moving around the earth in a circular orbit. Over the course of one complete orbit, the earth's gravitational force does

A. positive work on the satellite.

B. negative work on the satellite.

C. positive work on the satellite during part of the orbit and negative work on the satellite during the other part.

D. positive, negative, or zero work on the satellite during various parts of the orbit.

E. zero work on the satellite at all points in the orbit.

A13.10

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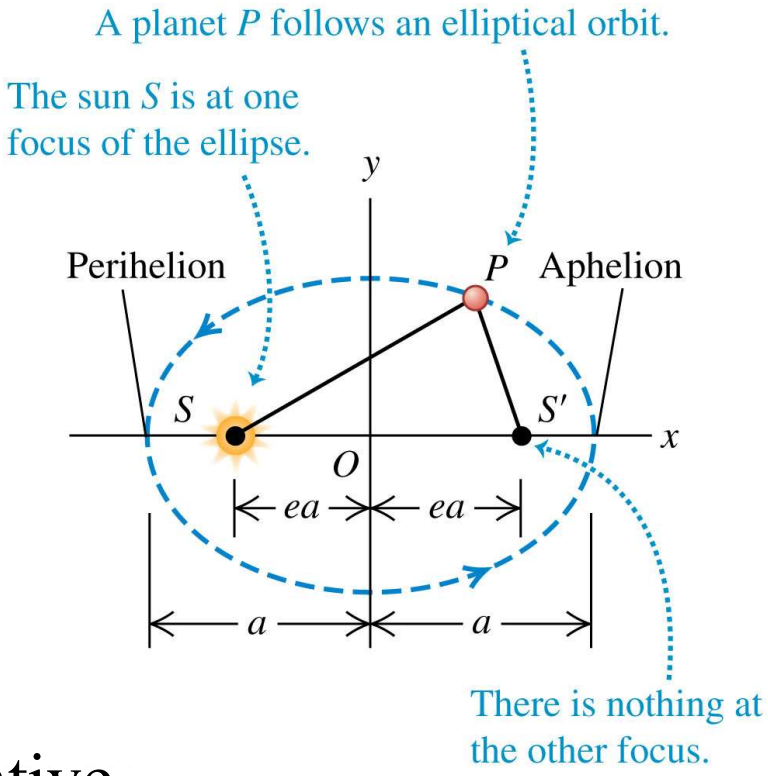
Q13.11

A planet (P) is moving around the sun (S) in an elliptical orbit. As the planet moves from aphelion to perihelion, the sun's gravitational force does



A. positive work on the planet.

B. negative work on the planet.

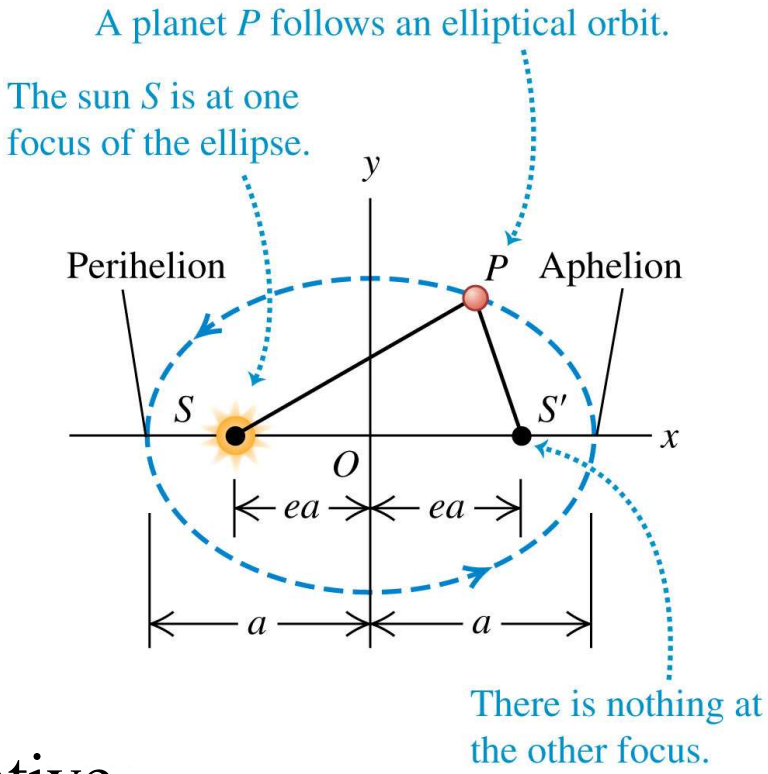
C. positive work on the planet during part of the motion and negative work on the planet during the other part.

D. positive, negative, or zero work on the planet during various parts of the motion.

E. zero work on the satellite at all points between aphelion and perihelion.

A13.11

A planet (P) is moving around the sun (S) in an elliptical orbit. As the planet moves from aphelion to perihelion, the sun's gravitational force does



A. positive work on the planet.

B. negative work on the planet.

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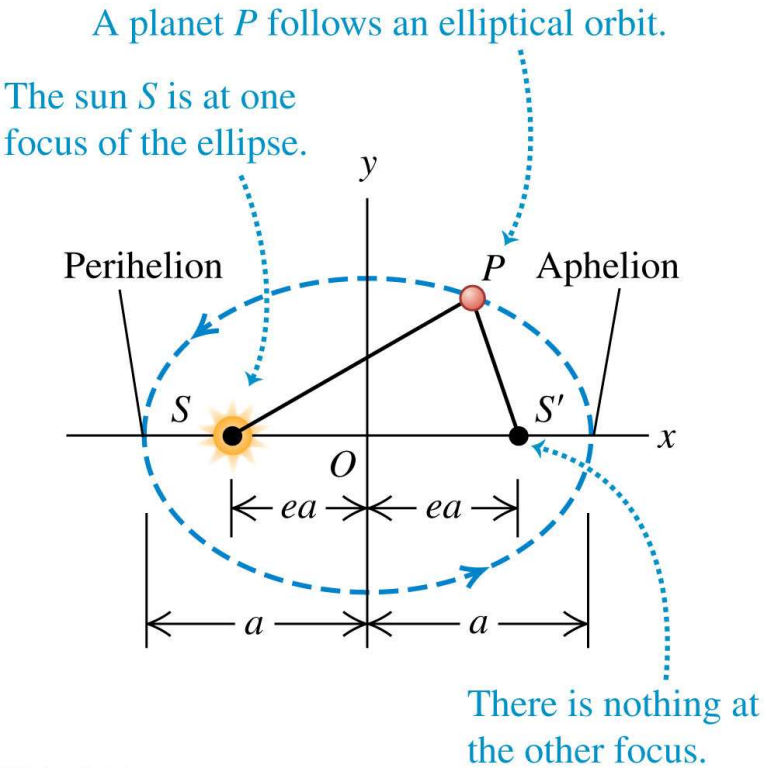
D. positive, negative, or zero work on the planet during various parts of the motion.

E. zero work on the satellite at all points between aphelion and perihelion.

Q13.12

A planet (P) is moving around the sun (S) in an elliptical orbit. As the planet moves from aphelion to perihelion, the planet's angular momentum



A. increases at all times.

B. decreases at all times.

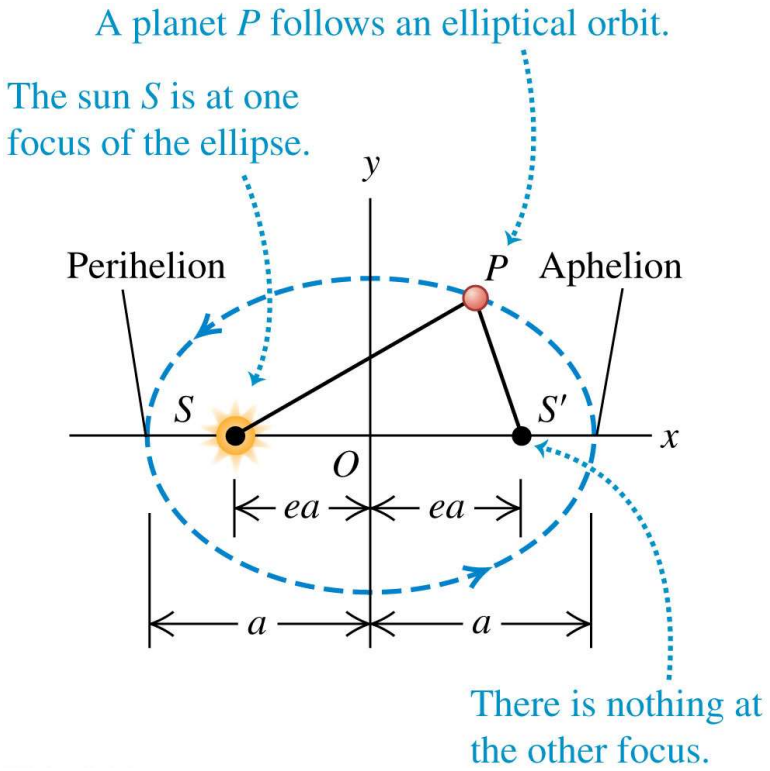
C. decreases during part of the motion and increases during the other part.

D. increases, decreases, or remains the same during various parts of the motion.

E. remains the same at all points between aphelion and perihelion.

A13.12

A planet (P) is moving around the sun (S) in an elliptical orbit. As the planet moves from aphelion to perihelion, the planet's angular momentum



A. increases at all times.

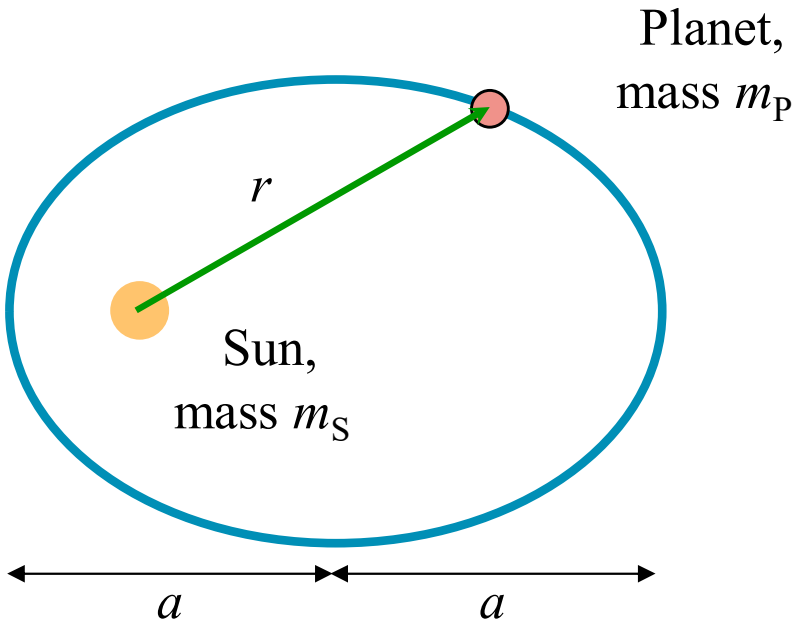
B. decreases at all times.

C. decreases during part of the motion and increases during the other part.

D. increases, decreases, or remains the same during various parts of the motion.

✔ E. remains the same at all points between aphelion and perihelion.

Q13.13



As a planet moves around an elliptical orbit, the sun exerts a force on the planet that points directly toward the sun. What is true about the *torque* that the sun exerts on the planet?

A. It is constant and nonzero.

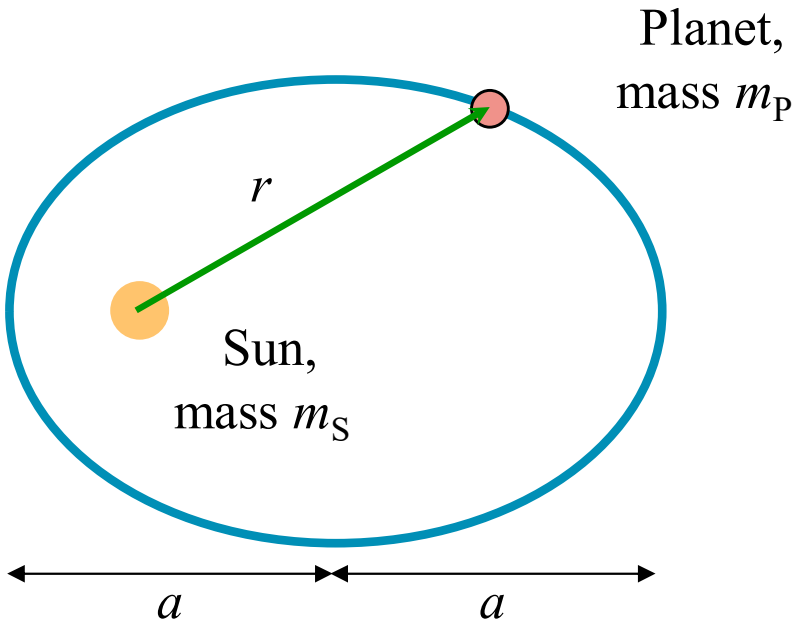
B. It is greatest when the planet is closest to the sun.

C. It is least (but not zero) when the planet is closest to the sun.

D. It is zero when the planet is closest to the sun.

E. It is zero at all times.

A13.13



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D. It is zero when the planet is closest to the sun.

✔ E. It is zero at all times.

Q-RT13.1

Rank the weight you would have on each of these worlds, from largest to smallest.

A. Earth

B. The forest moon of Endor (half earth's radius, one-sixth earth's mass)

C. The desert planet Arrakis (three times earth's radius, eight times earth's mass)

D. The planet Jinx (two-thirds earth's radius, twice earth's mass)

A-RT13.1

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Answer: DACB

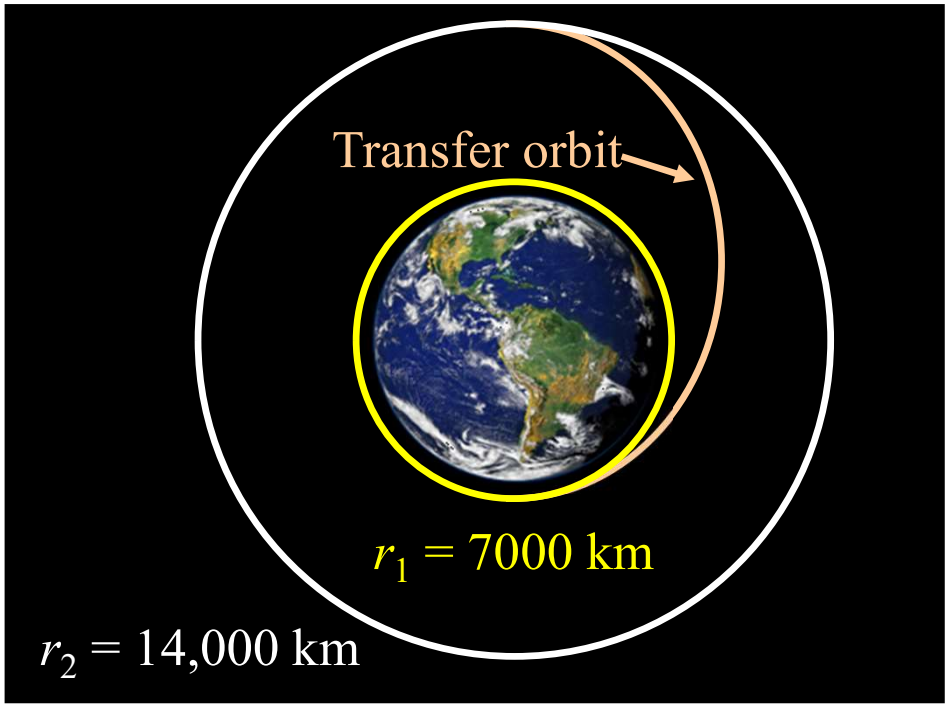
Q-RT13.2

The figure shows three different possible orbits of a spacecraft around earth. In each case the spacecraft moves in a counterclockwise direction around the orbit. **Rank** these three orbits in order of their *angular momentum*, from largest to smallest.

A. A circular orbit of radius $r_1 = 7000$ km

B. A circular orbit of radius $r_2 = 14{,}000$ km

C. An elliptical transfer orbit between the two circular orbits



A-RT13.2

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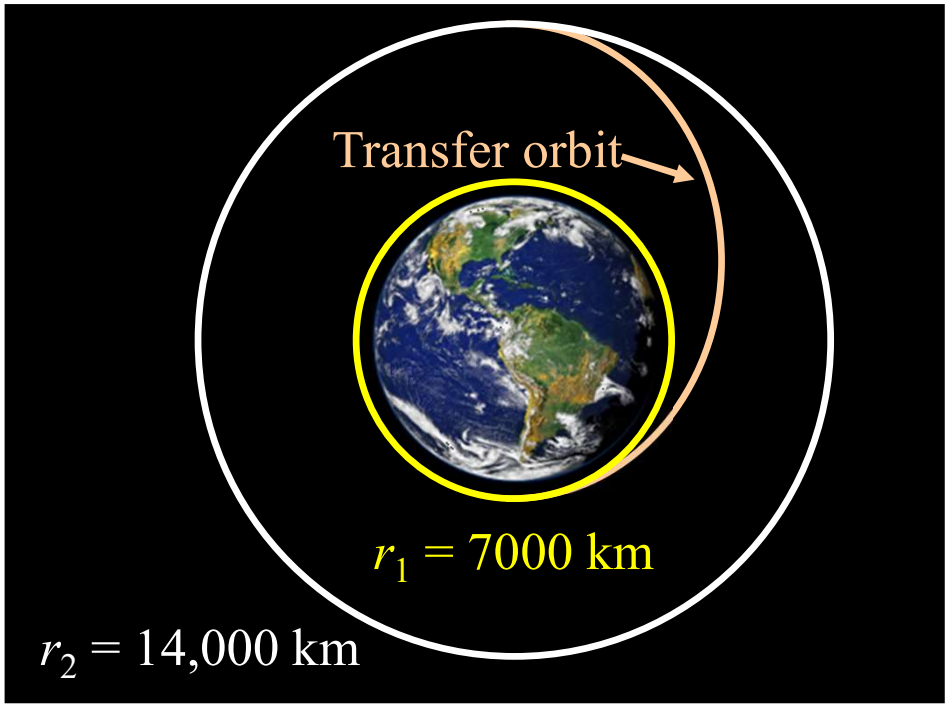

✔ Answer: BCA