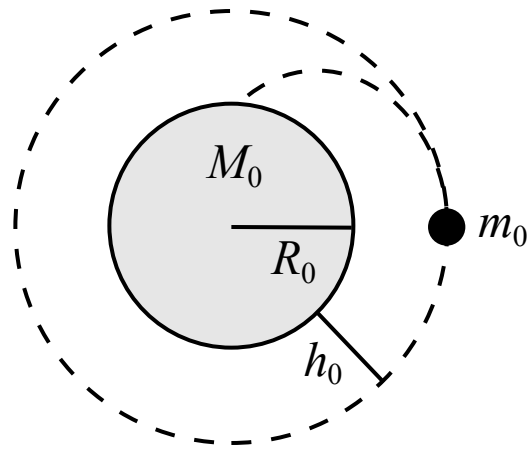
ORBITAL MOTION



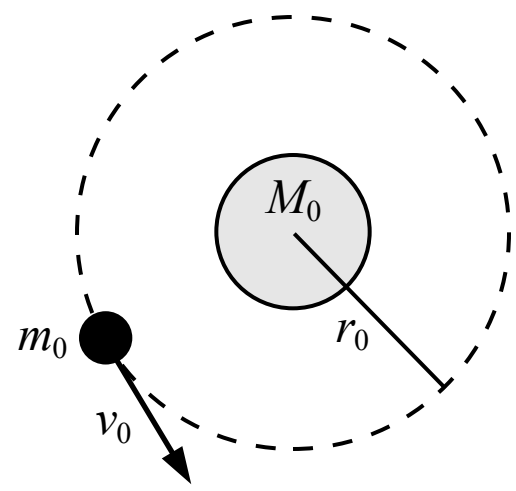
1. A space capsule with a mass m_0 of 500 kg is launched into a circular orbit at a height h_0 of 400 km above the surface of a planet which has a mass M_0 of 1×10^{24} kg and a radius of 1×10^{6} m . What is the speed of the capsule in orbit?

   (A) 8.2×10^{6} m/s

   (B) 12.9×10^{3} m/s

   (C) 8.2×10^{3} m/s

   (D) 6.9×10^{3} m/s



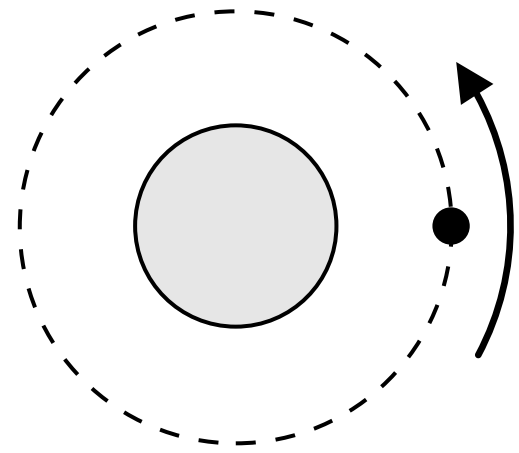
2. A satellite with a mass of m_0 is orbiting a planet with a mass of M_0. The satellite has a speed of v_0 and an orbital radius of r_0. If a second satellite has the same orbital radius but a mass of $2\,m_0$, what is the speed of the second satellite in terms of v_0?

   (A) $4\,v_0$

   (B) $2\,v_0$

   (C) v_0

   (D) $v_0 / \sqrt{2}$



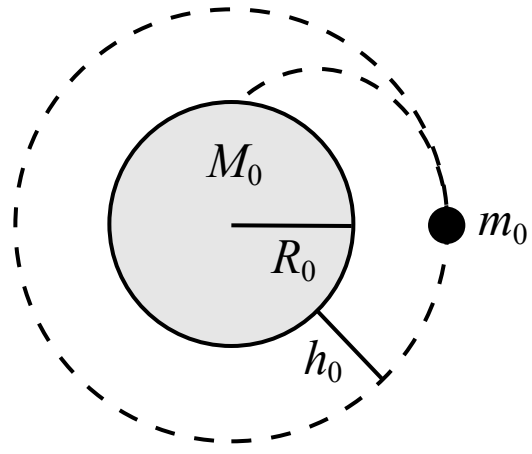
3. A satellite is orbiting the earth at a constant speed. Which of the following shows the direction of the acceleration of the satellite when it is at the position shown in the figure above?

(A) 

(B) 

(C) 

(D) 



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(A) 8.2×10^{6} m/s

(B) 12.9×10^{3} m/s

(C) 8.2×10^{3} m/s

(D) 6.9×10^{3} m/s

A Incorrect

This answer incorrectly uses r instead of r^2 in the equation for gravitational force.

B Incorrect

This answer incorrectly uses h_0 instead of $(R_0 + h_0)$ for the radius of the orbit.

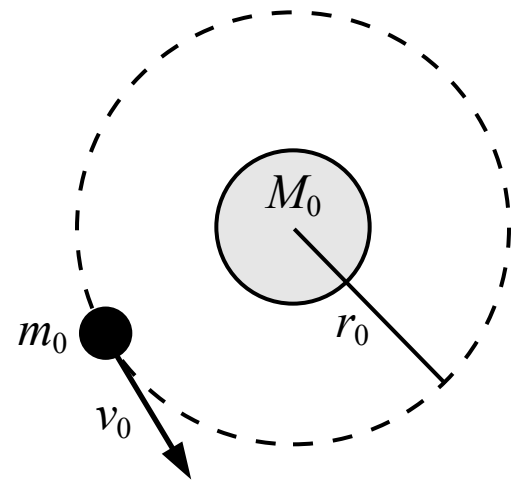
C Incorrect

This answer incorrectly uses R_0 instead of $(R_0 + h_0)$ for the radius of the orbit, or incorrectly uses 400 m instead of 400 km for h_0.

D Correct

The capsule is in uniform circular motion around the planet and the gravitational force is acting as the centripetal force. The mass of the capsule is not relevant to the speed.

$$F_c = F_g \qquad \frac{mv^2}{r} = \frac{GMm}{r^2} \qquad \frac{v^2}{(R_0 + h_0)} = \frac{GM_0}{(R_0 + h_0)^2} \qquad v^2 = \frac{(6.67 \times 10^{-11})(1 \times 10^{24}\ \text{kg})}{(1 \times 10^{6}\ \text{m}) + (400{,}000\ \text{m})} \qquad v = 6.9 \times 10^{3}\ \text{m/s}$$



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(A) $4\,v_0$

(B) $2\,v_0$

(C) v_0

(D) $v_0/\sqrt{2}$

A Incorrect

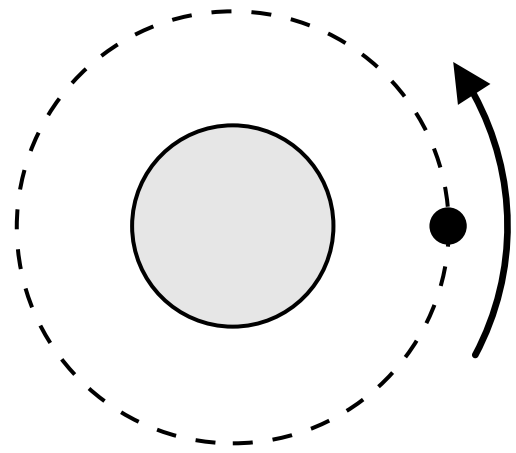
B Incorrect

C Correct

The satellites are in uniform circular motion around the planet and the gravitational force is acting as the centripetal force. The speed of the satellite does not depend on the mass of the satellite.

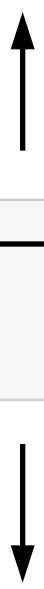
$$F_c = F_g \qquad \frac{mv^2}{r} = \frac{GMm}{r^2} \qquad v^2 = \frac{GM}{r}$$

D Incorrect



3. A satellite is orbiting the earth at a constant speed. Which of the following shows the direction of the acceleration of the satellite when it is at the position shown in the figure above?

(A) 

(B) 

(C) 

(D)

A Incorrect

B Incorrect

C Correct

The satellite is in uniform circular motion around the earth so the acceleration of the satellite (the centripetal acceleration) always points towards the center of the circular path.

D Incorrect