

Physics 05-03 Satellites

Names: _____

- Any object _____ another object only under the influence of _____
- One way to find the speed of a satellite in a _____ orbit
- $v = \frac{2\pi r}{T}$
 - Where r = orbital radius, T = period of orbit
- Gravity provides the _____ force

There is only _____ speed that a satellite can have if the satellite is to remain in an orbit with a _____ radius.

$$v = \sqrt{\frac{GM}{r}}$$

- r is measured from _____ of the Earth
- As r _____, v _____
- _____ of the satellite is not in equation

Calculate the speed of a satellite 500 km above the earth's surface.

Find the mass of a black hole where the matter orbiting it at $r = 2.0 \times 10^{20}$ m move at speed of 7,520,000 m/s.

Kelpler's Third Law (for circular orbits)

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

Or

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

Use the data of Mars to find the mass of the sun assuming a circular orbit. ($r = 2.279 \times 10^8$ km, $T = 1.881$ yr)

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Since satellites are moving only under the influence of _____, and the acceleration points towards _____, satellites are in _____.

Practice Work

1. Derive the formula for the speed of a satellite in a circular orbit around a planet of mass M .
2. What is the speed of a satellite 1.0×10^3 km above an unknown planet of radius 6.38×10^6 m if it takes 1.75 hours to complete one orbit? (RW) **7360 m/s**
3. A satellite is in a circular orbit around an unknown planet. The satellite has a speed of 1.70×10^4 m/s, and the radius of the orbit is 5.25×10^6 m. A second satellite also has a circular orbit around this same planet. The orbit of this second satellite has a radius of 8.60×10^6 m. What is the speed of the second satellite? (Cutnell 5.27) **1.33×10^4 m/s**
4. A satellite is placed in orbit 6.00×10^5 m above the surface of Jupiter. Jupiter has a mass of 1.90×10^{27} kg and a radius of 7.14×10^7 m. Find the orbital speed of the satellite. (Cutnell 5.29) **4.20×10^4 m/s**
5. The moon orbits the earth at a distance of 3.85×10^8 m. Assume that this distance is between the centers of the earth and the moon and that the mass of the earth is 5.98×10^{24} kg. Find the period for the moon's motion around the earth. Express the answer in days and compare it to the length of a month. (Cutnell 5.30) **27.5 days**
6. A geosynchronous Earth satellite is one that has an orbital period of precisely 1 day. Such orbits are useful for communication and weather observation because the satellite remains above the same point on Earth (provided it orbits in the equatorial plane in the same direction as Earth's rotation). Calculate the radius of such an orbit. (OpenStax 6.43) **4.23×10^4 km**
7. Calculate the mass of the Sun based on data for Earth's orbit and compare the value obtained with the Sun's actual mass. (OpenStax 6.44) **1.99×10^{30} kg**
8. Find the mass of Jupiter based on data for the orbit of one of its moons, and compare your result with its actual mass. (OpenStax 6.45) **1.90×10^{27} kg**
9. Astronomical observations of our Milky Way galaxy indicate that it has a mass of about 8.0×10^{11} solar masses. A star orbiting on the galaxy's periphery is about 6.0×10^4 light years from its center. (a) What should the orbital period of that star be? (b) If its period is 6.0×10^7 years instead, what is the mass of the galaxy? Such calculations are used to imply the existence of "dark matter" in the universe and have indicated, for example, the existence of very massive black holes at the centers of some galaxies. (OpenStax 6.47) **3×10^8 years, 2×10^{13} solar masses**