Chapter 8

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. uniform circular motion
2. period
3. angular speed (and angular velocity)
4. radius
5. direction of velocity for uniform circular motion
6. direction of acceleration for uniform circular motion
7. direction of net force for uniform circular motion
8. Newton's law of gravitation
9. universal gravitational constant, G
10. gravitational field
11. weight
12. weightlessness
13. circular orbit
14. geosynchronous orbit

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- speed of an object in uniform circular motion:

$$v = \frac{2\pi R}{T} \tag{1}$$

- magnitude of the net force on an object in uniform circular motion:

$$F_{net} = \frac{mv^2}{R} \tag{2}$$

- magnitude of the acceleration of an object in uniform circular motion:

$$a = \frac{v^2}{R} \tag{3}$$

- Newton's law of gravitation, where r is the distance between two bodies:

$$F_{grav} = \frac{Gm_1m_2}{r^2} \tag{4}$$

- Newton's law of gravitation for the force on body 2 (m_2), where g_1 is the gravitational field due to body 1 (m_1):

$$F_{grav\ by\ 1\ on\ 2} = m_2 g_1 \qquad \text{where } g_1 = \frac{Gm_1}{r^2} \tag{5}$$

- Circular orbit:

$$v = \sqrt{\frac{GM}{R}} \tag{6}$$

and

$$T^2 = \frac{4\pi^2}{GM} R^3 \tag{7}$$

Skills

1. Sketch the velocity vector, the acceleration vector, and the net force vector at any point on its path for an object in uniform circular motion.
2. Apply Newton's second law to any body that is in uniform circular motion and solve for an unknown force. Examples include a child on a merry-go-round, a gymnast on a high bar, a car turning a corner, and a Ferris-wheel or other amusement park ride. However, one should be able to apply Newton's second law to any body that is in uniform circular motion, not just the examples listed.
3. Explain why an astronaut feels weightless or a person in a vertical circle on an amusement park ride.
4. Apply conservation of energy to an object in a vertical circle to calculate its speed at any point in the circle.