# UCM Review

**Key Concepts:** The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

- Uniform circular motion
- Planetary and satellite motion
- Kepler's Laws

20-C1.1k describe uniform circular motion as a special case of two-dimensional motion

20-C1.2k explain, qualitatively and quantitatively, that the acceleration in uniform circular motion is directed toward the centre of a circle

**15.** A slingshot containing rocks is spun in a vertical circle. In what position must it be released so that the rocks fly vertically upward?

**6.** (5.2) A heavy mass attached to the end of a cable is spinning in a vertical circle. In what position is the cable likely to break?

20-C1.3k explain, quantitatively, the relationships among speed, frequency, period and radius for circular motion

$$\Delta \vec{v} = 2\pi r / T$$

$$a_c = v^2 / R$$

20-C1.4k explain, qualitatively, uniform circular motion in terms of Newton's laws of motion.

$$\vec{F}_c = \frac{m\vec{v}^2}{R}$$

$$\vec{F}_c = \frac{4\pi^2 R m}{T^2}$$

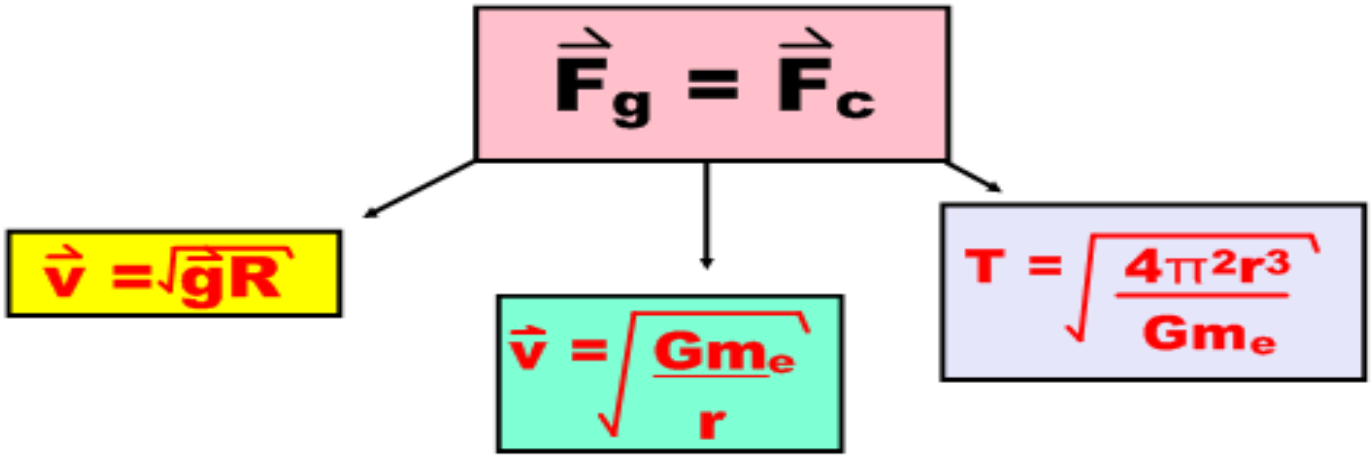
**17.** An eagle circles above the ground looking for prey. If it makes one complete circle with the radius of 25.0 m in 8.0 s, what is its speed?

**18.** A ride at the fair spins passengers around in a horizontal circle inside a cage at the end of a 5.0-m arm. If the cage and passengers have a speed of 7.0 m/s, what is the centripetal force the cage exerts on an 80.0-kg passenger?

**19.** What is the minimum speed that a glider must fly to make a perfect vertical circle in the air if the circle has a radius of 200.0 m?

**21.** A driver is negotiating a turn on a mountain road that has a radius of 40.0 m when the 1600.0-kg car hits a patch of ice. The coefficient of friction between the ice and the wheels is 0.500. If the car is moving at 30.0 km/h, determine if it skids off the road.

20-C1.5k explain, quantitatively, planetary and natural and artificial satellite motion, using circular motion to approximate elliptical orbits.




**ex) At what height above the surface of the Earth must a geosynchronous satellite orbit?**

**ex) Suppose a satellite was in a stable orbit a distance of 20 000 km above a planet where $g$ = 18 N/kg and the planet has a radius of 9 500 km. What velocity does the satellite have to maintain in order to keep this orbit?**

20-C1.6k predict the mass of a celestial body from the orbital data of a satellite in uniform circular motion around the celestial body.

**ex) Galileo discovered 4 moons of Jupiter, listed below. Also listed is their periods of revolution and their orbital radii (centre to centre). From this data, determine the mass of Jupiter.**

| moon | period (days) | distance ($10^6$ m) |
|---|---|---|
| Io | 1.769137786 | 422 |
| Europa | 3.551181041 | 671 |
| Ganymede | 7.154552960 | 1070 |
| Callisto | 16.68901840 | 1883 |

20-C1.7k explain, qualitatively, how Kepler's laws were used in the development of Newton's law of universal gravitation.

http://home.cvc.org/science/kepler.htm

**12.** (5.3) Use Kepler's second law to explain why planets move more quickly when they are nearer to the Sun than when they are farther away in their orbital path.