Gravitation (with Circular Motion)

\( G = 6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2 \)

<table>
<thead>
<tr>
<th>Mass (kg)</th>
<th>radius (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>5.98E24</td>
</tr>
<tr>
<td>Moon</td>
<td>7.3E22</td>
</tr>
<tr>
<td>Pluto</td>
<td>1.3E22</td>
</tr>
<tr>
<td>Uranus</td>
<td>8.68E25</td>
</tr>
<tr>
<td>Venus</td>
<td>4.87E24</td>
</tr>
<tr>
<td>Sun</td>
<td>1.99E30</td>
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</table>

1. A satellite (2340 kg) is orbiting Venus at an altitude of 20 km.
   a. Find the speed of the satellite
      \[ v = \sqrt{\frac{GM}{r^2}} = \frac{\pi v^2}{r} \]
   b. Find the period of the satellite’s orbit.
      \[ \frac{v}{2\pi r} = \frac{2\pi r}{T} \]
      \[ T = \frac{521.49\pi}{6} \]

2. Find the acceleration due to gravity near the surface of Uranus.
   \[ g = \frac{GM}{r^2} = \frac{G(5.6 \times 10^{25})}{(273.6 \times 10^3)^2} = 7.7 \text{m/s}^2 \]

3. A man weighs 690 N on Earth.
   a. What is the man’s weight on the moon?
      \[ F = \frac{GMm}{r^2} = \frac{G(7.3 \times 10^{22})(7.9 \times 10^3)}{(1.74 \times 10^3)^2} = 113.2 \]
   b. What is the man’s mass on the moon?
      \[ m = \frac{690}{g} \]
      \[ m = 70.41 \text{ kg} \]
   c. What is the man’s mass on Venus?
      \[ m = 70.41 \text{ kg} \]

4. Determine the speed Pluto is traveling if it has an orbital distance from the sun of 5900E6km.
   \[ v = \sqrt{\frac{G(1.99E32)}{5900E6}} = 4743 \text{ m/s} \]
5. Find the acceleration due to gravity near the surface of Venus.

\[ g = \frac{G \left(4.47 \times 10^5\right)}{(6051 \times 3)^2} = 8.47 \text{ m/s}^2 \]

6. How fast is a satellite moving if it is 3.59E7 meters above the surface of Uranus? What is that satellite’s orbital period?

\[ v = \sqrt{\frac{G \left(8.88 \times 10^{-7}\right)}{(3.59 \times 10^7 + 2.84 \times 10^3)^2}} = 9537.7 \text{ m/s} \]

\[ T = \frac{2\pi v}{G} = 41534.3 \text{ sec} \]

7. Determine the force between the sun and Venus if their orbital distance is 108B6 km.

\[ f = \frac{G \left(1.99 \times 10^{30}\right) \left(4.47 \times 10^5\right)}{(108B6)^2} = 5.5 \times 10^{-22} \text{ N} \]

8. What is the orbital speed of Uranus if it has an orbital radius of 2870B6 km from the sun?

\[ v = \sqrt{\frac{G \left(1.99 \times 10^{30}\right)}{2870B6}} = 6802.6 \text{ m/s} \]

9. A 1500 kg satellite is put 150 km above Pluto, and set into orbit.

a. What is the speed of this satellite?

\[ v = \sqrt{\frac{G \left(1.3 \times 10^{22}\right)}{1.5 \times 10^3 + 1.9 \times 10^3}} = 5044.1 \text{ m/s} \]

b. What is the period of this satellite (in hours)?

\[ T = \frac{2\pi \times 5044.1}{3600} = 1046.5 \text{ hours} \]

\[ = 2.9 \text{ hours} \]