

Chapter 5

A Good Thing To Know

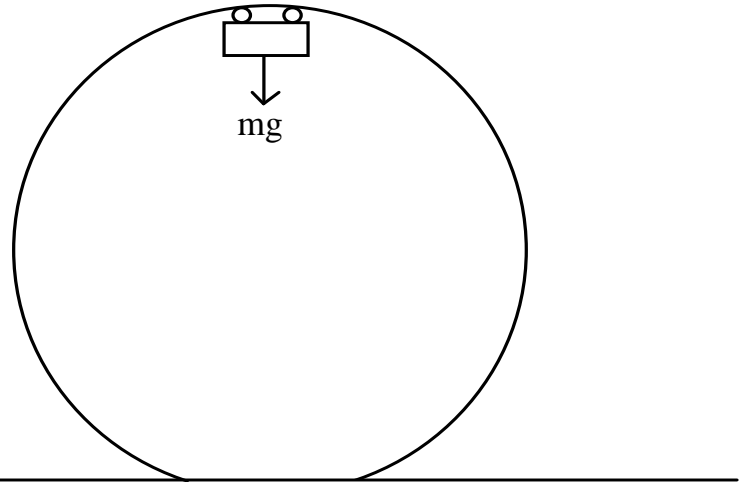
There is one Theme Equation in this chapter:

$$\text{Centripetal Force} = F_c = \frac{mv^2}{r}$$

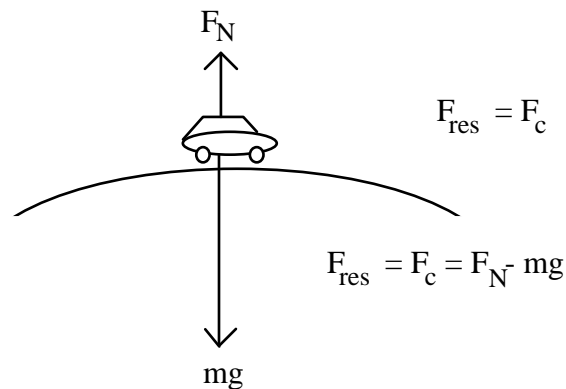
1. You are given distance and velocity, find acceleration. To find force, use $F = ma$.
2. The “theme equation” for this chapter is $F_c = \frac{mv^2}{r}$ or $a_c = \frac{v^2}{r}$. You’re given velocity and radius, find the acceleration. Don’t forget to convert distance to meters, and acceleration to g’s.
3. Centripetal acceleration = $a_c = \frac{v^2}{r}$.
The speed of any planet in orbit = $\frac{\text{distance}}{\text{time}} = \frac{\text{circumference}}{\text{period}}$. Express the circumference ($2\pi r$) in meters and the period (1 year) in seconds.
5. Centripetal acceleration = $a_c = \frac{v^2}{r}$. Convert km to meters and minutes to seconds.
The speed of the space shuttle = $\frac{\text{distance}}{\text{time}} = \frac{\text{circumference}}{\text{period}}$.
4. You are given force, mass, and distance. Use the “theme equation” and find velocity.
6. The centripetal acceleration = mass x centripetal force. Change rpm to meters/second using 1 revolution = $2\pi r$ radius, where the radius = the distance of the speck from the center.
7. See the diagram on page 140. At the top of the swing F_c is supplied by mg and F_T , all of which are pointing down. Add the vectors and solve for F_T . The same is true at the bottom of the swing, except F_T and F_c are pointing up and mg is pointing down. Add the vectors and solve for F_T .
8. You are given maximum force, mass, and distance. Use the “theme equation” and find the maximum possible velocity. To answer the second question, consider whether friction will add or subtract from the tension on the string.

9. The centripetal force is being supplied only by the static frictional force between the tires and the road. Since it is a flat road bed, $mv^2/r = mg\mu$. Solve for v .
10. The centripetal force is being supplied only by the static frictional force between the tires and the road. Since it is a flat road bed, $mv^2/r = mg\mu$. Solve for v .
12. Use the same equations as problems 7 and 9, but don't forget to convert cm to m, and rpm to m/s.

13. At the top of the arc, at minimum speed, then thing supplying the centripetal force is gravity. Set the gravitational force equal to the centripetal force and solve for velocity.

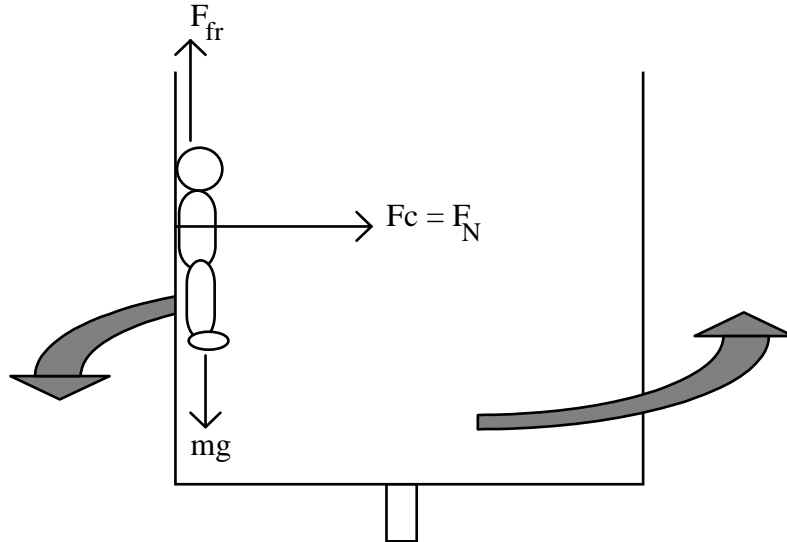


14.



- a) The resultant force is the centripetal force. Add the vectors making up (+) and down (-). Use the mass of the car for the mass in the problem.
- b) Same as (a), only use the mass of the driver as the mass in the problem.
- c) Use the same equation as in (a) and (b) and set the normal force = 0. Then solve for v .
15. This is just like problem #8 except that when you feel weightless, it is because F_t (in this case, the normal force) is 0. Set $F_c = mg$ and solve for velocity. To get revolutions per second, change m/s to rev/s using circumference = $2\pi r$.

18. To answer the first question presented, you will have to derive an equation for μ in terms of the radius and the linear velocity of the roto-ride. Use $F_c = F_N$, remembering that F_{fr} on a flat surface = $F_N\mu = mg\mu$. Convert revolutions per second to meters per second using $1 \text{ rev} = 2\pi r$.



Answer the next 3 questions in short answer essay form, expressing your answer in terms of centripetal force and Newton's 1st and 2nd laws.

28. Use the gravitational force equation on page 119 of the text. You are given mass and radius. Remember to convert the radius to meters.
30. Use the gravitational acceleration equation on page 121 of the text. You are given mass and radius. Remember to convert the radius to meters.
31. Use gravitational equation 5-4 on page 119 and decide what will happen to gravity if the mass is multiplied by the amount given.
34. Use gravitational equation 5-4 on page 119. The mass of the earth can be found on the inside front cover of the text. You are given two distances, but radius is measured from the center of the earth, so you will have to add them to the radius of the earth. It is also found on the inside front cover of the text.
35. Use the gravitational equation. Set $g = 0.98$ and solve for r .
36. Use gravitational equation 5-5 on page 128. You are given the mass as a multiple of the mass of the sun, which can be found on the inside front cover of the text. You are also given radius, but it must be converted to meters.
38. Convert 250 km to meters. Remember that 250 km above the earth's surface is $250 \text{ km} + 6.38 \times 10^3 \text{ km}$ from the center of mass.

42. Your initial equation is Newton's gravitational equation. First substitute F_c for F_g . Express velocity in terms of the distance the earth travels around the sun per year (period). Velocity = distance/time. Let the distance be $2\pi r$ (where r = distance between earth and sun), and let the time be 1 year expressed in seconds. Now solve for the mass of the sun.
46. Use $F_c = F_g$, substitute $2\pi r/T$ for velocity and solve for T . (T = the time for 1 revolution)
48. The mass and radius of the moon can be found in the inside front cover of the text. You know $F_g = F_c$. Set the two equations equal to each other and solve for v .
 Since the orbit is nearly circular, you can set $v = \frac{2\pi r}{T}$ and solve for T .
53. This is an elevator-going-up problem (chapter 4 problem #8). Solve for the resultant acceleration.
53. This is another elevator-going-up-or-down problem. In parts (a) and (b) there is no resultant acceleration. In part (c) the elevator is accelerating up in parts (d) and (e) it is accelerating down.
57. Use equation 5-6b on page 126 of the text, and the distance and period of an of the other planet's orbits found in Table 5-2 on page 125 to find the orbital distance of Icarus. Be sure to convert the period of Icarus to years.
58. Use equation 5-6b on page 126 of the text, and the distance and period of an of Earth's orbit found on the inside front cover of the text.
62. See problem 42.
66. This is just like problem 7. Let the maximum force Tarzan's arms can exert be the tension force and solve for v .
74. Refer to problem 42. Use the same general plan, but without actual numbers. In terms of the variables, solve for the mass of the planet.