GIANCOLI HOMEWORK SOLUTIONS
Section 5-8 and 5-10, #43-54

43. GIVEN

$h = 3600km = 3.6x10^6 m$

KNOWN

$r = r_{Earth} + h$

$r_{Earth} = 6.38x10^3 km = 6.38x10^6 m$

$G = 6.67x10^{-11} \frac{Nm^2}{kg^2}$

$M_{Earth} = 5.98x10^{24} kg$

SOLUTION

$r = 6.38x10^6 + 3.6x10^6 = 9.98x10^6$

$\sum F = ma$

$F_g = ma_c$

$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{r}}$

$\frac{GM}{r} = v^2$

$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(5.98x10^{24})}{(9.98x10^6)}} = 6.32x10^3 \, m/s$

44. GIVEN

$h = 650km = 6.5x10^5 m$

KNOWN

$r = r_{Earth} + h$

$r_{Earth} = 6.38x10^3 km = 6.38x10^6 m$

$G = 6.67x10^{-11} \frac{Nm^2}{kg^2}$

$M_{Earth} = 5.98x10^{24} kg$

SOLUTION

$r = 6.38x10^6 + 6.5x10^5 = 7.03x10^6$

$\sum F = ma$

$F_g = ma_c$

$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{r}}$

$\frac{GM}{r} = v^2$

$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(5.98x10^{24})}{(7.03x10^6)}} = 7.53x10^3\ m/s$

45. GIVEN

$a = 0.6g$

$d = 32m$

$r = 16m$

KNOWN

$g = 9.81\ m/s^2$

SOLUTION

$a = 0.6g = \frac{v^2}{r}$

$0.6gr = v^2$

$\sqrt{0.6(9.81)(16)} = v = 9.70\ m/s$

$v = \frac{2\pi r}{T}$

$T = \frac{2\pi r}{v} = \frac{2\pi(16)}{(9.70)} = 10.4\ s/rev$

46. GIVEN

$h = 0$

KNOWN

$r_{Earth} = 6.38x10^3 km = 6.38x10^6 m$

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$

$M_{Earth} = 5.98x10^{24} kg$

SOLUTION

$\sum F = ma$

$F_g = ma_c$

$$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{r}}$$

$$\frac{GM}{r} = v^2$$

$$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(5.98x10^{24})}{(6.38x10^{6})}} = 7.91x10^3\ m/s$$

$$v = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi(6.38x10^6)}{(7.91x10^3)} = 5070\ s/rev = 84.5\ min/rev$$

47. GIVEN

$h = 8850m$ Example 5-13, page 121

KNOWN

$r_{Earth} = 6.38x10^3 km = 6.38x10^6 m$

$$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$$

$M_{Earth} = 5.98x10^{24} kg$

SOLUTION

$$\sum F = ma$$

$F_g = ma_c$

$$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{r}}$$

$$\frac{GM}{r} = v^2$$

$r = r_{Earth} + h = 6.38x10^6 + 8850$

$$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(5.98x10^{24})}{(6.38x10^{6})}} = 7.90x10^3\ m/s$$

48. GIVEN

$h = 100km = 1x10^5 m$

KNOWN

$r_{Moon} = 1.74x10^3 km = 1.74x10^6 m$

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$

$M_{Moon} = 7.35x10^{22}kg$

SOLUTION

$\sum F = ma$

$F_g = ma_c$

$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{r}}$

$\frac{GM}{r} = v^2$

$r = r_{Moon} + h = 1.74x10^6 + 1x10^5 = 1.84x10^6$

$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(7.35x10^{22})}{(1.84x10^6)}} = 1.63x10^3\ m/s$

$v = \frac{2\pi r}{T}$

$T = \frac{2\pi r}{v} = \frac{2\pi(1.84x10^6)}{(1.63x10^3)} = 7083\ s/rev = 1.97\ hr/rev$

49. GIVEN

$r_{inner} = 73{,}000km = 7.3x10^7m$

$r_{outer} = 170{,}000km = 1.7x10^8m$

$M_{Saturn} = 5.7x10^{26}kg$

KNOWN

$G = 6.67x10^{-11}\frac{Nm^2}{kg^2}$

SOLUTION

$\sum F = ma$

$F_g = ma_c$

$G\frac{M\cancel{m}}{r^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{r}}$

$\frac{GM}{r} = v^2$

a. Inner ring:

$$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(5.7x10^{26})}{(7.3x10^{7})}} = 2.28x10^4\, m/s$$

$$v = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi(7.3x10^7)}{(2.28x10^4)} = 2.01x10^4\, s/rev = 5.59\, hr/rev$$

b. Outer ring:

$$\sqrt{\frac{GM}{r}} = v = \sqrt{\frac{(6.67x10^{-11})(5.7x10^{26})}{(1.7x10^{8})}} = 1.50x10^4\, m/s$$

$$v = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi(1.7x10^8)}{(1.45x10^4)} = 7.14x10^4\, s/rev = 19.8\, hr/rev$$

c. Comparing to Saturn's mean rotation period: The outer ring will complete around two rotations per Saturn day while the outer ring will take two Saturn days to complete one revolution.

50. GIVEN

$d = 24.0m$

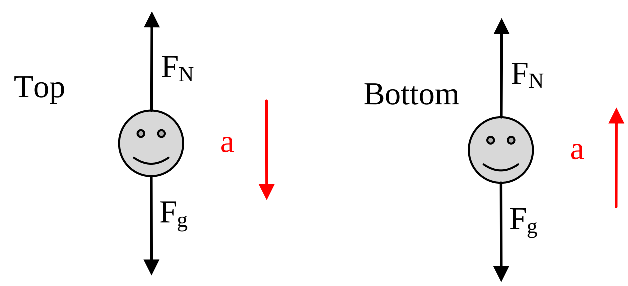
$r = 12.0m$

$T = 15.5s$

KNOWN

"Apparent weight" is the same thing as the normal force.

Looking for $\frac{F_N}{F_g}$



SOLUTION

$$v = \frac{2\pi r}{T} = \frac{2\pi(12.0)}{(15.5)} = 4.86\, m/s$$

$$a_c = \frac{v^2}{r} = \frac{(4.86)^2}{(12.0)} = 1.97\, m/s^2$$

a. Top of Ferris Wheel

$$\sum F = ma$$

$F_N - F_g = -ma_c$ positive up, negative down

$$F_N = F_g - ma_c$$

$$F_g = mg$$

$$\frac{F_N}{F_g} = \frac{mg - ma_c}{mg} = \frac{g - a_c}{g} = \frac{9.81 - 1.94}{9.81} = 0.802$$

b. Bottom of Ferris Wheel

$$\sum F = ma$$

$F_N - F_g = ma_c$ positive up, negative down

$$F_N = F_g + ma_c$$

$$F_g = mg$$

$$\frac{F_N}{F_g} = \frac{\cancel{m}g + \cancel{m}a_c}{\cancel{m}g} = \frac{g + a_c}{g} = \frac{9.81 + 1.94}{9.81} = 1.198$$

51. GIVEN

$m = 75kg$

$r = 4200km = 4.2x10^6 m$

KNOWN

$M_{Moon} = 7.35x10^{22} kg$

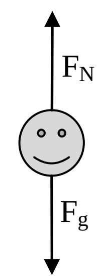
At constant velocity, there is no acceleration

"Apparent weight" is the same as the normal force, F_N

$$G = 6.67x10^{-11} \frac{Nm^2}{kg^2}$$

SOLUTION

a.

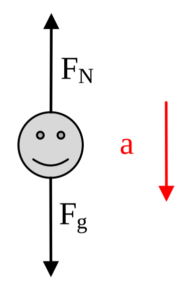


$$\sum F = ma$$

$$F_N - F_g = 0$$

$$F_N = F_g = G\frac{Mm}{r^2} = (6.67x10^{-11})\frac{(7.35x10^{22})(75)}{(4.2x10^6)^2} = 20.8N$$

b. $a = 2.9\, m/s^2$



$$\sum F = ma$$

$$F_N - F_g = -ma$$

$$F_N = F_g - ma = G\frac{Mm}{r^2} - ma$$

$F_N = (6.67x10^{-11})\frac{(7.35x10^{22})(75)}{(4.2x10^6)^2} - (75)(2.9) = -197N$ *the negative sign indicates the normal force is in the opposite direction that we assumed. In other words, it acts downward, toward the moon.*

52. GIVEN

$d = 360\ million\ km = 3.6x10^{11}m$ distance between the two stars

$r = 360\ million\ km = 1.8x10^{11}m$ distance to the axis of rotation

$T = 5.7yr = 1.80x10^{8}$

SOLUTION

$$\sum F = ma$$

$$F_g = ma_c$$

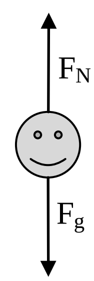
$$G\frac{m\cancel{m}}{d^2} = \cancel{m}\frac{v^2}{r}$$

$$m = \frac{v^2 d^2}{Gr}$$

$$v = \frac{2\pi r}{T} = \frac{2\pi(1.8x10^{11})}{(1.80x10^8)} = 6.28x10^3\ m/s$$

$$m = \frac{v^2 d^2}{Gr} = \frac{(6.28x10^3)^2(3.6x10^{11})^2}{(6.67x10^{-11})(1.8x10^{11})} = 4.26x10^{29}kg$$

53. GIVEN



$m = 55kg$

KNOWN

"Apparent weight" is the same as the normal force, F_N

SOLUTION

a. Constant velocity means no acceleration and normal force equals weight

$$\sum F = ma$$

$$F_N - F_g = 0$$

$$F_N = F_g = mg = (55)(9.81) = 540N$$

b. Constant velocity means no acceleration and normal force equals weight

$$\sum F = ma$$

$$F_N - F_g = 0$$

$$F_N = F_g = mg = (55)(9.81) = 540N$$

c. Acceleration is upward (positive) and equal to 0.33g.

$$\sum F = ma$$

$$F_N - F_g = ma$$

$$F_N = F_g + ma = mg + ma = (55)(9.81) + (55)(0.33)(9.81) = 718N$$

d. Acceleration is downward (negative) and equal to 0.33g.

$$\sum F = ma$$

$$F_N - F_g = -ma$$

$$F_N = F_g - ma = mg - ma = (55)(9.81) - (55)(0.33)(9.81) = 361N$$

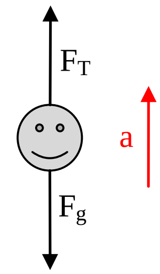
e. Acceleration is downward (negative) and equal to 1g.

$$\sum F = ma$$

$$F_N - F_g = -mg$$

$F_N = F_g - mg = mg - mg = 0$ apparent weightlessness

54. GIVEN



$m = 17.0kg$

$F_{T-max} = 220N$

KNOWN

Asks for the minimum acceleration of the elevator that will make the cord break. Problem does not address why a monkey was hanging from a cord in an elevator which is a very great concern.

SOLUTION

$$\sum F = ma$$

$$F_T - F_g = ma$$

$$\frac{F_T - mg}{m} = ma = \frac{220 - (17)(9.81)}{(17)} = 3.13\,m/s^2$$