Homework Solutions
10/3/2007

Problems

39. a.

$$r = r_{earth} + h = 6.38 \bullet 10^6 m + 2.00 \bullet 10^5 m = 6.58 \bullet 10^6 m$$

$$\frac{Gm_s m_R}{r^2} = \frac{m_s v^2}{r}$$

$$v = \sqrt{\frac{Gm_E}{r}} = \sqrt{\frac{\left(6.67 \bullet 10^{-11} \frac{Nm^2}{kg^2}\right)\left(5.98 \bullet 10^{24} kg\right)}{6.58 \bullet 10^6 m}}$$

$$v = 7.79 \bullet 10^3 \frac{m}{s}$$

$$v = \frac{d}{t}$$

$$t = \frac{d}{v} = \frac{2\pi r}{v} = \frac{2\pi\left(6.58 \bullet 10^6 m\right)}{7.79 \bullet 10^3 \frac{m}{s}} = 5.31 \bullet 10^3 s = 1.48h$$

b.

$$v = 7.79 \bullet 10^3 \frac{m}{s}$$

c. If the rocket is launched from the equator, its initial speed is the orbital speed of the earth.

$$v_i = \frac{2\pi\left(6.38 \bullet 10^6 m\right)}{86400 \ s} = 464 \ \frac{m}{s}$$

$$W = \left(KE + U_g\right)_f - \left(KE + U_g\right)_i$$

$$U_g = mgh$$

$$mg = \frac{Gm_e m}{r^2}$$

$$U_g = \frac{Gm_e mh}{r^2}$$

$$h = r$$

$$U_g = \frac{Gm_e m}{r}$$

$$W = \left(\frac{1}{2}mv^2 + \frac{Gm_e m_s}{r}\right)_f - \left(\frac{1}{2}mv^2 + \frac{Gm_e m_s}{r}\right)_i$$

$$W = \left(\frac{1}{2}(200kg)\left(7.79 \bullet 10^3 \frac{m}{s}\right)^2 + \frac{6.67 \bullet 10^{-11} \frac{Nm^2}{kg^2}(5.98 \bullet 10^{24} kg)(200kg)}{6.58 \bullet 10^6 m}\right) -$$

$$\left(\frac{1}{2}(200kg)\left(464 \frac{m}{s}\right)^2 + \frac{6.67 \bullet 10^{-11} \frac{Nm^2}{kg^2}(5.98 \bullet 10^{24} kg)(200kg)}{6.38 \bullet 10^6 m}\right)$$

$$W = 5.67 \bullet 10^9 J$$

49. a.

$$mg - \eta = \frac{mv^2}{r}$$

$$\eta = mg - \frac{mv^2}{r}$$

$$a_c = \frac{v^2}{r} = 0.0340\frac{m}{s^2}$$

Since the normal force is the person's perception of her/his weight, that value would be less than their actual weight, mg, by m times 0.0340 m/s/s.

b.

$$\eta = mg - \frac{mv^2}{r}$$

$$\eta = (75.0kg)\left(9.80\frac{m}{s^2}\right) - (75.0kg)\left(0.0340\frac{m}{s^2}\right) = 732N$$

At the Equator a person would feel like s/he weighs 732 N whereas at the poles s/he would feel like s/he weighs 735 N.

c.

$$\eta = mg - \frac{mv^2}{r}$$

$$\eta = (75.0kg)\left(9.80\frac{m}{s^2}\right) = 735N$$

59. a.

$$mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$$

$$mgh + \frac{1}{2}mv_0^2 = mg\left(\frac{2}{3}h\right) + \frac{1}{2}mv_A^2$$

$$v_A = \sqrt{2g\left(h - \frac{2}{3}h\right) + \left(v_0^2\right)} = \sqrt{2g\left(\frac{h}{3}\right) + \left(v_0^2\right)}$$

$$mg = \frac{mv_A^2}{R}$$

$$v_A = \sqrt{gR}$$

$$\sqrt{2g\left(\frac{h}{3}\right)+\left(v_0^2\right)}=\sqrt{gR}$$

$$2g\left(\frac{h}{3}\right)+\left(v_0^2\right)=gR$$

$$v_0^2=gR-2g\left(\frac{h}{3}\right)$$

$$v_0=\sqrt{gR-2g\left(\frac{h}{3}\right)}=\sqrt{g\left(R-\frac{2h}{3}\right)}$$

b.

$$mgh_i+\frac{1}{2}mv_i^2=mgh_f+\frac{1}{2}mv_f^2$$

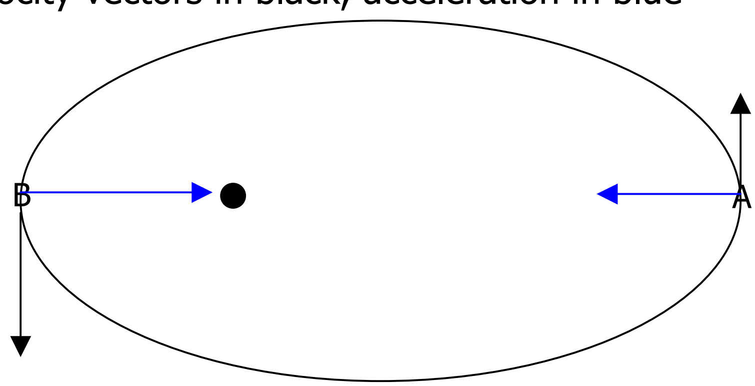
$$mgh+\frac{1}{2}mv_0^2=mgh'$$

$$h'=\frac{gh+\frac{1}{2}v_0^2}{g}=\frac{gh+\frac{1}{2}g\left(R-\frac{2h}{3}\right)}{g}=h+\frac{R}{2}-\frac{h}{3}$$

$$h'=\frac{R}{2}+\frac{2h}{3}$$

62. a.

velocity vectors in black, acceleration in blue



b. The velocity vector at B is longer than the velocity vector at A because of conservation of mechanical energy. The potential energy is greater at A so therefore kinetic energy must be greater at B, resulting from a larger velocity as the spacecraft accelerates toward B. The acceleration vector at B is larger than the acceleration vector at B because the net force on the spacecraft is larger at B and from Newton's Second Law we know that net force and acceleration are proportional.