Physics 20 - Lesson 23
Universal Gravitation – Satellites & Orbits

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1) /5

$r = 6.38\times10^{6}\,m + 250\times10^{3}\,m$

$r = 6.63\times10^{6}\,m$

$m = 5.98\times10^{24}\,kg$

$T = ?$

$F_c = F_g$

$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$

$T = \sqrt{\frac{4\pi^2 r^3}{GM}}$

$T = \sqrt{\frac{4\pi^2 (6.63\times10^{6}\,m)^3}{(6.67\times10^{-11}\,Nm^2/kg^2)(5.98\times10^{24}\,kg)}}$

$\boxed{T = 5.37\times10^{3}\,s}$

2) /4

$m = 8.80\times10^{25}\,kg$

$r = 1.91\times10^{8}\,n$

$T = ?$

$F_c = F_g$

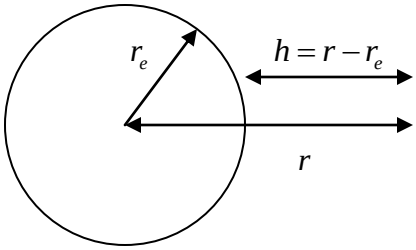
$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$

$T = \sqrt{\frac{4\pi^2 r^3}{GM}}$

$T = \sqrt{\frac{4\pi^2 (1.91\times10^{8}\,m)^3}{(6.67\times10^{-11}\,Nm^2/kg^2)(8.80\times10^{25}\,kg)}}$

$\boxed{T = 2.16\times10^{5}\,s}$

3) / 7



$F_c = F_g$

$\frac{mv^2}{r} = \frac{GMm}{r^2}$

$r = \frac{GM}{v^2} = \frac{6.67\times10^{-11}\,Nm^2/kg^2(5.98\times10^{24})}{(7600m/s)^2}$

$r = 6.91\times10^{6}\,m$

$h = r - r_e = 6.91\times10^{6}\,m - 6.38\times10^{6}\,m$

$\boxed{h = 5.26\times10^{5}\,m}$

4) $T = 2.36\times10^{6}\,s$

$r = 3.80\times10^{8}\,m$

$v = ?$

/ 6 $M_e = ?$

$$v = \frac{2\pi r}{T} = \frac{2\pi(3.80\times10^{8}\,m)}{2.36\times10^{6}\,s}$$

$$\boxed{v = 1012\,m/s}$$

$$F_c = F_g$$

$$\frac{mv^2}{r} = \frac{GM_e m}{r}$$

$$M_e = \frac{v^2 r}{G} = \frac{(1012\,m/s)^2(3.80\times10^{8})}{(6.67\times10^{-11}\,Nm^2/kg^2)}$$

$$\boxed{M_e = 5.83\times10^{24}\,kg}$$

5)

$T = 365\times24\times3600$

$T = 3.156\times10^{7}\,s$

$r = 1.49\times10^{11}\,m$

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$$v = \frac{2\pi r}{T} = \frac{2\pi(1.49\times10^{11}\,m)}{3.156\times10^{7}\,s}$$

$$\boxed{v = 2.97\times10^{4}\,m/s}$$

$$F_c = F_g$$

$$\frac{mv^2}{r} = \frac{GM_e m}{r}$$

$$M = \frac{v^2 r}{G} = \frac{(2.97\times10^{4}\,m/s)^2(1.49\times10^{11}\,m)}{(6.67\times10^{-11}\,Nm^2/kg^2)}$$

$$\boxed{M_s = 1.97\times10^{30}\,kg}$$

6) $r = 8\times r_e = 1.192\times10^{12}\,m$

$M = 1.98\times10^{30}\,kg$

/6

$$F_c = F_g$$

$$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$$

$$T = \sqrt{\frac{4\pi^2 r^3}{GM}}$$

$$T = \sqrt{\frac{4\pi^2(1.192\times10^{12}\,m)^3}{(6.67\times10^{-11}\,Nm^2/kg^2)(1.98\times10^{30}\,kg)}}$$

$$T = 7.12\times10^{8}\,s = \frac{7.12\times10^{8}\,s}{3.156\times10^{7}\,s/year}$$

$$\boxed{T = 22.5 \text{ Earth Years}}$$

7) /4

$T = 7.82\times10^{9}\,s$

$M = 1.98\times10^{30}\,kg$

$r = ?$

$F_c = F_g$

$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$

$r^3 = \frac{GMT^2}{4\pi^2}$

$r = \sqrt[3]{\frac{(6.67\times10^{-11}\,Nm^2/kg^2)(1.98\times10^{30}\,kg)(7.82\times10^{9}\,s)^2}{4\pi^2}}$

$\boxed{r = 5.89\times10^{12}\,m}$

8) /6

$T = 8.85\times10^{4}\,s$

$M = 6.37\times10^{23}\,kg$

$r_m = 3.43\times10^{6}\,m$

$F_c = F_g$

$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$

$r^3 = \frac{GMT^2}{4\pi^2}$

$r = \sqrt[3]{\frac{(6.67\times10^{-11}\,Nm^2/kg^2)(6.37\times10^{23}\,kg)(8.85\times10^{4}\,s)^2}{4\pi^2}}$

$r = 2.035\times10^{7}\,m$

$altitude = 2.035\times10^{7}\,m - 3.43\times10^{6}\,m$

$\boxed{alttude = 1.69\times10^{7}\,m}$

9) /3

$m = 1.98\times10^{30}\,kg$

$r = 4.8\times10^{11}\,m$

$F_c = F_g$

$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$

$T^2 = \frac{4\pi^2 r^3}{GM}$

$T = \sqrt{\frac{4\pi^2(4.8\times10^{11}\,m)^3}{6.67\times10^{-11}\,Nm^2/kg^2(1.98\times10^{30}\,kg)}}$

$\boxed{T = 1.8\times10^{8}\,s}$

10) /4

$r = 2r_e = 2\times6.38\times10^{6}\,m$

$r = 1.276\times10^{7}\,m$

$F_c = F_g$

$\frac{4\pi^2 mr}{T^2} = G\frac{Mm}{r^2}$

$T^2 = \frac{4\pi^2 r^3}{GM}$

$T = \sqrt{\frac{4\pi^2(1.276\times10^{7}\,m)^3}{6.67\times10^{-11}\,Nm^2/kg^2(5.90\times10^{24}\,kg)}}$

$\boxed{T = 1.43\times10^{4}\,s}$

11) /4

$r = 2.7\times10^{20}\,m = 2.7\times10^{17}\,km$

$T = 200,000,000\times365.25\times24$

$T = 1.75\times10^{12}\,h$

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

$$v = \frac{2\pi(2.7\times10^{17}\,km)}{(1.75\times10^{12}\,h)}$$

$$\boxed{v = 9.68\times10^{5}\,km/h}$$