HW solutions Lecture 25

HW25-1 Short explanations of why we made the errors we did and correct them.

HW25-2 Ignoring air drag!

a) \[ y = y_0 + v_0 \sin \theta \cdot t - \frac{1}{2} g t^2 = 0 \pm P \]
\[ t = \frac{-v_0 \sin \theta \pm \sqrt{(v_0 \sin \theta)^2 - 2gh}}{g} \]
\[ = \frac{14.3 \text{ s}}{60.2} \quad \text{(+ sign is extraneous: } t < 0) \]

b) \[ x = v_0 \cos \theta \cdot t = \frac{1140 \text{ m}}{1100 \text{ m}} \rightarrow 10.3 \text{ s} \]

HW25-3

The projectile reaches its peak when the time is half the total time.
\[ t = \frac{1}{2} T = \frac{v_0 \sin \theta}{g} \]
\[ y = v_0 \sin \theta t - \frac{1}{2} g t^2 = \frac{v_0^2 \sin^2 \theta}{g} - \frac{v_0^2 \sin^2 \theta}{2g} \]
\[ H = \frac{v_0^2 \sin^2 \theta}{2g} \]
\[ R = \frac{v_0^2 \sin 2\theta}{g} = \frac{v_0^2 \cdot 2 \sin \theta \cos \theta}{g} \]
\[ \frac{v_0^2}{g} = \frac{R}{2 \sin \theta \cos \theta} \]
\[ H = \frac{R}{2 \sin \theta \cos \theta} \cdot \frac{\sin^2 \theta}{2} = \frac{R}{4 \tan \theta} \]

Check:
\[ a = \frac{v_0^2}{g}, \quad \tan \theta = 1 \]
\[ H = \frac{R}{4} \]
By the way, we had to assume the canyon wasn’t too shallow. Sally’s ball hits the opposite wall in 10 s (see above), so it has dropped a distance $4.9 \times (100) = 490$ m. If the canyon weren’t this deep, Sally’s ball would hit the bottom and perhaps roll along it before Mary’s ball hits Sally’s ball in the air. So in that case the two balls would hit the bottom and perhaps roll toward each other if they didn’t get stuck in the sand or whatever. Then they would always hit anyway! But they might just get stuck in the mud, so to heck with that complication!
HW solutions Lecture 25

HW25-5

a) The minimum velocity it must have leads to minimum $E_{\text{min}} = 0 = \frac{1}{2} m v^2 - \frac{G M}{r}$.

\[ V = \sqrt{\frac{2 G M}{r}} = \sqrt{\frac{2 (6.67 \times 10^{-11}) \times \frac{3}{2} \times (1.99 \times 10^{30})}{5 \times 10^9 \times 10^3}} \]

\[ = \sqrt{5.31 \times 10^7 \frac{2}{3}} = 7.3 \times 10^3 \frac{3}{1} = 7.3 \text{ km/s} \]

b) Circular orbit \( \frac{v^2}{r} = \frac{G m}{r} \).

\[ V = \sqrt{\frac{G M}{r}} = \sqrt{2 \text{ above}} = 5.2 \text{ km/s} \]

No change

Less than above so it must be!

c) No cancelled out of both! No change

You would have to get masses so big as the sun to change

(Sun would then move, too.)