MARKUS KLUTE: Welcome back to 8.20, Special Relativity. So if there is a time dilation effect due to gravitational fields, then there's also a redshift which is of gravitational fields. So a consequence of time dilation is a change in the light frequency.

And I asked you to estimate the magnitude of this effect. And the example you want to use is the one shown here. So you have a tower just-- not randomly, but 22 and 1/2 meters tall. And a light beam is sent down. Basically, the tower is built on this planet, and there's gravity that's acting. So this is basically an accelerating reference frame.

The length of the tower is, again, 22 meters. And I would like you to just get a feeling. How big can this effect be, the effect of redshift here? So please, try to work this out.

The way to think about this is first to say, OK, now the light-- the delta t equals the light to travel-- is l divided by c. The speed of light is c. The length is l. The change in velocity is g, acceleration, times l divided by c.

So the Doppler shift then is the frequency, the new frequency, divided by the initial frequency. And that can be approximated by 1 plus delta v over c. So we find that it's 1 plus g times l over c square.

Now the speed of light is pretty fast, 3 times 10 to the 9 meter per second. And this distance is only 22 and 1/2 meters. So we find that this is a tiny, tiny, tiny effect.

But nevertheless, experimentalists at Harvard tested this effect. So Pound, Rebka, and Snider in the 1950s and '60s were able to show this very tiny effect. You want to know more about this, you can, for example, look up a small description in Wikipedia here. But there's quite some literature on those experimental tests [INAUDIBLE]