Gravitational Red-Shift

Light feels the gravitational field: as it moves in different regions it feels the gravitational potential Φ and its changes cause its energy $E = h\nu$ to change, thus its frequency to change.

Accelerating Rocket (no gravity) $\sim$ Static Rocket with gravity

Same description of a clock sending photons inside the rocket$\rightarrow$frequency shift.

$$\Delta E = (\text{mass}) \times \Delta\Phi = \frac{E}{c^2}\Delta\Phi \Rightarrow$$

$$\Rightarrow \frac{\Delta\nu}{\nu} = \frac{\Delta\Phi}{c^2} = \frac{g\Delta h}{c^2}$$

Since frequency $\sim$ $(\text{time})^{-1}$ we have a similar relation for time dilation

$$\Rightarrow \frac{\Delta t}{t} = \frac{\Delta\Phi}{c^2} = \frac{g\Delta h}{c^2}$$

Put $g \simeq 10\ m/sec^2$, $\Delta h = 20m \rightarrow \Delta\nu/\nu \sim 10^{-15}$!!!

It was measured for the first time by Pound and Rebka in the 60's.