Gravitational potential energy: $V - V_\infty = -\frac{GMm}{r}$ [1]

gravitational potential: $U = \frac{V - V_\infty}{m} = \frac{-GM}{r}$ [2]

escape velocity: $v_{\text{esc}} = \sqrt{\frac{2GM}{r}}$ $\therefore v_{\text{esc}}^2 = -2U$ $\therefore \frac{v_{\text{esc}}^2}{c^2} = \frac{-2U}{c^2} = \frac{2GM}{rc^2}$ [3]

Kinetic energy of free fall: $T = \frac{1}{2}mv_{\text{ff}}^2$ [4]

free fall from ∞ starts with: $v_{\text{ff@}\infty} = 0 \therefore T_\infty = 0$ [5]

specific *kinetic energy*: $S = \frac{T}{m} = \frac{1}{2}v_{\text{ff}}^2$ [6]

free fall *velocity*: $\therefore v_{\text{ff}}^2 = 2S$ $\therefore \frac{v_{\text{ff}}^2}{c^2} = \frac{2S}{c^2}$ [7]

Conservation of *energy*: $T = V_\infty - V$ $\therefore S = -U$ $\therefore v_{\text{ff}}^2 = v_{\text{esc}}^2$ [8]

therefore (obviously): $\frac{2S}{c^2} = \frac{-2U}{c^2}$ [9]

This renders: $\sqrt{1 - \frac{2S}{c^2}} = \sqrt{1 + \frac{2U}{c^2}}$ [10]

therefore: $\sqrt{1 - \frac{v_{\text{ff}}^2}{c^2}} = \sqrt{1 - \frac{v_{\text{esc}}^2}{c^2}} = \sqrt{1 - \frac{2GM}{rc^2}}$ [11]

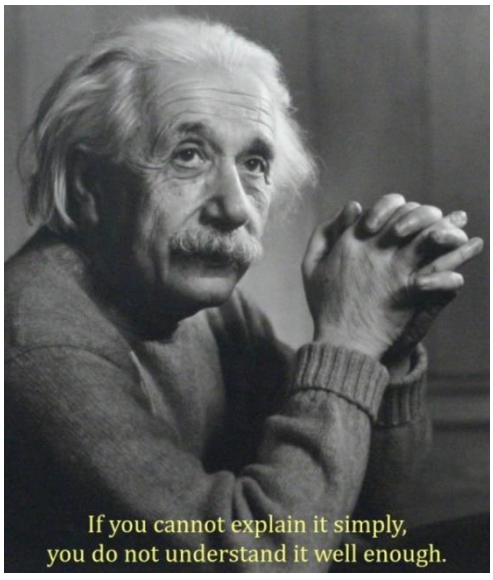
We have from SR: $\sqrt{1 - \frac{v_{\text{ff}}^2}{c^2}} = \frac{1}{\gamma}$ = the reciprocal *Lorentz factor* [12]

and from GR: $\sqrt{1 - \frac{v_{\text{esc}}^2}{c^2}} = \sqrt{1 - \frac{2GM}{rc^2}}$ = the "*Schwarzschild factor*" [13]

Yielding (with $r_S = \frac{2GM}{rc^2}$)**:** $\frac{1}{\gamma} = \sqrt{1 - \frac{r_S}{r}}$ [14]

The reciprocal *Lorentz factor* of a freely falling body (which has *accelerated* to its free fall velocity) equals the *Schwarzschild factor* that arises from the *gravitational field* at its current location. This simply follows from the conservation of *energy*. We obviously arrived at Einstein's equivalence principle which says that a *gravitational field* and *acceleration* are indistinguishable.

Apparently, conservation of *energy* and Einstein's equivalence principle are the very same.



He actually said (to Louis de Broglie): All physical theories, their mathematical expression apart, ought to lend themselves to so simple a description that even a child could understand them.

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