$$T[a\_] := \left(\frac{\hbar}{(2\pi\,(c)\,(k))}\right) a \quad \text{(*Unruh effect *)}$$

$$Tbh[Mass\_] := \left(\frac{\hbar\, c^3}{8\pi G\, k}\right)\frac{1}{Mass} \quad \text{(*Hawking Temp *)}$$

$$g[Mass\_, Distance\_] := \frac{(G\,Mass)}{(Distance\wedge 2)} \quad \text{(* magnitude of grav acceleration *)}$$

```
Tbh[1]
```

$$\frac{c^3 \hbar}{8\, G\, k\, \pi}$$

$\hbar$ = 1.054571800 * (10^(-34)); (* Js *)
c = 299 792 458; (* m/s *)
k = 1.38064852 * (10^(-23)); (* J/K Boltzmann constant *)
G = 6.67408 * (10^(-11)); (* $\frac{m\wedge 3}{kg\ s\wedge 2}$ *)
MSun = 1.98855 * (10^(30)); (* kg *)
MEarth = 5.9722 * (10^(24)); (* kg *)
MMilkyWay = 2 * (10^(42)); (* Appx mass of milky way galaxy *)
RSun = 695 700 000; (* mean radius in meters *)
REarth = 6 371 000; (* mean radius in meters *)
AU = 149 597 870 700; (* 1AU in meters *)
RMilkyWay = 10^8 AU; (*Appx size of milky way galaxy *)
MElectron = 9.1 * (10^(-31)); (* Electron Mass *)
mPlanck = $\sqrt{\frac{\hbar\, c}{G}}$; (* Planck Mass *)
H = 0.2 * (10^(-17)); (*Appx hubble constant in s^-1 = Hz,
also is about the inverse of the age of the universe *)

^ S.I. Unit values

```
T[1]
T[9.8]
```

4.05501×10^{-21}

3.97391×10^{-20}

```
g[MSun, r]
```

$$\frac{1.32717 \times 10^{20}}{r^2}$$

```
T[g[MSun, r]] (*works correctly as double fn within fn *)
```

$$\frac{0.538171}{r^2}$$

```
T[g[MSun, RSun]]
```

1.11193×10^{-18}

$$rs = \frac{2\,G}{(c\hat{}2)} M \Rightarrow g = \frac{G\,M}{rs\hat{}2} = \frac{G\,M}{\left(\frac{2\,G}{(c\hat{}2)} M\right)\hat{}2} = (c\hat{}4)\ \frac{1}{4\,G}\ \frac{1}{M}$$

$$\Rightarrow Tbh = \left(\frac{\hbar}{2\,\pi\,c\,k}\right) g = \left(\frac{\hbar}{2\,\pi\,c\,k}\right) (c\hat{}4)\ \frac{1}{4\,G}\ \frac{1}{M} = \left(\frac{\hbar\,c^3}{8\,\pi\,G\,k}\right) \frac{1}{M}$$

$$Tbh = \left(\frac{mp^2\,c^2}{8\,\pi\ \ k}\right) \frac{1}{M}$$

Tbh[MSun]

6.17003×10^{-8}

T[g[MMilkyWay, RMilkyWay]]
Tbh[MMilkyWay]

2.41859×10^{-27}

6.13471×10^{-20}

Tbh[MSun]
Tbh[MEarth]
Tbh[1] (* 1 kg *)
Tbh[MElectron]

6.17003×10^{-8}

0.0205442

1.22694×10^{23}

1.34829×10^{53}

$$\lambda[\text{Mass\_}] := \left(\frac{2\,\pi\,\hbar}{c}\right) \frac{1}{(\text{Mass})}$$

T[g[MSun, λ[MSun]]]
T[g[MEarth, λ[MEarth]]]
T[g[1, λ[1]]] (* 1 kg *)
T[g[MElectron, λ[MElectron]]]
T[g[mPlanck, λ[mPlanck]]]

4.35635×10^{143}

1.18009×10^{127}

5.54004×10^{52}

4.17482×10^{-38}

5.71178×10^{29}

de Sitter Unruh Effect

de Sitter Unruh effect :

$T_H = \frac{H}{2\,\pi}$ in natural units, H = Hubble Constant

$$\Rightarrow \frac{T_H}{T_{planck}} = \frac{H}{2\pi} t_{planck} \Rightarrow T_H = \frac{H}{2\pi} t_{planck}\, T_{planck}$$

$$\Rightarrow T_H = \frac{H}{2\pi} \sqrt{\frac{\hbar G}{c^5}} \sqrt{\frac{\hbar c^5}{G k^2}} = \frac{H}{2\pi} \sqrt{\frac{\hbar^2}{k^2}} = \frac{H}{2\pi} \frac{\hbar}{k}$$

$$\mathbf{\frac{H}{2\pi} \frac{\hbar}{k}}$$

2.43133×10^{-30}