Maple code for the article: Derivation of fundamental constants and SI units via black-hole electron and sqrt of Planck momentum
https://philpapers.org/rec/MACAMU
http://planckmomentum.com/

```
> #initialize parameters
> Digits:=16:
c:=299792458:
R:=10973731.568508:
pi:=3.14159265358979323846264338327 95:
a:=137.035999139:
mu0:=(pi/(2^5*5^7)):
epsilon0:=(2500000/(pi*c^2)):
Omega:=(c^35/(2^295*3^21*pi^157*mu0^9*R^7*a^26))^(1./225):
Q:=(2^5*c^5*mu0^3/(3^3*pi*a^8*R))^(1./15):
Omega; Q;
```

$$2.007134949636316$$

$$1.019113410989319$$

```
>
>
> #2. units as q; eq(2-15)
> m:=q^2*s/kg: c:=m/s: Q:=q: lp:=m:
> c; mP=(kg*m/s)/(m/s); Ep=(kg*m/s)*(m/s); Fp=(kg*m/s)/s;
```

$$\frac{q^2}{kg}$$

$$mP = kg$$

$$Ep = \frac{q^4}{kg}$$

$$Fp = \frac{q^2}{s}$$

```
>
> AQ=c^3/Q^3; ed=c^2*lp/Q^3; Tp=c^4/Q^3; kB=Q^5/c^3;
```

$$AQ = \frac{q^3}{kg^3}$$

$$ed = \frac{q^3\, s}{kg^3}$$

$$Tp = \frac{q^5}{kg^4}$$

$$kB = \frac{kg^3}{q}$$

```
> mu0:=Q^8/(lp*c^5): mu=mu0;
```

$$\mu = \frac{kg^6}{q^4\, s}$$

```
> sigmae:=(c^2*lp/Q^3)*c: sigma[e]=sigmae;
```

$$\sigma_e = \frac{q^5\, s}{kg^4}$$

```
> fe=sigmae^3/s; lp^2*c^10/Q^9=Q^7/mu0^2;
```

$$fe = \frac{q^{15}\, s^2}{kg^{12}}$$

$$\frac{q^{15}\, s^2}{kg^{12}} = \frac{q^{15}\, s^2}{kg^{12}}$$

```
> Rydberg=c^5*mu0^3/Q^15;
```

$$Rydberg = \frac{kg^{13}}{q^{17}\, s^3}$$

```
>
> #eq(26)
> R:=1/m: Q^15=c^5*mu0^3/R;
```

$$q^{15} = \frac{kg^{12}}{s^2}$$

```
> #eq(28-39)
> #Constants in terms of c, mu0, R, alpha
> hd:=(2*pi^10*mu0^3/(3^6*c^5*a^13*R^2))^(1./3):
ed:=(4*pi^5/(3^3*c^4*a^8*R))^(1./3):
ld:=(pi^22*mu0^9/(2^35*3^24*a^49*c^35*R^8))^(1./15):
td:=(pi^22*mu0^9/(2^20*3^24*a^49*c^50*R^8))^(1./15):
md:=(2^25*pi^13*mu0^6/(3^6*c^5*a^16*R^2))^(1./15):
Aq:=(2^10*pi*3^3*c^10*a^3*R/mu0^3)^(1./5):
kd:=(pi^5*mu0^3/(2*3^3*a^5*c^4*R))^(1./3):
Gd:=(pi^3*mu0/(2^20*3^6*a^11*R^2))^(1./5):
Td:=(2^10*3^3*c^15*a^3*R/(pi^4*mu0^3))^(1./5):
med:=(16*pi^10*R*mu0^3/(3^6*a^7*c^8))^(1./3):
h=hd; e=ed; l[p]=ld; t[p]=td; m[P]=md; k[B]=kd; G=Gd; T[p]=Td;
m[e]=med;
```

$$h = 0.6626069134128426\ 10^{-33}$$

$$e = 0.1602176511296910\ 10^{-18}$$

$$l_p = 0.1616036600960468\ 10^{-34}$$

$$t_p = 0.1078103573212951\ 10^{-42}$$

$$m_P = 0.2176728175801019\ 10^{-7}$$

$$k_B = 0.1379510147516053\ 10^{-22}$$

$$G = 0.6672497192291777\ 10^{-10}$$

$$T_p = 0.1418145219320148\ 10^{33}$$

$$m_e = 0.9109382312560075\ 10^{-30}$$

```
>
>
> #eq(40-41)
> 4*2*pi^5*kd^4/(15*hd^3*c^3);
```

$$0.7540804678501488\ 10^{-15}$$

```
> q^(15/2)=k^(6)/t^(1); q^(15/2)/q^6;
rd^3=three^3*4*pie^5*mu0^3*alpha^19*R^2/(five^3*c^10);
```

$$q^{(15/2)} = \frac{k^6}{t}$$

$$q^{(3/2)}$$

$$rd^3 = \frac{4\ three^3\ pie^5\ kg^{30}\ \alpha^{19}}{q^{36}\ s^5\ five^3}$$

```
>
>
> #eq(42-46)
> sigmae:=3*a^2*ed*c/(2*pi^2): sigmae;
```

$$0.1370856255928262\ 10^{-6}$$

```
> sigmatp:=3*a^2*Aq*c/(2*pi^2): sigmatp;
```

$$0.1271544116900421\ 10^{37}$$

```
> fe=sigmae^2*sigmatp; fe=sigmae^3/td; fe=td^2*sigmatp^3;
```

$$fe = 0.2389545307369271\ 10^{23}$$

$$fe = 0.2389545307369291\ 10^{23}$$

$$fe = 0.2389545307369230\ 10^{23}$$

```
>
>
> #3 Planck units
> #formulas in terms of k (mass), t (time);
> k:=(2^25*pi^13*mu0^6/(3^6*c^5*a^16*R^2))^(1./15):
```

```
t:=(pi^22*mu0^9/(2^20*3^24*a^49*c^50*R^8))^(1./15)/(2*pi):
M:=1*k: md=M; T:=2*pi*t: td=T; P:=Omega*k^(4/5)/t^(2/15): Qd=P;
V:=2*pi*P^2/M: cd=V;   L:=(T*V/2): ld=L; A:=(8*V^3/(a*P^3)): Aq=A;
sigma:=(pi^2/(3*a^2*A*L)):   fe:=(T*sigma^3): med=M*fe;
Td=(A*V/pi);    mu=pi*M*V^2/(a*L*A^2); epsilon=a*L*A^2/(pi*M*V^4);
ed=(A*T);  hd=(2*pi*L*M*V); kd=pi*M*V/A;  Gd=(V**2*L/M);
```

$$md = 0.2176728175801019\ 10^{-7}$$

$$td = 0.1078103573212951\ 10^{-42}$$

$$Qd = 1.019113410989320$$

$$cd = 0.2997924580000004\ 10^{9}$$

$$ld = 0.1616036600960470\ 10^{-34}$$

$$Aq = 0.1486106299158358\ 10^{25}$$

$$med = 0.9109382312559975\ 10^{-30}$$

$$Td = 0.1418145219320154\ 10^{33}$$

$$\mu = 0.1256637061435917\ 10^{-5}$$

$$\varepsilon = 0.8854187817620372\ 10^{-11}$$

$$ed = 0.1602176511296900\ 10^{-18}$$

$$hd = 0.6626069134128366\ 10^{-33}$$

$$kd = 0.1379510147516044\ 10^{-22}$$

$$Gd = 0.6672497192291777\ 10^{-10}$$

```
>
>
>
> #formulas in terms of p (sqrt momentum), v (velocity);
> v:=c/(2*pi*Omega^2): p:=Q/Omega: P:=Omega*p: V:=2*pi*Omega^2*v:
T:=2*pi*p^(9/2)/v^6: M:=(2*pi*P^2/V): md=M; td=T; Qd=P;   cd=V;
L:=(T*V/2): ld=L;  A:=(8*V^3/(a*P^3)): Aq=A;
sigma:=(pi^2/(3*a^2*A*L)):  fe:=(T*sigma^3): med=M*fe;
Td=(A*V/pi);    mu=pi*M*V^2/(a*L*A^2); epsilon=a*L*A^2/(pi*M*V^4);
ed=(A*T);  hd=(2*pi*L*M*V); kd=pi*M*V/A;  Gd=(V**2*L/M);
```

$$md = 0.2176728175801018\ 10^{-7}$$

$$td = 0.1078103573212955\ 10^{-42}$$

$$Qd = 1.019113410989319$$

$$cd = 0.2997924580000000\ 10^{9}$$

$$ld = 0.1616036600960474\ 10^{-34}$$

$$Aq = 0.1486106299158357\ 10^{25}$$

$$med = 0.9109382312559951\ 10^{-30}$$

$$Td = 0.1418145219320151\ 10^{33}$$

$$\mu = 0.1256637061435911\ 10^{-5}$$

$$\varepsilon = 0.8854187817620429\ 10^{-11}$$

$$ed = 0.1602176511296905\ 10^{-18}$$

$$hd = 0.6626069134128368\ 10^{-33}$$

$$kd = 0.1379510147516042\ 10^{-22}$$

$$Gd = 0.6672497192291780\ 10^{-10}$$

```
>
>
> #3.4 Dimensionless formulas eq(68)
> cd:=2*pi*Omega^2*k^(3/5)/t^(4/15):
Rd:=(1/(2^23*3^3*pi^11*a^5*Omega^17))/(t^(11/15)*k^(3/5)):
mud:=(a/(2^11*pi^5*Omega^4))*(k^(14/5)/t^(7/15)):
> cd^35/(mud^9*Rd^7);
 665878618739896054120533442955768088193530539360523161604236329280006 \
      1303470710070515405332733231104  π^157 Ω^225 a^26

>
>
> #3.5 p and v eq(70-74)
> vx=2*pi*Omega^2/c; px=(2^11*pi^5*Omega^4*mu0/a)^(2./7);
                              vx = 0.8443301776759008 10^-7

                                 px = 0.5077453367916186

> cd:=2*pi*Omega^2*k^(3/5)/t^(4/15):
Rd:=(1/(2^23*3^3*pi^11*a^5*Omega^17))/(t^(11/15)*k^(3/5)):
mud:=(a/(2^11*pi^5*Omega^4))*(k^(14/5)/t^(7/15)):
Omega^225=(cd^35/(2^295*pi^157*3^21*a^26*mud^9*Rd^7));
                                  Ω^225 = Ω^225

>
>
> #eq(75-84)
> cd:=two*pi*Omega^2*v:
Rd:=(1/(two^23*three^3*pi^11*a^5*Omega^17))*(v^5/p^(9/2)):
mud:=(a/(two^11*pi^5*Omega^4))*p^(7/2):
h^3=(two*pi^10*mud^3/(three^6*cd^5*a^13*Rd^2));
e^3=(two^2*pi^5/(three^3*cd^4*a^8*Rd));
```

```
kB^3=(pi^5*mud^3/(two*three^3*a^5*cd^4*Rd));
G^5=(pi^3*mud/(two^20*three^6*a^11*Rd^2));
med^3=(two^4*pi^10*Rd*mud^3/(three^6*a^7*cd^8));
```

$$h^3 = \frac{two^9\ \pi^{12}\ \Omega^{12}\ p^{(39/2)}}{v^{15}}$$

$$e^3 = \frac{two^{21}\ \pi^{12}\ \Omega^9\ p^{(9/2)}}{v^9\ a^3}$$

$$kB^3 = \frac{a^3\ p^{15}}{\pi^3\ two^{15}\ \Omega^3\ v^9}$$

$$G^5 = \frac{\pi^{20}\ two^{15}\ \Omega^{30}\ p^{(25/2)}}{v^{10}}$$

$$med^3 = \frac{p^6}{two^{60}\ \pi^{24}\ three^9\ a^9\ \Omega^{45}\ v^3}$$

```
>
> #3.6
> A:=(64*pi^3*Omega^3/a)*(1/(k^(3/5)*t^(2/5))): T:=2*pi*t:
V:=(2*pi*Omega^2)*(k^(3/5)/t^(4/15)):
> three*a^2*A*T*V/(2*pi^2); three*a^2*A*V/(2*pi^2);
>
```

$$128\ three\ a\ \pi^3\ \Omega^5\ t^{(1/3)}$$

$$\frac{64\ three\ a\ \pi^2\ \Omega^5}{t^{(2/3)}}$$

```
> #3.7
> l:=ld/(2*pi^2*Omega^2): v:=c/(2*pi*Omega^2): p:=Q/Omega:
t:=td/(2*pi): m:=md: ax:=Aq*(a/(64*pi^3*Omega^3)):
> time=t; l^(15/11)/m^(9/11)=t; m^6/p^(15/2)=t; p^(9/2)/v^6=t;
(ax*l)^3=t; l^(6/5)/p^(9/10)=t; 1/(ax^2*p^(3/2))=t;
```

$$time = 0.1715855128418762\ 10^{-43}$$

$$0.1715855128418759\ 10^{-43} = 0.1715855128418762\ 10^{-43}$$

$$0.1715855128418776\ 10^{-43} = 0.1715855128418762\ 10^{-43}$$

$$0.1715855128418768\ 10^{-43} = 0.1715855128418762\ 10^{-43}$$

$$0.1715855128418743\ 10^{-43} = 0.1715855128418762\ 10^{-43}$$

$$0.1715855128418761\ 10^{-43} = 0.1715855128418762\ 10^{-43}$$

$$0.1715855128418774\ 10^{-43} = 0.1715855128418762\ 10^{-43}$$

```
>
>
> #eq(101, 104)
> hd:=two^3*pi^4*Omega^4*t^(7/15)*k^(11/5):
ed:=two^7*pi^4*Omega^3*t^(3/5)/(k^(3/5)*a):
cd:=two*pi*Omega^2*k^(3/5)/t^(4/15):
Rd:=(1/(two^23*three^3*pi^11*a^5*Omega^17))/(t^(11/15)*k^(3/5)):
mud:=(a/(two^11*pi^5*Omega^4))*(k^(14/5)/t^(7/15)):
a=two*hd/(mud*ed^2*cd);
```

$$a = a$$

```
> rd^3=three^3*two^2*pi^5*mud^3*a^19*Rd^2/(five^3*cd^10);
```

$$rd^3 = \frac{a^{12}\, k^{(6/5)}}{three^3\ two^{87}\ \pi^{42}\ \Omega^{66}\ t^{(1/5)}\ five^3}$$

```
>
>
> #formulas in terms of p (sqrt momentum), v (velocity);
> P:=Omega*p: V:=2*pi*Omega^2*v: T:=2*pi*p^(9/2)/v^6:
M:=(2*pi*P^2/V): m[P]=M; t[p]=T; Q=P;   c=V;   L:=(T*V/2): l[p]=L;
A:=(8*V^3/(a*P^3)): Aq=A; sigma:=(pi^2/(3*a^2*A*L)):
fe:=(T*sigma^3): m[e]=M*fe;     TP=(A*V/pi);
mu0=pi*M*V^2/(a*L*A^2); epsilon0=a*L*A^2/(pi*M*V^4); e=(A*T);
h=(2*pi*L*M*V); k[B]=pi*M*V/A;  G=(V**2*L/M);
```

$$m_{\Omega p} = \frac{p^2}{v}$$

$$t_p = \frac{2\,\pi\,p^{(9/2)}}{v^6}$$

$$Q = \Omega\, p$$

$$c = 2\,\pi\,\Omega^2\, v$$

$$l_p = \frac{2\,\pi^2\,p^{(9/2)}\,\Omega^2}{v^5}$$

$$Aq = \frac{64\,\pi^3\,\Omega^3\,v^3}{a\,p^3}$$

$$m_e = \frac{p^2}{28311552\,v\,\pi^8\,a^3\,\Omega^{15}}$$

$$TP = \frac{128\,\pi^3\,\Omega^5\,v^4}{a\,p^3}$$

$$\mu 0 = \frac{p^{(7/2)}\, a}{2048\, \pi^5\, \Omega^4}$$

$$\varepsilon 0 = \frac{512\, \pi^3}{a\, p^{(7/2)}\, v^2}$$

$$e = \frac{128\, \pi^4\, \Omega^3\, p^{(3/2)}}{v^3\, a}$$

$$h = \frac{8\, \pi^4\, p^{(13/2)}\, \Omega^4}{v^5}$$

$$k_B = \frac{p^5\, a}{32\, \pi\, v^3\, \Omega}$$

$$G = \frac{8\, \pi^4\, \Omega^6\, p^{(5/2)}}{v^2}$$

>
>
>