

Fusible

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[1]: import numpy as np
import matplotlib.pyplot as plt
```

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[2]: P0=1e5
Tfus=327.5+273.15
cPb=129
mu=11350
l,d=1e-2,0.150e-3
s=np.pi*d**2/4
a,b,c=2.41e-13,6.54e-10,-4.43e-9
def rho(T):
    return a*T**2+b*T+c
def r(T):
    return rho(T)*l/s
Te=21+273.15
h=5
# calculs
V=np.pi*d**2/4*l
m=mu*V
Cp=cPb*m
Gth=h*l*np.pi*d
Rth=1/Gth
print(m,Cp,Rth)
```

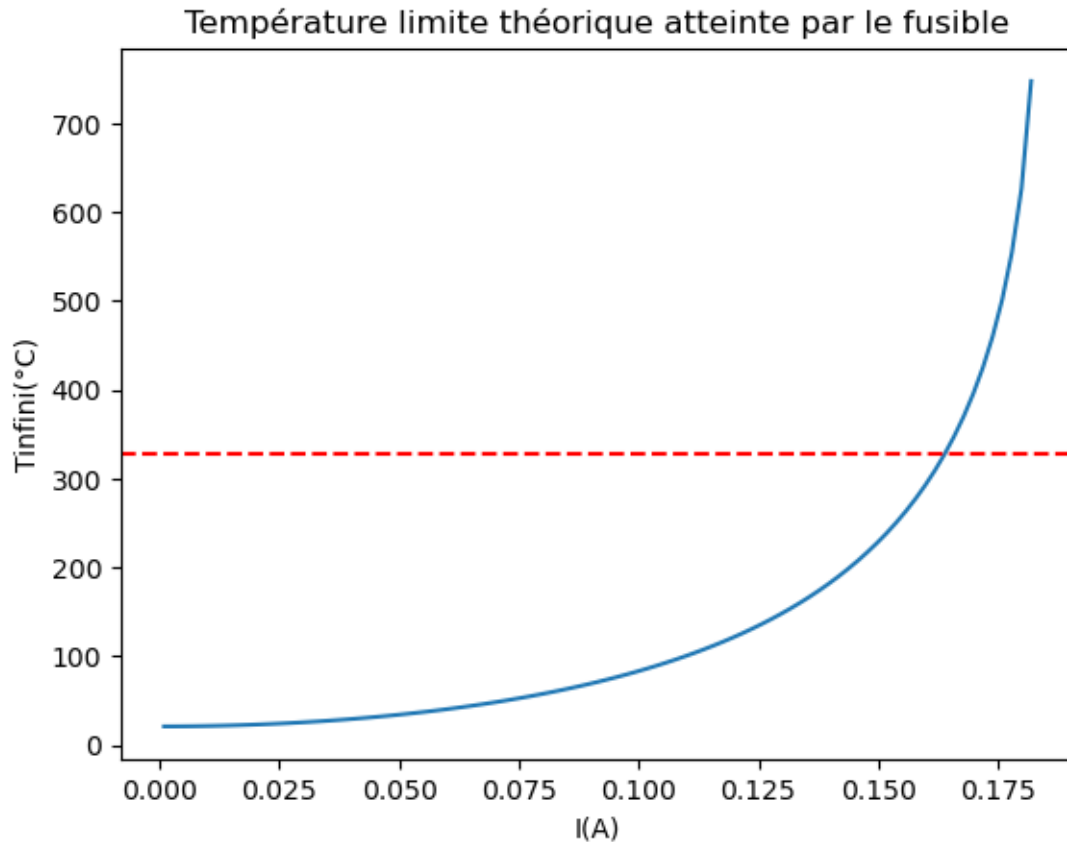
2.0057105597762333e-06 0.0002587366622111341 42441.31815783876

L'équation $T = T_e + \frac{\ell}{s}(aT^2 + bT + c)I^2R_{th}$ se met sous la forme $a_s^\ell I^2 R_{th} T^2 + (b_s^\ell I^2 R_{th} - 1)T + (c_s^\ell I^2 R_{th} + T_e) = 0$ dont on peut calculer les racines.

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[3]: def Tinfini(I):
    fact=1/s*I**2*Rth
    A=a*fact
    B=b*fact-1
    C=c*fact+Te
    delta=B**2-4*A*C
    return (-B-np.sqrt(delta))/2/A
tab_I=np.linspace(0.001,0.2,100)
plt.figure()
plt.plot(tab_I,Tinfini(tab_I)-273.15)
```

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plt.xlabel("I(A)")
plt.ylabel("Tinfini(°C)")
plt.axhline(327.5,ls="--",color="red")
plt.title("Température limite théorique atteinte par le fusible")
plt.show()
```

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/tmp/ipykernel_26434/1470835064.py:7: RuntimeWarning: invalid value encountered
in sqrt
    return (-B-np.sqrt(delta))/2/A
```



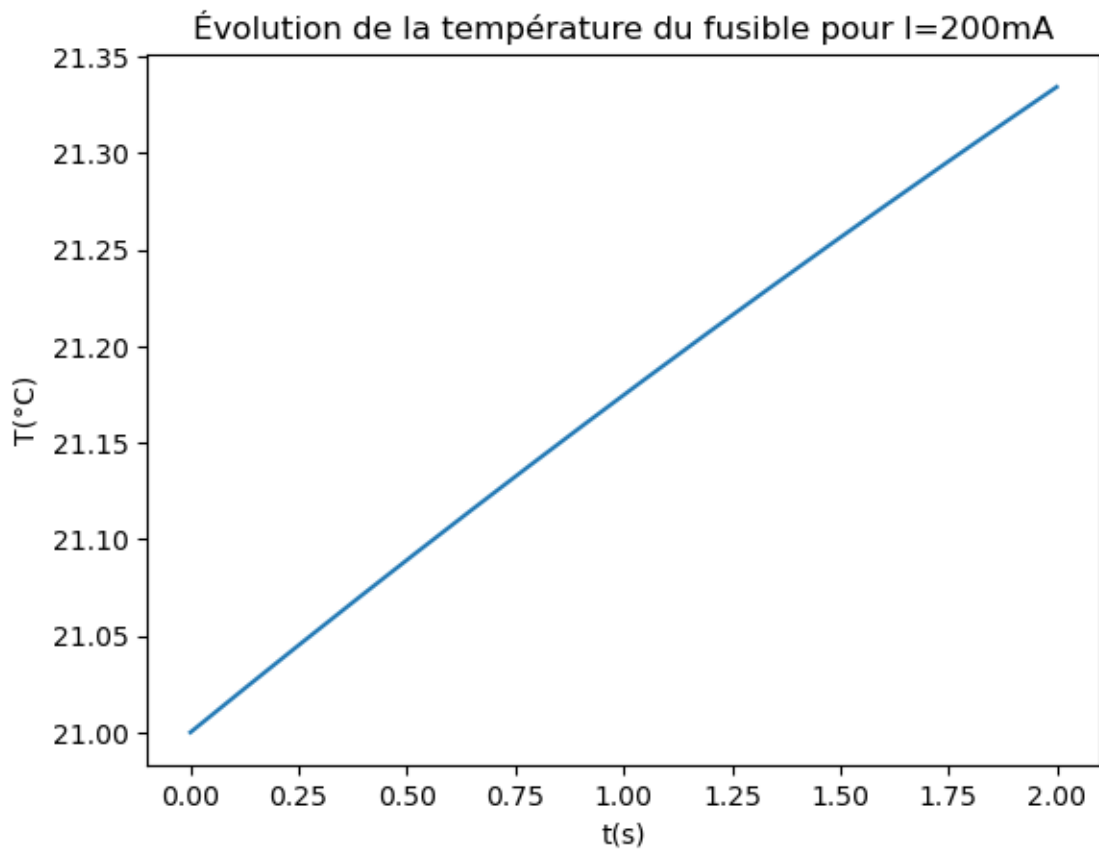
A priori, ce fusible fond donc au-dessus de 160mA.

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[4]: # résolution par la méthode d'Euler
I=0.02
tau=Cp*Rth
tmax=2
pas=0.01
N=int(tmax/pas)
tab_t=np.zeros(N+1)
tab_T=np.zeros(N+1)
```

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tab_T[0]=Te
for n in range(N):
    tab_t[n+1]=tab_t[n]+pas
    tab_T[n+1]=tab_T[n]+pas*((Te-tab_T[n])/tau+r(tab_T[n])*I**2/Cp)
plt.figure()
plt.plot(tab_t,tab_T-273.15)
plt.xlabel("t(s)")
plt.ylabel("T(°C)")
plt.title("Évolution de la température du fusible pour I=200mA")
plt.show()

```



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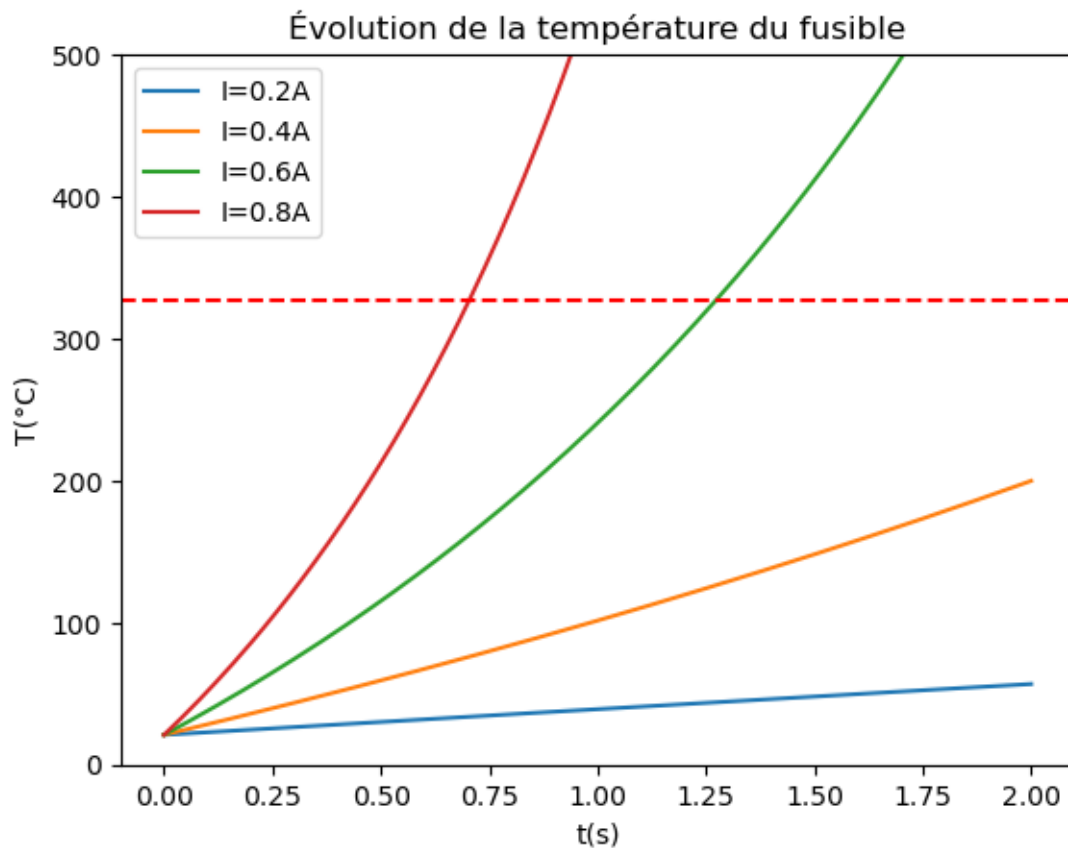
[5]: def trace_T(I):
    tau=Cp*Rth
    tmax=2
    pas=0.01
    N=int(tmax/pas)
    tab_t=np.zeros(N+1)
    tab_T=np.zeros(N+1)
    tab_T[0]=Te

```

```

for n in range(N):
    tab_t[n+1]=tab_t[n]+pas
    tab_T[n+1]=tab_T[n]+pas*((Te-tab_T[n])/tau+r(tab_T[n])*I**2/Cp)
plt.plot(tab_t,tab_T-273.15,label="I="+str(I)+"A")
plt.figure()
trace_T(0.2)
trace_T(0.4)
trace_T(0.6)
trace_T(0.8)
plt.xlabel("t(s)")
plt.ylabel("T(°C)")
plt.axhline(327.5,ls="--",color="red")
plt.legend()
plt.ylim([0,500])
plt.title("Évolution de la température du fusible")
plt.show()

```



En-dessous de 500mA, le temps de coupure est long

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