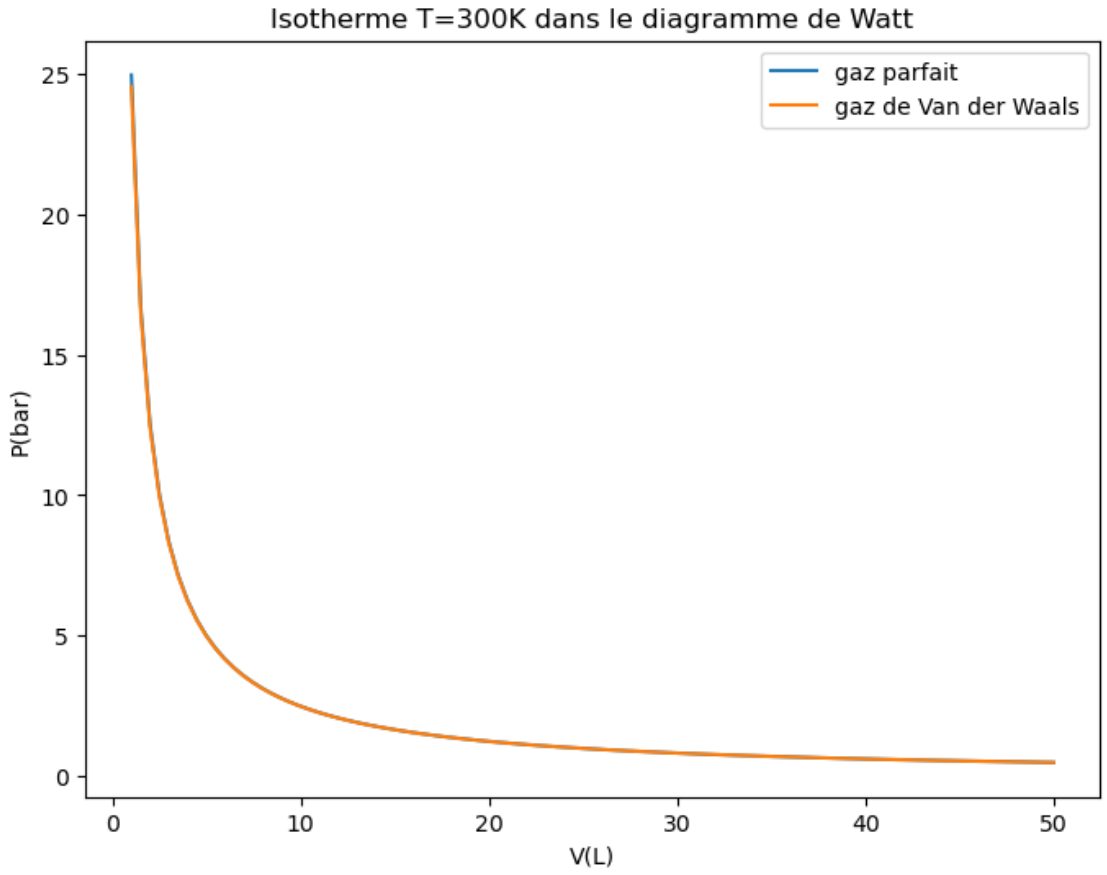
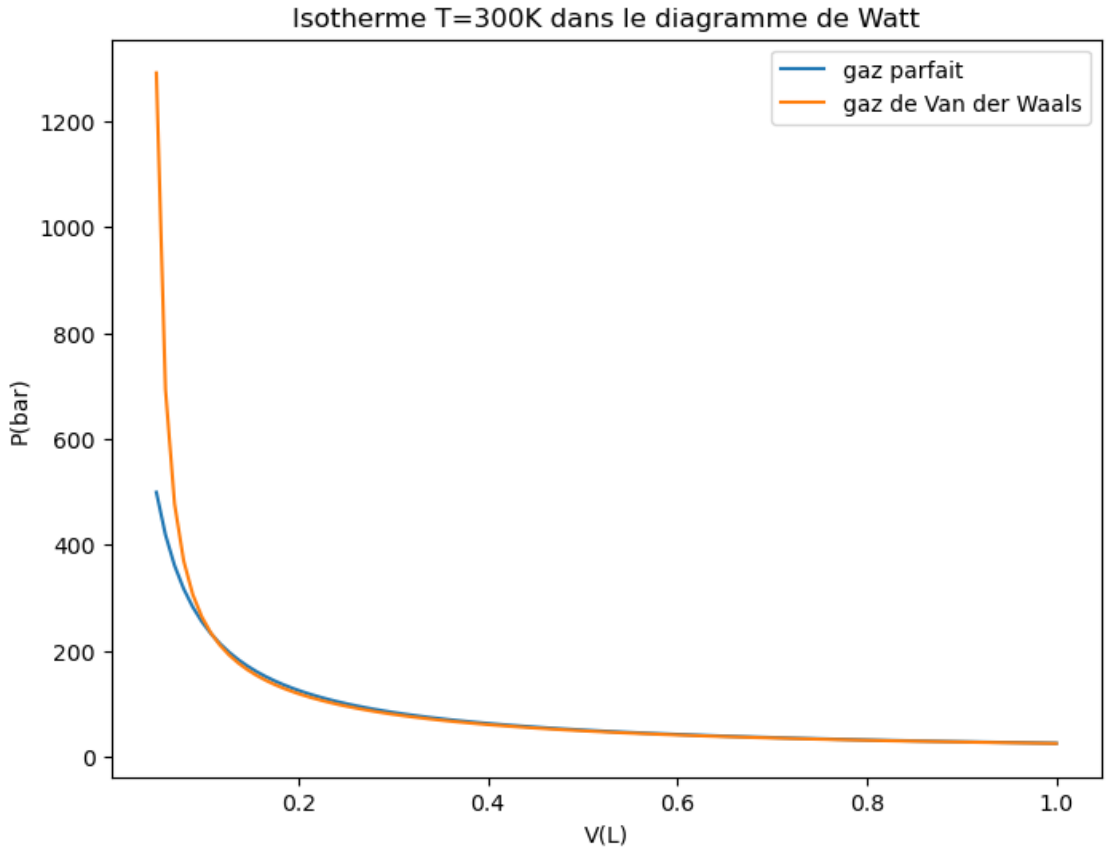
# Modèle du gaz de Van der Waals

[6]:
```
import numpy as np
import matplotlib.pyplot as plt

R=8.314
a=135.8e-3
b=36.4e-6
```

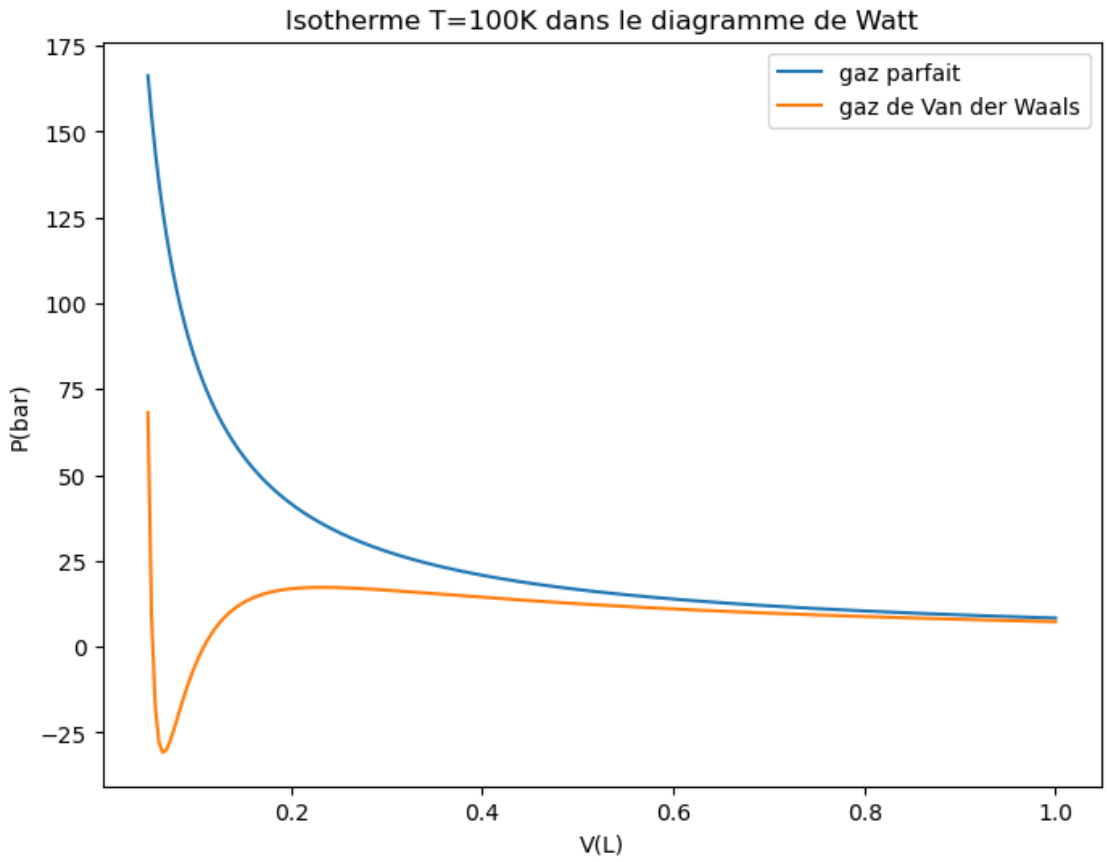
[2]:
```
def pressionGP(n,T,V):
    return n*R*T/V
def pressionGVdW(n,T,V):
    return n*R*T/(V-n*b)-a*n**2/V**2

tab_V=np.linspace(1e-3,50e-3,100)
tab_PGP=pressionGP(1,300,tab_V)
tab_PGVdW=pressionGVdW(1,300,tab_V)
plt.figure(figsize=(8,6))
plt.plot(tab_V*1000,tab_PGP*1e-5,label="gaz parfait")
plt.plot(tab_V*1000,tab_PGVdW*1e-5,label="gaz de Van der Waals")
plt.xlabel("V(L)")
plt.ylabel("P(bar)")
plt.legend()
plt.title("Isotherme T=300K dans le diagramme de Watt")
plt.show()
```




[3]:
```
tab_V=np.linspace(5e-5,10e-4,100)
tab_PGP=pressionGP(1,300,tab_V)
tab_PGVdW=pressionGVdW(1,300,tab_V)
plt.figure(figsize=(8,6))
plt.plot(tab_V*1000,tab_PGP*1e-5,label="gaz parfait")
plt.plot(tab_V*1000,tab_PGVdW*1e-5,label="gaz de Van der Waals")
plt.xlabel("V(L)")
plt.ylabel("P(bar)")
plt.legend()
plt.title("Isotherme T=300K dans le diagramme de Watt")
plt.show()
```




[4]:
```
tab_V=np.linspace(5e-5,10e-4,250)
tab_PGP=pressionGP(1,100,tab_V)
tab_PGVdW=pressionGVdW(1,100,tab_V)
plt.figure(figsize=(8,6))
plt.plot(tab_V*1000,tab_PGP*1e-5,label="gaz parfait")
plt.plot(tab_V*1000,tab_PGVdW*1e-5,label="gaz de Van der Waals")
plt.xlabel("V(L)")
plt.ylabel("P(bar)")
plt.legend()
plt.title("Isotherme T=100K dans le diagramme de Watt")
plt.show()
```




[7]:
```
def volumeGP(n,P,T):
    return n*R*T/P
def volumeGVdW(n,P,T):
    def f(V):
        return (P+a*n**2/V**2)*(V-n*b)-n*R*T
    VGP=volumeGP(n,P,T)
    g=VGP/10
    d=10*VGP
    eps=1e-5*VGP
    while d-g>eps:
        m=(d+g)/2
        if f(m)*f(g)<0:
            d=m
        else:
            g=m
    return d
```

[8]:
```
print(volumeGP(1,1e5,300))
print(volumeGVdW(1,1e5,300))
```

```
0.024942
0.024924081595802304
```

[9]:
```
print(volumeGP(1,1e7,300))
print(volumeGVdW(1,1e7,300))
```

```
0.00024942
0.0002373864107723236
```

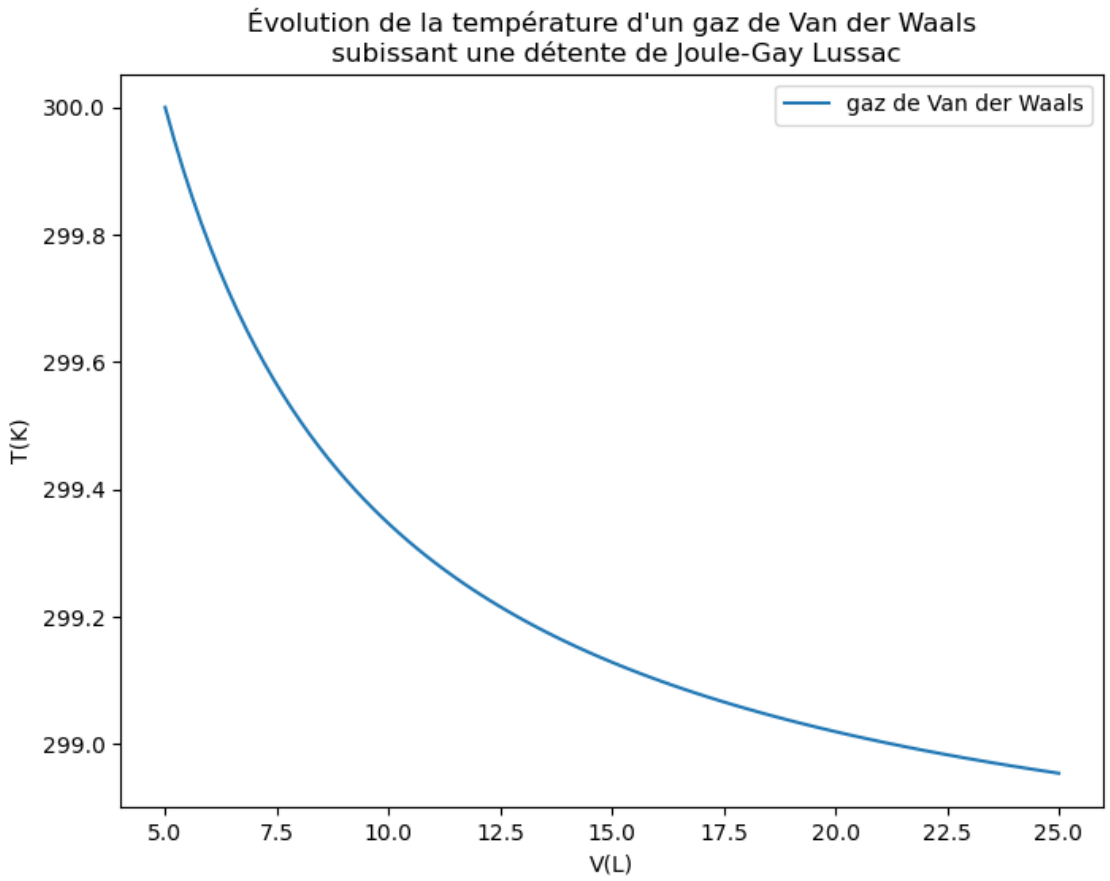
[10]:
```
import scipy.optimize
def volumeGVdW2(n,P,T):
    def f(V):
        return (P+a*n**2/V**2)*(V-n*b)-n*R*T
    VGP=volumeGP(n,P,T)
    g=VGP/10
    d=10*VGP
    return scipy.optimize.bisect(f,g,d)
print(volumeGVdW2(1,1e5,300))
print(volumeGVdW2(1,1e7,300))
```

```
0.024923993922462175
0.00023738532647522257
```

[13]:
```
def energieGVdW(n,V,T):
    return 2.5*n*R*T-a*n**2/V
U0=energieGVdW(1,5e-3,300)
print(U0)
```

```
6208.34
```

[14]:
```
tab_V=np.linspace(5e-3,25e-3,100)
tab_TGVdW=(U0+a*1**2/tab_V)/(2.5*1*R)
plt.figure(figsize=(8,6))
plt.plot(tab_V*1e3,tab_TGVdW,label="gaz de Van der Waals")
plt.xlabel("V(L)")
plt.ylabel("T(K)")
plt.legend()
plt.title("Évolution de la température d'un gaz de Van der Waals\n subissant␣
 ↪une détente de Joule-Gay Lussac")
plt.show()
```


Évolution de la température d'un gaz de Van der Waals
subissant une détente de Joule-Gay Lussac
gaz de Van der Waals
300.0
299.8
299.6
299.4
299.2
299.0
T(K)
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
V(L)

[ ]: