

Travail des forces de pression

```
[1]: import numpy as np
```

1 Détente isotherme

```
[19]: n=1
R=8.314
T=150+273.15
V1,V2=2.5e-3,35e-3
def PGP(V):
    return n*R*T/V
Wref=-n*R*T*np.log(V2/V1)
WGP=0
N=1000
dV=(V2-V1)/N
for i in range(N):
    V=V1+(i+0.5)*dV
    WGP=WGP-PGP(V)*dV
print(Wref)
print(WGP)
```

-9284.386044447956

-9284.361398503825

```
[20]: aaair,bair=135.8e-3,36.4e-6
aeau,beau=557.3e-3,31e-6
def Pair(V):
    return n*R*T/(V-n*bair)-aaair*n**2/V**2
def Peau(V):
    return n*R*T/(V-n*beau)-aeau*n**2/V**2
Wair,Weau=0,0
N=1000
dV=(V2-V1)/N
for i in range(N):
    V=V1+(i+0.5)*dV
    Wair=Wair-Pair(V)*dV
    Weau=Weau-Peau(V)*dV
print(Wref)
print(WGP)
```

```
print(Wair)
print(Weau)
```

```
-9284.386044447956
-9284.361398503825
-9281.860380090562
-9118.14616609669
```

2 Détente AR

Lois de Laplace: $T_{2Lap} = T_1 \left(\frac{V_1}{V_2} \right)^{\gamma-1} = 307,7K = 34,7^\circ C$

$W_{2Lap} = \Delta U = n \cdot \frac{R}{\gamma-1} (T_{2Lap} - T_1) = -9670J$

```
[33]: n=1
T1=273.15+500
V1,V2=5e-3,50e-3
R=8.314
Cv=2.5*R*n
gamma=1.4
T2Lap=T1*(V1/V2)**(gamma-1)
W2Lap=Cv*(T2Lap-T1)
print(T2Lap-273.15,W2Lap)
def PGP(V,T):
    return n*R*T/V
N=50000
dV=(V2-V1)/N
T=T1
WGP=0
for i in range(N):
    V=V1+(i+0.5)*dV
    P=PGP(V,T)
    T=T-P/Cv*dV
    WGP+=-P*dV
print(WGP)
print(T-273.15)
```

```
34.64655891343648 -9672.371272984223
-9672.454183482767
34.64256995512301
```

```
[34]: R=8.314
aaair,bair=135.8e-3,36.4e-6
aeau,beau=557.3e-3,31e-6
def PVdW(a,b,V,T):
    return n*R*T/(V-n*b)-a*n**2/V**2
def calcule_AR_VdW(a,b,n,T1,V1,V2):
    N=50000
```

```

Cv=2.5*R*n
gamma=1.4
dV=(V2-V1)/N
T=T1
W=0
for i in range(N):
    V=V1+(i+0.5)*dV
    P=PVdW(a,b,V,T)
    T=T-P/Cv*dV
    W+=-P*dV
return (T-273.15,P*1e-5,W)
print(calcule_AR_VdW(aair,bair,1,273+500,5e-3,50e-3))

```

(34.42264147162933, 0.5112694655431566, -9673.907647012265)

```

[35]: M=0.029
n=1/M
T1=273.15+20
P1,P2=200e5,1e5
V1=n*R*T/P1
V2=V1*45.148
print(calcule_AR_VdW(aair,bair,n,T1,V1,V2))

```

(-201.2971586868336, 1.0000145848646567, -158609.01528640912)