Ex.1

```
ClearAll["Global`*"]
T1 := UnitConvert[85 °C, "K"]
T2 := UnitConvert[20 °C, "K"]
Cv := 4.18 kJ/(kg K); m := 200 g
ΔSKaffee = UnitConvert[Integrate[m * Cv / T, {T, T1, T2}], "KJ/K"]
```

Out[11]=

$$-0.167424\ \text{kJ/K}$$

```
In[•]:= ΔSRaum = UnitConvert[Integrate[-m * Cv / T2, {T, T1, T2}], "KJ/K"]
```

Out[•]= $0.185366\ \text{kJ/K}$

```
In[•]:= ΔSUniversum = ΔSRaum + ΔSKaffee
```

Out[•]= $0.0179422\ \text{kJ/K}$

```
In[•]:= ClearAll["Global`*"]
ΔSUniversum =
 Integrate[-m * Cv / T2, {T, T1, T2}] + Integrate[m * Cv / T, T] - Integrate[m * Cv / t, t] ≥ 0 /.
   {T → T1, t → T2} // FullSimplify
```

Out[•]= $$\frac{\text{Cv m}\left(\text{T1} - \text{T2} + \text{T2 Log[T1]} - \text{T2 Log[T2]}\right)}{\text{T2}} \geq 0$$

$\Delta S = 0$, weil es reversibel ist.

Ex.2

In[•]:=
```
ClearAll["Global`*"]
S := kB * (3 n / 2 Log[e / n] + n Log[V / n] + n Log[c])
Eges = Solve[T == 1 / D[S, e], e][[1]][[1]]
p * V == T D[S, V] * V
μ == -T D[S, n]
```

Out[•]= $e \to \frac{3\ kB\ n\ T}{2}$

Out[•]= $p\ V == kB\ n\ T$

Out[•]= $\mu == -kB\ T\left(-\frac{5}{2} + \text{Log}[c] + \frac{3}{2}\ \text{Log}\left[\frac{e}{n}\right] + \text{Log}\left[\frac{V}{n}\right]\right)$

In[•]:=
```
T := 300 K
p1 := 1 bar
V1 := 1 m^3
V2 := 2 m^3
kB := k
n := p1 * V1 / (T * kB) // N
p2 = UnitConvert[n * kB * T / V2, "bar"]
e1 = UnitConvert[Eges[2], "eV"]
e2 = UnitConvert[Eges[2], "eV"]
```

Out[•]= 0.5 bar

Out[•]= 9.36226×10^{23} eV

Out[•]= 9.36226×10^{23} eV

In[•]:=
$$\mu 1 = -kB\,T\left(-\frac{5}{2}+\frac{3}{2}\,\text{Log}\left[\frac{e1}{n}\right]+\text{Log}\left[\frac{V1}{n}\right]\right)$$
$$\mu 2 = -kB\,T\left(-\frac{5}{2}+\frac{3}{2}\,\text{Log}\left[\frac{e2}{n}\right]+\text{Log}\left[\frac{V2}{n}\right]\right)$$
(*Einheiten im Log ???*)

Out[•]=
$$\left(-\frac{5}{2}+\text{Log}\left[4.14195\times 10^{-26}\ \text{m}^3\right]+\frac{3}{2}\,\text{Log}\left[0.038778\ \text{eV}\right]\right)\left(-300\ \text{K}\,k\right)$$

Out[•]=
$$\left(-\frac{5}{2}+\text{Log}\left[8.28389\times 10^{-26}\ \text{m}^3\right]+\frac{3}{2}\,\text{Log}\left[0.038778\ \text{eV}\right]\right)\left(-300\ \text{K}\,k\right)$$

Ex.3 Isotherme expansion

```
ClearAll["Global`*"]
kB := k ; T1 := 300 K ; V1 := 1 L ; V2 := 2 V1
p := 1 bar ; n := V1 p / (T1 R) ; Cp := 7 / 2 R
T2 := 2 T1
```

In[•]:=
```
ΔU = UnitConvert[n * Cp * (T2 - T1), "J"]
ΔS = UnitConvert[
    Integrate[n * Cp / T, {T, T1, T2}] + Integrate[n R / V, {V, V1, V2}], "J/K"] // N
ΔW = UnitConvert[-Integrate[p, {V, V1, V2}], "J"]
ΔQ = ΔU - ΔW
```

Out[•]= 350 J

Out[•]= 1.03972 J/K

Out[•]= -100 J

Out[•]= 450 J

```
In[•]:= T2 := T1
        ΔU = UnitConvert[n * Cp * (T2 - T1), "J"]
        ΔS = UnitConvert[Integrate[n R / V, {V, V1, V2}], "J/K"] // N
```

Out[•]= 0 J

Out[•]= 0.231049 J/K

```
In[•]:= d := 1 mm ; A := 0.01 m^2 ; F := 200 N
        ΔQ := 0
In[•]:= ΔW = UnitConvert[F * d, "J"]
        ΔU = ΔW + ΔQ
        ΔT = UnitConvert[ΔU / (Cp * n)] // N
```

Out[•]= $\frac{1}{5}$ J

Out[•]= $\frac{1}{5}$ J

Out[•]= 0.171429 K

$\Delta S > 0$, weil der Prozess irreversibel ist.

Ex .4

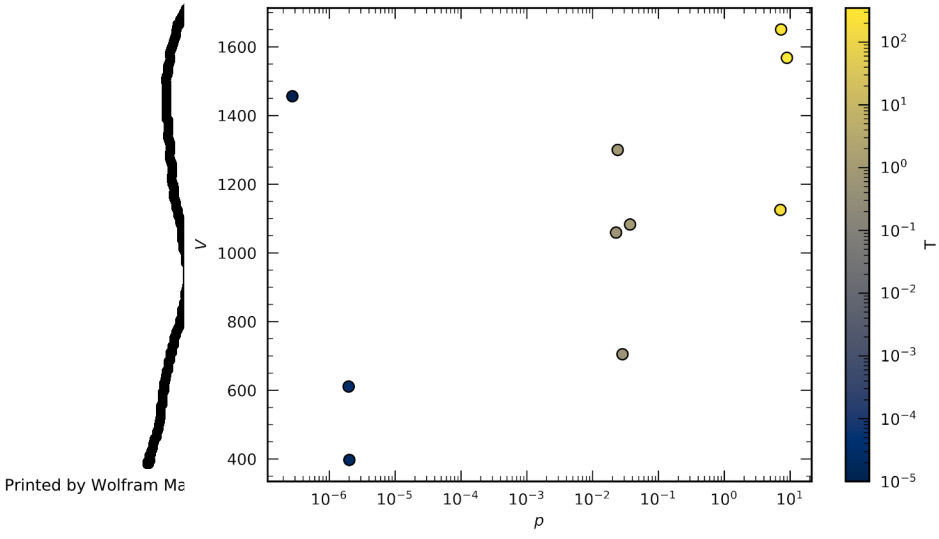
```
In[•]:= Na := N_A ; k := k
        S[options_] := UnitConvert[k * Na * Log[options], "J/K/mol"] // N
In[•]:= S[2]
        S[6 / 4]
        S[5]
```

Out[•]= 5.76315 J/(K mol)

Out[•]= 3.37122 J/(K mol)

Out[•]= 13.3816 J/(K mol)

Bonus



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