```
In[700]:= ClearAll["Global`*"]
kB = 1.38064852 × 10^(-23) * m^2 * kg / s^2 / K;
Troom = 300 * K;

In[703]:= (* problem 1 *)

In[704]:= (* find radius from eta *)

In[705]:= Solve[eta == mAr * vAr / (Pi * (2 * R)^2)  / 3 / Sqrt[2], R]
```

Out[705]= $\left\{\left\{R \to -\frac{\sqrt{mAr}\ \sqrt{vAr}}{2 \times 2^{1/4}\ \sqrt{eta}\ \sqrt{3\pi}}\right\}, \left\{R \to \frac{\sqrt{mAr}\ \sqrt{vAr}}{2 \times 2^{1/4}\ \sqrt{eta}\ \sqrt{3\pi}}\right\}\right\}$

```
T = 500 * K;
eta = 3.5 * 10^(-6) * kg / m / s
mp = 1.6726219 × 10^(-27) * kg;
mAr = 40 * mp;
vAr = Assuming[kg > 0 && m > 0 && s > 0, Simplify[Sqrt[3 * kB * T / mAr]]]
```

R = Assuming$\left[\text{kg} > 0 \ \&\&\ \text{m} > 0 \ \&\&\ \text{s} > 0,\ \text{Simplify}\left[\frac{\sqrt{mAr}\ \sqrt{vAr}}{2 \times 2^{1/4}\ \sqrt{eta}\ \sqrt{3\pi}}\right]\right]$

Out[707]= $\frac{3.5 \times 10^{-6}\ \text{kg}}{\text{m s}}$

Out[710]= $\frac{556.363\ \text{m}}{\text{s}}$

Out[711]= 4.46633×10^{-10} m

```
In[712]:= (* this is the radius of the atom *)

In[713]:=
(* problem 2 *)

In[714]:=
σ = 4 * 10^(-19) * m^2;
T = 300 * K;
newton = kg * m / s^2;
patm = 10^5 * newton / m^2;
n = patm / kB / T
```

Out[718]= $\frac{2.41432 \times 10^{25}}{\text{m}^3}$

```
In[719]:= λ = 1 / n / σ / Sqrt[2.]
```

Out[719]= 7.32199×10^{-8} m

```
(* this in mean free path at 1 atm , but we want it to be larger than
    2R=10*10^{-2)m
 so pressure needs to be reduced by 6 orders of magnitude *)
```

In[720]:=

```
(* problem 3 *)
(* if mass density is the same, pressure along the river is the same,
the river is the same, so dz is the same
  eta*v is constant for all cases
  milk river has vmilk=vwater*(etawater/etamilk)=1/3 m/s
   honey river has 10^4 larger eta so 10^(-4)m/s velocity ,
like 1 m per 3 hours *)

(* problem 4 *)
```

In[727]:=

```
(* same as 3 but now pressure is not the same but scales as mass density *)
```

In[731]:=

```
ρair = 1.3 * kg / m^3;
ρwater = 1000 * kg / m^3;
etawater = 1.7 * 10^(-5) * Pas;
etaair = 10^(-3) * Pas;

(* (ρair* g *h/ρwater *g *h)=(etaair*vair)/(etawater*vwater)
  therefore *)
vairtovwater = (ρair / ρwater) * (etawater / etaair)
```

Out[735]=

```
0.0000221
```

```
(* the lesson: airflow would be way too low,
one would need to pump it not using gravity
 On Earth g is larger but the ratio is the same as it cancels out
 *)
```

```
(* problem 5 *)
(* calculate the mean free path at this pressure:

   it is 10 times larger than  λ=7.32199448195378`*^-8 m
  we calculated above for normal conditions
  As  it is much smaller than 1cm
  so we are in collisional regime and this
  termos does not work! kappa is density independent,
unless we lower pressure by another 5 orders of magnitude
 as in problem 2 *)
```