**Some practical questions**

1. Knowing the relationship between diffusion and viscosity (Stokes – Einstein equation):

where D – diffusion coefficient, k – Boltzmann constant. T absolute temperature (in K), r – molecular radius, – viscosity, please provide the units and estimate water viscosity at 25oC knowing that D=2.3\*10-9m2/s

Let us first do a simple math to convert this formula to explicitly get the viscosity

k – Boltzmann constant , 1.38064852 × 10-23 [m2 kg s-2 K-1]

T – absolute temperature (temperature in K) 25+273=298K

r – radius of water molecule, 1.8 Å =1.8\*10-10m

1Å=1\*10-10m

D – diffusion coefficient 2.3\*10-9m2/s

= (1.38\*10-23\*298)/(6\*3.14\*1.8\*10-10\*2.3\*10-9)

1.38\*298/(6\*3.14\*1.8\*2.3) \*10-4

m2 kg s-2 K-1\*K= m2 kg s-2

m\*m2/s=m3/s

m2 kg s-2 m-3 s= kg/(m\*s)

1. Can the following function have a maxima or an inflection point? What should one do to increase its value for small x and decrease for large x?

Let us increase A – this is not a good idea. Y(x) will become larger for small x, but also for large x

For small x the function converges to 5AB, this means that one can increase the value of y for small x by increasing B

For large x the function behaves like A/(Bx2), this mean that increasing B one decreases the y value for large x

No maximum

1. The equation describes the water steam pressure as a function of temperature:

where

p- saturated vapour pressure at temperature t

p0 - saturated vapour pressure at temperature 0 oC

*t* – temperature in oC

Please try to figure out whether the pressure *p* can reach saturation

It goes to infinity

1. Is it possible that diffusion coefficients follow the relationship:

where E is called and activation energy, R is referred to as gas constant and T is temperature in K?

1. The procedures applied in MRI (Magnetic Resonance Imaging) to increase the contrast between healthy and pathological tissues lead to increasing of A in the equation of point 2) and decreasing B. Let assume that A has been increased 1000 times and B has been decreased 100 times. At which x one can expect that the procedure will turn out to be beneficial (y(x) becomes larger).

For small x, y(x) converges 5AB – enhancement 50

For large x, A/(Bx2) +A/(Bx2) 100000/x2 - it is more beneficial for large x

provided Bx>>1

ratio between this value for a given B

and B 100 smaller versus x

1. The question reads: How many liters of a 70% alcohol solution must be added to 50 liters of a 40% alcohol solution to produce a 50% alcohol solution? Is the answer 80 liters plausible?

(0.7x+0.4\*50)/(x+50)=0.5

0.7x+20=0.5x+25

0.2x=5

x=25

1. The following expression allows to predict the air pressure versus the height:

where:

p0 - reference pressure ([Pa](https://en.wikipedia.org/wiki/Pascal_(unit)))

T – air temperature (in K)

– air molar mass (0,0289644 kg/mol)

R – gas constant

T – temperature in K

Is it possible that the pressure drops by factor 2, 10 km above the zero level?

Yes – probably even more

h=0 (zero level)

p=p0

Can one get for h=10 km p=0.5p0?

1. Is it possible that electromagnetic wave of the frequency of GHz has the length of the order of nm?

Distance=velocity\*time

Frequency=1/time

Distance=velocity/frequency

(3\*108m/s)/ (1\*1091/s) =0.3m

1nm=10-9m

1. Knowing that the parameter B=Bo please try to figure out whether it is possible to reach o maximum of the equation of point 2 for a given x versus reciprocal temperature.
2. Two states on a streamline are linked by the following equation:

p+0.5ρv2+ρgh = const

ρ – density of the liquid

p-static pressure

h – height

g – Earth acceleration

Is it possible that in a tube of constant diameter the velocity changes by factor 2 when the high changed by 1 meter?