

Exam: Physics of molecular and biological Nanostructures

1. If you scale down the size of an object by a factor of 10 in all three spacial dimensions, its mass-to-volume ratio increases by a factor of
 - ☐ 1
 - ☐ 10
 - ☐ 100
 - ☐ 1000
2. If you scale down the size of a rubber rod by a factor of 100 in all three spacial dimensions, the persistence length of the rod decreases by a factor of
 - ☐ 10^2
 - ☐ 10^4
 - ☐ 10^6
 - ☐ 10^8
3. What is the Debye-layer?
 - ☐ Mean free path of ions in an electrolyte
 - ☐ The average distance between two ions
 - ☐ The max. Distance of the counterions from a charged surface in an electrolyte
 - ☐ The average distance of the counterions from a charged surface in an electrolyte
4. Consider two solutions: a) 0,1mM NaCl in water b) 0,1mM NaCl in ethanol
In which solution is the debye-length larger?
 - ☐ Same in both
 - ☐ a)

☐ b)

☐ Depends on the sign of the charge

5. Suppose that uncharged sea water (400mM salt concentration) is filled into an uncharged glass cup. The net charge of the liquid is the center of the glass (far away from the walls) will

☐ become negative

☐ remain the same

☐ become positive

☐ depend on the temperature

6. The contour length of linear DNA molecule with 10^9 base pairs is approximately

☐ 3 cm

☐ 10 cm

☐ 30 cm

☐ 100 cm

7. Consider a flexible polymer segment with $P < L$ that bends thermally in 2D. How does the statistical distribution of $p(\alpha)$ look like ? [y-axis: $p(\alpha)$; x-axis α]



8. The persistence length of a single actin filament in solution is $p = 10 \text{ } \mu\text{m}$. Consider an actin filament with a contour length of $L = 5 \text{ } \mu\text{m}$. What is the mean bending angle between the ends if the filament?

☐ 0°

☐ ca. 15°

☐ ca. 45°

☐ ca. 90°

9. A flexible Polymer molecule is held at its ends under constant mechanical tension. The system is in a thermal equilibrium. When temperature increases...

☐ The distance between the ends increases

☐ The distance between the ends is constant

☐ The distance between the ends decreases

☐ molecule breaks apart

10. Debye length of a charge particle in a saline solution does not depend on

☐ Salt concentration in the solution

☐ Temperature

☐ Charge of the particle

☐ Chemical consistency of the salt

11. If the volume of an isolated system is doubled, how does S increase?

☐ by factor $k_B \ln(2)$

☐ by factor $\ln(2)$

☐ by $k_B \ln(2)$

☐ by $\ln(2)$

12. For a 1D mass-spring system in thermal equilibrium with spring constant of 0.1 N/m and a mass of 2 ng , what is the root mean squared distance of the mass?

☐ 0.1 nm

☐ 0.14 nm

☐ 0.2 nm

☐ 0.28 nm

13. A system consists of two non-interacting states in thermal equilibrium. Their energy difference is 1 kT . What is the probability to find the system in state 1 (p_1)

☐ $p_1 = 0.37 p_2$

☐ $p_1 = 0.5 p_2$

☐ $p_1 = 2 p_2$

☐ $p_1 = 2.7 p_2$

14. A system consists of three non-interacting states in thermal equilibrium. Their energy difference is 1 kT . What is the probability to find the system in state 1 (p_1)

☐ 0.12

☐ 0.33

☐ 0.66

☐ 0.77

15. Consider a glass capillary with $a = 1 \mu\text{m}$, Zeta potential 80 mV and a maximum applied voltage of 12 V. What is the maximum pressure?
- ☐ ca. 69 Pa ☐ ca. 540 Pa ☐ ca. 690 Pa ☐ ca. 5 kPa
16. The reverse effect of electroosmosis is
- ☐ the sedimentation potential
- ☐ the streaming potential
- ☐ electrophoresis
- ☐ elctrodynamics
17. In a cylindrical channel with an electrolyte where the debye layers significantly overlap, with an electrical field leading to EO flow, what is the velocity in the center of the channel?
- ☐ $v < v_{eo}$ ☐ $v = v_{eo}$ ☐ $v > v_{eo}$ ☐ $v < \text{or} > v_{eo}$ (depends on the temperature)
18. Consider an ideal gas spread from a smaller to a larger volume at constant temperature (the same problem from the lecture). Which statement about U, S and the (Hemholtz) free energy F is correct?
- ☐ S, F and U increase
- ☐ S, F and U decrease
- ☐ S decreases and F increases
- ☐ S increases and F decreases
19. Which methods are used in DNA computers to select the sequences a) with the correct number of cities b) in which each city occurs once :
- ☐ a) electrophoresis b) PCR
- ☐ a) electrophoresis b) magnetic beads
- ☐ a) PCR b) electrophoresis
- ☐ a) PCR b) magnetic beads

20. In the lecture, a method was presented to solve the travelling salesman's problem with DNA computing. Suppose the solution sequence is 5'- GCCATC ... CTTACC-3'. Which primer sequences do we need to selectively amplify the solution by PCR?

☐ 5'GCCATC3' and 5'GGTAAG3'

☐ 5'GCCATC3' and 5'GAATGG3'

☐ 5'GATGGC3' and 5'GGTAAG3'

☐ 5'GATGGC3' and 5'GAATGG3'