

Example Test Questions

1. If you increase the contour length L of a worm-like chain (WLC) polymer by a factor of 2, the persistence length P will,...
 - ☐ decrease by a factor of 2
 - ☐ increase by a factor of $\sqrt{2}$
 - ☐ increase by a factor of 2
 - ☒ not change
2. If you increase the contour length L of a freely-jointed chain (FJC, random walk) molecule by a factor of 2, the average squared end-to-end distance $\langle R^2 \rangle$ will...
 - ☐ not change
 - ☐ increase by a factor of $\sqrt{2}$
 - ☒ increase by a factor of 2
 - ☐ increase by a factor of 4
3. Consider a system in thermal equilibrium that can occupy one of two states, denoted as 1 and 2, with a probability p_1 and p_2 , respectively (see schematic). Which of the following statements is wrong?

- ☒ p_1 is always smaller than p_2
 - ☐ p_1 is always larger than p_2
 - ☐ If the temperature is decreased, p_1 will increase
 - ☐ p_1 and p_2 are related by the Boltzmann factor
4. The diffusion constant of a protein in solution is $D=10^{-11} \text{ m}^2/\text{s}$. How long does it take on average until it diffuses through a narrow 100- μm -long channel?
 - ☐ ca. 5 s
 - ☐ ca. 50 s
 - ☒ ca. 500 s
 - ☐ ca. 5000 s
5. The motor protein myosin V hydrolyses one ATP molecule to perform a step with a typical length of $l \approx 35 \text{ nm}$. Hydrolysis of one ATP molecule delivers free energy of $\Delta G \approx 20 k_B T = 80 \text{ pN} \cdot \text{nm}$. What is the estimated maximum force a myosin V motor protein can generate?
 - ☐ ca. 1 pN
 - ☒ ca. 2 pN
 - ☐ ca. 10 pN
 - ☐ ca. 20 pN
6. For a semi-flexible worm-like chain (WLC) polymer with contour length L and persistence length P , the relation between an external force F (applied between the ends) and the end-to-end extension z of the molecule is given by:

$$F(z) = \frac{k_B T}{P} \left[\frac{z}{L} + \frac{1}{4} \left(1 - \frac{z}{L} \right)^{-2} - \frac{1}{4} \right]$$

In a particular experiment, the force required to extend a WLC polymer to half of its contour length ($z = 0.5L$) is measured as $F = 0.1 \text{ pN}$. What is the persistence length P of the polymer?

- ☐ ca. 1 nm
- ☐ ca. 5 nm
- ☒ ca. 50 nm
- ☐ ca. 50 μm

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7. To observe dielectrophoresis you need...

- ☐ a particle with a net charge
- ☐ a homogeneous electric field
- ☒ an inhomogeneous electric field
- ☐ an inhomogeneous magnetic field.

8. The surface of an electrolyte-filled microfluidic channel are negatively charged. When a hydrostatic pressure difference is applied between the left and the right ends of the channel (see schematic), an electric potential (streaming potential) will build up. What can you say about this electric potential?

- ☐ The potential does not depend on the pressure difference.
- ☐ The potential does not depend on the viscosity of the electrolyte.
- ☒ The potential at the left end is higher (positive) compared to that at the right end.
- ☐ The potential at the left end is lower (negative) compared to that at the right end.

9. Consider an electroosmotic pump in a microfluidic chip with given maximum flow rate Q_{eo} and maximum pressure Δp . If you increase the radius a of the channel, how Q_{eo} and Δp change?

- ☒ Q_{eo} increases and Δp decreases
- ☐ Q_{eo} decreases and Δp increases
- ☐ Q_{eo} and Δp both increases
- ☐ Q_{eo} and Δp both decrease.

10. The maximum flow rate and the maximum pressure of an electroosmotic pump in a microfluidic chip filled with a water-based electrolyte are $Q_{eo} = 10$ nL/s and $\Delta p = 2$ kPa, respectively. The channel length is $L = 1$ cm. What is the radius a of the channel? (Hint: $1 \text{ nL} = 10^{-9}$; $L = 10^{-12} \text{ m}^3$.)

- ☐ ca. $10 \text{ }\mu\text{m}$
- ☒ ca. $20 \text{ }\mu\text{m}$
- ☐ ca. $50 \text{ }\mu\text{m}$
- ☐ ca. $100 \text{ }\mu\text{m}$