Determination of the Physical Properties of Drug Molecules

20 Very Difficult Multiple-Choice Questions (15 Conceptual + 5 Calculation-Based)

Conceptual Questions

1. Two compounds have identical molecular formulas but different molar refractions. Which explanation is most consistent with the additive-constitutive nature of molar refraction?

A. Molar refraction depends exclusively on molecular weight.
B. Atomic contributions are additive, but their bonding environments can alter their contributions.
C. Molar refraction depends only on the total number of electrons.
D. Constitutional arrangement has no influence if elemental composition is identical.

2. Which property is most accurately classified as being at least partly both additive and constitutive?

A. Total molecular mass only
B. Number of atoms only
C. Refraction of light
D. Total mass of a solution only

3. When a polar dielectric is inserted between the plates of a charged capacitor at constant applied voltage, the capacitance increases primarily because:

A. The dielectric permanently increases the plate separation.
B. Molecular orientation permits additional charge to be stored per unit voltage.
C. The dielectric eliminates the electric field between the plates.
D. The dielectric converts the capacitor into a conductor.

4. Which statement concerning dielectric constant, epsilon, is correct?

A. It has units of farads because it represents capacitance.
B. It equals C0/Cx.
C. It is normally dimensionless because it is a ratio of capacitances.
D. It must always be less than unity.

5. A nonpolar molecule is placed in an external electric field and develops a temporary dipole. After removal of the field, which outcome is expected?

A. The induced dipole remains permanently.
B. The molecule becomes permanently ionic.
C. The original electron distribution is restored and the induced dipole disappears.
D. The molecular polarizability becomes zero.

6. Which change would directly increase the induced dipole moment of a particular nonpolar molecule?

A. Decreasing the electric-field strength while keeping polarizability constant.
B. Increasing the electric-field strength while keeping molecular polarizability constant.
C. Increasing molecular symmetry until the electron cloud cannot distort.
D. Removing the external electric field.

7. Why can CO2 contain polar bonds yet possess no net permanent molecular dipole moment?

A. C=O bonds contain no charge separation.

B. CO2 cannot interact with electromagnetic radiation.

C. The molecular geometry causes the individual bond-dipole vectors to cancel.

D. Carbon and oxygen have identical electronegativities.

8. Which ordering is most consistent with the dipole moments of dichlorobenzene isomers discussed in the lecture?

A. p-Dichlorobenzene has the largest dipole because the C-Cl bonds reinforce each other.

B. All three isomers must have identical dipole moments because they have identical molecular formulas.

C. p-Dichlorobenzene has zero net dipole because of symmetry, whereas the ortho and meta isomers have nonzero dipole moments.

D. Only p-dichlorobenzene can possess individual bond dipoles.

9. When a polar liquid is subjected to an external electric field, its total polarization results primarily from:

A. Orientation polarization only

B. Induced polarization only

C. Both induced and orientation polarization

D. Nuclear polarization without electron-cloud distortion

10. Light passes from air into a material with a higher refractive index. Which combination is correct?

A. Frequency decreases and wavelength remains constant.

B. Frequency remains constant while velocity and wavelength decrease.

C. Frequency and velocity remain constant while wavelength increases.

D. Frequency increases while velocity remains constant.

11. The notation n_D^20 specifically indicates a refractive-index measurement:

A. At 20 nm and 589 degrees C

B. At 20 degrees C using the sodium D-line at 589 nm

C. At 589 degrees C using radiation of 20 nm

D. At 20 degrees C using infrared radiation at 589 cm^-1

12. Which statement correctly describes electromagnetic radiation?

A. Its electric and magnetic fields oscillate parallel to each other.

B. Its electric field is perpendicular to its magnetic field, and both are perpendicular to the propagation direction.

C. Only its electric component propagates through vacuum.

D. Its magnetic component determines wavelength while the electric component determines frequency.

13. When electromagnetic radiation passes from vacuum into another medium, which parameter is determined by the source and therefore remains unchanged?

A. Velocity

B. Wavelength

C. Frequency

D. Refractive index

14. Which sequence correctly represents increasing photon energy?

A. Increasing wavelength -> decreasing frequency -> increasing energy

B. Decreasing wavenumber -> increasing frequency -> increasing energy

C. Decreasing wavelength -> increasing frequency -> increasing energy

D. Increasing wavelength -> increasing wavenumber -> increasing energy

15. A molecular vibration will be IR inactive when:

A. Its frequency lies within 4000-200 cm^-1.

B. It involves bond stretching rather than bending.

C. The vibration produces no change in the molecular dipole moment.

D. It contains atoms of different masses.

Calculation-Based Questions

16. A capacitor has a capacitance of 2.40 microF when vacuum occupies the space between its plates. After introducing a liquid, the capacitance becomes 11.52 microF. What is the dielectric constant of the liquid?

A. 2.40

B. 4.80

C. 9.12

D. 13.92

17. A nonpolar compound has a dielectric constant of 3.50, molar mass of 126 g mol^-1, and density of 1.20 g cm^-3. Using Pi = [(epsilon-1)/(epsilon+2)] x (M/rho), what is its induced molar polarization?

A. 21.0 cm^3 mol^-1

B. 35.0 cm^3 mol^-1

C. 47.7 cm^3 mol^-1

D. 73.5 cm^3 mol^-1

18. A beam enters a material from air with an incident angle of 50.0 degrees and is refracted at 30.0 degrees. Using n = sin(i)/sin(r), what is the refractive index of the material?

A. 0.653

B. 1.286

C. 1.532

D. 1.879

19. Electromagnetic radiation has a wavelength of 6.00 x 10^-7 m in vacuum. Using c = 2.998 x 10^8 m s^-1, what is its frequency?

A. 4.997 x 10^12 Hz

B. 4.997 x 10^14 Hz

C. 1.799 x 10^15 Hz

D. 5.003 x 10^16 Hz

20. An IR absorption occurs at a wavelength of 5.00 micrometers. What is the corresponding wavenumber in cm^-1?

A. 200 cm^-1

B. 500 cm^-1

C. 2000 cm^-1

D. 5000 cm^-1

Model Answer Key

1-B 2-C 3-B 4-C 5-C
6-B 7-C 8-C 9-C 10-B
11-B 12-B 13-C 14-C 15-C
16-B 17-C 18-C 19-B 20-C

Calculation answers:

16. epsilon = 4.80
17. Pi approximately 47.7 cm^3/mol
18. n approximately 1.532
19. nu approximately 4.997 x 10^14 Hz
20. 2000 cm^-1