Intermolecular Forces

Use this key to check answers and read the explanations.

1. Which example shows an intermolecular attraction?
   A. The attraction between two neighboring water molecules
   B. The O–H covalent bond inside one water molecule
   C. The attraction that keeps a proton in an atomic nucleus
   D. The bond between the two atoms in a nitrogen molecule
   Correct answer: A. The attraction between two neighboring water molecules
   Intermolecular attractions act between separate molecules. A covalent bond within one molecule connects its constituent atoms.

2. Electrons in a nonpolar molecule momentarily bunch toward one side. Which type of attraction can this fluctuation induce with a neighboring molecule?
   A. A covalent bond between the two molecules
   B. An ionic bond between the two molecules
   C. London dispersion
   D. A metallic bond
   Correct answer: C. London dispersion
   A momentary dipole can distort the neighboring electron cloud. The resulting attraction is a London dispersion force.

3. Which arrangement favors dipole–dipole attraction between two polar molecules?
   A. The two partially positive ends closest together
   B. The partially positive end of one near the partially negative end of the other
   C. The two partially negative ends closest together
   D. Both molecules lose their dipoles first
   Correct answer: B. The partially positive end of one near the partially negative end of the other
   Opposite partial charges attract. The strength of the interaction depends on how the molecules are oriented.

4. Which bond gives a neutral molecule a common site for donating a hydrogen bond?
   A. C–Si
   B. C–C
   C. Cl–Cl
   D. O–H
   Correct answer: D. O–H
   Oxygen draws electron density toward itself, leaving the bonded hydrogen partially positive and able to interact with a suitable acceptor.

5. Which property is larger for a liquid that, under otherwise comparable conditions, pours more slowly?

A. Vapor pressure
B. Viscosity
C. Temperature
D. Volume

Correct answer: B. Viscosity
Viscosity measures a fluid’s resistance to flow. A more viscous liquid usually pours more slowly in the same setup.

6. Carbon dioxide has two polar C=O bonds. Why does a single CO_2 molecule have no permanent dipole?

A. Its linear shape makes the two bond dipoles cancel.
B. Its oxygen atoms neutralize all electrons.
C. The carbon atom has no electrons.
D. Polar bonds can only occur in ions.

Correct answer: A. Its linear shape makes the two bond dipoles cancel.
The two identical bonds lie along the same line in opposite directions. Their dipole vectors cancel.

7. Which substance can form hydrogen bonds between its own molecules in the standard introductory chemistry model?

A. Dimethyl ether, CH_3OCH_3
B. Methane, CH_4
C. Ethane, C_2H_6
D. Methanol, CH_3OH

Correct answer: D. Methanol, CH_3OH
Methanol has an O–H donor and an oxygen acceptor. Dimethyl ether’s oxygen can accept a hydrogen bond from another molecule with a suitable donor.

8. When sodium ions are surrounded by water molecules, which end of a water molecule tends to face a Na^+ ion?

A. The midpoint between both hydrogen atoms
B. Either partially positive hydrogen end
C. The partially negative oxygen end
D. Neither end, because water has no dipole

Correct answer: C. The partially negative oxygen end
Water’s oxygen end carries partial negative charge and is attracted to the positive sodium ion. This is an ion–dipole interaction.

9. Two nonpolar molecules have similar shapes. One has a larger, more easily distorted electron cloud. Which property is typically higher for that substance?

A. Normal boiling point
B. Mean kinetic energy at the same temperature
C. Formal charge of each molecule
D. Fraction of molecules that are ions

Correct answer: A. Normal boiling point
A more polarizable electron cloud usually increases dispersion attractions. More thermal energy is then needed to separate the molecules into a vapor.

10. Two equal samples of the same liquid are left in matching shallow dishes. One sample is warmer. Why does the warmer sample usually evaporate faster?

A. Its molecules become heavier.
B. Its molecules no longer attract each other.
C. Its molecules split into atoms as they evaporate.
D. A larger fraction of its molecules can escape from the surface.

Correct answer: D. A larger fraction of its molecules can escape from the surface.
At higher temperature, a greater fraction of molecules have enough kinetic energy to leave the liquid surface.

11. As liquid bromine, Br_2, becomes Br_2 gas, which attraction is mainly overcome?

A. Hydrogen bonds between Br_2 molecules
B. The covalent Br–Br bond inside every molecule
C. London dispersion attractions between Br_2 molecules
D. Ionic bonds between Br^+ and Br^- in the liquid

Correct answer: C. London dispersion attractions between Br_2 molecules
The molecules separate into the gas phase. The covalent bond that holds the two bromine atoms together remains in each Br_2 molecule.

12. Straight-chain pentane and highly branched neopentane have the same molecular formula. Straight-chain pentane boils at the higher temperature. Which explanation fits the result?

A. It has a higher molar mass.
B. Its less compact shape allows more contact between neighboring molecules.
C. Branching gives neopentane an O–H bond.
D. Straight chains are held together by ionic bonds.

Correct answer: B. Its less compact shape allows more contact between neighboring molecules.
The isomers have the same molar mass. The extended shape of straight-chain pentane increases contact and thus dispersion attractions compared with its compact isomer.

13. Acetone has an oxygen atom that accepts hydrogen bonds but has no O–H or N–H bond. Which pair can form a hydrogen bond using acetone as the acceptor?

A. Acetone and argon
B. Two acetone molecules
C. Acetone and methane
D. Acetone and water

Correct answer: D. Acetone and water
A hydrogen on water can act as the donor to acetone's oxygen. The other choices supply no conventional hydrogen bond donor.

14. Water rises in a clean, narrow glass tube. Which pair of effects helps explain this capillary rise?

A. Water adheres to glass and water molecules cohere to each other.
B. Water forms covalent bonds with the glass and evaporates.
C. Water becomes less dense near the tube wall and floats above itself.
D. The glass increases the mass of the liquid's molecules.

Correct answer: A. Water adheres to glass and water molecules cohere to each other.
Attraction to glass pulls water up at the wall. Cohesion among water molecules helps lift the adjoining liquid until its weight balances the effect.

15. Two liquids of similar density are on the same clean solid. Liquid A spreads into a film and liquid B stays beaded. What does A's behavior suggest?

A. It has zero intermolecular attraction.
B. Its molecules must form ionic bonds with one another.
C. Its attraction to the solid is more favorable relative to its internal cohesion.
D. Its molecules must all be nonpolar.

Correct answer: C. Its attraction to the solid is more favorable relative to its internal cohesion.
Wetting depends on competing attractions. A spreads when contact with the surface is favorable relative to keeping the liquid gathered in a droplet.