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Answer Key: Stellar Matter Phase Transitions College Quiz

Evaluate thermodynamic transitions and intermolecular forces through varying pressures and temperatures found in interstellar nebulae and planetary cores.

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1. At the critical point of a substance, such as Xenon, what phenomenon occurs to the physical boundaries between phases?

Answer: A) The meniscus between liquid and gas disappears as densities equalize.

At the critical point, the temperature and pressure are high enough that the liquid and gas phases have the same density, making them indistinguishable and forming a supercritical fluid.

2. Supercritical fluids possess the low viscosity characteristic of a gas while maintaining the high dissolving power of a liquid.

Answer: A) True

Supercritical fluids are unique states of matter that combine the high diffusion rates/low viscosity of gases with the high density and solvent properties of liquids.

3. Metals like Gallium have a remarkably low melting point; however, what describes the state of 'Metallic Hydrogen' predicted in Jupiter's core?

Answer: C) A liquid state where protons exist in a sea of electrons

Under extreme pressure, hydrogen molecules dissociate into individual atoms that behave like a liquid metal, conducting electricity through a detached electron sea.

4. Applying the Clausius-Clapeyron equation, what happens to the boiling point of a refrigerant like R-134a when the ambient pressure is significantly reduced?

Answer: B) The boiling point decreases as vapor pressure reaches ambient pressure sooner.

Boiling occurs when vapor pressure equals external pressure; lowering the external pressure means less heat is required for vapor pressure to match it, thus lowering the boiling point.

5. Which term describes a solid that lacks a long-range ordered crystalline structure, such as Obsidian or certain polymers?

Answer: C) Amorphous solid

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Amorphous solids have particles arranged randomly rather than in a repeating geometric lattice, leading to unique properties like glass transitions rather than sharp melting points.

6. The triple point of a substance represents the unique temperature and pressure where all three common phases coexist in thermodynamic equilibrium.

Answer: A) True

The triple point is a fixed thermodynamic constant for a pure substance where the rates of phase change between solid, liquid, and gas are perfectly balanced.

7. In the context of intermolecular forces, why does Glycerol exhibit exceptionally high viscosity compared to Ethanol?

Answer: B) Glycerol has three hydroxyl groups, leading to extensive hydrogen bonding networks.

Viscosity is influenced by molecular complexity and intermolecular attraction; the three -OH groups in glycerol create a dense network of hydrogen bonds that resist flow.

8. What is the term for the process where a gas transitions directly into a solid, such as the formation of Iodine crystals on a cold surface?

Answer: D) Deposition

Deposition is the exothermic phase transition where a gas loses energy and bypasses the liquid phase to become a solid.

9. As temperature increases, the surface tension of a liquid generally increases due to higher kinetic energy of the surface molecules.

Answer: B) False

Surface tension actually decreases with increasing temperature because increased kinetic energy disrupts the intermolecular forces holding the surface molecules together.

10. Which of the following describes the 'Bose-Einstein Condensate' state of matter observed at near-absolute zero temperatures?

Answer: A) A state where atoms behave as a single quantum mechanical entity.

At temperatures approaching 0 Kelvin, bosonic particles collapse into the lowest quantum state, causing individual wave functions to overlap and act as one 'super-atom'.