Solids & Liquids questions

Name and date submitted (3 pts): Marco Klap, February 19, 2025

Instructions: Using this form as a template, write or type your answers. KEEP THE SAME NUMBERING. The questions are taken directly from Ch. 11, BJU Chemistry, 3rd edition.

(35 sub-questions)

1. How many atoms are you? Assume you weigh 65 kg and you are mostly water.

6.52 * 10^27 atoms if mostly water

2. (BJU #1): Predict the type of INTERmolecular forces that may act between the molecules in these substances.
    a. CO_2

Dispersion forces

    b. NH_3

Dipole-dipole or hydrogen bond

    c. HCl

dipole-dipole

    d. C_3H_8

dispersion forces

3. (BJU #2): Based on your understanding of intermolecular forces, which substance in each of the pairs would have the higher boiling point? Give your reasoning.
    a. NF_3, NH_3

NH3 because it could have hydrogen bonds which are stronger than dipole dipole bonds.

    b. NaCl, HCl

NaCl because it has ionic bonds which are very strong. HCl has much weaker dipole dipole bonds.

    c. CF_4, CHF_3

CHF3 because it could have hydrogen bonds which are stronger than dipole dipole bonds.

d. Cl_2, C_3H_5Cl

C3H5Cl because it could have dipole-dipole bonds which are stronger than dispersion bonds.

4. (BJU #4): Explain the major differences in melting point between a crystal and an amorphous solid.
   A melting point in a crystal is more predictable because of the evenness of the structure of molecules; in an amorphous solid the heating is more uneven so the melting point is different for different parts of the structure.

5. (BJU #5): Assume that the particles in table salt (NaCl) vibrate just as forcefully as the particles in lead (Pb). Explain why table salt remains a solid at 500 °C while lead exists as a liquid at that temperature.
   NaCl has very strong ionic bonds, whereas lead has weaker dispersion bonds.

6. (BJU #7): After a jar of liquid has been sealed, the level of the liquid decreases slightly because of evaporation. After a slight decrease, the level of the liquid ceases to change. Why?

If the level of liquid continued to decrease, the vapor pressure would have to increase. But increasing the vapor pressure pushes some of the vapor back into liquid state. In this way the liquid remains at equilibrium.

7. (BJU #11): In terms of attractive forces and kinetic energies of particles, explain what happens during the following phase changes. Example: Melting – The particles gain enough kinetic energy to overcome the attractive forces that hold them in fixed positions.
   a. Boiling

Boiling occurs when the vapor pressure of the liquid reaches a higher pressure than the surrounding atmosphere. Then the molecules have enough energy to break out of the liquid state and become a gas.

b. Evaporation

Molecules at the surface of a liquid with more kinetic energy lose energy to become a gas and break free from the surface. Stronger attractions between molecules prevent evaporation, while weaker attractions between molecules in a liquid enable evaporation.

c. Freezing

Molecules in a liquid lose enough energy that the bonds between molecules can overcome them and cause them to become a solid.

d. Sublimation

Molecules at the surface of a solid gain enough energy to break free from the intermolecular bonds and go straight into a gaseous state.

8. (BJU #12): A white powder contains tiny, cube-shaped grains and melts at a temperature between 141.6 °C and 142.2 °C. Is this solid more likely to be a crystalline solid or an amorphous solid?
   Crystalline because of the cube shaped grains.

9. (BJU #13): Fill in the following chart, which summarizes the properties of solids, liquids, and gases.

State	Compressible	Fluid	Density
Solid	no	no	Relatively high
Liquid	very little	Yes	relatively high
Gas	Yes	yes	low

10. (BJU #14): What causes surface tension in a liquid?

The molecules on the surface of a liquid being attracted back towards the liquid by intermolecular forces

11. (BJU #15): Water rolls off a duck's back but thoroughly wets a head of human hair. What do these observations reveal about the chemical nature of these two surfaces?

    The feathers on a duck are probably made of nonpolar substance(s) and the humans' aren't, because water is attracted to polar substances as it is polar itself.

12. (BJU #17): How does perspiration cool the skin on a person's body?

    The evaporation of water causes the water still on the skin to have a net loss in kinetic energy or a loss in temperature. When liquids evaporate, the highest energy molecules break off the surface, leaving the lower energy molecules and decreasing the average temperature of the liquid.

13. (BJU #18): Why does the surface of water in a glass test tube curve upward at the edges? (this is called a meniscus)
    The water is attracted to the sides of the test tube because of adhesion between the sides and the water. The adhesion between the sides and water is greater than the cohesion of the water to itself, so the water climbs up the glass slightly at the edges.

14. (BJU #19): Automobile engines are designed to be lubricated with motor oils of specific viscosities. These are rated from the lowest viscosity of 5 W up to the highest viscosity of 70 W. What can you conclude about the intermolecular attractions in an oil rated 10 W?
    The attractions in a 10 w oil are much lower than that of a 70 w oil, but the attractions are stronger than that of a 5 w oil.

15. (BJU #20): What is the essential difference between boiling and evaporation?

    Evaporation occurs only at the surface of a liquid; boiling happens throughout a liquid.

16. (BJU #21): Water in a truck's radiator can get hotter than 100 °C when the radiator is sealed tightly. How is it possible for water to exist as a liquid at temperatures above its normal boiling point?
    If the water is not allowed to expand, it cannot become a gas because to become a gas, the water would have to increase its volume greatly. In the radiator, the pressure is held constant so the water cannot expand.

17. (BJU #26): T/F: The bonds between atoms within a molecule are stronger than the forces that exist between molecules.
    True

18. (BJU #27): T/F: A hydrogen bond is a special kind of dispersion force that can occur only in a molecule containing hydrogen.
    True, but the hydrogen bonds to atoms in other molecules that aren't hydrogen.

19. (BJU #28): T/F: In most cases, a substance has a greater density in its solid than in its liquid state.
    True except water

20. (BJU #31): Using Fig. 11-27, determine the state of water at
    a. 80 C, 300 torr

Gas

    b. 100 C, 900 torr

liquid

    c. -10 C, 500 torr

solid

21. (BJU #32): Using Fig. 11-25, determine
    a. Boiling point of ethanol at normal atmospheric pressure

78.4 degrees C

b. Boiling point of methanol at 720 torr

~62 degrees C

c. Atmospheric pressure at which diethyl ether boils at 20 C
300 torr

22. (BJU #34): Write the three common states of matter – solid, liquid, and gas – in a triangle with space for long arrows between each pair of terms. Draw an arrow in each direction from each term and write the term for the phase change that goes in that direction. For instance, the arrow from solid to liquid would be identified as 'melting'.

    I can't paste images in here for some reason so here is a link to my drawing. I used Google Slides and text boxes.
    https://docs.google.com/presentation/d/1nrE5MWUiDazNr614mA-RnWeLIWChhXo66ndtY8vznrM/edit#slide=id.p

Solids & Liquids questions

Name and date submitted (3 pts):
Instructions: Using this form as a template, write or type your answers. KEEP THE SAME NUMBERING.
The questions are taken directly from Ch. 11, BJU Chemistry, 3rd edition.
(35 sub-questions)

1. How many atoms are you? Assume you weigh 65 kg and you are mostly water.
   Approximately 6.52×10^{27}

2. (BJU #1): Predict the type of INTERmolecular forces that may act between the molecules in these substances.
   a. CO_2: Dispersion

   b. NH_3: Hydrogen Bonding

   c. HCl: Dipole-Dipole

   d. C_3H_8: Dispersion

3. (BJU #2): Based on your understanding of intermolecular forces, which substance in each of the pairs would have the higher boiling point? Give your reasoning.
   a. NF_3, NH_3
      NH_3 because it forms hydrogen bonds, whereas NF_3 does not.

   b. NaCl, HCl
      NaCl has a higher boiling point because it is an ionically bonded salt.

   c. CF_4, CHF_3
      CHF_3 has a higher boiling point because of its dipole-dipole forces, hydrogen bonds, and dispersion forces, compared to CF_4, which only has dispersion forces.

   d. Cl_2, C_3H_5Cl
      C_3H_5Cl has a higher boiling point because of its dipole-dipole forces, hydrogen bonds, and dispersion forces.

4. (BJU #4): Explain the major differences in melting point between a crystal and an amorphous solid.

   Crystals have an organized, geometric structure, and have a distinct melting point, whereas amorphous solids are without an organized structure, and have a range for melting point.

5. (BJU #5): Assume that the particles in table salt (NaCl) vibrate just as forcefully as the particles in lead (Pb). Explain why table salt remains a solid at 500 °C while lead exists as a liquid at that temperature.

Lead consists of lead atoms fastened together via metallic bonds. Table salt contains ionic bonds, which are far stronger than metallic bonds. Therefore more energy is required to break ionic bonds than metallic bonds, so NaCl has a higher melting point.

6. (BJU #7): After a jar of liquid has been sealed, the level of the liquid decreases slightly because of evaporation. After a slight decrease, the level of the liquid ceases to change. Why?
   The level of the liquid ceases to change when dynamic equilibrium is reached, where the processes of condensation and evaporation balance each other out.

7. (BJU #11): In terms of attractive forces and kinetic energies of particles, explain what happens during the following phase changes. Example: Melting – The particles gain enough kinetic energy to overcome the attractive forces that hold them in fixed positions.
   a. Boiling
      Boiling takes place throughout the liquid when the particles gain enough kinetic energy via the application of heat to overcome the bonds in the liquid and perform and phase change to a gas.

   b. Evaporation
      Evaporation occurs on the surface of the liquid when the particles complete a phase change to a gas by gaining sufficient kinetic energy.

   c. Freezing
      Freezing occurs when a liquid changes into a solid, due to a lack of kinetic energy.

   d. Sublimation
      Sublimation occurs when a solid changes into a gas without turning into a liquid.

8. (BJU #12): A white powder contains tiny, cube-shaped grains and melts at a temperature between 141.6 °C and 142.2 °C. Is this solid more likely to be a crystalline solid or an amorphous solid?

   It is most likely an amorphous solid due to the fact that its melting point is given as a range and not a fixed value.

9. (BJU #13): Fill in the following chart, which summarizes the properties of solids, liquids, and gases.

State	Compressible	Fluid	Density
Solid	No	No	Relatively high
Liquid	No	Yes	Relatively High
Gas	Yes	Yes	Low

10. (BJU #14): What causes surface tension in a liquid?
    Surface tension is caused by the imbalance of attractive forces between surface particles.

11. (BJU #15): Water rolls off a duck's back but thoroughly wets a head of human hair. What do these observations reveal about the chemical nature of these two surfaces?

    Duck feathers are coated in an oil, which is a non-polar compound. As such it repels water, keeping the duck dry. Human hair does not have an oil, and so gets soaked upon contact with water.

12. (BJU #17): How does perspiration cool the skin on a person's body?

    Perspiration uses evaporation (which is a cooling process) to remove excess thermal energy from the body.

13. (BJU #18): Why does the surface of water in a glass test tube curve upward at the edges? (this is called a meniscus)
    A meniscus occurs when the attractions between the container and the liquid molecules exceed the intermolecular attractions in the liquid.

14. (BJU #19): Automobile engines are designed to be lubricated with motor oils of specific viscosities. These are rated from the lowest viscosity of 5 W up to the highest viscosity of 70 W. What can you conclude about the intermolecular attractions in an oil rated 10 W?

    An oil rated 10 W has high cohesion and thus strong intermolecular forces.

15. (BJU #20): What is the essential difference between boiling and evaporation?

    Boiling occurs throughout the liquid; evaporation only occurs at the surface.

16. (BJU #21): Water in a truck's radiator can get hotter than 100 °C when the radiator is sealed tightly. How is it possible for water to exist as a liquid at temperatures above its normal boiling point?
    Because the radiator is under pressure, the pressure of the water is higher than atmospheric pressure. Water boils at 100 °C only at atmospheric pressure. If the pressure is raised, the boiling point is also raised.

17. (BJU #26): T/F: The bonds between atoms within a molecule are stronger than the forces that exist between molecules.
    False.

18. (BJU #27): T/F: A hydrogen bond is a special kind of dispersion force that can occur only in a molecule containing hydrogen.
    True.

19. (BJU #28): T/F: In most cases, a substance has a greater density in its solid than in its liquid state.
    True

20. (BJU #31): Using Fig. 11-27, determine the state of water at
    a. 80 C, 300 torr
       Gas (Vapor)
    b. 100 C, 900 torr
       Liquid
    c. -10 C, 500 torr
       Solid
21. (BJU #32): Using Fig. 11-25, determine
    a. Boiling point of ethanol at normal atmospheric pressure
       78.4 °C
    b. Boiling point of methanol at 720 torr
       64 °C
    c. Atmospheric pressure at which diethyl ether boils at 20 C
       300 torr

22. (BJU #34): Write the three common states of matter – solid, liquid, and gas – in a triangle with space for long arrows between each pair of terms. Draw an arrow in each direction from each term and write the term for the phase change that goes in that direction. For instance, the arrow from solid to liquid would be identified as 'melting'.