AQA (GCSE Notes)

Chapter 3: Particle Model of Matter

Q1. Define the term density and write its formula.
Answer: Density is the amount of mass in a given volume. It shows how compact the particles are in a substance. The formula is:
Density = Mass ÷ Volume
$\rho = m \div V$

Q2. How can you calculate the volume of a regular solid object?
Answer: The volume of a regular solid object can be calculated using a mathematical formula based on its shape. For example, for a cube or cuboid:
Volume = Length × Width × Height

Q3. Describe how to find the volume of an irregular solid object.
Answer: The volume of an irregular object can be found using the displacement method. Submerge the object in water and measure how much the water level rises. That rise equals the volume of the object in cm^3 or m^3.

Q4. What apparatus would you use to measure the mass of a solid object?
Answer: To measure the mass of a solid object, a digital balance or electronic scale should be used. It gives accurate mass in grams or kilograms.

Q5. How can a displacement method help in finding volume?
Answer: The displacement method helps in finding volume by showing how much water an object pushes out when it's fully submerged. The volume of water displaced is equal to the volume of the object.

Q6. Explain why gases have lower densities than solids.
Answer: Gases have lower densities because their particles are far apart and move freely. This means there is a lot of empty space, so fewer particles in a given volume compared to solids.

Q7. Describe how particles are arranged in a solid.
Answer: In a solid, particles are tightly packed in a fixed, orderly pattern. They vibrate in place but do not move around, giving solids a definite shape and high density.

Q8. How does the particle arrangement in a liquid differ from that in a gas?
Answer: In a liquid, particles are close together but can move past each other, allowing liquids to flow. In a gas, particles are far apart and move freely in all directions.

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Q9. Why do solids have a higher density than gases?

Answer: Solids have higher density because their particles are closely packed, so there is more mass in a given volume. In gases, particles are spread out, so mass per volume is lower.

Q10. What happens to the density of a substance if its volume increases but mass stays the same?

Answer: If the volume increases and the mass stays the same, the density decreases. This is because the same amount of matter is spread over a larger space.

Q11. Describe how you would use a ruler to calculate the volume of a cube.

Answer: Use the ruler to measure one side of the cube. Then use the formula:

Volume = Side × Side × Side
Volume = s^3

Q12. What is the importance of using the correct units in density calculations?

Answer: Using correct units ensures the results are accurate and understandable. For density, mass should be in kilograms and volume in cubic metres so the density is in kg/m^3.

Q13. Explain how the particle model describes a change from liquid to gas.

Answer: When a liquid is heated, particles gain energy, move faster, and spread apart. Eventually, they break away from the liquid and become a gas with free-moving particles.

Q14. What is meant by a physical change in terms of state changes?

Answer: A physical change is when a substance changes its state but not its chemical structure. The process is reversible and the material keeps its original properties.

Q15. Why is mass conserved when a substance changes state?

Answer: Mass is conserved because the number of particles stays the same. Only their arrangement and energy change, so no mass is lost or gained during the change.

Q16. What happens to the mass of a substance when it melts?

Answer: The mass stays the same because melting is a physical change. No particles are added or removed, only their arrangement changes.

Q17. Describe how to measure the density of a liquid using appropriate apparatus.

Answer: Measure the mass of an empty container using a balance. Fill it with the liquid and record the total mass. Subtract to find the liquid's mass. Measure the liquid volume with a measuring cylinder, then use the formula $\rho = m \div V$.

Q18. How do you ensure accuracy when measuring the volume of a liquid?

Answer: Use a measuring cylinder on a flat surface and check at eye level to avoid parallax error. Use cylinders with fine graduations for better accuracy.

Q19. What is the relationship between particle spacing and density?
Answer: When particles are closely packed, density is high because more mass fits into the same volume. Greater spacing between particles means lower density.

Q20. How would you use a micrometer to measure a small object's dimension?
Answer: Place the object between the spindle and anvil of the micrometer. Turn the ratchet until it clicks, then read the scale to get the accurate measurement.

Q21. Why is a Vernier calliper more accurate than a ruler?
Answer: Vernier callipers can measure to 0.01 cm while a ruler usually measures to 0.1 cm. They also allow measurement of internal and external diameters precisely.

Q22. What causes the volume of a substance to change when heated?
Answer: Heating gives particles more energy, causing them to move further apart. This increases the space between them, so volume increases.

Q23. How does the particle model explain the process of freezing?
Answer: When a liquid cools, particles lose energy and move less. They get closer and form a fixed structure, turning into a solid.

Q24. What physical property remains unchanged during a change of state?
Answer: The mass remains unchanged during a change of state. The substance's chemical composition and total number of particles stay the same.

Q25. Describe the motion of particles in a gas.
Answer: In a gas, particles move rapidly in all directions. They are far apart and collide with each other and the walls of their container.

Q26. What is meant by the term 'sublimation'?
Answer: Sublimation is when a solid changes directly into a gas without passing through the liquid state, like dry ice turning into gas.

Q27. How can you show that evaporation is a physical change?
Answer: Evaporation changes the state but not the substance. The vapour can be condensed back to the liquid, showing it is reversible and physical.

Q28. Explain the term 'conservation of mass' in simple words.
Answer: Conservation of mass means that mass stays the same in a closed system. No matter is created or destroyed, just rearranged.

Q29. Why does ice float on water in terms of density?
Answer: Ice floats because it is less dense than liquid water. The particles in ice are more spread out due to its crystalline structure.

Q30. How does boiling differ from evaporation?
Answer: Boiling happens at a fixed temperature and throughout the liquid. Evaporation can happen at any temperature but only at the surface.

Q31. How can a diagram show differences between solids, liquids, and gases?
Answer: A diagram can show solids with packed particles, liquids with particles close but free to move, and gases with widely spaced moving particles.

Q32. Why do gases expand to fill their container?
Answer: Gas particles move freely and rapidly in all directions. They spread out until they fill all available space in the container.

Q33. What happens to particle energy during melting?
Answer: Particles gain energy from heating, move faster, and break free from their fixed positions in a solid to become a liquid.

Q34. Why does the volume of a gas increase with temperature?
Answer: Heating gives gas particles more energy, so they move faster and push outwards, increasing the volume if the container allows it.

Q35. What safety precautions are needed when heating a liquid during an experiment?
Answer: Wear safety goggles, keep face away from the container, use heatproof gloves if needed, and never heat a sealed container to avoid pressure build-up.

Q36. Describe a method to compare densities of two different liquids.
Answer: Measure equal volumes of both liquids. Find their masses using a balance. Then use $\rho = m \div V$ to calculate and compare densities.

Q37. Why must you use a balance with appropriate sensitivity for density experiments?
Answer: A sensitive balance gives more accurate mass readings. This reduces errors and improves the reliability of density results.

Q38. How does pressure relate to the particle movement in gases?
Answer: Gas pressure comes from particles colliding with container walls. Faster movement from heating increases collisions, raising pressure.

Q39. What are the limitations of using the particle model?
Answer: The particle model does not show forces between particles, their actual sizes, or differences in particle types. It’s a simplified idea.

Q40. Describe how to draw a simple particle diagram of a solid.
Answer: Draw circles close together in a regular pattern to show particles that are tightly packed and fixed in position.

Q41. How does the particle model explain condensation?
Answer: When gas cools, particles lose energy and move slower. They come closer and form a liquid, changing from gas to liquid.

Q42. What changes when a solid becomes a liquid?
Answer: Particles gain energy and move out of their fixed positions. The structure becomes less rigid and particles can slide past each other.

Q43. Why is it important to use the correct measuring instrument for each property?
Answer: Using the right instrument improves accuracy and reliability. For example, a micrometer is better for small thickness than a ruler.

Q44. How can you ensure your density measurement is reliable?
Answer: Use precise equipment, repeat measurements, avoid parallax error, and calculate average values to improve reliability.

Q45. Describe how you would calculate the average density of several objects.
Answer: Measure the mass and volume of each object, find density using $\rho = m \div V$, then add all density values and divide by the number of objects.

Q46. What does a high-density value tell you about a substance?
Answer: It means the particles are tightly packed, and the substance has more mass in a given volume. It is heavier for its size.

Q47. Why must the container's volume be subtracted when measuring the density of a liquid?
Answer: To get the actual volume of the liquid only. Otherwise, the container's volume would give a wrong reading.

Q48. How does mass change when a liquid evaporates in a closed system?
Answer: Mass stays the same because the particles remain in the system. They just change from liquid to gas but are not lost.

Q49. Why are the properties of a material unchanged after a physical state change?
Answer: Because no new substance is formed. The change is only in arrangement or movement of particles, not in the chemical structure.

Q50. Explain how the density of an object can determine whether it sinks or floats in water.
Answer: If an object is denser than water, it sinks. If it is less dense, it floats. This is due to the balance of forces from displaced water.

Q51. What is internal energy in terms of particles in a system?
Answer: Internal energy is the total energy stored inside a system by all the particles that make it up. It includes both the kinetic energy from the particles' movement and the potential energy from the forces between them. Internal energy changes when energy is transferred to or from the system.

Q52. Name the two types of energy that make up internal energy.
Answer: Internal energy is made up of kinetic energy and potential energy. Kinetic energy comes from the motion of the particles, and potential energy comes from the positions of particles and the forces between them.

Q53. How does heating affect the energy of particles in a system?
Answer: Heating a system transfers energy to the particles, which increases their kinetic energy. This makes the particles move faster. As a result, the internal energy of the system increases and may also cause a temperature rise or a change of state.

Q54. What happens to the temperature of a system when its internal energy increases?
Answer: When internal energy increases due to heating, the temperature of the system usually increases as well. This is because the particles move faster, which means their average kinetic energy rises. However, during a change of state, the temperature may stay constant even though internal energy increases.

Q55. What does specific heat capacity mean?
Answer: Specific heat capacity is the amount of energy needed to raise the temperature of one kilogram of a substance by one degree Celsius. It shows how much energy a substance can store and how it reacts to heating. Different materials have different specific heat capacities.

Q56. What is the unit of specific heat capacity?
Answer: The unit of specific heat capacity is joules per kilogram per degree Celsius, written as J/kg°C. It shows how much energy is needed to raise the temperature of each kilogram of the material by 1°C.

Q57. How does the mass of a substance affect the temperature change when heated?
Answer: A greater mass means more particles, so more energy is needed to raise the temperature. If the same amount of energy is added to two objects of different masses, the object with more mass will show a smaller temperature increase.

Q58. How can a change of state occur without a temperature rise?
Answer: During a change of state, such as melting or boiling, the energy added increases the potential energy of the particles, not their kinetic energy. This means the temperature stays constant while the substance changes state.

Q59. What does the equation $\Delta E = mc\Delta\theta$ represent?
Answer: The equation $\Delta E = mc\Delta\theta$ is used to calculate the change in thermal energy in a system when the temperature changes. ΔE is the thermal energy change, m is the mass, c is the specific heat capacity, and $\Delta\theta$ is the temperature change.

Q60. Write the full names for the symbols in the equation $\Delta E = mc\Delta\theta$.
Answer: In the equation $\Delta E = mc\Delta\theta$: ΔE stands for change in thermal energy measured in joules (J),

m is mass in kilograms (kg), c is specific heat capacity in J/kg°C, and $\Delta\theta$ is temperature change in degrees Celsius (°C).

Q61. What is the unit for thermal energy change in the equation $\Delta E = mc\Delta\theta$?
Answer: The unit for thermal energy change (ΔE) is joules (J). This is the standard unit used to measure energy in physics and shows how much heat energy has been transferred.

Q62. Describe what happens to particle movement when a substance is heated.
Answer: When a substance is heated, its particles gain more kinetic energy and start moving faster. In solids, particles vibrate more. In liquids and gases, the particles move faster and spread out. This leads to an increase in temperature or a change of state.

Q63. How does the type of material affect its temperature change when heated?
Answer: Different materials have different specific heat capacities. Materials with high specific heat capacity require more energy to raise their temperature, so they heat up more slowly. Materials with low specific heat capacity heat up faster for the same energy input.

Q64. What happens to internal energy when a substance cools?
Answer: When a substance cools, its internal energy decreases. The particles lose kinetic energy, move more slowly, and may also get closer together, reducing potential energy. If it cools enough, it may also change state, such as condensing or freezing.

Q65. What role does potential energy play in internal energy?
Answer: Potential energy in internal energy comes from the positions and attractions between particles. When particles move further apart during a state change, their potential energy increases. This change adds to the internal energy even if temperature remains constant.

Q66. What causes an increase in potential energy during heating?
Answer: When energy is added during heating and a substance is changing state, the energy goes into overcoming the forces between particles instead of increasing their speed. This increases their potential energy, helping the particles move further apart.

Q67. How can you increase the internal energy of a system?
Answer: You can increase the internal energy of a system by heating it. Heating transfers energy to the particles, increasing their kinetic and/or potential energy. This raises the total internal energy of the system.

Q68. How can energy input raise the temperature without changing the state?
Answer: When energy is added to a substance and it does not change state, the energy increases the kinetic energy of the particles. As a result, the temperature rises without a change in state.

Q69. Why do some materials heat up faster than others?
Answer: Materials heat up at different rates because they have different specific heat capacities. A

material with a low specific heat capacity needs less energy to increase its temperature, so it heats up quickly compared to a material with a high specific heat capacity.

Q70. How is specific heat capacity useful in everyday life?
Answer: Specific heat capacity helps us choose materials for heating or cooling. For example, water has a high specific heat capacity and is good for storing heat in heating systems. Metals with low specific heat capacity heat up fast, which is useful for cooking pans.

Q71. What is the relationship between mass and thermal energy change?
Answer: Thermal energy change is directly proportional to the mass of a substance. If mass increases, more energy is required to cause the same temperature change, because more particles need to be heated.

Q72. Why does a higher mass require more energy to heat up?
Answer: A higher mass means more particles. More energy is needed to increase the kinetic energy of all the particles, so a greater amount of energy is required to achieve the same temperature change.

Q73. Explain why metals have low specific heat capacity.
Answer: Metals have low specific heat capacities because their particles can transfer energy quickly between them. This means less energy is needed to increase their temperature by 1°C, so they heat up and cool down quickly.

Q74. Describe a situation where heating changes the state but not the temperature.
Answer: When ice melts at 0°C or water boils at 100°C, the temperature stays constant during the process. The energy added is used to break the bonds between particles, changing the state but not raising the temperature.

Q75. What does $\Delta\theta$ represent in the thermal energy equation?
Answer: $\Delta\theta$ represents the change in temperature of the substance in degrees Celsius. It is calculated by subtracting the initial temperature from the final temperature after heating or cooling.

Q76. How can you calculate specific heat capacity from a heating experiment?
Answer: Measure the mass of the substance (m), record the temperature change ($\Delta\theta$), and measure the energy supplied (ΔE) using a joulemeter.

Use the formula: $c = \Delta E \div (m \times \Delta\theta)$
Substitute values and solve for c.

Q77. What happens to the internal energy when water boils?
Answer: During boiling, the internal energy increases because energy is added. This energy breaks the bonds between water molecules, increasing their potential energy, while temperature remains constant.

Q78. If two objects are made of different materials, why might one heat up faster?
Answer: The object with the lower specific heat capacity heats up faster because it requires less energy per kilogram to increase its temperature. Materials respond differently to the same amount of energy based on their thermal properties.

Q79. What happens to the energy supplied during melting or boiling?
Answer: The energy supplied goes into increasing the potential energy of the particles. It is used to break the bonds between them during the change of state, not to increase the temperature.

Q80. How do you measure the temperature change in a system during heating?
Answer: Use a thermometer or digital temperature probe. Measure the initial temperature before heating and the final temperature after heating.

$\Delta\theta$ = Final temperature - Initial temperature

Q81. How would doubling the mass affect the temperature change, if energy input stays the same?
Answer: If the mass is doubled and the same energy is supplied, the temperature change will be smaller. This is because the energy is spread across more particles, resulting in less temperature rise.

Q82. Why does water take longer to heat up than metal?
Answer: Water has a higher specific heat capacity than metal. It needs more energy to raise its temperature, so it heats up more slowly than metal with the same energy input.

Q83. How can the internal energy of a gas be increased without heating it?
Answer: You can compress the gas. Compression forces the particles closer together and increases their potential and kinetic energy, which increases internal energy even without adding heat.

Q84. What factors determine how much thermal energy is needed to heat a substance?
Answer: The required energy depends on the mass of the substance, its specific heat capacity, and the temperature change. More mass or greater temperature change requires more energy.

Q85. How does increasing temperature affect the kinetic energy of particles?
Answer: As temperature increases, particles gain more kinetic energy. They move faster and collide more often, which can also lead to expansion or change of state if enough energy is supplied.

Q86. Give an example of when thermal energy increases but the temperature stays constant.
Answer: During the boiling of water at 100°C, thermal energy continues to be added, but the temperature stays constant. The energy goes into changing the state from liquid to gas.

Q87. Why is it important to know the specific heat capacity of a substance in heating systems?

Answer: Knowing the specific heat capacity helps in selecting materials that store or transfer heat efficiently. It helps in designing systems that control temperature and energy usage effectively.

Q88. What is meant by thermal equilibrium in a system?
Answer: Thermal equilibrium occurs when all parts of a system reach the same temperature and no more heat flows between them. The energy is evenly distributed, and the system becomes stable.

Q89. What happens to the internal energy during condensation?
Answer: During condensation, particles lose energy and move closer together. This causes a decrease in internal energy as the gas turns into a liquid.

Q90. How can a thermometer be used to find $\Delta\theta$ in a practical?
Answer: Record the starting temperature using the thermometer before heating. Then heat the substance and record the final temperature.

$\Delta\theta$ = Final temperature - Initial temperature

Q91. Why is more energy needed to heat a large pot of water than a small cup?
Answer: A large pot has more mass, meaning more water particles must be heated. More energy is needed to raise the temperature of all those particles.

Q92. How can heat loss affect an experiment measuring specific heat capacity?
Answer: Heat loss to the surroundings causes less energy to go into the substance. This leads to inaccurate results because the temperature rise will be smaller than expected.

Q93. How does the specific heat capacity help in designing thermal storage systems?
Answer: Substances with high specific heat capacity can store large amounts of energy. These are ideal for thermal storage, keeping systems warm for longer periods with less temperature change.

Q94. What does a small specific heat capacity mean for temperature change?
Answer: A small specific heat capacity means that the material heats up or cools down quickly, even with a small amount of energy. It does not store heat well.

Q95. Describe the effect of heating a substance with high specific heat capacity.
Answer: It will heat up slowly because it takes more energy to raise its temperature. However, it can store more energy, which is useful for keeping temperature stable over time.

Q96. What is the difference between internal energy and thermal energy?
Answer: Internal energy is the total of all kinetic and potential energy in the system. Thermal energy usually refers only to the energy that causes a temperature change due to particle motion.

Q97. Why does temperature not change during a state change, even though energy is added?
Answer: During a state change, added energy is used to overcome the forces holding particles together. This increases potential energy but not kinetic energy, so temperature stays the same.

Q98. How do kinetic and potential energy contribute to total internal energy?
Answer: Kinetic energy comes from particle movement and affects temperature. Potential energy comes from the forces between particles. Both combine to form the internal energy of the system.

Q99. Explain why ice requires energy to melt, even at 0°C.
Answer: At 0°C, the temperature does not rise, but energy is still needed to break the bonds between water molecules in ice. This energy increases potential energy and causes melting.

Q100. Why does internal energy increase even if the temperature does not?
Answer: During a change of state, energy is added to increase the potential energy of particles. Although temperature remains constant, the internal energy still increases due to the added potential energy.

Q101. What is meant by latent heat in terms of particle energy?
Answer: Latent heat is the energy needed to change the state of a substance without changing its temperature.
During this process, energy is used to overcome or form forces between particles. This changes their potential energy but not their kinetic energy, so temperature remains constant.

Q102. Why does temperature stay constant during a change of state?
Answer: Because the energy is used to break or form bonds between particles, not to increase kinetic energy.
Since kinetic energy stays the same, there is no rise in temperature. Instead, internal energy changes due to altered particle positions.

Q103. Define specific latent heat in simple terms.
Answer: Specific latent heat is the amount of energy required to change the state of 1 kg of a substance with no temperature change.
It varies depending on whether the substance is melting, freezing, boiling, or condensing and is measured in J/kg.

Q104. What is the correct unit of specific latent heat?
Answer: The unit of specific latent heat is joules per kilogram (J/kg).
It tells us how much energy in joules is needed to change the state of one kilogram of substance without a change in temperature.

Q105. State the equation used to calculate energy during a change of state.
Answer: The equation is $E = mL$.
In this equation, E is the energy in joules, m is the mass in kilograms, and L is the specific latent heat in J/kg. Multiplying mass by specific latent heat gives the energy needed.

Q106. What is meant by specific latent heat of fusion?
Answer: It is the energy needed to change 1 kg of a substance from solid to liquid with no temperature change.

The energy breaks the bonds holding particles in a solid. The temperature remains steady during this process.

Q107. What is meant by specific latent heat of vaporisation?
Answer: It is the energy needed to change 1 kg of a substance from liquid to gas with no temperature change.
This energy is used to break intermolecular forces so particles can move freely as a gas.

Q108. What type of energy is involved when a substance melts?
Answer: Latent heat of fusion is involved, increasing the potential energy of the particles.
The energy is used to overcome bonds in the solid. The temperature stays constant, but the internal energy increases.

Q109. What energy transfer occurs during boiling?
Answer: Thermal energy is transferred to increase potential energy as the liquid turns to gas.
The energy breaks bonds between liquid particles. Kinetic energy and temperature remain constant during the change.

Q110. Why is energy still needed to melt ice even at 0°C?
Answer: Because energy is required to break the forces between the solid particles.
Although the temperature is already at the melting point, latent heat of fusion must still be supplied to complete the change of state.

Q111. What happens to the internal energy of a substance during freezing?
Answer: The internal energy of the substance decreases during freezing.
When a substance freezes, it loses energy to the surroundings. This energy loss reduces the potential energy of the particles as they come closer together to form a solid. Although temperature remains the same, the overall internal energy falls because there is less energy stored in the movement and spacing of particles.

Q112. In the equation E = mL, what does the letter L represent?
Answer: The letter L represents the specific latent heat of the substance.
Specific latent heat is the amount of energy required to change the state of 1 kilogram of a substance without any temperature change. It is measured in joules per kilogram (J/kg). There are two types: latent heat of fusion (solid to liquid) and latent heat of vaporisation (liquid to gas).

Q113. In the equation E = mL, what does the letter m represent?
Answer: The letter m stands for the mass of the substance in kilograms.
The amount of energy required for a change of state depends on how much of the substance is changing. A larger mass needs more energy. By multiplying the mass (m) by the specific latent heat (L), we can calculate the total energy (E) required for the change.

Q114. In the equation E = mL, what does the letter E represent?
Answer: The letter E represents the energy needed to change the state of the substance.

This energy is measured in joules (J) and is the result of multiplying the mass of the substance (m) by its specific latent heat (L). It reflects how much energy must be supplied or removed to melt, boil, freeze, or condense the substance without changing its temperature.

Q115. What happens to the arrangement of particles during condensation?
Answer: The particles move closer together and become more ordered during condensation.
As a gas cools and condenses into a liquid, the particles lose energy. They slow down and the attractive forces between them bring them closer. The motion becomes more restricted, and the random movement of gas is replaced by the more ordered flow of liquid.

Q116. Give one difference between specific latent heat and specific heat capacity.
Answer: Specific latent heat is for state change without temperature change; specific heat capacity is for temperature change without state change.
Specific latent heat relates to phase changes like melting or boiling. Specific heat capacity refers to how much energy is needed to raise the temperature of 1 kg of a substance by 1°C. They involve different processes and equations.

Q117. During vaporisation, why doesn't the temperature rise even when energy is added?
Answer: The energy is used to break bonds between liquid particles, not to increase temperature.
During vaporisation, added heat energy increases the potential energy of the particles as they escape into the gas phase. Since the kinetic energy (which determines temperature) does not increase, the temperature remains constant until the entire substance has changed state.

Q118. How does adding energy during a change of state affect the bonds between particles?
Answer: The added energy weakens or breaks the bonds between the particles, allowing a change of state.
In melting or boiling, energy is used to overcome the forces holding the particles together. This increases their potential energy. The bonds are loosened (melting) or fully broken (boiling), enabling the particles to move more freely in the new state.

Q119. Define internal energy during a state change in terms of particles.
Answer: Internal energy is the total energy stored in a substance's particles, including kinetic and potential energy.
During a change of state, the internal energy changes as potential energy increases or decreases due to bond changes, while kinetic energy remains the same. For example, during melting or boiling, potential energy increases, raising internal energy overall.

Q120. What is one method of measuring the latent heat of fusion of water?
Answer: One method is to melt a known mass of ice using a known electrical energy input.
Use an electrical heater to supply energy to ice in an insulated container. Measure the mass of ice melted and the energy supplied. Apply the equation $L = E \div m$. This allows calculation of the specific latent heat of fusion using accurate values.

Q121. Why is no temperature rise observed while a substance is melting?

Answer: Because the energy supplied is used to break the bonds between particles, not increase their speed.

During melting, all added heat is absorbed as latent heat. It raises potential energy but not kinetic energy, so the temperature remains constant until the phase change is complete. Only after melting does temperature start to rise again.

Q122. A sample of ice is melting. How can you calculate the energy used?

Answer: Use the equation E = mL to find the energy used for melting.

Measure the mass of the ice in kilograms. Multiply it by the specific latent heat of fusion for ice (approximately 334,000 J/kg). This gives the energy needed to change the ice into water without raising the temperature.

Q123. Why does evaporation from the skin cause a cooling effect?

Answer: Because the fastest-moving particles escape as gas, taking energy away from the skin.

This energy loss reduces the average kinetic energy of the remaining particles, lowering the skin temperature. The body feels cooler because internal energy has decreased as a result of particle escape during evaporation.

Q124. Describe the change in motion of particles during boiling.

Answer: The particles move faster and escape from the liquid into the air as gas.

As energy is added, particles gain enough energy to overcome intermolecular forces and break free from the liquid. Their motion becomes random and rapid as they enter the gas phase, where they are widely spaced and move independently.

Q125. What kind of energy do particles gain during melting?

Answer: Particles gain potential energy during melting.

As heat is applied, particles use the energy to overcome the attractive forces holding them in a solid. Their positions shift, and they can move more freely in the liquid state. Kinetic energy and temperature remain constant during this phase.

Q126. What information can you obtain from a heating curve?

Answer: A heating curve shows how temperature changes over time and identifies phase changes.

It includes sloped sections where temperature rises, and flat sections where state changes occur. From the graph, you can determine melting and boiling points and analyse the energy input during different stages of heating.

Q127. What does a flat section on a heating curve graph represent?

Answer: It represents a phase change where temperature stays constant.

During this time, energy is being used to change the state of the substance, such as melting or boiling. The energy is absorbed as latent heat and is not used to increase kinetic energy, so there's no temperature rise.

Q128. How does the energy required for vaporisation compare to fusion?
Answer: Vaporisation usually requires more energy than fusion.
More energy is needed to fully separate particles into a gas than to convert a solid into a liquid. This is because intermolecular forces must be completely broken during vaporisation, while they're only partially loosened during fusion.

Q129. How does mass affect the energy required for a change of state?
Answer: The greater the mass, the more energy is required to change state.
According to the formula E = mL, energy is directly proportional to mass. If you double the mass, you double the energy needed to complete the phase change, assuming the same specific latent heat.

Q130. List two safety precautions for a latent heat practical.
Answer: Use heatproof gloves and keep electrical equipment dry.
Melting and boiling involve high temperatures, so gloves prevent burns. Since heaters are powered by electricity, it's essential to avoid water contact to reduce the risk of electric shock. Follow lab safety protocols at all times.

Q131. Which units would you use for energy in a latent heat calculation?
Answer: Energy in a latent heat calculation is measured in joules (J).
The formula used is E = mL, where E is energy in joules, m is mass in kilograms, and L is specific latent heat in joules per kilogram (J/kg). Since joule is the SI unit of energy, it must be used to keep the units consistent and correct in physics calculations.

Q132. Why do different substances have different values of latent heat?
Answer: Because the strength of the forces between their particles is different.
Substances with stronger intermolecular forces need more energy to overcome those forces during a change of state. For example, water requires more energy to boil than alcohol due to stronger hydrogen bonds, resulting in a higher latent heat value.

Q133. What happens to potential energy during the melting process?
Answer: Potential energy of particles increases during melting.
As a solid melts into a liquid, energy is absorbed to break the bonds holding the particles in fixed positions. This increases their potential energy while kinetic energy and temperature stay the same, allowing the substance to change state without a temperature rise.

Q134. Why is more energy needed to vaporise a liquid than to melt a solid?
Answer: Because particles move further apart during vaporisation, breaking more forces.
In melting, particles only loosen slightly. But during vaporisation, particles must fully overcome intermolecular attractions to escape as gas. This requires more energy, which is why specific latent heat of vaporisation is greater than fusion.

Q135. Describe what happens to particles at the boiling point of a liquid.
Answer: They gain energy, overcome forces, and escape into the air as gas particles.
At the boiling point, particles absorb latent heat, which increases their potential energy. This energy allows them to break free from the liquid's surface. They then move rapidly and randomly in all directions as they transition into the gas state.

Q136. Explain why your skin feels cold after alcohol evaporates from it.
Answer: Because the alcohol absorbs heat energy from your skin to evaporate.
Evaporation requires energy. When alcohol on your skin changes from liquid to gas, it takes thermal energy from your skin. This reduces your skin's internal energy and temperature, creating a cooling sensation as the faster particles escape first.

Q137. How can you calculate specific latent heat from experiment data?
Answer: Divide energy supplied by the mass of the substance changed.
Use the formula $L = E \div m$. Measure the energy input (E) using a joulemeter or power × time, and the mass (m) of the substance that changed state. This gives the specific latent heat in J/kg. Ensure temperature stays constant during the change.

Q138. On a heating graph, what does the flat part during boiling represent?
Answer: It shows a state change where temperature stays constant.
During the flat section, the substance is boiling. The energy supplied is not raising temperature but is used to overcome the forces between particles. This latent heat input increases potential energy while kinetic energy and temperature stay the same.

Q139. Explain how latent heat is related to internal energy.
Answer: Latent heat increases the internal energy by raising potential energy of particles.
During a change of state, added latent heat energy changes the particle arrangement by overcoming forces. Although temperature remains constant, internal energy rises because the particles' positions and stored potential energy are changing.

Q140. What happens to particle spacing during vaporisation?
Answer: The particles move far apart and become more randomly arranged.
In the liquid, particles are close with some freedom. During vaporisation, they absorb energy, overcome attractions, and move independently. This increases spacing and decreases particle interaction, turning the substance into a low-density gas.

Q141. Describe the motion of gas particles in a sealed container.
Answer: They move quickly in all directions and collide with each other and the walls.
Gas particles have random, constant motion. These collisions with container walls create pressure. Since there's no fixed pattern or path, their motion is considered random, and their speed depends on the gas temperature.

Q142. How is the temperature of a gas linked to its kinetic energy?
Answer: Temperature is directly proportional to the average kinetic energy of gas particles.
When temperature increases, particles move faster. The faster the motion, the higher the average kinetic energy. So a higher temperature means more energetic and rapid particle collisions in the gas.

Q143. What happens to gas pressure when temperature increases at constant volume?
Answer: The pressure increases.
At constant volume, higher temperature gives particles more kinetic energy. They move faster and hit the container walls more frequently and forcefully. This increases the total force per unit area, which is pressure.

Q144. Why does faster movement of gas particles increase pressure?
Answer: Because they collide more often and with more force against the container walls.
Pressure is caused by particle collisions. When particles move faster due to increased kinetic energy, they hit the walls more frequently and harder. This raises the overall pressure inside the container.

Q145. How does temperature affect the average speed of gas molecules?
Answer: As temperature increases, the average speed of gas molecules increases.
Higher temperatures give more kinetic energy to gas particles, making them move faster. This increase in motion leads to more energetic collisions and is directly linked to the gas's internal energy and pressure.

Q146. What is meant by random motion in gases?
Answer: It means gas particles move in unpredictable directions with varying speeds.
Gas particles travel in straight lines until they collide with other particles or the walls. These collisions change their direction randomly, creating a constantly shifting pattern of motion that has no fixed direction or sequence.

Q147. Why does a rise in temperature increase pressure in a gas at constant volume?
Answer: Because particles move faster and hit the walls more often and with more force.
As temperature increases, particles gain kinetic energy, causing more frequent and forceful collisions with the container walls. Since volume doesn't increase, the extra collisions raise the gas pressure.

Q148. Describe how gas particles exert pressure on the walls of a container.
Answer: They collide with the walls and transfer momentum, creating force.
Each collision exerts a tiny force on the wall. Billions of these collisions per second produce a measurable pressure. The faster and more often the particles hit the walls, the greater the pressure they exert on the container.

Q149. What effect does cooling have on the pressure of a fixed volume of gas?
Answer: Cooling reduces the pressure of the gas.

When temperature drops, gas particles lose kinetic energy and move slower. This means they collide with the walls less frequently and with less force, resulting in a lower pressure inside the container, assuming volume stays constant.

Q150. How would you describe the particle movement of a gas at a higher temperature?
Answer: Particles move faster and collide more often at higher temperatures.
As temperature rises, kinetic energy increases. This causes gas particles to move rapidly in all directions, resulting in more frequent and energetic collisions with each other and the container walls, increasing pressure if volume is constant.

Q151. What is the effect on gas pressure when the gas is compressed at constant temperature?
Answer: When a gas is compressed at constant temperature, its pressure increases.
Compression means reducing the volume of the gas. Since the number of particles and the temperature stay the same, the particles have less space to move. This causes them to collide more often with the walls of the container, increasing the force per unit area, which results in higher pressure according to the particle model.

Q152. Explain why gas pressure decreases when volume increases at constant temperature.
Answer: Pressure decreases because the particles have more space to move and collide less frequently with the walls.
When volume increases but the number of gas particles and temperature stay the same, the particles are more spread out. This means fewer collisions per second with the walls of the container. Since pressure is caused by particle collisions, fewer collisions lead to lower pressure.

Q153. State the equation that links gas pressure and volume for a fixed mass at constant temperature.
Answer: The equation is $p \times V = \text{constant}$.
This is known as Boyle's Law. It shows the inverse relationship between pressure and volume for a fixed mass of gas at constant temperature. If pressure increases, volume must decrease to keep the product the same, and vice versa.

Q154. If pressure increases, what must happen to volume for temperature to remain constant?
Answer: The volume must decrease.
According to the equation $p \times V = \text{constant}$, pressure and volume are inversely related at constant temperature. If the pressure is increased, to maintain the same product, the volume must decrease. This ensures the relationship holds.

Q155. Describe how gas particles create pressure on the walls of a container.
Answer: Gas particles move randomly and collide with the walls, exerting force that causes pressure.
The pressure of a gas is due to the continuous, random motion of its particles. When these

particles collide with the walls of the container, they exert a small force. The total pressure is the sum of many such collisions per second over the surface area of the walls.

Q156. What unit is used to measure pressure in gas laws?

Answer: The unit for pressure in gas laws is the pascal (Pa).

One pascal is equal to one newton per square metre (N/m^2). It is the SI unit used in the equation $p \times V$ = constant, ensuring consistency when calculating pressure-volume relationships in physics problems involving gases.

Q157. What unit is used to measure volume in gas laws?

Answer: Volume is measured in cubic metres (m^3) in gas laws.

SI units are used in physics calculations. While volume can also be expressed in litres or cm^3 in other contexts, for calculations involving gas pressure and volume, the standard unit is the cubic metre (m^3) to match the units in the $p \times V$ = constant equation.

Q158. Why does compressing a gas increase its pressure?

Answer: Compression reduces volume, so particles collide more often with container walls.

Compressing a gas brings the particles closer together. As a result, the frequency of collisions with the container walls increases. Since pressure is due to the force from these collisions, more frequent impacts mean greater pressure.

Q159. How does increasing the volume of a gas container affect particle collisions?

Answer: It decreases the frequency of collisions with the container walls.

When the volume increases, particles have more space to move, so they travel longer distances between collisions. This results in fewer impacts on the container walls in a given time, leading to a reduction in pressure.

Q160. What does the equation pV = constant assume about the temperature of the gas?

Answer: It assumes that the temperature of the gas remains constant.

The equation $p \times V$ = constant is derived from Boyle's Law, which only applies when temperature does not change. A constant temperature means the kinetic energy of the particles stays the same, so any change in volume must result in an opposite change in pressure.

Q161. Explain what is meant by a gas being "compressed."

Answer: It means the gas is forced into a smaller volume, increasing its pressure.

Compression reduces the space available for gas particles to move. This increases the frequency of their collisions with each other and the container walls, leading to greater pressure. The gas becomes denser and its particles are closer together.

Q162. What is meant by the term "constant temperature" in relation to the pV equation?

Answer: It means the temperature of the gas does not change during the volume or pressure change.

Keeping temperature constant ensures that the kinetic energy of gas particles remains unchanged. This makes the pressure-volume relationship valid under Boyle's Law, where $p \times V$ = constant.

Q163. How does the particle model explain changes in pressure with volume?

Answer: It shows that less volume leads to more frequent collisions and higher pressure.

In the particle model, gas particles move randomly and collide with walls. If the volume is reduced, there's less space, so particles hit the walls more often. This results in more force per unit area and increased pressure.

Q164. Why do gases exert pressure on the walls of their containers?

Answer: Because their particles collide with the walls and transfer momentum.

As gas particles move randomly, they constantly collide with the container's walls. Each collision exerts a small force. The cumulative effect of these continuous collisions results in gas pressure on the walls.

Q165. What would happen to the pressure of a gas if its volume is halved at constant temperature?

Answer: The pressure would double.

According to Boyle's Law: $p_1V_1 = p_2V_2$. If volume is halved ($V_2 = ½V_1$), then pressure must double to keep the product constant. For example, if $V_1 = 2\ m^3$ and $p_1 = 100$ Pa, then $V_2 = 1\ m^3$, and $p_2 = 200$ Pa.

Q166. What happens to the pressure of a gas if the volume doubles and temperature stays the same?

Answer: The pressure is halved.

Using the formula $p_1V_1 = p_2V_2$, if volume doubles ($V_2 = 2V_1$), then pressure must halve to maintain the same product. This is an inverse relationship and explains how gases behave under constant temperature conditions.

Q167. Describe how a gas can be compressed in a laboratory setting.

Answer: A gas can be compressed using a syringe or piston to reduce its volume.

In the lab, a sealed syringe can be used to trap a fixed amount of gas. By pushing the plunger inwards while keeping the temperature steady, the volume decreases, which increases the gas pressure due to more frequent particle collisions.

Q168. How does the frequency of particle collisions change when volume is decreased?

Answer: The frequency of collisions increases.

Decreasing the volume of gas reduces the distance particles can travel before hitting the walls. This results in more collisions in a given time, raising the pressure inside the container as a result of increased force per unit area.

Q169. What effect does increasing pressure have on the shape of a flexible gas container?

Answer: It can cause the container to expand or bulge outward.

When gas pressure increases inside a flexible container (like a balloon), the force from the internal collisions pushes outward more strongly. If the material is elastic, it stretches to accommodate the higher pressure and larger volume.

Q170. What is meant by the term "net force at right angles to the wall" in gas pressure?

Answer: It means the pressure force from gas particles acts perpendicular to the surface.

Each particle collision exerts a force in the direction of impact. Since the particles hit the container walls directly, the resulting net force from many such impacts acts at right angles to the surface, which defines gas pressure directionally.

Q171. What assumption is made about the gas particles in the particle model?

Answer: That they move randomly and have no intermolecular forces.

The particle model treats gas particles as small, hard spheres that move in straight lines between elastic collisions. It assumes no forces between particles and that their total volume is negligible compared to the container.

Q172. If volume remains the same, what must happen to pressure for pV to remain constant?

Answer: Pressure must remain constant as well.

In the equation $p \times V$ = constant, if volume does not change, then pressure must also stay the same to maintain the constant value. Any change in pressure would only be valid if there was a corresponding change in volume.

Q173. How can the pressure of a gas be measured practically?

Answer: By using a pressure sensor or manometer.

In experiments, a digital pressure sensor can be connected to a sealed gas container to display pressure in pascals. Alternatively, a U-tube manometer can measure the pressure difference between the gas and atmospheric pressure using liquid columns.

Q174. Why is it important to keep temperature constant when investigating pressure and volume?

Answer: So that the pressure-volume relationship is valid under Boyle's Law.

Temperature affects the kinetic energy of particles. If temperature changes during the experiment, it alters the pressure independently of volume, making it difficult to observe the true relationship between pressure and volume alone.

Q175. State one example of a real-life device where gas pressure increases due to compression.

Answer: A bicycle pump is a real-life example.

When you push the handle of a bicycle pump, the air inside is compressed into a smaller volume. This increases the pressure of the air, allowing it to flow into the tyre. The temperature may also rise slightly due to the work done on the gas.

Q176. What is meant by “work is done on a gas”?

Answer: Work is done on a gas when a force is applied to compress it, transferring energy to the gas.

When an external force compresses a gas, like pushing a piston, energy is transferred to the gas particles. This energy increases their motion and can raise the temperature. The work done is the product of force and distance moved, and it leads to an increase in internal energy.

Q177. Give an example where doing work on a gas increases its temperature.

Answer: Using a bicycle pump is an example where doing work on a gas raises its temperature.

As the pump handle is pushed down, air inside is compressed. The particles are forced into a smaller space and gain kinetic energy from the work done. This results in a temperature increase, which can be felt as the pump barrel warms up.

Q178. What is the energy transfer involved when a gas is compressed?

Answer: The energy transfer is from mechanical work to internal energy of the gas.

Compression involves applying a force, doing work on the gas. This mechanical energy transfers to the gas, increasing the kinetic energy of the particles. As a result, the internal energy and temperature of the gas increase.

Q179. Why does compressing a gas increase its internal energy?

Answer: Compression transfers energy to gas particles, increasing their motion and internal energy.

When a gas is compressed, work is done on it. This energy input increases the kinetic energy of the particles. Since internal energy is the total of kinetic and potential energies, compressing a gas increases its internal energy and often its temperature too.

Q180. Describe how a bicycle pump demonstrates gas compression and temperature increase.

Answer: A bicycle pump compresses air, increasing pressure and temperature due to work done on the gas.

As the handle is pushed, the air is forced into a smaller volume. Particles collide more often and gain energy. This increased energy raises the temperature, which can be felt by touching the pump after several compressions.

Q181. What happens to the temperature of a gas when it is compressed quickly?

Answer: The temperature of the gas rises because the internal energy increases due to the work done.

Rapid compression doesn't allow heat to escape. The energy from compression goes into increasing the kinetic energy of particles, raising the temperature. This is an adiabatic process where no heat is lost to the environment.

Q182. Explain how doing work on a gas can increase its internal energy without heating.

Answer: Work adds energy to gas particles directly, increasing their speed and internal energy.

Heating means energy is added via thermal contact, but doing work like compression also adds energy. The force used to compress the gas increases particle motion, raising internal energy without a heat source.

Q183. How does the particle model explain an increase in temperature during compression?
Answer: Particles are forced closer and move faster, increasing temperature.
In the particle model, gas temperature depends on particle kinetic energy. Compression decreases space, increasing collision frequency and energy. This causes a rise in average kinetic energy and therefore, temperature.

Q184. What happens to the motion of gas particles when work is done on the gas?
Answer: Their speed increases, leading to more energetic collisions and higher pressure.
Work done on the gas increases kinetic energy. This causes particles to move faster and collide more frequently and forcefully with the container walls, increasing both temperature and pressure.

Q185. State one safety consideration when compressing gases.
Answer: Avoid overpressurising the container to prevent explosion.
Compressed gases can reach high pressures quickly. If the container is not rated for that pressure, it may burst. Use pressure gauges and release valves to control and monitor the pressure during experiments or operations.

Q186. What is meant by the internal energy of a gas?
Answer: Internal energy is the total kinetic and potential energy of all particles in the gas.
It includes the energy due to particle motion (kinetic) and interactions between them (potential). For ideal gases, internal energy mainly comes from kinetic energy since there are negligible intermolecular forces.

Q187. Explain how volume and pressure are related if temperature and mass stay constant.
Answer: They are inversely related; as volume increases, pressure decreases.
This is Boyle's Law: pV = constant. If temperature and mass are fixed, increasing volume means particles collide less often with the walls, reducing pressure. Decreasing volume increases collisions, raising pressure.

Q188. What happens to gas particles during a rapid compression?
Answer: They move faster, collide more, and temperature rises.
Rapid compression reduces volume quickly, forcing particles into a smaller space. Their energy increases from the work done, which increases the speed and frequency of collisions, raising internal energy and temperature.

Q189. Why does a sealed syringe become harder to push as it is compressed?
Answer: Pressure builds up inside due to increased particle collisions.
As the plunger compresses the gas, volume decreases. Gas particles have less space and collide more often with the syringe walls and plunger, resisting further compression. This results in a noticeable opposing force.

Q190. What is the role of kinetic energy in determining gas pressure?
Answer: More kinetic energy means faster particles, which increases pressure.
Pressure arises from collisions with container walls. Higher kinetic energy leads to more frequent and forceful collisions. Therefore, pressure is directly linked to the average kinetic energy of gas particles.

Q191. What happens to pressure if the volume of a gas is reduced to one-third at constant temperature?
Answer: Pressure triples.
Using $p_1V_1 = p_2V_2$: If $V_2 = 1/3\ V_1$, then p_2 must be 3 times p_1. This is due to the inverse relationship between pressure and volume at constant temperature (Boyle's Law).

Q192. How does temperature rise when a gas is compressed without losing energy?
Answer: The energy from compression goes into particle motion, increasing temperature.
This is an adiabatic process. No heat is exchanged with surroundings, so all the work done stays in the gas as kinetic energy. More motion means more internal energy and a temperature rise.

Q193. What is the relationship between volume and pressure according to Boyle's Law?
Answer: Volume and pressure are inversely proportional at constant temperature.
Boyle's Law: $p \times V$ = constant. If volume increases, pressure decreases and vice versa, as long as temperature and mass of the gas remain unchanged.

Q194. Explain how gas pressure is affected in a scuba tank during compression.
Answer: Compression increases gas pressure significantly.
Air is pumped into the tank at high pressure, reducing its volume. The particles are packed closer together, increasing collision frequency and force on the walls. This raises the internal pressure needed to supply air to the diver.

Q195. What does it mean when we say gas pressure acts "at right angles" to the wall?
Answer: The force from particle collisions is directed perpendicularly to the surface.
Each collision transfers momentum to the wall. Because particles hit the wall straight on during random motion, the net force from many such collisions acts at right angles to the surface.

Q196. In terms of particles, explain why a gas exerts more pressure in a smaller container.
Answer: Particles collide more often due to reduced space.
When volume decreases, particles have less room to move. They collide with the container walls more frequently, increasing the force exerted per unit area and therefore, raising the pressure.

Q197. Describe how the internal energy of a gas changes when it is compressed in a pump.
Answer: Internal energy increases due to added particle kinetic energy.
When a gas is compressed, work is done on it. This work increases the motion of particles, raising kinetic energy. Since internal energy is the total energy of particles, it also increases.

Q198. If pV = constant, what happens to pressure if volume is decreased?
Answer: Pressure increases.
Rearranging the formula gives p = constant / V. So as volume decreases, pressure must rise to keep the product the same, assuming constant temperature.

Q199. Why does compressing air in a container make it feel warmer?
Answer: Compression increases internal energy, raising temperature.
When a gas is compressed, work is done on it. This adds energy to the particles, increasing their speed. As kinetic energy rises, so does temperature, which can be felt as heat in the container.

Q200. What must remain constant for pV = constant to apply accurately?
Answer: The temperature and mass of the gas must remain constant.
Boyle's Law assumes no temperature or mass change. If temperature changes, so does particle kinetic energy, invalidating the pV = constant relationship. Constant temperature ensures kinetic energy is stable during pressure-volume changes.