

How particles explain solids, liquids and gases

Grade 7 science (Year 8 · Class 7) · Worksheet answers

Use these answers to check your work after you have tried every problem. Read the reasoning, not only the final result, and look for the particle idea that justifies each statement. Final answers are in bold.

Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS1-1, MS-PS1-4

Problem 1 Fixed shape or not

1. The steel spoon keeps its shape: **spoon**.
2. The milk has a fixed volume but takes the shape of the cup: **milk**.
3. The air fills any container: **the air in the balloon**.

Problem 2 Describe the state

1. Fixed places, touching: **solid**.
2. Far apart, fast: **gas**.
3. Touching but sliding: **liquid**.

Problem 3 Reading the particle boxes

1. Box Z has a few particles far apart: **Z is the gas**.
2. Box X has particles touching in a regular pattern: **X is the solid**.
3. In Y the particles slide past one another and keep changing neighbours: **they move around each other in a jumble**.

Problem 4 Name the change

1. **Evaporating** (liquid to gas).
2. **Freezing** (liquid to solid).
3. **Condensing** (gas to liquid).
4. **Freezing** (the wax goes from liquid to solid).

Problem 5 Complete the sentences

1. **vibrate**.
2. **slide**.
3. **far apart**.

Problem 6 States at room temperature

A substance is solid below its melting point, liquid between its melting and boiling points, and gas above its boiling point.

1. 25 °C is above -183 °C: **oxygen is a gas.**
2. 25 °C is between -114 °C and 78 °C: **ethanol is a liquid.**
3. 25 °C is below 327 °C: **lead is a solid.**
4. Ethanol (boiling point 78 °C) and mercury (357 °C) are both liquid, but only ethanol boils below 100 °C: **ethanol.**

Problem 7 Perfume in a classroom

1. **Diffusion.**
2. Perfume particles move randomly, colliding with air particles, and spread from the crowded place near the spray to the empty parts of the room.
3. Each particle collides with air particles billions of times every second and changes direction each time, so its path is a zigzag, not a straight line. The net movement across the room is slow: **minutes, not seconds.**

Problem 8 Warm and cold cups

1. **The warm water.**
2. Particles in warm water move faster, so they collide and spread the colouring sooner.
3. In ice the particles only vibrate in fixed places, so **the colouring would hardly spread.**

Problem 9 Pouring and not pouring

1. Water particles are close together but can slide past one another, so **water flows in a stream.**
2. Wood particles are locked in fixed positions, so **the block cannot flow.**
3. Each grain is a small solid piece. The pile pours because whole grains slide over one another, not because the particles inside each grain move: **the grains slide, the particles do not.**

Problem 10 Why a balloon pushes out

1. Gas particles move fast in all directions and hit the inside wall everywhere; the many hits give a push on every side.
2. The same particles are in a smaller space, so each patch of wall is hit more often: **the number of collisions per second increases.**
3. **The pressure increases.**

Problem 11 Dye front data

1. First interval: 12 mm - 0 mm = 12 mm. Second interval: 17 mm - 12 mm = 5 mm. **12 mm and 5 mm.**

2. $12 \text{ mm} \div 10 \text{ min} = 1.2 \text{ mm/min}$; $5 \text{ mm} \div 10 \text{ min} = 0.5 \text{ mm/min}$. **1.2 mm/min and 0.5 mm/min.**
3. The next intervals give 4 mm and 3 mm, that is 0.4 and 0.3 mm/min. **The average speed keeps decreasing**, because the dye becomes more spread out, so fewer particles move away from crowded places each minute.

Problem 12 Drying puddle

1. **Evaporation.**
2. The fastest-moving water particles at the surface have enough energy to escape from the liquid and join the air.
3. Wind carries away water vapour near the surface, so fewer particles return to the puddle: **more particles leave than return.**

Problem 13 Spot the error

1. Mistake one: particles do not melt or turn soft; only their arrangement and movement change. Mistake two: particles in ice do move, because they vibrate about fixed positions. **Two mistakes.**
2. **When ice melts, its particles stay the same, but they vibrate more strongly, break from their fixed positions and slide past each other.**

Problem 14 Bike pump

1. **The volume decreases.**
2. **The particles move closer together.**
3. The closer the particles are, the more often they hit the plunger and walls, so the pressure grows and pushes back harder: **pressure increases as volume decreases.**

Problem 15 Air or water in a syringe

1. **The air syringe** can be pushed in much further.
2. Air particles are far apart, so there is room to push them closer. Water particles already touch, so they cannot be pushed much closer.
3. The volume stays almost **30 cm³**, because liquid particles are already touching.

Problem 16 Heating ice

1. **-10 °C.**
2. The graph is flat at 0 °C from 2 min to 6 min: $6 - 2 = 4$ **minutes.**
3. The energy is used to free particles from their fixed positions so the solid becomes a liquid, not to make particles move faster. **The energy goes into melting, so the temperature stays at 0 °C.**
4. At 8 min the temperature is 10 °C and at 12 min it is 30 °C: $30 - 10 = 20$ **°C.**

Problem 17 Specks in smoke

1. The jiggling shows that air particles are moving at random and are in constant motion.
2. Billions of air particles hit a speck every second. The hits from different sides are not perfectly balanced, so the speck is pushed one way, then another. **Unbalanced hits from invisible particles move the specks.**
3. Cooled air particles move more slowly, so the specks would jiggle **less vigorously**.

Problem 18 Squashing gas in a syringe

1. Before: $14 \div 60 = 0.233$ particles per cm^3 . After: $14 \div 20 = 0.70$ particles per cm^3 . $60 \div 20 = 3$. **The particles are 3 times more crowded.**
2. Particles are not removed or created: **14 particles**.
3. With more particles per cm^3 , more collisions with the plunger each second give a larger push on it, so more force is needed to hold it: **the pressure rises**.

Problem 19 Plan a diffusion test

1. Independent variable: water temperature. Dependent variable: time for the dye to spread through the water. **Temperature and time.**
2. Any three of: volume of water, size of drop, type of dye, size of cup, no stirring. **Three controls given.**
3. Decide when the colour looks the same throughout; use a white background and a timer to judge the same end point each time.
4. The warmer the water, the faster the particles move, so **the time falls as the temperature rises**.

Problem 20 Cooling a vapour

1. Condensing (gas to liquid), then freezing (liquid to solid). **Condensing, then freezing.**
2. In condensing the particles go from far apart to touching; in freezing they stay touching but settle into fixed positions.
3. In condensing the particles slow down and begin to slide; in freezing they slow further and only vibrate in place.
4. The wax particles are rearranged, not destroyed, so **the number of particles stays the same**.