

Kinetic Particle Theory

Simulation: edtechsims.com/kinetic-particle-theory

Name: _____ Class: _____ Date: _____



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By the end of this activity, you should be able to:

- describe the movement of particles using the kinetic particle theory
- relate temperature to the kinetic energy and speed of particles
- explain how the mass of particles affects their speed and rate of diffusion
- explain gas pressure in terms of particles colliding with the walls of a container
- describe the arrangement and movement of particles in solids, liquids and gases, and interpret a heating curve

Part A: Temperature

On the sim: Click Reset. Keep Particle Mass and No. of particles at their starting values. Change only the Temperature slider.

A1 Set the temperature to its lowest value. Describe how the particles move. [1]

.....

A2 Slowly increase the temperature to its highest value. Describe what happens to the particles. [2]

.....

.....

A3 Complete the sentence:

As the temperature increases, the particles gain _____ energy and move _____.

A4 Watch the particles hitting the walls of the container. How does the number of collisions with the walls change as the temperature increases? [1]

.....

A5 Why is it wrong to say that the particles themselves get bigger when a substance is heated? [1]

.....

Part B: Particle Mass

On the sim: Click Reset. Keep the temperature and No. of particles fixed. Change only the Particle Mass slider.

B1 Compare how fast light particles and heavy particles move at the same temperature. [1]

.....

.....

B2 Complete the sentence:

At the same temperature, particles with a _____ mass move faster.

B3 Use your answer to B2 to predict which gas diffuses faster: hydrogen ($M_r = 2$) or carbon dioxide ($M_r = 44$). Explain. [2]

.....

.....

Part C: Number of Particles

On the sim: Click Reset. Keep the temperature and Particle Mass fixed. Change only the No. of particles slider.

C1 Increase the number of particles. What happens to how often the particles hit the walls of the container? [1]

.....

.....

C2 Use your answer to C1 to explain why pumping more air into a tyre increases the pressure inside it. [2]

.....

.....

.....

C3 Complete Table 1 by writing increases, decreases or no change. [3]

Change made (others kept constant)	Speed of particles	Collisions with walls per second
Temperature increased		
Particle mass increased		
Number of particles increased		

Table 1

Part D: States of Matter

D1 In Fig. 1, draw about 12 particles in each box to show the arrangement of particles in a solid, a liquid and a gas. [3]

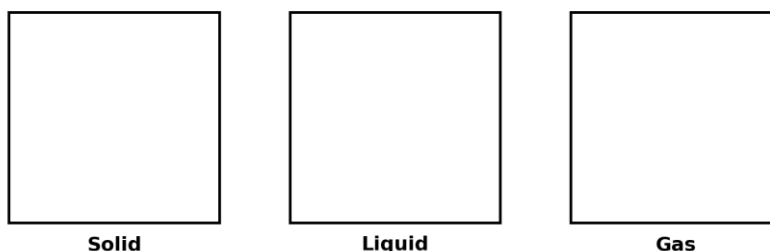


Fig. 1

D2 Complete Table 2.

[6]

	Solid	Liquid	Gas
Arrangement			
Distance between particles			
Movement			

Table 2

Part E: Exam-Style Questions

E1 Fig. 2 shows the heating curve for a pure substance X.

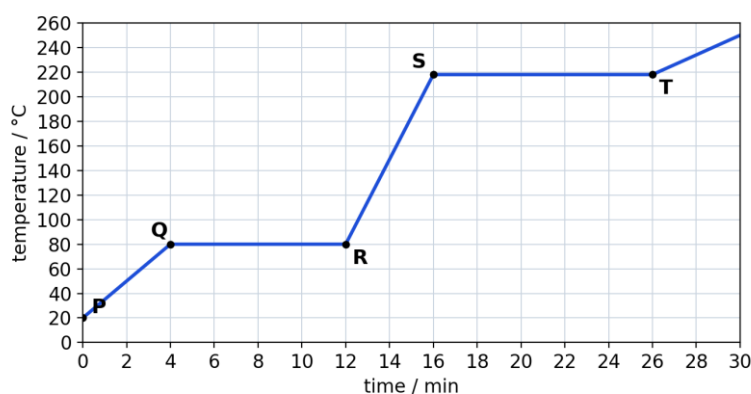


Fig. 2

(a) State the melting point and boiling point of X. [2]

melting point = ... °C boiling point = ... °C

(b) State the physical state(s) of X between Q and R, and between S and T. [2]

Q to R:

S to T:

(c) Explain, in terms of particles, why the temperature stays constant from Q to R even though heat is still being supplied. [2]

.....

.....

E2 Fig. 3 shows a long glass tube. Cotton wool soaked in concentrated ammonia is placed at one end, and cotton wool soaked in concentrated hydrochloric acid at the other end. After a few minutes, a white ring of ammonium chloride forms inside the tube.

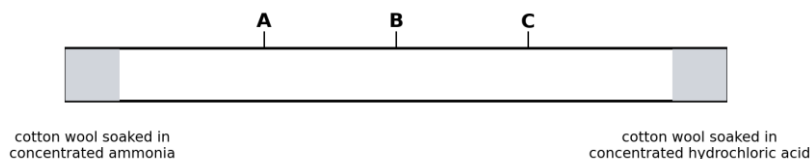


Fig. 3

(a) State the letter, A, B or C, where the white ring forms. [1]

.....

(b) Explain your answer to (a). [Mr: $\text{NH}_3 = 17$, $\text{HCl} = 36.5$] [2]

.....

.....

(c) State and explain how the time taken for the ring to form would change if the experiment were done at a higher temperature. [2]

.....

.....

Answer Key: Kinetic Particle Theory

Part A

A1 The particles move slowly (in constant random motion).

A2 The particles move faster and collide more often and more forcefully with each other and with the walls.

A3 kinetic; faster

A4 The particles hit the walls more often (and with more force).

A5 The particles stay the same size. Heating makes them move faster, so the spaces between them increase.

Part B

B1 Light particles move faster than heavy particles at the same temperature.

B2 smaller (lower)

B3 Hydrogen. Its particles have a much lower mass (M_r 2 compared with 44), so they move faster and diffuse faster.

Part C

C1 The particles hit the walls more often (more collisions per second).

C2 More air particles are in the same volume, so they hit the walls of the tyre more often. More frequent collisions with the walls cause a higher pressure.

C3

Change made	Speed of particles	Collisions with walls per second
Temperature increased	increases	increases
Particle mass increased	decreases	decreases
Number of particles increased	no change	increases

Part D

D1 Solid: particles touching in a regular, orderly arrangement. Liquid: particles mostly touching, randomly arranged, with no regular pattern. Gas: particles far apart and randomly spread throughout the box.

D2

	Solid	Liquid	Gas
Arrangement	Orderly, regular pattern	Random, disorderly	Random, disorderly
Distance between particles	Very close together	Close together	Far apart
Movement	Vibrate about fixed positions	Slide past one another	Move quickly and randomly in all directions

Part E

E1(a) Melting point = 80 °C; boiling point = 218 °C.

E1(b) Q to R: solid and liquid. S to T: liquid and gas.

E1(c) The heat energy absorbed is used to overcome the forces of attraction between the particles (to change the state), not to increase their kinetic energy, so the temperature does not rise.

E2(a) C

E2(b) Ammonia has a lower Mr (17) than hydrogen chloride (36.5), so its particles move faster and diffuse faster. The ammonia travels further before the gases meet, so the ring forms closer to the hydrochloric acid end.

E2(c) Shorter time. At a higher temperature the particles have more kinetic energy and move faster, so they diffuse faster and meet sooner.