Chapter 9. The kinetic particle model of matter

Contents:

New word list:

2 Thermal physics

2.1 Kinetic particle model of matter

2.1.1 States of matter

Core

1 Know the distinguishing properties of solids, liquids and gases

2 Know the terms for the changes in state between solids, liquids and gases (gas to solid and solid to gas transfers are **not** required)

Supplement

2.1 Kinetic particle model of matter continued

2.1.2 Particle model

Core

1 Describe the particle structure of solids, liquids and gases in terms of the arrangement, separation and motion of the particles, and represent these states using simple particle diagrams

2 Describe the relationship between the motion of particles and temperature, including the idea that there is a lowest possible temperature (–273 °C), known as absolute zero, where the particles have least kinetic energy

3 Describe the pressure and the changes in pressure of a gas in terms of the motion of its particles and their collisions with a surface

4 Know that the random motion of microscopic particles in a suspension is evidence for the kinetic particle model of matter

5 Describe and explain this motion (sometimes known as Brownian motion) in terms of random collisions between the microscopic particles in a suspension and the particles of the gas or liquid

Supplement

6 Know that the forces and distances between particles (atoms, molecules, ions and electrons) and the motion of the particles affects the properties of solids, liquids and gases

7 Describe the pressure and the changes in pressure of a gas in terms of the forces exerted by particles colliding with surfaces, creating a force per unit area

8 Know that microscopic particles may be moved by collisions with light fast-moving molecules and correctly use the terms atoms or molecules as distinct from microscopic particles

2.1.3 Gases and the absolute scale of temperature

Core

1 Describe qualitatively, in terms of particles, the effect on the pressure of a fixed mass of gas of:

(a) a change of temperature at constant volume

(b) a change of volume at constant temperature

2 Convert temperatures between kelvin and degrees Celsius; recall and use the equation

T (in K) = θ (in °C) + 273

Supplement

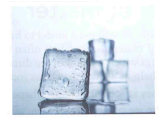
3 Recall and use the equation

pV = constant

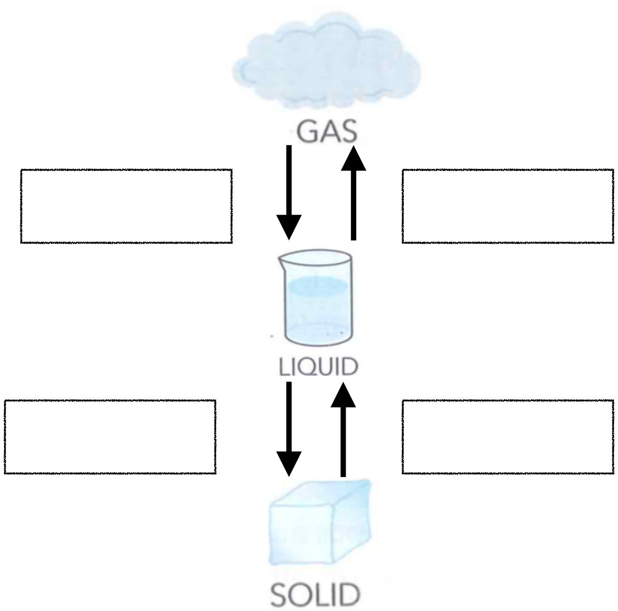
for a fixed mass of gas at constant temperature, including a graphical representation of this relationship

9.1 States of matters

Do you know the three states of matter? And what are the differences between them. Fill in the form below.

States	Volume	Shape	
Solid *(rigid)*			
Liquid *(Not rigid)*			
Gas *(Not rigid)*			

Change of states:



Boiling point/condensing point:

Melting point/freezing point:

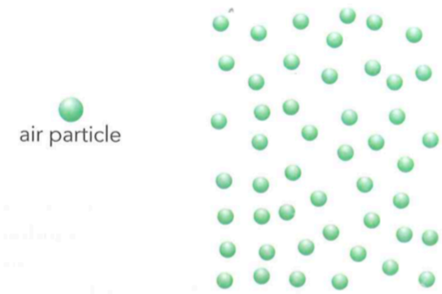
There are two ways for liquid to change state from liquid to gas: **evaporation and boiling.** What’s the difference between these two ways?

9.2 The kinetic particle model of matter

Kinetic:

Particle:

Model:



The kinetic particle model:

<u>Particle movement and temperature:</u>

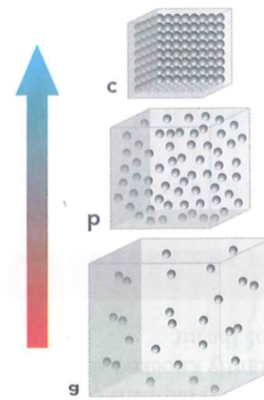
<u>Temperature:</u>

<u>Absolute zero:</u>

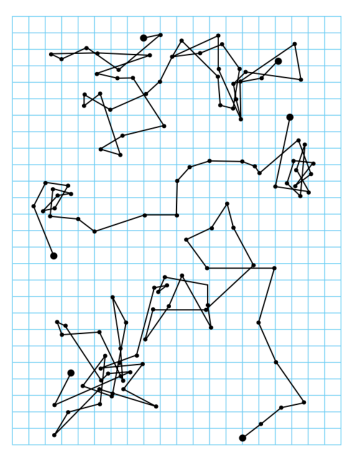
<u>Evidence for the kinetic model:</u>

In 1827, Scientist **Robert Brown** observed pollen grains jiggling about using a microscope.

States	Arrangement to explain shape	Seperation to explain volume	Motion to explain arrangement
Solid			
Liquid			
Gas			

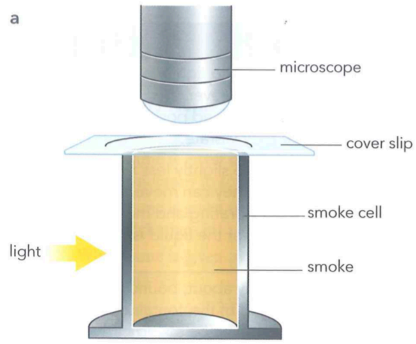


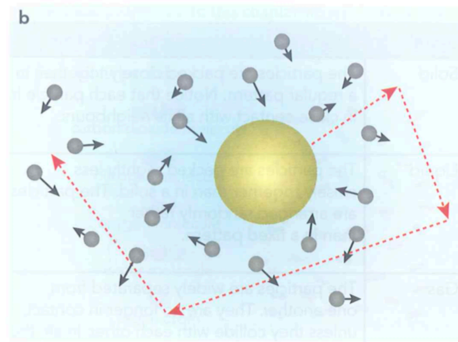
Brownian motion:



Explanation:

Brownian motion of smoke particles:





More about brownian motion:

Using the kinetic model to explain following phenomena:

1. Solids keep their shape, liquids take up shape of their container; gas fill their container

2. You can smell perfume across the room. Sugar crystal in a hotter drink dissolve more quickly.

3. Most solids expand when they melt. Liquid expands a lot when they boil.

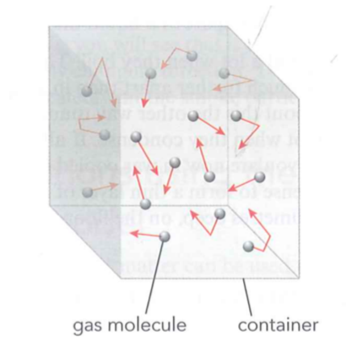
Forces and the kinetic model

Why do particles stick together to make solids/liquids?

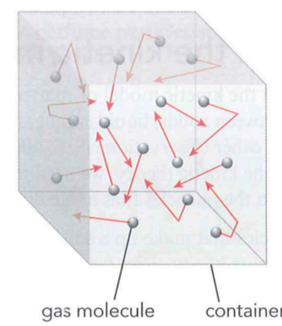
States	Attractive forces between molecules
Solid	
Liquid	
Gas	

9.3 Gases, the kinetic model and the gas laws

Why do gases cause pressure on the wall of its container?



Heat the gas?

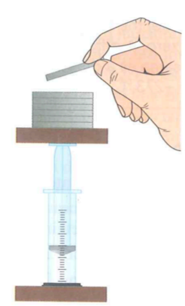


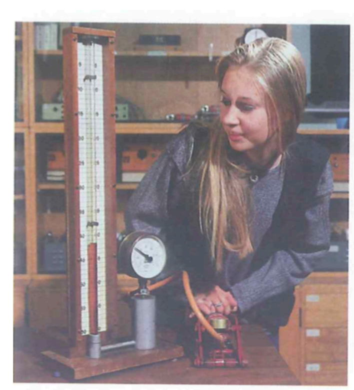
Compress the gas?

The gas laws:

For a **<u>fixed mass</u>** of gas, the temperature, volume and pressure of the gas all affects each other.

1. Compressed: **<u>Boyle's law</u>**

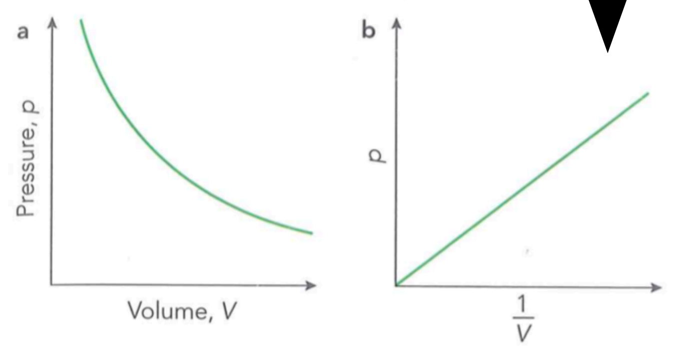




Units:

p is inversely proportional to V

Pressure, p/Pa	Volume, V/cm³	Pressure × volume, pV/Pa cm³
100	60	6000
125	48	6000
150	40	6000
200	30	6000
250	24	6000
300	20	6000



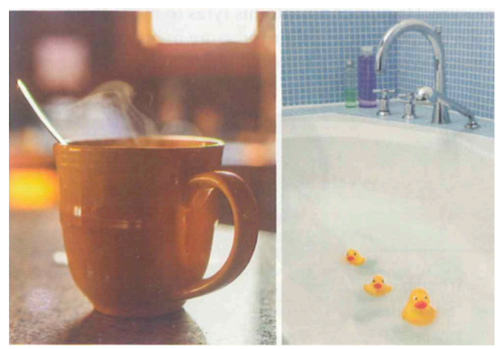
Exercise 9.1:

A cube diver releases a bubble of air. The bubble has a volume of 2 cm3. He watches it rise to the surface, expanding as it rises. The diver is at a depth where the pressure is 5 atmospheres. What will the volume of the bubble be when it reaches the surface, where the volume is 1 atmosphere? Assume that the temperature does not change.

- Boyle's law (Equation 1)
  $$PV = C_1 \quad \text{or} \quad P_1V_1 = P_2V_2$$
- Charles's law (Equation 2)
  $$\frac{V}{T} = C_2 \quad \text{or} \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$
- Avogadro's law (Equation 3)
  $$\frac{V}{N} = C_3 \quad \text{or} \quad \frac{V_1}{N_1} = \frac{V_2}{N_2}$$
- Gay-Lussac's law (Equation 4)
  $$\frac{P}{T} = C_4 \quad \text{or} \quad \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

2. Heated: Charles's law

9.4 Temperature and the Celsius scale



Temperature:

Macroscopic:

Microscopic:

Temperature vs internal energy:

Measuring temperature:

The Celsius scale ($^\circ C$):

Fixed points: 0 $^\circ C$:

100 $^\circ C$:

Divide the space between 0 $^\circ C$ and 100 $^\circ C$ into 100 equal parts.

The Kelvin temperature scale: absolute temperature

- ✳ *Start from*
- ✳ *A change of temperature in one degree*
- ✳ *Conversion between Kelvin temperature and degree Celsius:*