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NATURE AND MATTER

Matter is anything that occupies space and has weight. Matter is made up of particles that are too small. These tiny particles cannot be seen by the naked eye. The tiny particles are called molecules. The molecules consist of more tiny particles called atoms.
Atoms are made of small particles called protons, electrons and neutrons

States of matters

There are three states of matter namely

(i) solid
(ii) liquid
(iii) gaseous

Kinetic theory of matter

The kinetic theory of matter states that:

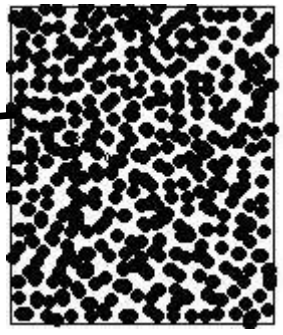
- **All matter is made up of very many tiny molecules.**
- **There exists a force of attraction between these molecules.**
- **The molecules are in a constant random motion.**

The kinetic theory of matter is used to explain the existence of solids, liquids and gases. The kinetic theory of mater also helps us to explain the Brownian motion and diffusion.

Solid state

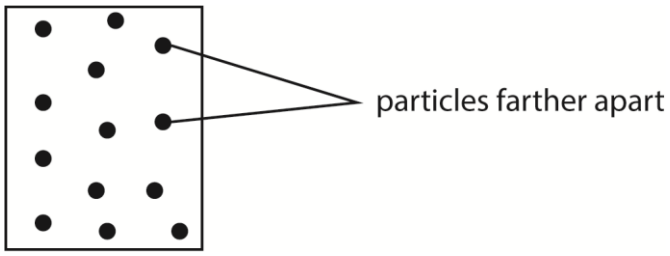
In solid state, the molecules are closely packed together and are vibrating within fixed positions. So in solid state, the particles vibrate within fixed positions but are not free to move due to the strong forces of attraction between the molecules. Solid state has a definite shape and volume.

Particles are closely packed



Liquid state

In liquid state, molecules are further apart compared to solids. The particles are free to move and are in constant random motion but within the surface of the liquid. The forces of attraction between the particles are weaker compared to solid state. Liquids take up the shape of the container in which they are put. So liquids do not have a definite shape but have definite volume.



Note:

- Solids have higher density than liquids because in solids, the particles in solids are closely packed together compared to liquids.
- Liquids have lower density than solids because in liquids, the particles are further apart compared to solids.

Differences

Solid	**Liquid**
Solids have definite shape	Liquids do not have definite shape
Particles are closely packed together	Particles are further apart
Particles vibrate in a fixed position	Particles are free to move but within the surface of the liquid

Gaseous state

The particles are much further apart compared to liquids and solids. These particles can move independently and at a high speed compared to solids and liquids. The intermolecular forces of attraction are almost negligible. Gases have no particular shape and volume.

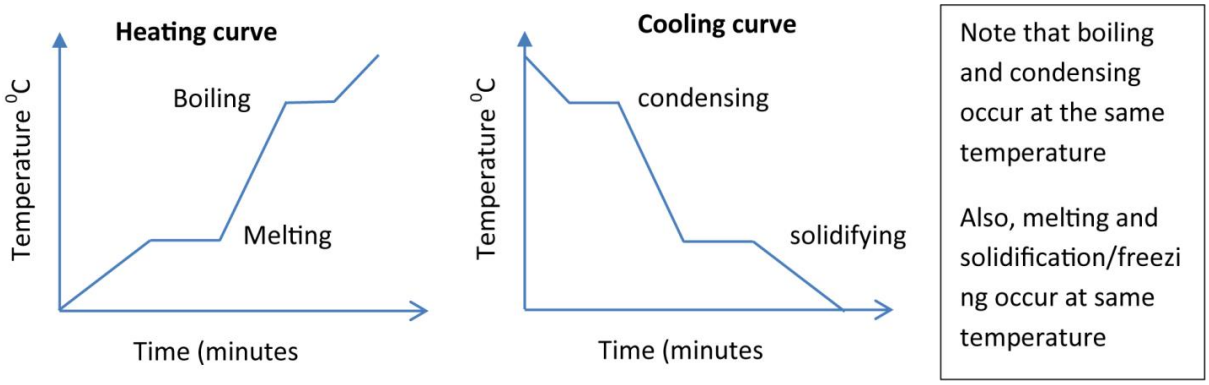
Summary table

Properties	Solid	Liquid	Gas
Distance of separation	Least	Closer	Largest
Intermolecular forces	Strongest	Strong	Weakest
Potential energy	Highest	Low	Lowest
Kinetic energy	Lowest	High	Highest

Effect on heat on the states of matter

When a solid is heated its temperature rises up to the melting point. At the melting point the solid turns into a liquid at constant temperature. Then the temperature of the liquid rises up to the boiling point. At the boiling point, temperature remains constant until all the liquid turns into the liquid before the temperature rises again.

When a gas is cooled the temperature drops up to the condensation temperature at which the temperature remains constant until all the gas has turned into a liquid. The temperature of the liquid drops up to the melting point. At the freezing point the temperature remains constant until all the liquid turns into a solid. Thereafter the temperature of the solid drops as illustrated by the graphs below.



Note that boiling and condensing occur at the same temperature

Also, melting and solidification/freezing occur at same temperature

BROWNIAN MOTION

Robert Brown used a microscope to study tinny grains of pollen suspended in water. He noticed that the pollen grains were in a constant random motion.

Brown explained the random motion as being caused by moving water molecules in random motion colliding with pollen grains.

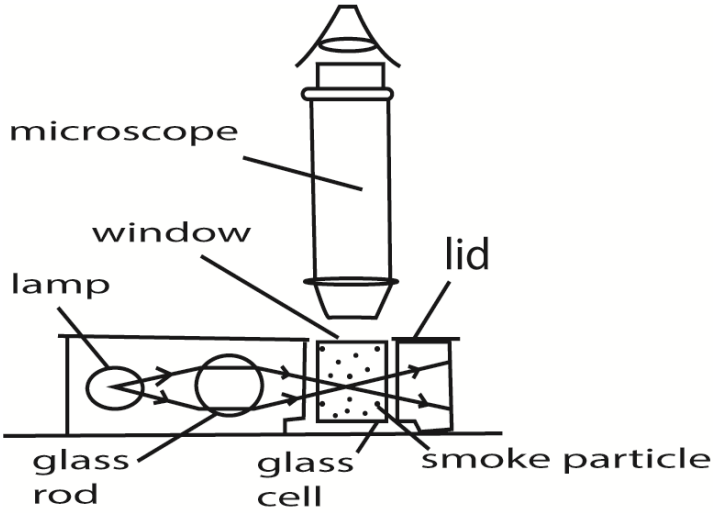
Brownian motion is the random movement of molecules in a liquid or gas.

Not that:

(i) The temperature of a substance remains constant at its melting and boiling points until all the substance melts or boils **because, the heat supplied is continuously used up in changing the state of the substance by overcoming the forces of attraction between the particles**.

(ii) The temperature of a substance remains constant at its condensation and freezing points until all the substance condense or freeze **because, latent heat discarded in changing the state of the substance to increase the forces of attraction between the particles**. These processes take place at constant temperature, because latent heats are a constant quantities.

Experiment to demonstrate Brownian motion



A glass cell is filled with smoke particles using a smouldering cloth.
It is then covered tightly with a thin glass cover

Arrangement of Apparatus
Apparatus are arranged as above and the microscope is adjusted until brighter particles of smoke are seen moving randomly.

Observation:
Smoke particles are seen in a constant random motion.

Explanation:
The smoke particles are in random motion due to their collision with invisible fast moving air molecules that are also in random motion.

Increasing temperature.
Observation:
The smoke particles are seen to move faster and their random motion increases.

Explanation:
Increasing temperature makes the invisible air molecules move faster, so their collisions with smoke particles make the smoke particles move faster resulting in the random motion of the smoke particles to increase.

When the temperature of the glass cell is lowered by placing it on ice.
Observation
The speed at which the smoke particles move decreases and the random motion of the smoke particles also decreases.

Explanation
This is because on decreasing the temperature the speed of the invisible air molecules also decreases.

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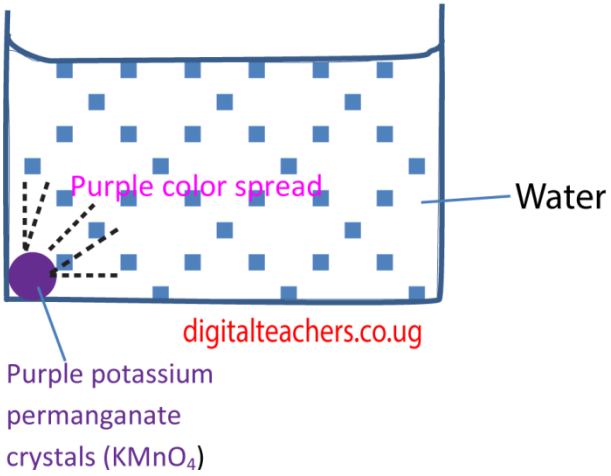
The thin glass cover- its main function is to reduce air current and stop smoke from escaping.
The lamp- it provides light which focuses on the smoke particles.

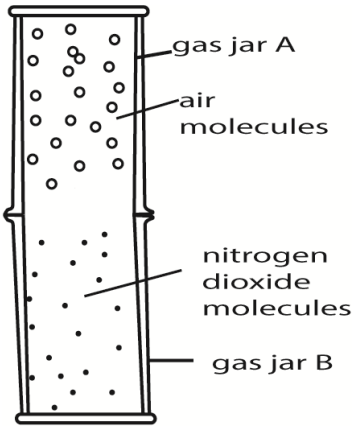
DIFFUSION
This is the movement of molecules from region of high concentration to region of low concentration. Diffusion occurs in both gases and liquids.

Simple experiment to demonstrate diffusion in liquids



Using a drinking straw or funnel, Crystals of potassium permanganate are place at the bottom of a beaker containing water.
Observation
After some time, the purples colour of the crystals is spread throughout the water. This is due to diffusion.
Explanation using kinetic theory of matter
This is because the water molecules and the molecules of dissolved potassium permanganate are in constant random motion, resulting in the molecules of potassium permanganate to be spread throughout the water.
Note: Instead of potassium permanganate, copper II sulphate which is blue can be used.

Diffusion in gas
Simple experiment to demonstrate diffusion in gases



- Introduce brown nitrogen dioxide in Jar **B** and air in Jar **A**.
- Then jar **A** containing air is inverted over the jar **B** containing nitrogen dioxide gas.

Observation

- After sometimes it is observed that the brown colour of nitrogen dioxide spreads into the Jar **A** containing clear air. The nitrogen dioxide molecules diffuse upward while the air molecules diffuse downwards into the lower Jar **B**.

Rate of diffusion in gases

Rate of diffusion in gases depends on

- Temperature
- Density of the gas

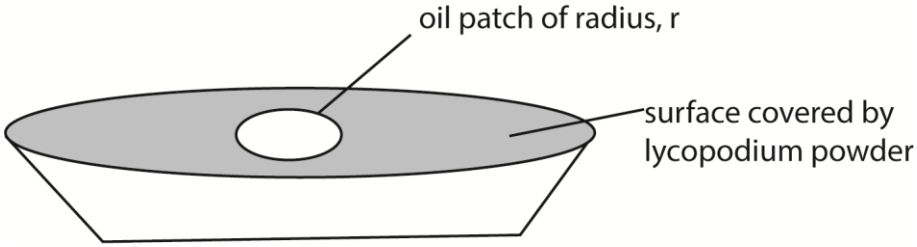
Temperature

The higher the temperature the higher the speed of the molecules of the gas so greater rate of diffusion.

Density of the gas

The denser the gas, the less the diffusion i.e. lighter gases spread more than heavier gases

Determination of the size of oil molecules



- Lycopodium powder is sprinkled on water in a large dish
- Then oil of known volume V, is dropped into the middle of the water in the dish.
- The average diameter, d, and hence the average radius, r, of the patch is measured.
- Thickness = $\frac{volume}{area} = \frac{volume}{\pi r^2}$

Assumptions made.

-The film or patch formed is cylindrical

-The oil spread out to form a film which is one molecule thick. Film formed is one molecule thick

-Volume of film= volume of oil in drop

-Molecules are spherical

Example 1

(a) In an experiment to estimate the thickness of an oil molecule, the diameter of an oil drop is given to be 0.5mm and the diameter of the circular patch of the same drop on water surface is 13cm. calculate the thickness of the oil molecule.

Radius of the drop = $\frac{0.5mm}{2} = 0.25mm = \frac{0.25}{10} = 0.025cm$

Volume of oil drop = $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.025)^3$ = 6.54 x 10^{-5}cm^3

Radius of oil patch = $\frac{13}{2} = 6.5cm$

Area of oil patch = $\pi r^2 = \pi(6.5)^2$ = 133cm^2

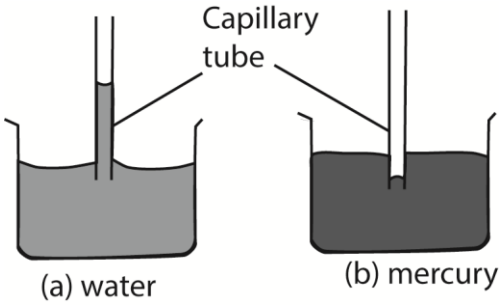
Thickness of oil molecule = $\frac{volume}{area} = \frac{6.54\ x\ 10^{-5}}{133}$ 4.89 x 10^{-7}cm

(b) State the assumption made

- The oil patch is one molecule thick
- The oil patch is circular
- There are no gaps between oil molecules

Capillarity

Capillarity is the rise or depression of a liquid in a narrow tube.
The narrower the tube, the further the liquid rises or depresses.
Water, alcohol and other liquids rise in a tube while mercury is depressed.



Note that the meniscus of water in capillary tube is concave while that of mercury is convex

Application of capillarity in our daily life

- Absorption of water from the body by a towel
- The rise of paraffin in wicks of candles
- Soil contains air space in which water rises to the plant roots
- Water rises through plant vessels by capillarity
- Blotting paper absorbs ink from a paper capillarity
- Absorption blood from a woman's body by always pad

Disadvantage of capillarity

Water rises through the walls from the ground by capillary. This water makes the houses very damp and eventually weaker.

In short capillarity results in water rising through the walls of the building making the building damp and eventually weaker.

How to minimize capillarity in building

Capillarity is minimized by placing a water proof layer like plastic or polythene between the layers of bricks at the base.

Forces between molecules

There are two main forces between molecules mainly:

- Cohesion
- Adhesion

Cohesion

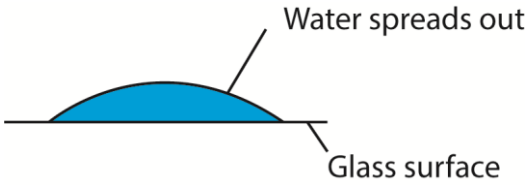
Cohesion is a force of attraction between molecules of the same substance. For instance, force of attraction between a water molecule and a water molecule.
Force of attraction between a mercury molecule and a mercury molecule is cohesion.

Adhesion

Adhesions are forces of attraction between molecules of the different substances.
For instance, the force of attraction between a water molecule and a glass molecule is adhesion. Force of attraction between mercury molecule and glass molecule is adhesion.

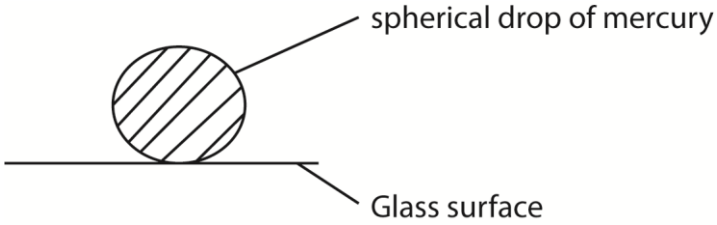
Behaviour of liquids on surfaces

Water on glass surface



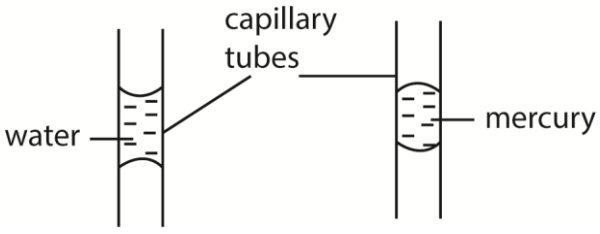
Water spread out on the glass surface because for water adhesive forces are greater than cohesion forces.
In general, for liquids in which adhesion is greater than cohesion, the liquid spread out on the surface between two different substances

Mercury on a glass surface



For this case, mercury forms spherical drops because for mercury, cohesive forces are greater than adhesive forces. In general for liquid in which cohesive forces are greater than adhesive forces, it forms spherical drops
For mercury where cohesive forces are greater than adhesive forces

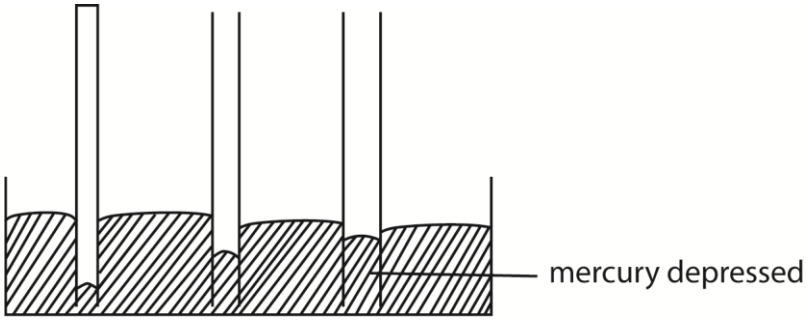
Open tubes



Note the meniscus for water is concave while that of mercury is convex. In water and glass adhesive forces are stronger than cohesive force while in mercury and glass, cohesive forces are stronger than adhesive forces.

For a number of capillary tubes of different bores

(a) Mercury

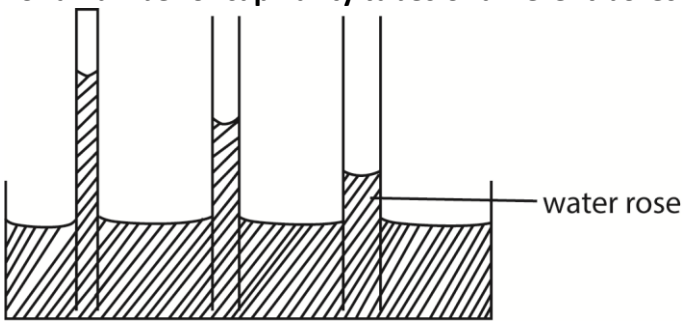


Mercury is depressed in the capillary tubes because cohesive forces are greater than adhesive forces. Notice that the meniscus is convex.

(b) Water

Water rises in the capillarity tube because for water adhesive forces are better than cohesive forces

For a number of capillarity tubes of different bores



Water rises because adhesive forces are greater than cohesive forces
The meniscus curves upwards because adhesive forces are greater than cohesive forces

Meniscus

Meniscus is a curved surface of a liquid in a tube

Surface tension

Surface tension is a force acting perpendicular to one side of an imaginary line of length 1m drawn in the surface of a liquid.

Or surface tension is a tangential force in the surface of a liquid acting normally per unit length across any line in the surface.

The force only acts on the surface of the liquid. Surface tension is the force of attraction between molecules of liquid surface which makes the liquid surface behave like an elastic skin.

Effect of surface tension

-Formation of liquid drops
-Formation of soap bubble and film
-Needles and razor blades can be made to float on water
-Some creatures e.g. mosquito larvae float on water

Explanation to formation of liquid drops, soap bubble and film.

Formation of liquid drops, soap bubbles and film are due to cohesion which pulls molecules together to form shapes with the smallest possible area. This shape is that of a sphere.

Liquid drops and bubbles are spherical because cohesion pulls the molecules together to form shapes with the smallest possible area.

Why liquid drops and bubbles are spherical

This is because of cohesion which pulls molecules together to form spheres with the smallest possible are in order to minimize surface energy

Explanation to needles **and razor blades being made to float on water**

Because of surface tension, the surface of the liquid behaves like elastic skins on which some insects can walk and a needle can float.

Factors affecting surface tension

-Temperature
-Presence of impurities

Temperature

The higher the temperature, the less is the surface tension. This is why clothes can easily be washed in warm water.

Why is it easier to wash clothes using warm water?

Because the higher the temperature of water, the less is surface tension since the higher the temperature of water weakens surface tension so that water easily wets the cloth and remove the dirt.

Presence of impurities

Detergents, soap, salt etc. reduce surface tension. That is why clothes can easily be washed with soap because soap weakens surface tension so that the water wets the cloth and remove the dirt.

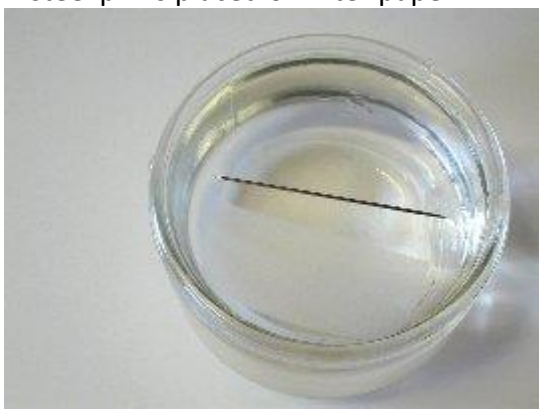
Why is it easier to wash clothes using soap?

Because soap weakens the surface tension so that water wets the cloth and removes the dirt.

Simple experiment to show surface tension

Using steel pin, filter paper, water in a beaker

A steel pin is placed on filter paper



Then the filter paper with pin it carefully placed on a clean water surface.

Observation

The filter paper absorbs water and sinks but the steel pin remains floating

Explanation

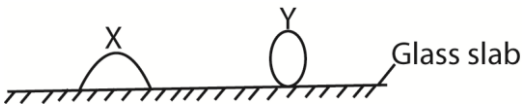
This is because the water surface behaves like a stretched elastic skin due to the existence of surface tension on the surface.

Revision exercise

1. In an oil-film experiment to estimate the size of a molecule, 0.005cm^3 of oleic acid was dropped on lycopodium powder on a water surface. The mean diameter of the acid was 5cm.The thickness of a molecule of oleic acid is

   A. $\frac{0.005}{\pi\ (2.5)^5}$ B. $\frac{0.005\ \text{x}\ 4}{25\pi}$ C. $\frac{\pi(2.5)^2}{0.005}$ D. $\frac{0.005\ \text{x}\ 3}{4\pi\ \text{x}\ 2.5\ \text{x}\ 2.5}$

2. The diagram below shows drops of liquids X and Y carefully put on a clean sheet of flat glass.

   Which of the following statements does NOT explain why the drops take different shapes?

   (i) The force of attraction between molecules of X is less than that between molecules of Y
   (ii) The force of attraction between molecules of Y and glass is less than that between molecules of Y
   (iii) The force of attraction between molecules of X is less than that between molecules of X and glass
   (iv) The force of attraction between molecules of Y and glass is greater than that between molecules of Y

   A. (i) only B. (ii) and (iii) only C. (iii) only D. (i),(ii),(iii) only

3. When a liquid is heated

   A. its molecules move with the same speed
   B. its density decreases
   C. evaporation takes place throughout the liquid
   D. boiling occurs at low temperatures

4. At room temperature, air is less dense than water because air molecules

   A. move faster
   B. are smaller
   C. have greater force of attraction
   D. are more widely separated from each other

5. An oil drop of volume 1x10^{-9}m^3 spreads on a water surface to form a patch of area 5x10^{-2}m^2. If the patch is one molecule thick, find the approximate number of molecules in the drop

   A. 1x10^9 B. 2x10^8 C. 2.4x10^{14} D. 5x10^7

6. It is more difficult to compress a liquid than a gas because
   A. the speed of liquid molecules is lower than that of gas molecules
   B. liquid particles attract one another when compressed while gas particles repel each other
   C. the distances between liquid particles are less than those between gas particles
   D. liquid molecules repel one another when compressed while gas molecules repel one another

7. The graph in fig.5 is that of temperature against time for a substance which is heated at a constant rate

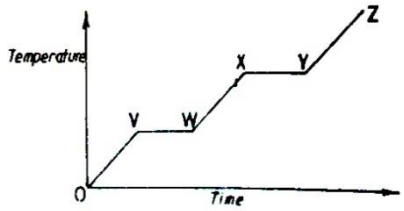


Fig 5

Which part of the graph corresponds to the situation when the molecules of the substance have the highest average kinetic energy

A. OV B. VW C. WX
D. YZ

8. Mercury forms spherical drops when spilt on a wooden bench because it

   A. is very viscous

   B. has a high density

   C. has a high cohesive force

   D. has a low surface tension

9. Capillary rise in a tube dipped in water is due to

   A. surface tension

   B. high vapour pressure

   C. adhesive force being greater than cohesive force

   D. atmospheric pressure acting on the surface of the water

10. Which one of the following statements is true

    A. the average kinetic energy of the molecules of the gas depends on temperature

    B. each molecule of a gas at a given temperature has a different speed

    C. the pressure of a fixed mass of gas decreases as temperature increases

    D. the volume of a fixed mass of gas increases as temperature decreases

11. Which of the following statements about states of matter is/are true?
    (i) a liquid has a definite volume but not a definite shape
    (ii) vapour has no definite volume and no definite shape
    (iii) a solid has a definite volume and shape
    (iv) a gas has a definite volume and shape

    A. (i) and (iv) only
    B. (i), (ii) and (iii) only
    C. (i) (ii) and (iv) only
    D. (i), (ii), (iii) and (iv)

12. A balloon is filled with hydrogen and released in the open air. It will rise

    A. to a certain height and then float

    B. to a certain height and then drop

    C. to a certain height and then burst

    D. indefinitely

The balloon rises because hydrogen is less dense than air, as it rises the atmospheric pressure decrease, the balloon expands and bursts. The empty balloon is denser than air thus falls

13. When smoke is introduced in a smoke cell and observed under a microscope, it is observed as particles moving at random. This is mainly because the particles

    A. are hot

    B. collide with one another

    C. collide with air molecules

    D. collide with the walls of the smoke cell

14. Water wets glass because

    A. adhesion forces between water and glass molecules are less than cohesion forces

    B. adhesion forces between water and glass molecules are more than cohesion forces

C. surface tension forces between water and glass molecules are more than adhesion forces

D. surface tension forces are less than cohesion forces.

15. In a Brownian motion experiment, the

A. smoke particles are seen moving about with uniform velocity.

B. motion observed is caused by the air molecules colliding with the smoke particles.

C. size of particles are found to increase the motion.

D. smoke cell has a vacuum within it.

16.

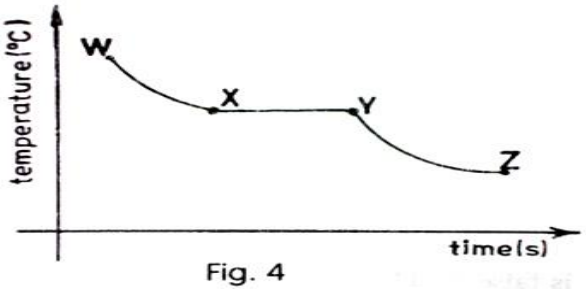


Fig. 4

The graph in figure 4 shows a cooling curve of a pure substance. The substance is all in solid state between

A. W and X. B. W and Y. C. X and Y. **D.** Y and Z.

Surface tension in a liquid may be weakened by

A. lowering the temperature.

B. adding soap solution.

C. increasing the amount of liquid.

D. increasing the density of the liquid.

17. When oil of volume 6×10^{-3} cm ^{3}is dropped on a clean water surface, it forms a circular patch of one molecule of diameter 2 cm. Find the thickness of oil.

A. 4.77×10^{-4} cm. B. 14.32×10^{-4} cm

C. 1.91×10^{-3} cm. D. 5.24×10^{2} cm

Thickness = $\frac{volume}{area} = \frac{volume}{\pi r^2} = \frac{6\ x\ 10^{-3}}{\pi\ x\ 1^2} = 1.91 \times 10^{-3}$ cm.

18. Gas leaking from a cylinder, at one corner of a room reaches another comer by way of

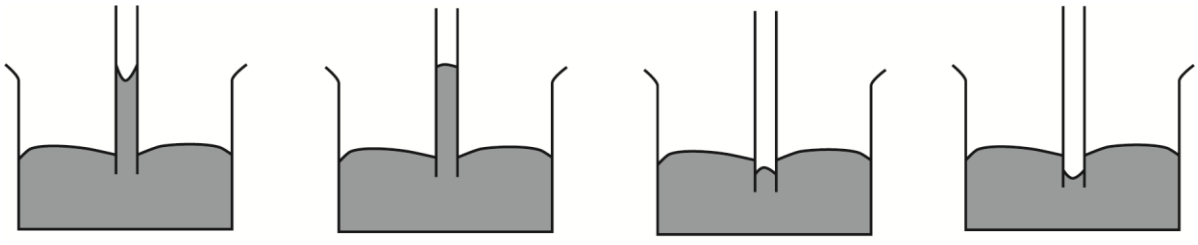
A. diffusion.
B. evaporation.
C. Brownian motion.
D. osmosis.

19. Oil of volume 1.0×10^{-2} cm is dropped on the surface of clean water. If it spreads to form a circle of radius 4 cm, find the diameter of a molecule of oil.

A. 1.99 x 10^{-4}cm.
B. 7.96 x 10^{-4}cm.
C. 1.26 x 10^{1} cm
D. 5.03 x 10^{1} cm

Thickness = $\frac{volume}{area} = \frac{volume}{\pi r^2} = \frac{1.0\ x\ 10^{-2}}{\pi\ x\ 4^2}$ = 1.99 x 10^{-4}cm.

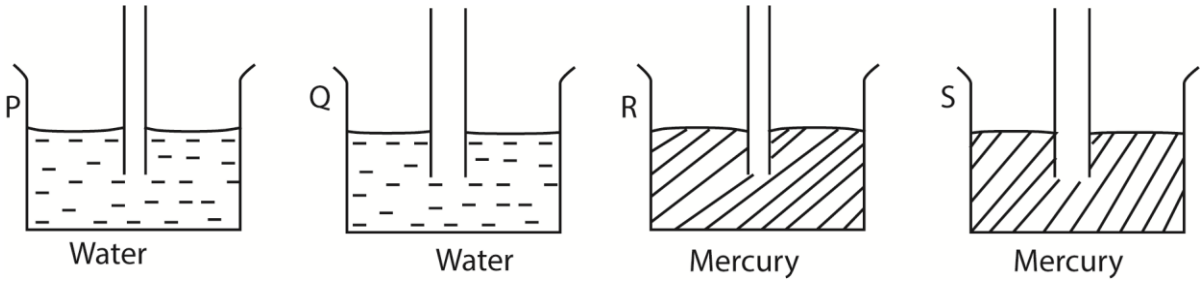
20. Which of the following does not affect the rate at which a gas diffuses through a porous partition
    A. Temperature of the gas
    B. Size of molecules
    C. Volume of the gas
    D. Size of the pore
21. Solids are not easily compressed because their molecules
    A. Are far apart
    B. Are closely packed
    C. Vibrate about the mean position
    D. Have strong adhesive forces between them
22. Which of the following diagrams shows capillary depression in a liquid.



23. The force which holds the molecules of water together is called
    A. Gravity
    B. Adhesion
    C. Cohesion
    D. Electrostatic
24. Which of the following statement is correct about diffusion
    A. It is faster in gases than liquids
    B. It takes place at the same rate in all the states of matter
    C. It is faster in liquids than in gases
    D. It is independent of temperature

25. Smoke cell is used to demonstrate phenomenon called.
    A. Diffusion
    B. Brownian motion
    C. Capillarity
    D. Surface tension
26. Hairs of wet brush cling together because of
    A. Adhesion
    B. Diffusion
    C. Capillarity
    D. Surface tension

27. Which of the following statement(s) is/are correct about a liquid in a capillary tube if the adhesive force is greater than the cohesive force?
    (i) It wet the glass
    (ii) It form a concave meniscus
    (iii) It is depressed in the capillary tube
    A. (ii) and (iii) only
    B. (i) and (iii) only
    C. (i) and (ii)only
    D. (i), (ii)and (iii)
28. Glass tubes of different diameter are dipped in water and mercury as shown in the figure below

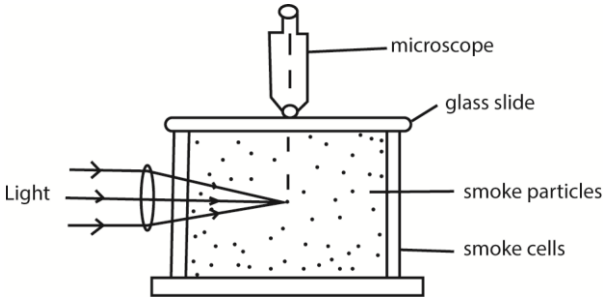


Which one of the following shows the correct order of height of liquid in the tubes from the lowest to highest

    A. R, S, Q, P
    B. S, R, Q, P
    C. Q, S, R, P
    D. P, Q R, S

Structured questions

29.



The diagram above shows the arrangement for the Brownian motion experiment.

(a) Describe what would be seen through the microscope

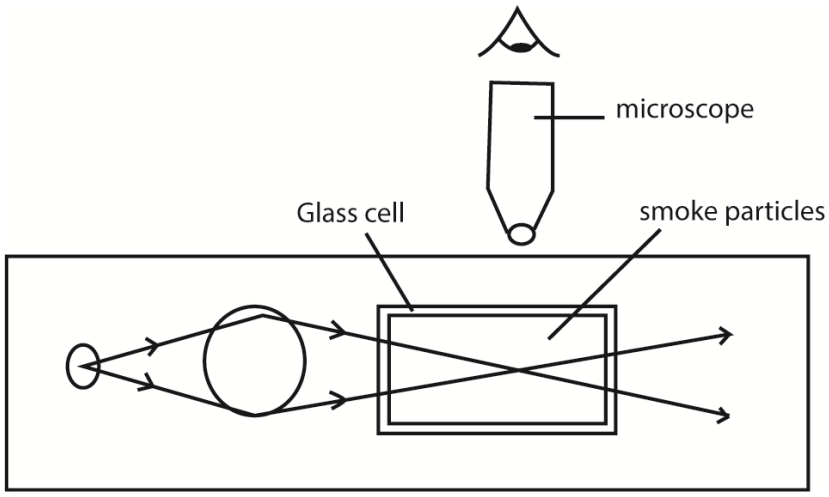
(b) What would be observed if the temperature of the smoke cell was increased?

30. Two identical capillary tubes are placed upright, one in a beaker of mercury and the other in a beaker of water

(a) Draw diagram to show the liquid levels inside and outside the capillary tubes

(b) Explain the observations in (a) in terms of forces between molecules

31. The diagram in figure 9 shows an arrangement for observing Brownian motion.



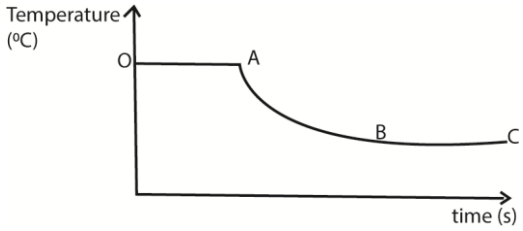
(a) Explain:

(i) the observation made.

(ii) what will be observed when the glass cell temperature is raised.

(b) State one factor which determines the rate of diffusion of a gas.

32.



(a) The figure shows temperature versus time curve for a liquid. State what is happening along BC

(b) Use the kinetic theory of matter to explain what is happening along OA.

33. (a)(i) What is meant by the term diffusion?

(ii) Explain what is observed when smoke enclosed in an illuminated transparent cells is viewed through a microscope

(iii) State what is observed in (a)(ii) when the cell is placed on an ice block. Give a reason for your answer.

(b) (i) describe an experiment to determine the thickness of an oil molecule

(ii) State any assumption

34. (a) State what is observed in a smoke cell when studying Brownian motion

(b) Explain what is would be observed if the temperature of the smoke cell is reduced.

(c) In an experiment to estimate the thickness of an oil molecule, the diameter of an oil drop is given to be 0.5mm and the diameter of the circular patch of the same drop on water surface is 13cm. calculate the thickness of the oil molecule.

(d) State the assumption made

34. (a) What is diffusion?

(b) State three factors which affect the rate of diffusion.

35. (a) Define surface tension

It is the tangential force in the surface acting normally per unit length

(b) A small piece of filter paper is placed on a water surface and a needle placed gently on it

(i) State what is observed

(ii) Explain what happens if the water is heated gently.

Suggested answers

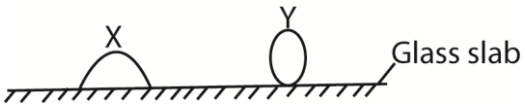
1. In an oil-film experiment to estimate the size of a molecule, 0.005cm^3 of oleic acid was dropped on lycopodium powder on a water surface. The mean diameter of the acid was 5cm.The thickness of a molecule of oleic acid is

   A. $\frac{0.005}{\pi\ (2.5)^5}$ B. $\frac{0.005 \text{ x } 4}{25\pi}$ C. $\frac{\pi(2.5)^2}{0.005}$ D. $\frac{0.005 \text{ x } 3}{4\pi \text{ x } 2.5 \text{ x } 2.5}$

   Radius of the patch =5/2 = 2.5cm

   Thickness of the molecule = $\frac{volume}{area} = \frac{0.005}{\pi\ (2.5)^5}$

2. The diagram below shows drops of liquids X and Y carefully put on a clean sheet of flat glass.



   Which of the following statements does NOT explain why the drops take different shapes?

   (i) The force of attraction between molecules of X is less than that between molecules of Y
   (ii) The force of attraction between molecules of Y and glass is less than that between molecules of Y
   (iii) The force of attraction between molecules of X is less than that between molecules of X and glass
   (iv) The force of attraction between molecules of Y and glass is greater than that between molecules of Y

   A. (i) only **B.** (ii) and (iii) only C. (iii) only D. (i),(ii),(iii) only

3. When a liquid is heated

   A. its molecules move with the same speed

   B. its density decreases

   C. evaporation takes place throughout the liquid

   D. boiling occurs at low temperatures

4. At room temperature, air is less dense than water because air molecules

   A. move faster

   B. are smaller

   C. have greater force of attraction

   D. are more widely separated from each other

5. An oil drop of volume $1x10^{-9}m^3$ spreads on a water surface to form a patch of area $5x10^{-2}m^2$. If the patch is one molecule thick, find the approximate number of molecules in the drop

   A. $1x10^9$ B. $2x10^8$ **C.** $2.4x10^{14}$ D. $5x10^7$

   Diameter of the molecule = $\frac{volume}{area} = \frac{10^{-9}}{5\ x\ 10^{-2}}$ = 2 x 10^{-8}m

   Radius of the molecule = $\frac{2\ x\ 10^{-8}}{2}$ = 1 x 10^{-8}m

   Volume of the molecule $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi(1\ x\ 10^{-8})^3$ = 4.2 x $10^{-24}m^3$

   Number of molecules = $\frac{10^{-9}}{4.2\ x\ 10^{-24}}$ = 2. 4 $x10^{14}$

6. It is more difficult to compress a liquid than a gas because
   A. the speed of liquid molecules is lower than that of gas molecules
   B. liquid particles attract one another when compressed while gas particles repel each other
   C. the distances between liquid particles are less than those between gas particles
   D. liquid molecules repel one another when compressed while gas molecules repel one another

   Answer s C

7. The graph in fig.5 is that of temperature against time for a substance which is heated at a constant rate

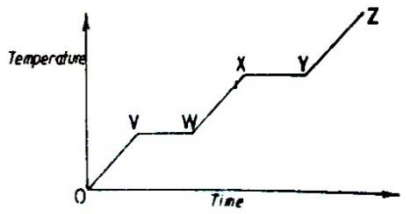


Fig 5

   Which part of the graph corresponds to the situation when the molecules of the substance have the highest average kinetic energy?

   A. OV B. VW C. WX **D.** YZ

   The higher the temperature the higher the average kinetic energy

8. Mercury forms spherical drops when spilt on a wooden bench because it

   A. is very viscous

   B. has a high density

   C. has a high cohesive force

   D. has a low surface tension

9. Capillary rise in a tube dipped in water is due to

   A. surface tension

   B. high vapour pressure

   C. adhesive force being greater than cohesive force

   D. atmospheric pressure acting on the surface of the water

10. Which one of the following statements is true

    A. the average kinetic energy of the molecules of the gas depends on temperature

    B. each molecule of a gas at a given temperature has a different speed

    C. the pressure of a fixed mass of gas decreases as temperature increases

    D. the volume of a fixed mass of gas increases as temperature decreases

11. Which of the following statements about states of matter is/are true?
    (i) a liquid has a definite volume but not a definite shape
    (ii) vapour has no definite volume and no definite shape
    (iii) a solid has a definite volume and shape
    (iv) a gas has a definite volume and shape

    A. (i) and (iv) only
    B. (i), (ii) and (iii) only
    C. (i) (ii) and (iv) only
    D. (i), (ii), (iii) and (iv)

12. A balloon is filled with hydrogen and released in the open air. It will rise

    A. to a certain height and then float

    B. to a certain height and then drop

    C. to a certain height and then burst

    D. indefinitely

The balloon rises because hydrogen is less dense than air, as it rises the atmospheric pressure decrease, the balloon expands and bursts. The empty balloon is denser than air thus falls

13. When smoke is introduced in a smoke cell and observed under a microscope, it is observed as particles moving at random. This is mainly because the particles

    A. are hot

    B. collide with one another

C. collide with air molecules

D. collide with the walls of the smoke cell

14. Water wets glass because

A. adhesion forces between water and glass molecules are less than cohesion forces

B. adhesion forces between water and glass molecules are more than cohesion forces

C. surface tension forces between water and glass molecules are more than adhesion forces

D. surface tension forces are less than cohesion forces.

15. In a Brownian motion experiment, the

A. smoke particles are seen moving about with uniform velocity.

B. motion observed is caused by the air molecules colliding with the smoke particles.

C. size of particles are found to increase the motion.

D. smoke cell has a vacuum within it.

16.

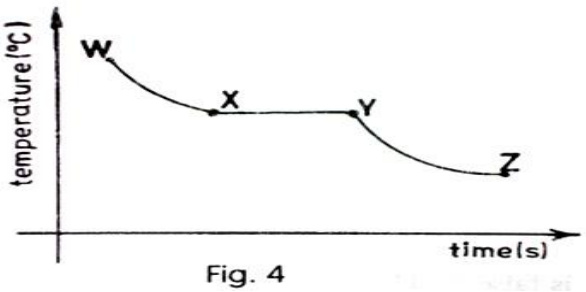


Fig. 4

The graph in figure 4 shows a cooling curve of a pure substance. The substance is all in solid state between

B. W and X. B. W and Y. C. X and Y. **D.** Y and Z.

Surface tension in a liquid may be weakened by

A. lowering the temperature.

B. adding soap solution.

C. increasing the amount of liquid.

D. increasing the density of the liquid.

17. When oil of volume 6×10^{-3} cm ^{3}is dropped on a clean water surface, it forms a circular patch of one molecule of diameter 2 cm. Find the thickness of oil.

A. 4.77×10^{-4} cm.
B. 14.32×10^{-4} cm
C. 1.91×10^{-3} cm.
D. 5.24×10^{2} cm

Thickness = $\frac{volume}{area} = \frac{volume}{\pi r^2} = \frac{6\ x\ 10^{-3}}{\pi\ x\ 1^2} = 1.91 \times 10^{-3}$ cm.

18. Gas leaking from a cylinder, at one corner of a room reaches another comer by way of

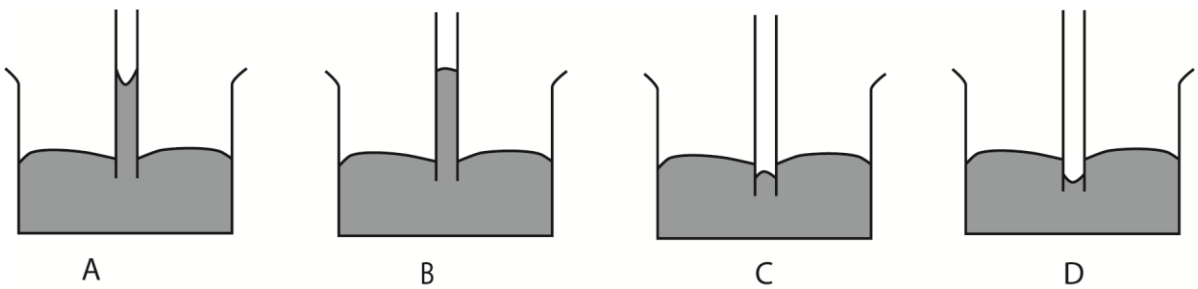
A. diffusion.
B. evaporation.
C. Brownian motion.
D. osmosis.

19. Oil of volume 1.0×10^{-2} cm is dropped on the surface of clean water. If it spreads to form a circle of radius 4 cm, find the diameter of a molecule of oil.

A. 1.99 x 10^{-4}cm.
B. 7.96 x 10^{-4}cm.
C. 1.26 x 10^{1} cm
D. 5.03 x 10^{1} cm

Thickness = $\frac{volume}{area} = \frac{volume}{\pi r^2} = \frac{1.0\ x\ 10^{-2}}{\pi\ x\ 4^2}$ = 1.99 x 10^{-4}cm.

20. Which of the following does not affect the rate at which a gas diffuses through a porous partition
    A. Temperature of the gas
    B. Size of molecules
    C. Volume of the gas
    D. Size of the pore
21. Solids are not easily compressed because their molecules
    A. Are far apart
    B. Are closely packed
    C. Vibrate about the mean position
    D. Have strong adhesive forces between them
22. Which of the following diagrams shows capillary depression in a liquid.



Answer is C

Capillary depression is seen in tubes dipped in mercury. Capillary rise is seen in tubes dipped in water and alcohol.

C is correct because the meniscus is convex while D is wrong because the meniscus is concave.

23. The force which holds the molecules of water together is called
    A. Gravity
    B. Adhesion
    C. Cohesion
    D. Electrostatic

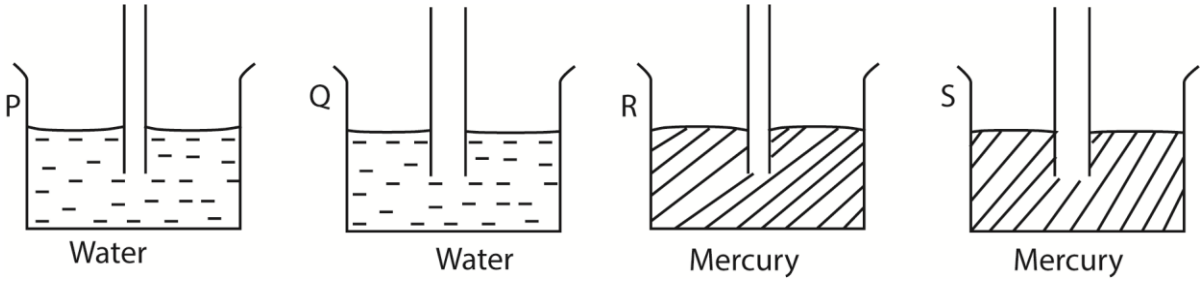
    Cohesion is the force of attraction between molecules of the same substance e.g. water molecules

    Adhesion is the force of attraction between molecules of different substance e.g. water and glass molecules.

24. Which of the following statement is correct about diffusion
    A. It is faster in gases than liquids
    B. It takes place at the same rate in all the states of matter
    C. It is faster in liquids than in gases
    D. It is independent of temperature
25. Smoke cell is used to demonstrate phenomenon called.
    A. Diffusion
    B. Brownian motion
    C. Capillarity
    D. Surface tension
26. Hairs of wet brush cling together because of
    A. Adhesion
    B. Diffusion
    C. Capillarity
    D. Surface tension

27. Which of the following statement(s) is/are correct about a liquid in a capillary tube if the adhesive force is greater than the cohesive force?
    (iv) It wet the glass
    (v) It form a concave meniscus
    (vi) It is depressed in the capillary tube
    A. (ii) and (iii) only
    B. (i) and (iii) only
    C. (i) and (ii)only
    D. (i), (ii)and (iii)

28. Glass tubes of different diameter are dipped in water and mercury as shown in the figure below



Which one of the following shows the correct order of height of liquid in the tubes from the lowest to highest

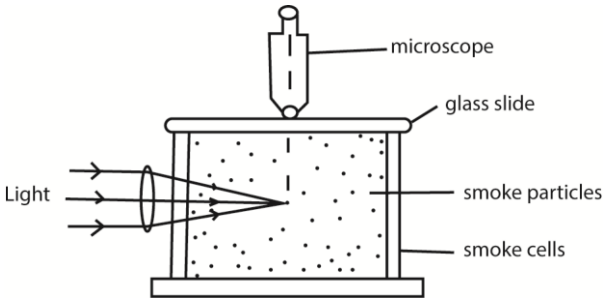
A. R, S, Q, P
B. S, R, Q, P
C. Q, S, R, P
D. P, Q R, S

In R and S, there is capillary depression while in P and Q there is capillary rise.

Depression is greatest n narrowest tube which is R while capillary rise is greatest in narrowest tube P

Structured questions

29.



The diagram above shows the arrangement for the Brownian motion experiment.

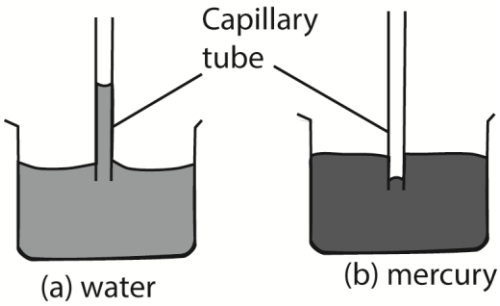
(a) Describe what would be seen through the microscope
Smoke particles are seen moving randomly

(b) What would be observed if the temperature of the smoke cell was increased?

The speed of movement of smoke particles increase due to increase in kinetic energy

30. Two identical capillary tubes are placed upright, one in a beaker of mercury and the other in a beaker of water

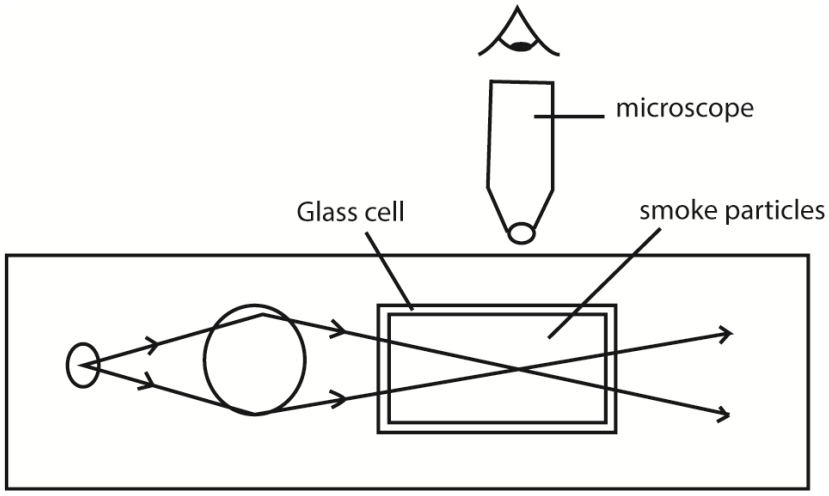
(a) Draw diagram to show the liquid levels inside and outside the capillary tubes



(b) Explain the observations in (a) in terms of forces between molecules

The level of water in capillary tube rises because adhesive forces between water and glass molecules are stronger than cohesive forces between water molecules whereas the level of mercury in capillary tube drops because the cohesive forces between mercury molecules are stronger than adhesive forces between mercury and glass molecules

31. The diagram in figure 9 shows an arrangement for observing Brownian motion.



(a) Explain:

(i) the observation made.

Continuous random movement of smoke particles due to their collision with air particles that are randomly moving

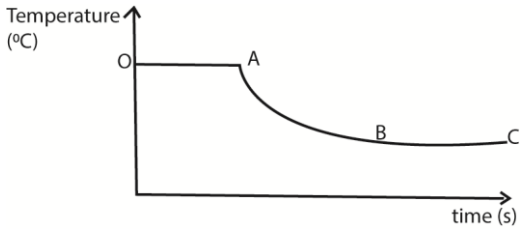
(ii) what will be observed when the glass cell temperature is raised.

Continuous random movement of air particles will move faster due to I ncrease in kinetic energy of air molecules

(b) State one factor which determines the rate of diffusion of a gas.

- temperature

- size of air molecules / density of air



The figure shows temperature versus time curve for a liquid. State what is happening along BC

the temperature of the solid equates that of the surrounding

(b) Use the kinetic theory of matter to explain what is happening along OA.

Along AO liquid is turning into solid. i.e.,molecules are becoming closer to one another. There is reduction in their potential energy but not their kinetic energy. The temperature remains constant because the kinetic energy remains unchanged.

32. (a)(i) What is meant by the term diffusion?

Diffusion is the spreading of molecules of a substance from a region of high concentration to a region of low concentration.

(ii) Explain what is observed when smoke enclosed in an illuminated transparent cells is viewed through a microscope

The smoke particles are seen to be in random motion due to collision with air molecules.

(iii) State what is observed in (a)(ii) when the cell is placed on an ice block. Give a reason for your answer.

The smoke particles slow down due to loss of kinetic energy as temperature drops

(b) (i) describe an experiment to determine the thickness of an oil molecule

- Lycopodium powder is sprinkled on water in a large dish
- Then oil of known volume V, is dropped into the middle of the water in the dish.
- The average diameter, d, and hence the average radius, r, of the patch is measured.
- Thickness = $\frac{volume}{area} = \frac{volume}{\pi r^2}$

(ii) State any assumption

- The oil patch is one molecule thick
- The oil patch is circular
- There are no gaps between oil molecules

33. (a) State what is observed in a smoke cell when studying Brownian motion

Smoke particles are seen to be random motion

(b) Explain what is would be observed if the temperature of the smoke cell is reduced.

The speed of the smoke particles reduces due to loss in kinetic energy

(e) n an experiment to estimate the thickness of an oil molecule, the diameter of an oil drop is given to be 0.5mm and the diameter of the circular patch of the same drop on water surface is 13cm. calculate the thickness of the oil molecule.

Radius of the drop = $\frac{0.5mm}{2} = 0.25mm = \frac{0.25}{10} = 0.025cm$

Volume of oil drop = $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.025)^3$ = 6.54 x 10^{-5}cm^3

Radius of oil patch = $\frac{13}{2} = 6.5cm$

Area of oil patch = $\pi r^2 = \pi(6.5)^2$ = 133cm^2

Thickness of oil molecule = $\frac{volume}{area} = \frac{6.54\ x\ 10^{-5}}{133}$ 4.89 x 10^{-7}cm

(f) State the assumption made

- The oil patch is one molecule thick
- The oil patch is circular
- There are no gaps between oil molecules

36. (a) What is diffusion?

Spreading of molecules from a region of high concentration to a region of law concentration.

(c) State three factors which affect the rate of diffusion.

- Temperature
- Molecular weight
- Concentration gradient

37. (a) Define surface tension

It is the tangential force in the surface acting normally per unit length

(c) A small piece of filter paper is placed on a water surface and a needle placed gently on it

(iii) State what is observed

The filter paper absorbs water and sinks leaving the needle floating on water

(iv) Explain what happens if the water is heated gently.

The needle sinks because the surface tension reduces

Thanks you so much