Compiled by Leong Yee Pak

Phases of Matter
9.1 Density
9.2 Solids, liquids, gases
9.3 Pressure in fluids
9.4 Change of phase

Density
Solids, liquids, gases

****1 June 02 P1 Q21**

21 A mass of a liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. No change of the total volume occurs.

What is the density of the liquid mixture?

A $\frac{4}{3}\rho$ B $\frac{3}{2}\rho$ C $\frac{5}{3}\rho$ D 3ρ

***2 Nov 02 P1 Q20**

20 Pollen grains are suspended in a liquid and are illuminated strongly. When observed under a microscope they are seen to be in continuous random motion.

What is the reason for this?

A convection currents in the liquid

B evaporation of the liquid

C molecules of the liquid colliding with the pollen grains

D pollen grains colliding with each other

****3 Nov 02 P1 Q22**

2

22 Which line in the table gives approximate ratios of density and molecular spacing for a substance in its solid, liquid and gas phases?

	density	molecular spacing
	solid : liquid : gas	solid : liquid : gas
A	1000 : 1000 : 1	1 : 1 : 10
B	1000 : 100 : 1	1 : 10 : 1000
C	1000 : 1000 : 1	1 : 1 : 1000
D	1000 : 100 : 1	1 : 10 : 100

***4 Nov 03 P1 Q20**

20 In an experiment to demonstrate Brownian motion, smoke particles in a container are illuminated by a strong light source and observed through a microscope.

The particles are seen as small specks of light that are in motion.

What causes this motion?

A collisions between the smoke particles and air molecules

B collisions between the smoke particles and the walls of the container

C convection currents within the air as it is warmed by the light source

D kinetic energy gained by the smoke particles on absorption of light

***5 June 04 P1 Q19**

19 Comparing the properties of solids, liquids and gases, which option is correct?

	property	solids	liquids	gases
A	ordering of molecules	high	not so high	random
B	spacing of molecules	close	far	far
C	translation of molecules	no	no	yes
D	vibration of molecules	no	yes	yes

***6 June 04 P1 Q20**

***6 June 04 P1 Q20**

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20 Particles of dust, suspended in water, are viewed through a microscope. The particles can be seen to move irregularly.

This movement is due to

A convection currents in the water.

B evaporation of the water near the dust particles.

C gravitational forces acting on the particles of dust.

D water molecules hitting the dust particles in a random way.

*****7 June 04 P1 Q21**

21 Two solid substances P and Q have atoms of mass M_P and M_Q respectively. They have N_P and N_Q atoms per unit volume.

It is found by experiment that the density of P is greater than that of Q.

Which of the following deductions from this experiment must be correct?

A $M_P > M_Q$

B $N_P > N_Q$

C $M_P N_P > M_Q N_Q$

D $\frac{M_P}{N_P} > \frac{M_Q}{N_Q}$

***8 Nov 04 P1 Q21**

21 Which two substances are normally both crystalline?

A copper and diamond

B copper and glass

C diamond and glass

D diamond and rubber

***9 June 05 P1 Q19**

4

19 Pollen grains are suspended in a liquid and are illuminated strongly. When observed under a microscope they are seen to be in continuous random motion.

What is the reason for this?

A convection currents in the liquid

B evaporation of the liquid

C molecules of the liquid colliding with the pollen grains

D pollen grains colliding with each other

**10 Nov 05 P1 Q19

19 When white sugar granules are heated, they melt. When the melt is cooled quickly, a brittle solid form of toffee is produced.

How does the structure of the sugar change?

A amorphous to polymeric

B crystalline to amorphous

C crystalline to polymeric

D polymeric to amorphous

**11 June 06 P1 Q19

19 Below are four short paragraphs describing the molecules in a beaker of water at 50°C.

Which paragraph correctly describes the molecules?

A The molecules all travel at the same speed. This speed is not large enough for any of the molecules to leave the surface of the water. There are attractive forces between the molecules.

B The molecules have a range of speeds. Some molecules travel sufficiently fast to leave the surface of the water. There are no forces between the molecules.

C The molecules have a range of speeds. Some molecules travel sufficiently fast to leave the surface of the water. There are attractive forces between the molecules.

D The molecules have a range of speeds. The fastest molecules are unable to leave the surface of the water. There are attractive forces between the molecules.

*12 June 06 P1 Q20

*12 June 06 P1 Q20

[Type text] Compiled by Leong Yee Pak [Type text]

20 In an experiment to demonstrate Brownian motion, smoke particles in a container are illuminated by a strong light source and observed through a microscope.

The particles are seen as small specks of light that are in motion.

What causes the Brownian motion?

A collisions between the smoke particles and air molecules

B collisions between the smoke particles and the walls of the container

C convection currents within the air as it is warmed by the light source

D kinetic energy gained by the smoke particles on absorption of light

***13 Nov 06 P1 Q19**

19 Which statement defines the density of a substance?

A the force per unit area acting on the substance

B the increase in length per unit length of the substance

C the mass per unit volume of the substance

D the work done per unit time by the substance

***14 June 07 P1 Q16**

16 Which group of statements applies only to the liquid state?

A	B
atoms separated by many atomic diameters positions of atoms can change atoms vibrate	atoms separated by many atomic diameters atoms are in fixed positions atoms are in continuous, random motion

C	D
atoms can touch each other positions of atoms can change some random motion of atoms	atoms can touch each other atoms are in fixed positions some random motion of atoms

*****15 Nov 07 P1 Q17**

17 Two solid substances P and Q have atoms of mass M_P and M_Q respectively. There are n_P and n_Q atoms per unit volume respectively.

It is found by experiment that the density of P is greater than that of Q.

Which deduction from this experiment must be correct?

A $M_P > M_Q$

B $n_P > n_Q$

C $M_P n_P > M_Q n_Q$

D $\frac{M_P}{n_P} > \frac{M_Q}{n_Q}$

***16 Nov 08 P1 Q19**

19 Which properties best describe modelling clay?

A brittle and ductile

B ductile and elastic

C elastic and plastic

D plastic and ductile

***17 June 09 P1 Q16**

7

16 Which row best describes how the molecules move in solids, in liquids and in gases?

	solids	liquids	gases
A	fixed in position	only vibrate	move about freely
B	slowly in all directions	quickly in all directions	very quickly in all directions
C	vibrate about mean position	vibrate and move about	move about freely
D	vibrate in one direction only	vibrate in two directions	vibrate in all three directions

Section B

1 June 05 P2 Q2

The Brownian motion of smoke particles in air may be observed using the apparatus shown in Fig. 2.1.

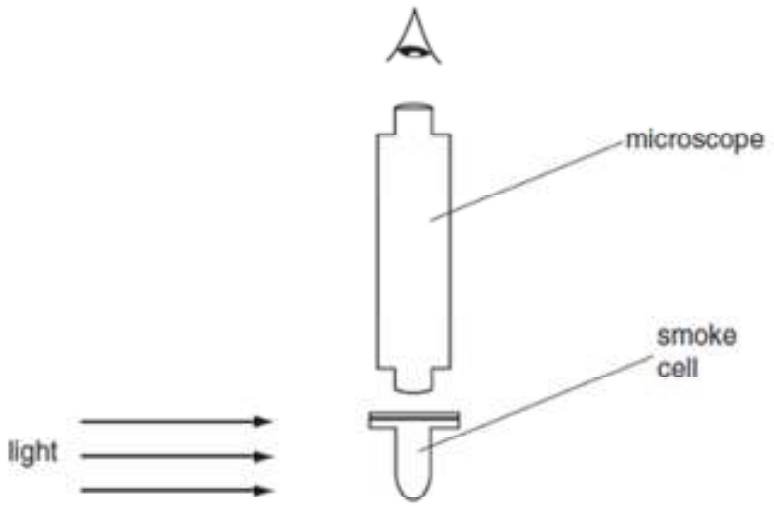

Fig. 2.1

(a) Describe what is seen when viewing a smoke particle through the microscope.

.....

.....

.....[2]

[Type text] [Type text] [Type text]
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(b) Suggest and explain what difference, if any, would be observed in the movement of smoke particles when larger smoke particles than those observed in **(a)** are viewed through the microscope.

.....

.....

.....[2]

1 June 05 P2 Q2

1 June 05 P2 Q2

(a) Move in random motion.

(b) Motion is less or no motion. Reason: 1 more than 1 air molecules strike the smoke particle at the same time. The impulsive forces cancelled out.

2. The mass of the smoke particle is large.

2 June 06 P2 Q3

3 **(a)** Explain what is meant by the *internal energy* of a substance.

.....

.....

..... [2]

(b) State and explain, in molecular terms, whether the internal energy of the following increases, decreases or does not change.

(i) a lump of iron as it is cooled

.....

.....

.....

..... [3]

(ii) some water as it evaporates at constant temperature

.....

.....

.....

..... [3]

2 June 06 P2 Q3

2 June 06 P2 Q3

(a) Internal energy = total kinetic energy and potential energy of all molecules.

(b) (i) Internal energy decreases. As temperature falls, the mean k.e. of molecules decreases.

(a) Internal energy = total kinetic energy and potential energy of all molecules.

(b) (i) Internal energy decreases. As temperature falls, the mean k.e. of molecules decreases.

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e water molecules remain constant, the mean k.e. of the water molecules remains constant as water changes into vapour, the potential energy of the molecules increases.

(ii) At constant temperature, the mean k.e. of the water molecules remains constant as water changes into vapour, the potential energy of the molecules increases.

(ii) At constant temperature, the mean k.e. of th
increases.

3 Nov 06 P2 Q5

5 **(a)** Distinguish between the structure of a metal and of a polymer.

metal: .....

.....

.....

polymer: .....

.....

..... [4]

(b) Latex is a natural form of rubber. It is a polymeric material.

(i) Describe the properties of a sample of latex.

.....

.....

..... [2]

(ii) The process of heating latex with a small amount of sulphur creates cross-links between molecules. Natural latex has very few cross-links between its molecules.

Suggest how this process changes the properties of latex.

.....

.....

..... [2]

3 Nov 06 P2 Q5

metal: polycrystaline. Atoms are arranged in long range orderly and regular manner in atomic lattice which repeat itself.

Polymer: each molecule consists of laong chain of atoms. The chain contains units which repeat themself.

(b)(i) soft, sticky, elastic limit easily exceeded

(ii) hard, stronger, elastic limit higher, increase toughness,

ghness,

(b)(i) soft, sticky, elastic limit easily exceeded
(ii) hard, stronger, elastic limit higher, increase tou

4 Nov 08 P2 Q5

5 Some smoke particles are viewed through a microscope, as illustrated in Fig. 5.1.

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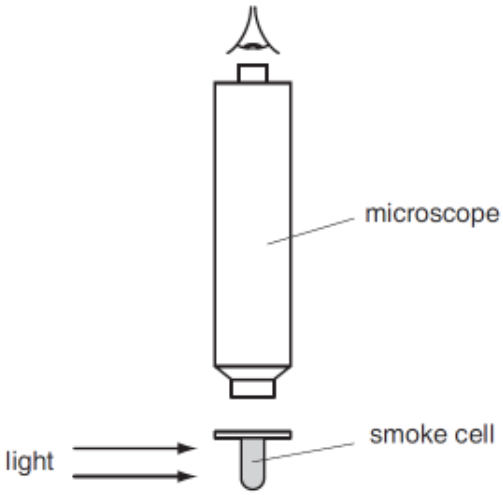


Fig. 5.1

Brownian motion is observed.

(a) Explain what is meant by *Brownian motion.*

.....

.....

..... [2]

(b) Suggest and explain why Brownian motion provides evidence for the movement of molecules as assumed in the kinetic theory of gases.

.....

.....

.....

..... [2]

(c) Smoke from a poorly maintained engine contains large particles of soot.
Suggest why the Brownian motion of such large particles is undetectable.

.....

.....

..... [2]

Pressure in Liquids
Change of Phase

***1 June 02 P1 Q20**

20 For a given liquid at atmospheric pressure, which process can occur at any temperature?

A boiling

B evaporation

C melting

D solidification

****2 Nov 02 P1 Q21**

21 At a depth of 20 cm in a liquid of density 1800 kg m^{-3}, the pressure due to the liquid is p.

Another liquid has a density of 1200 kg m^{-3}.

What is the pressure due to this liquid at a depth of 60 cm?

A $\frac{p}{2}$ B $\frac{3p}{2}$ C $2p$ D $3p$

*****3 June 03 P1 Q20**

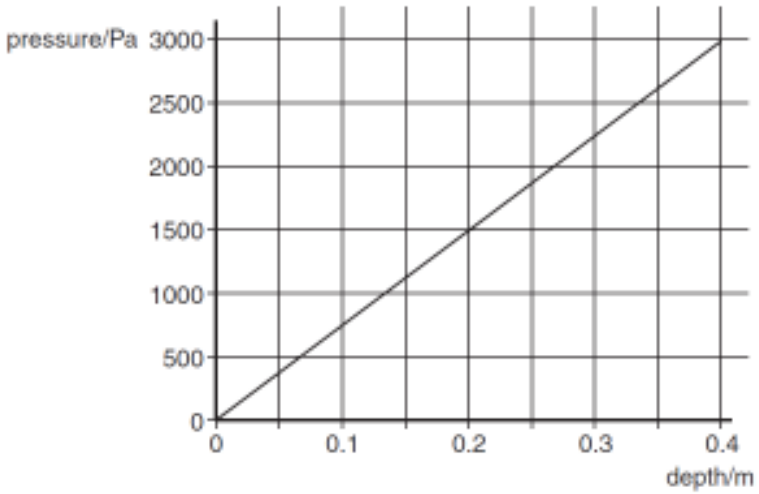
20 A child drinks a liquid of density ρ through a vertical straw.
Atmospheric pressure is p_0 and the child is capable of lowering the pressure at the top of the straw by 10%. The acceleration of free fall is g.

What is the maximum length of straw that would enable the child to drink the liquid?

A $\frac{p_0}{10\rho g}$ B $\frac{9p_0}{10\rho g}$ C $\frac{p_0}{\rho g}$ D $\frac{10p_0}{\rho g}$

****4 Nov 03 P1 Q19**

19 The graph shows how the pressure exerted by a liquid varies with depth below the surface.



What is the density of the liquid?

A 600 kg m^{-3} **B** 760 kg m^{-3} **C** 5900 kg m^{-3} **D** 7500 kg m^{-3}

***5 Nov 04 P1 Q19**

19 Which statement applies to the boiling but **not** to the evaporation of a liquid?

A All the bonds between molecules in the liquid are broken.

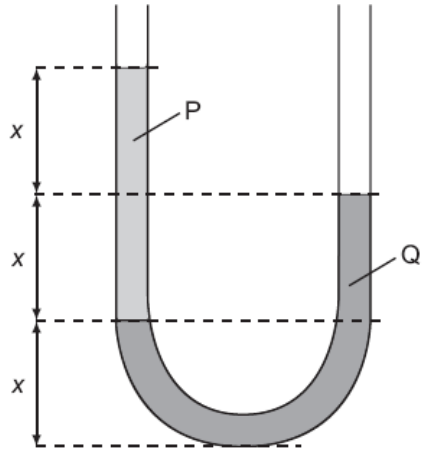
B At normal atmospheric pressure, the process occurs at one temperature only.

C Energy must be provided for the process to happen.

D The separation of the molecules increases greatly.

****6 Nov 04 P1 Q20**

20 The diagram shows two liquids, labelled P and Q, which do **not** mix. The liquids are in equilibrium in an open U-tube.



What is the ratio $\frac{\text{density of P}}{\text{density of Q}}$?

A $\frac{1}{2}$ **B** $\frac{2}{3}$ **C** $\frac{3}{2}$ **D** 2

****7 June 05 P1 Q18**

18 The hydrostatic pressure p at a depth h in a liquid of density ρ is given by the formula $p = h\rho g$.

Which equation, or principle of physics, is used in the derivation of this formula?

A density = mass ÷ volume

B potential energy = mgh

C atmospheric pressure decreases with height

D density increases with depth

****8 Nov 05 P1 Q17**

17 Why does the pressure increase when a sealed container of gas is heated?

A The gas molecules collide more often with each other.

B The gas molecules expand when they are heated.

C The gas molecules travel faster and hit the walls of the container more often.

D There are more gas molecules present to collide with the walls of the container.

**9 Nov 05 P1 Q18

18 Liquids X and Y are stored in large open tanks. Liquids X and Y have densities of 800 kg m^{-3} and 1200 kg m^{-3} respectively.

At what depths are the pressures equal?

	depth in liquid X	depth in liquid Y
A	8 m	12 m
B	10 m	10 m
C	15 m	10 m
D	18 m	8 m

*10 Nov 06 P1 Q20

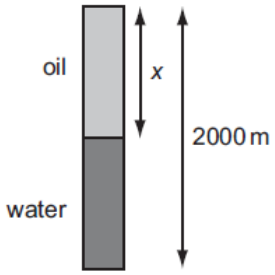
20 The table summarises some properties of evaporation.

Which row of the table is correct?

	involves a change in state from liquid to vapour	occurs at a fixed temperature	involves a reduction in the average kinetic energy of the remaining atoms
A	true	true	true
B	true	false	true
C	true	false	false
D	false	true	false

**11 Nov 06 P1 Q21

21 A bore hole of depth 2000 m contains both oil and water as shown. The pressure at the bottom is 17.5 MPa. The density of the oil is 830 kg m^{-3} and the density of the water is 1000 kg m^{-3}.



What is the depth x of the oil?

A 907 m **B** 1000 m **C** 1090 m **D** 1270 m

****12 June 07 P1 Q15**

15 The density of mercury is $13.6 \times 10^3\,kg\,m^{-3}$.

The pressure difference between the bottom and the top of a column of mercury is 100 kPa.

What is the height of the column?

A 0.75 m **B** 1.3 m **C** 7.4 m **D** 72 m

****13 Nov 07 P1 Q18**

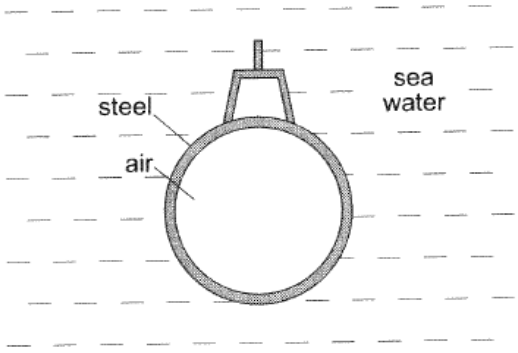
18 A submarine carries a pressure meter so that the crew can work out how far they are below the surface of the sea. At the surface, the meter indicates a pressure of 100 kPa. The density of seawater is $1030\,kg\,m^{-3}$.

What is the depth below the surface when the meter reads 450 kPa?

A 34.6 m **B** 44.5 m **C** 340 m **D** 437 m

***14 June 08 P1 Q15**

15 A submarine is in equilibrium in a fully submerged position.



What causes the upthrust on the submarine?

A The air in the submarine is less dense than sea water.

B The sea water exerts a greater upward force on the submarine than the weight of the steel.

C The submarine displaces its own volume of sea water.

D There is a difference in water pressure acting on the top and bottom of the submarine.

****15 Nov 08 P1 Q20**

20 Why does the pressure of a gas increase when the gas is compressed at constant temperature?

A The gas molecules collide more often with each other.

B The gas molecules expand under pressure.

C The gas molecules hit the walls of the container more frequently.

D The gas molecules travel faster.

***16 June 09 P1 Q17**

17 Water can exist in three states: solid, liquid or vapour. Transitions between these states can involve melting, freezing, evaporation or boiling.

Under conditions of constant pressure, which transition can occur over a range of temperatures rather than at one fixed temperature?

A boiling

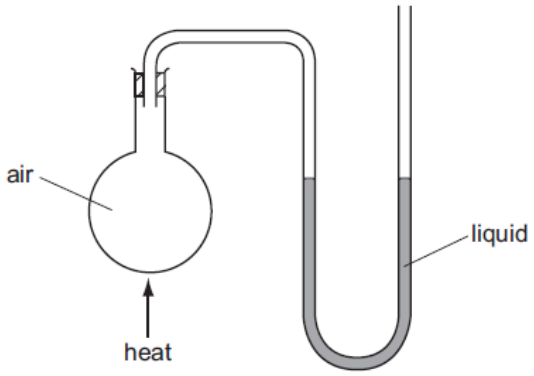
B evaporation

C freezing

D melting

*****17 June 09 P1 Q18**

18 The diagram shows a flask connected to a U-tube containing liquid. The flask contains air at atmospheric pressure.



17

The flask is now gently heated and the liquid level in the right-hand side of the U-tube rises through a distance h. The density of the liquid is ρ.

What is the increase in pressure of the heated air in the flask?

A $h\rho$ B $\frac{1}{2}h\rho g$ C $h\rho g$ D $2h\rho g$

Section B
Pressure in Liquids
Change of Phase

1 June 06 P2 Q4

4 (a) Define *density*.

.....

.....

..... [1]

(b) A U-tube contains some mercury. Water is poured into one arm of the U-tube and oil is poured into the other arm, as shown in Fig. 4.1.

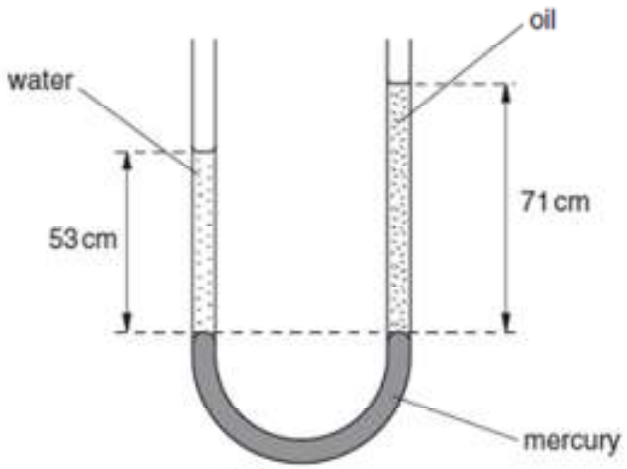


Fig. 4.1

The amounts of oil and water are adjusted until the surface of the mercury in the two arms is at the same horizontal level.

(i) State how it is known that the pressure at the base of the column of water is the same as the pressure at the base of the column of oil.

.....

..... [1]

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18

(ii) The column of water, density $1.0 \times 10^3 \text{ kg m}^{-3}$, is 53 cm high. The column of oil is 71 cm high.

Calculate the density of the oil. Explain your working.

density = ... kg m^{-3} [3]

1 June 06 P2 Q4

(a) Density = mass per unit volume of the substance.

(b)((i) They are at the same level.

(ii) Pressure at base of water = pressure at base of oil.

$(h\rho g)_{water} + P_{atm} = (h\rho g)_{oil} + P_{atm}$

$(h\rho g)_{water} = (h\rho g)_{oil}$

2 June 07 Q3

3 **(a)** Define *density*.

.....[1]

(b) Liquid of density ρ fills a container to a depth h, as illustrated in Fig. 3.1.

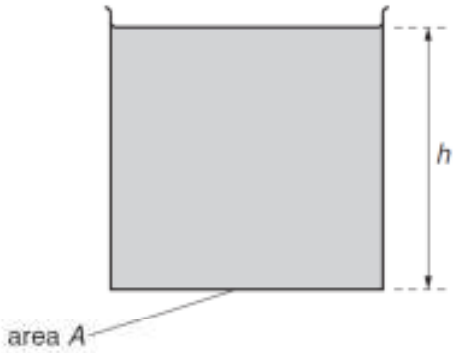

Fig. 3.1

The container has vertical sides and a base of area A.

(i) State, in terms of A, h and ρ, the mass of liquid in the container.

.....[1]

(ii) Hence derive an expression for the pressure p exerted by the liquid on the base of the container. Explain your working.

[Type text] Compiled by Leong Yee Pak [Type text]

[2]

(c) The density of liquid water is $1.0\,g\,cm^{-3}$. The density of water vapour at atmospheric pressure is approximately $\frac{1}{1600}\,g\,cm^{-3}$.

Determine the ratio

(i) $\frac{\text{volume of water vapour}}{\text{volume of equal mass of liquid water}}$,

ratio = ...[1]

(ii) $\frac{\text{mean separation of molecules in water vapour}}{\text{mean separation of molecules in liquid water}}$.

ratio = ...[2]

(d) State the evidence for

(i) the molecules in solids and liquids having approximately the same separation,

.....

.....[1]

(ii) strong rigid forces between molecules in solids.

strong: .....

rigid: .....[2]