DIFFUSION

Define diffusion:

Diffusion is the random movement of particles from a region of their high concentration to a region of their low concentration down the concentration gradient.

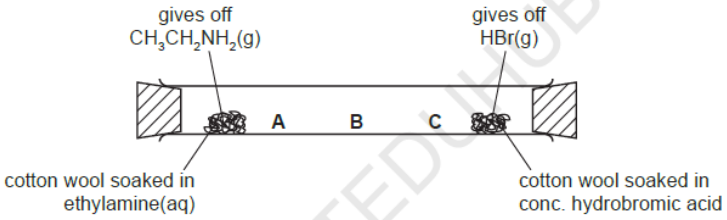
Speed of diffusion depends upon the M_r(relative molecular mass):

This means that the speed of diffusion of a gas depends on how heavy it's molecules are. Molecules with a lighter mass diffuse faster than those with a heavier mass.

When the colourless gases hydrogen bromide and ethylamine come into contact, a white solid is formed.

$$CH_3CH_2NH_2(g) + HBr(g) \rightarrow \underset{\text{white solid}}{CH_3CH_2NH_3Br(s)}$$

The following apparatus can be used to compare the rates of diffusion of the two gases ethylamine and hydrogen bromide.



Observations:

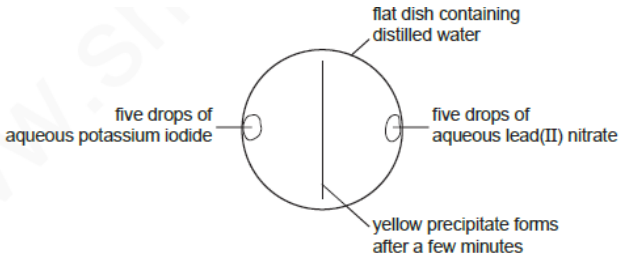
- **The white ring is formed at C. This is because ethylamine is less dense(or has a lower M_r) than HBr. Hence ethylamine diffuses faster than HBr.**

Why do the gases diffuse?- Explanation based on kinetic theory:

Gases diffuse because their particles move in random motion. These particles then collide .This diffusion is from a region of high concentration to a region of low concentration.

Diffusion happens faster in warmer temperatures than in cooler temperatures.

When a liquid spills on a floor and can be smelt far away it means that it has first evaporated then diffused.



When a precipitate is formed during chemical reactions, the particles, diffuse, collide and then react

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Particles spread out evenly as a result of diffusion

Note here sugar dissolves then diffuses. You cannot say sugar melts and then diffuses.

Generally diffusion happens in liquids and gases as the particles are free to move. Their particles are constantly moving colliding and changing directions.

Diffusion in gases is faster than diffusion in liquids because the gas particles move rapidly. They are able to move freely because kinetic theory assumes that there are no forces of attraction between the gas particles while there are weak forces of attraction between liquid particles.

Diffusion does not happen in solids because the particles are tightly packed and they can only vibrate in their mean positions and not move about.

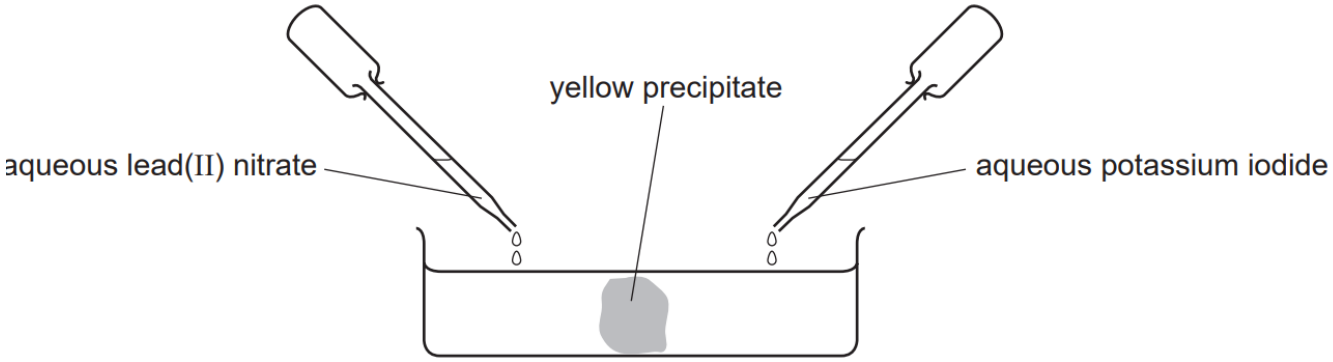
Diffusion can occur in liquids which are miscible

Diffusion is also possible in solids that dissolve in liquids.

At the same temperature, the molecules that have the lower mass diffuse faster than the heavier molecules. If the lighter and heavier molecules have the same amount of energy when they collide, then, the lighter ones will bounce off the heavier ones at a faster rate. So, lighter molecules diffuse faster than the heavier molecules.

APPLICATION BASED QUESTIONS-NEW

1 Aqueous lead(II) nitrate and aqueous potassium iodide are added to a dish containing water, as shown.



A yellow precipitate forms after a few minutes.

Which process occurs before the precipitate forms?

A diffusion

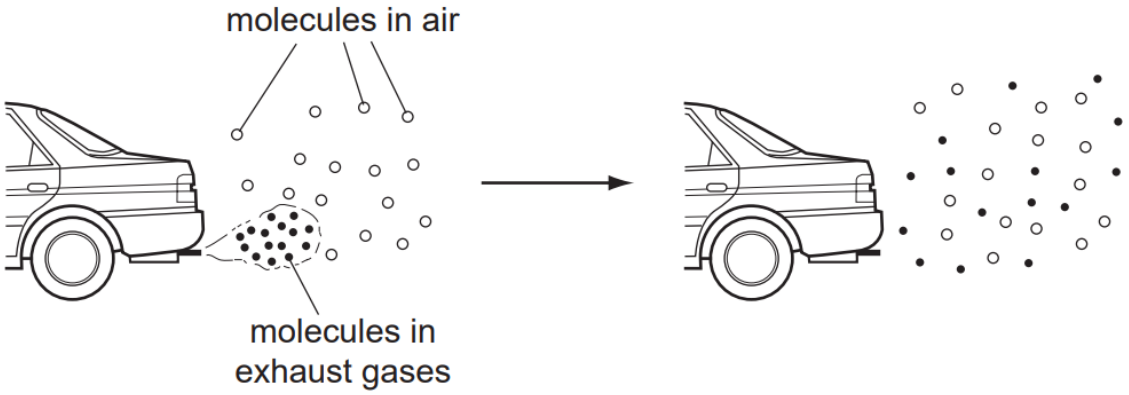
B distillation

C fermentation

D filtration

ANSWER:A

2 The diagram shows how the molecules in the exhaust gases diffuse into the air.



Which statement describes what happens to these molecules next?

A The molecules fall to the ground because they are heavier than air molecules.

B The molecules go back together as they cool.

C The molecules spread further into the air.

D The molecules stay where they are.

ANSWER:C

3 The diagram shows a cup of tea.

Which row describes the water particles in the air above the cup compared with the water particles in the cup?

	moving faster	closer together
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

ANSWER:B

4 'Particles moving **very slowly** from an area of high concentration to an area of low concentration.'

Which process is being described above?

A a liquid being frozen

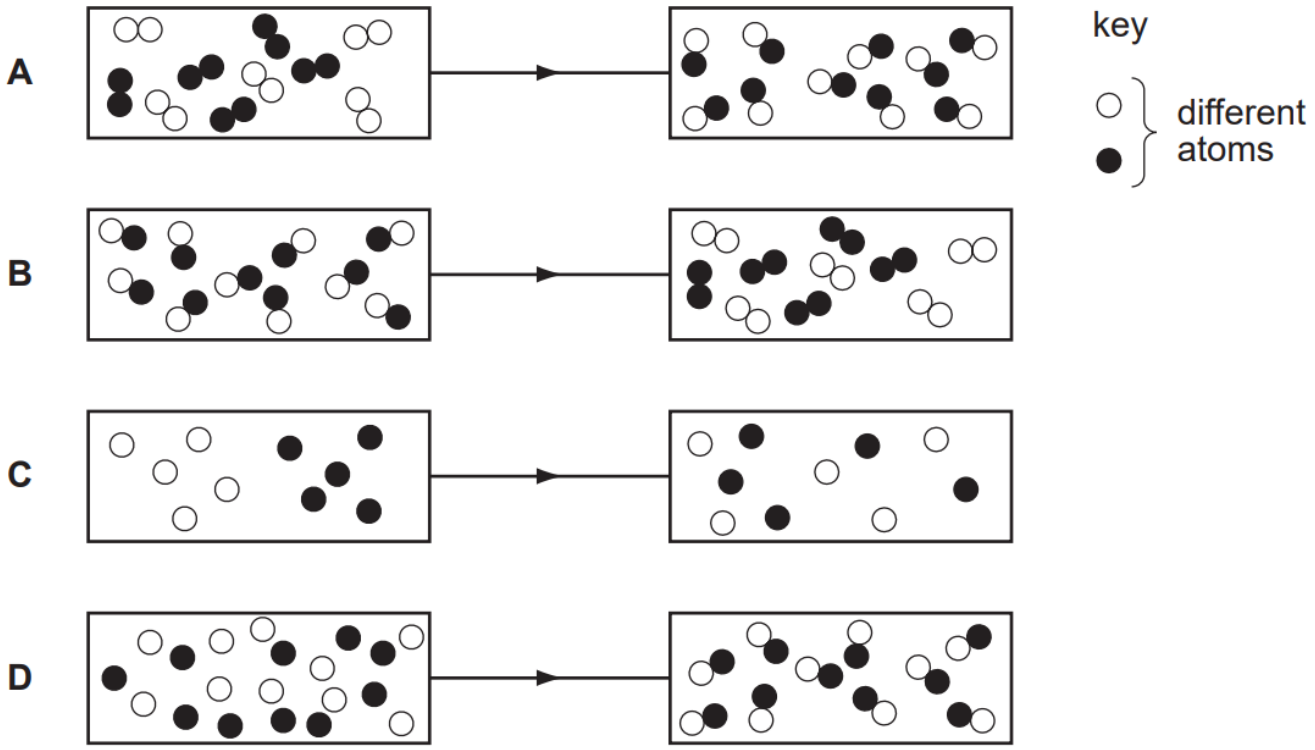
B a solid melting

C a substance diffusing through a liquid

D a substance diffusing through the air

ANSWER:C

5 Which diagram shows the process of diffusion?



ANSWER:C

6 A gas jar of bromine vapour and a gas jar of air are set up as shown in diagram 1.

The glass slide is removed. Diagram 2 shows the appearance of the gas jars after one hour.

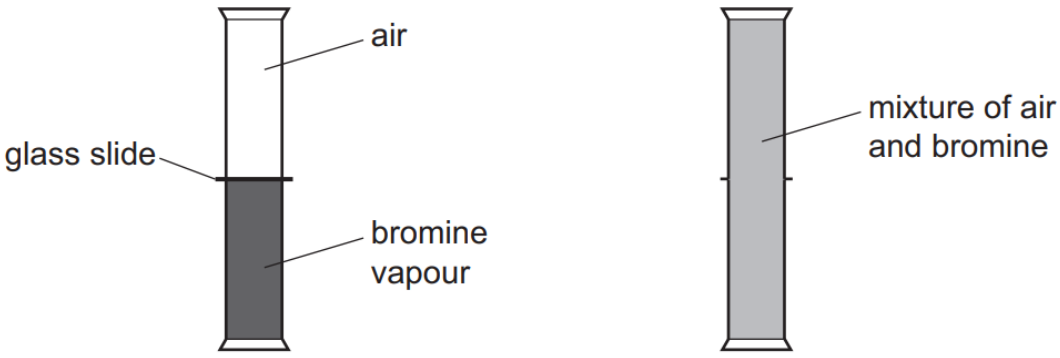


diagram 1 diagram 2

Which statement explains why the bromine and air mix together?

A Bromine is denser than air.

B Bromine is lighter than air.

C Bromine molecules moved upwards and molecules in air moved downwards.

D Molecules in bromine and air moved randomly.

ANSWER:D

7 Which statement is an example of diffusion?

A A kitchen towel soaks up some spilt milk.

B Ice cream melts in a warm room.

C Pollen from flowers is blown by the wind.

D The smell of cooking spreads through a house.

ANSWER:D

8 A few drops of perfume were spilt on the floor. A few minutes later the perfume could be smelt a few metres away.

Which two processes had taken place?

A distillation and condensation

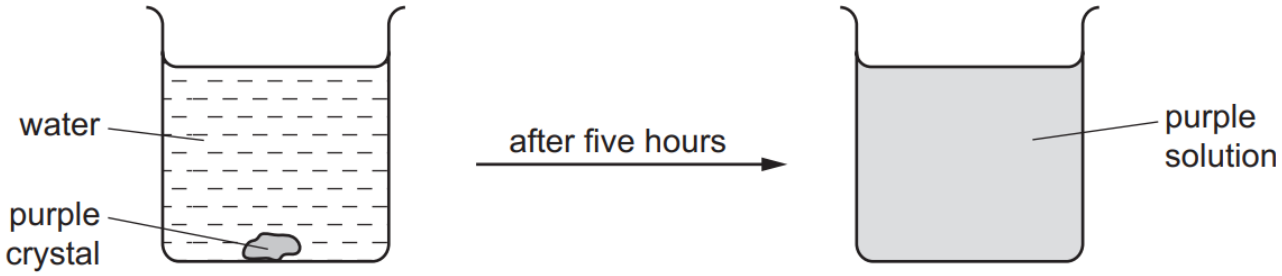
B distillation and diffusion

C evaporation and condensation

D evaporation and diffusion

ANSWER:D

9 The diagram shows the result of dropping a purple crystal into water.



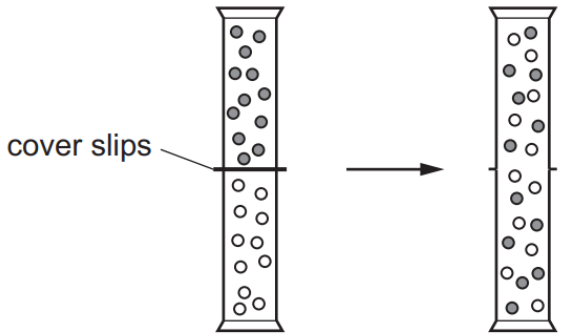
Which processes take place in this experiment?

	chemical reaction	diffusing	dissolving
A	✓	✓	✓
B	✓	✗	✓
C	✗	✗	✓
D	✗	✓	✓

ANSWER:D

10 Two gas jars each contain a different gas. The gas jars are connected and the cover slips are removed.

The diagram shows what happens to the particles of the gases.



Which process has occurred?

A chemical reaction

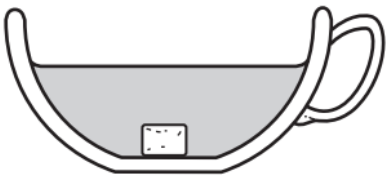
B condensation

C diffusion

D evaporation

ANSWER:C

11 The diagram shows a sugar lump in a cup of tea.

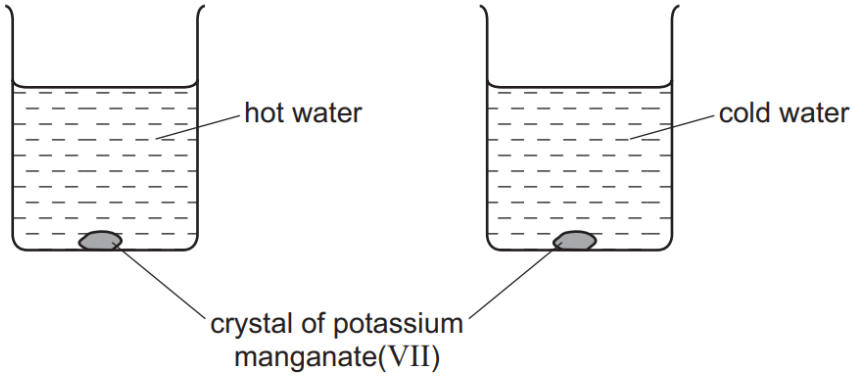


Which two processes must happen to spread the sugar evenly in the tea?

	first process	second process
A	diffusion	dissolving
B	dissolving	diffusion
C	dissolving	melting
D	melting	diffusion

ANSWER:B

12 A crystal of purple potassium manganate(VII) was added to each of the beakers shown in the diagram.



One beaker contained hot water and the other beaker contained cold water.

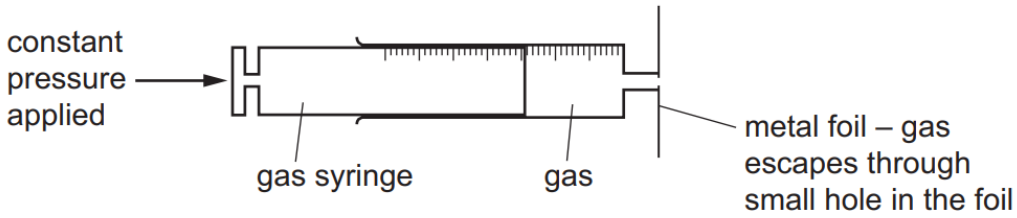
In both beakers the purple colour of the potassium manganate(VII) spreads out.

Which result and explanation are correct?

	result	explanation
A	colour spreads faster in cold water	particles move faster at a higher temperature
B	colour spreads faster in cold water	particles move slower at a higher temperature
C	colour spreads faster in hot water	particles move faster at a higher temperature
D	colour spreads faster in hot water	particles move slower at a higher temperature

ANSWER:C

13 The rate of diffusion of two gases, methane, CH_4, and ethene, C_2H_4, is measured using the apparatus shown.

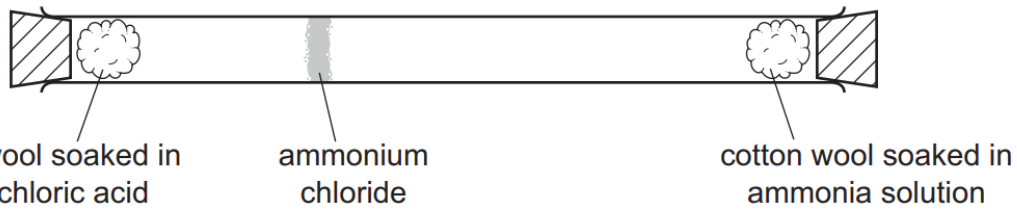


Which gas diffuses faster and why?

	gas that diffuses faster	reason
A	ethene	Ethene molecules are heavier and so move faster.
B	ethene	Ethene molecules have a double bond which makes them more reactive.
C	methane	Methane molecules are lighter and so move faster.
D	methane	Methane molecules are smaller so they can get out of the small hole more easily.

ANSWER: C

14 The diagram shows an experiment to demonstrate diffusion.



Which statement explains why the ring of ammonium chloride appears as shown?

A Ammonia solution only produces a gas which moves until it meets the hydrochloric acid.

B Both solutions produce a gas, but ammonia moves quicker than hydrogen chloride because it is lighter.

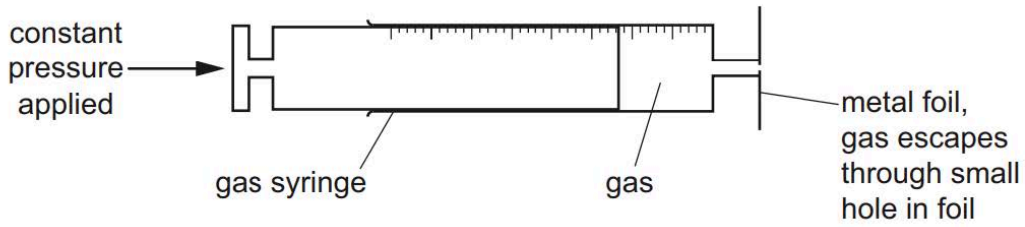
C Hydrochloric acid produces hydrogen chloride which stays at one end of the tube until the ammonia reaches it.

D The two solutions run along the tube until they meet.

ANSWER:B

APPLICATION-BASED QUESTIONS-THEORY-NEW

1 The following apparatus can be used to measure the rate of diffusion of a gas.



The following results were obtained.

gas	temperature / °C	rate of diffusion in cm^3 / min
nitrogen		1.00
chlorine		0.63
nitrogen		1.05

Explain why nitrogen gas diffuses faster than chlorine gas.

.....

..... [2]

(ii) Explain why the nitrogen gas diffuses faster at the higher temperature.

..... [1]

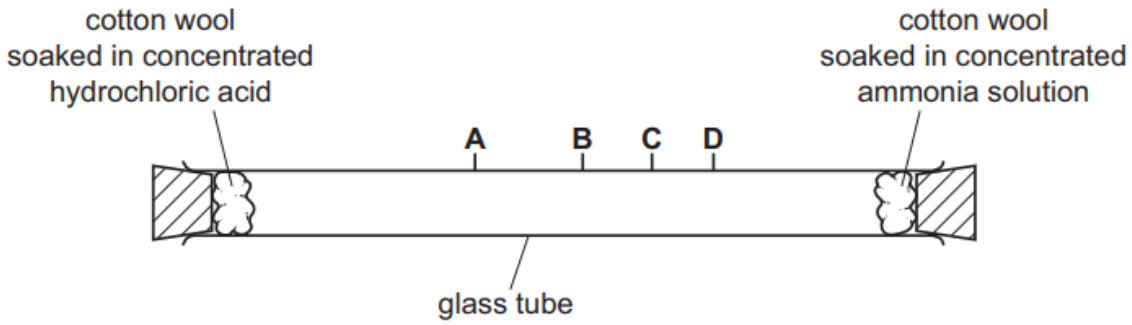
MARKING SCHEME:

(i) nitrogen has smaller M_r; [1
nitrogen (molecules) move faster (than chlorine molecules) / ora; [1]
note: comparison must be made

(ii) (at higher temperature) molecules move faster / have more energy [1]

2 Concentrated ammonia solution gives off ammonia gas. Concentrated hydrochloric acid gives off hydrogen chloride gas. Ammonia, NH_3, and hydrogen chloride, HCl, are both colourless gases. Ammonia reacts with hydrogen chloride to make the white solid ammonium chloride.

Apparatus is set up as shown.



After ten minutes a white solid forms in the tube where the gases meet.

(a) (i) Write the chemical equation for the reaction of ammonia with hydrogen chloride.

..... [1]

(ii) Name the process by which the ammonia and hydrogen chloride gases move in the tube.

..... [1]

(iii) At which point, **A**, **B**, **C** or **D**, does the white solid form? Explain why the white solid forms at that point.

the solid forms at .....

explanation .....

.....

[3]

(iv) The experiment was repeated at a higher temperature.

Predict how the results of the experiment would be different. Explain your answer.

.....

.....

..... [3]

MARKING SCHEME:

(a)(i)	$NH_3 + HCl \rightarrow NH_4Cl$;	**1**
(a)(ii)	diffusion:	**1**
(a)(iii)	solid forms at: A; explanation: ammonia molecules / particles have a smaller mass; (and so) move / diffuse faster;	**3** 1 2
(a)(iv)	**M1** solid forms in less time / faster / quicker; **M2** particles / molecules have more energy; **M3** (and so) move faster / diffuse faster;	**3** 1 1 1

3

1 **(a)** A small amount of liquid bromine is added to a container which is then sealed.

$$Br_2(l) \rightarrow Br_2(g)$$

Use the ideas of the Kinetic Theory to explain why, after about an hour, the bromine molecules have spread uniformly to occupy the whole container.

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..... [3]

(b) The diagrams below show simple experiments on the speed of diffusion of gases.

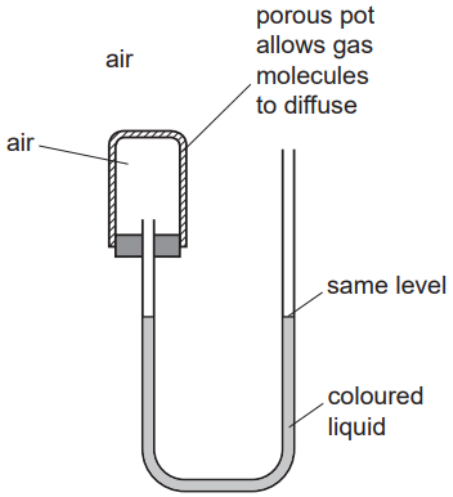

diagram 1

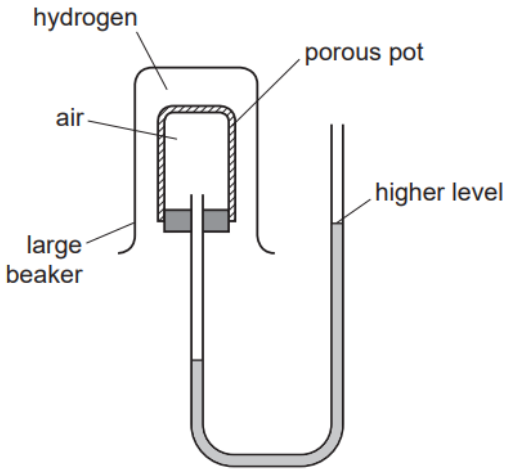

diagram 2

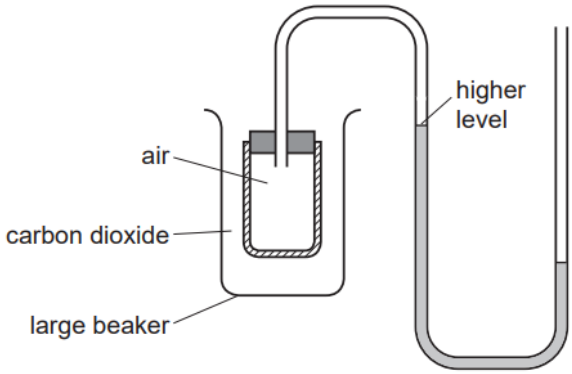

diagram 3

Complete the following explanations. Diagram 1 has been done for you.

Diagram 1

There is air inside and outside the porous pot so the rate of diffusion of air into the pot is the same as the rate of diffusion of air out of the pot. The pressure inside and outside the pot is the same so the coloured liquid is at the same level on each side of the tube.

Diagram 2

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.....

.....

..... [3]

Diagram 3

.....

.....

.....

..... [3]

[Total: 9]

MARKING SCHEME:

(a explanation of evaporation e.g. particles (or molecules) with a lot of energy leave the liquid / bromine particles break free from each other / forces or bonds between bromine molecules broken / molecules (in liquid) have weak forces holding them together / weak intermolecular forces / Van der Waals forces between molecules (don't have to be stated as weak) / (weak intermolecular forces alone scores this mark);
allow: particles (or molecules) of bromine escape from liquid [1]

diffusion / diffuse / movement of particles; [1]

explanation of diffusion involving qualified movement of molecules / particles
i.e. random movement of molecules / particles move in all direction [1]

(b) air more dense / heavier / higher M_r than hydrogen; [1]
hydrogen diffuses faster (than air diffuses out); [1]
accept: diffusion in is faster than out (without naming gases)
pressure inside pot is greater (than outside); [1]
air less dense / lighter / lower M_r than carbon dioxide; [1]

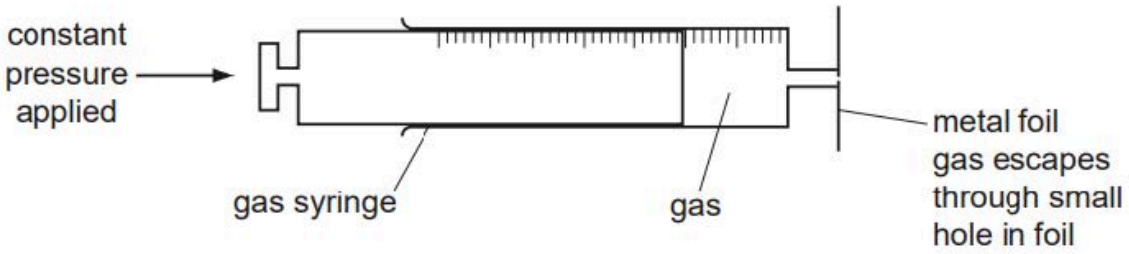
air diffuses / moves faster (than carbon dioxide); [1]
accept: diffusion out is faster than in (without naming gases)

pressure inside pot less (than outside); [1]

ORA in both parts

[Total: 9]

4 The following apparatus can be used to measure the rate of diffusion of a gas.



The following results were obtained.

gas	temperature /°C	rate of diffusion in cm^3/min
nitrogen	25	1.00
chlorine	25	0.63
nitrogen	50	1.05

Explain why nitrogen diffuses faster than chlorine.

.....

..... [2]

Explain why the nitrogen diffuses faster at the higher temperature.

..... [1]

MARKING SCHEME:

(1) nitrogen has small**er** M_r / light**er** molecules / low**er** density [1]
nitrogen **molecules** / **particles** **move** fast**er** (than chlorine molecules) [1]

(2) at higher temperature nitrogen **molecules or particles** (not atoms) move faster / have more energy [1]

5 Gases diffuse, which means that they move to occupy the total available volume.

(i) Explain, using kinetic particle theory, why gases diffuse.

.....

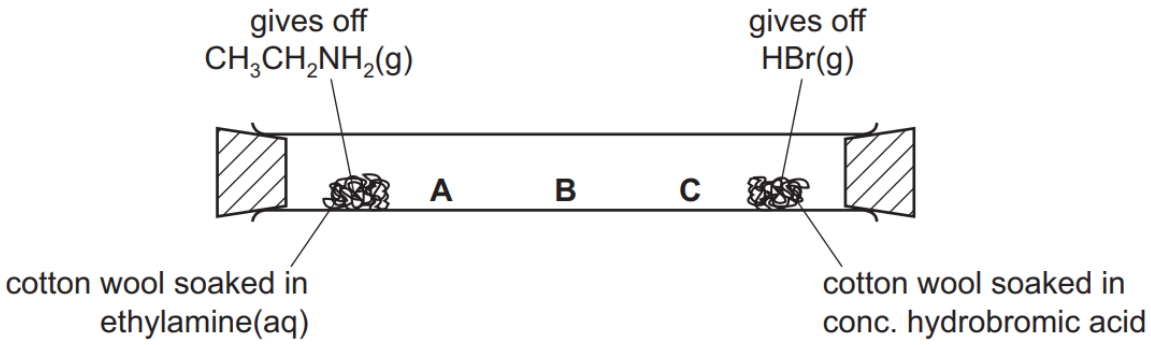
.....

..... [2]

(ii) When the colourless gases hydrogen bromide and ethylamine come into contact, a white solid is formed.

$$CH_3CH_2NH_2(g) + HBr(g) \rightarrow \underset{\text{white solid}}{CH_3CH_2NH_3Br(s)}$$

The following apparatus can be used to compare the rates of diffusion of the two gases ethylamine and hydrogen bromide.



Predict at which position, **A**, **B** or **C**, the white solid will form. Explain your choice.

.....

.....

..... [3]

MARKING SCHEME:

(c)(i)	*Any **two** from:* (particles move in) random motion; (particles) collide; (particles) move from a region of high concentration to low concentration;	2	**A** alternative phrases for collide **A** down a concentration gradient
(c)(ii)	C; M2 it has a lower (relative) molecular mass (than HBr); M3 ethylamine diffuses faster (than HBr);	3	**A** ethylamine is less dense **A** ethylamine is a lighter molecule but **I** 'ethylamine is lighter' **I** ethylamine is a smaller molecule **A** ethylamine **molecules** or **particles** move faster **A** ECF for M2 and M3 if A is given e.g. HBr diffuses faster for M3 because it is a lighter molecule for M2 **A** ECF for M2 if B is given e.g. they diffuse at same rate for M3 because molecules weigh the same for M2