THERMAL PROPERTIES OF MATTER

Specific heat capacity
Melting and boiling
Thermal Expansion of Solids, Liquids and Gases

Describe a rise in temperature of a body in terms of an increase in its internal energy (random thermal energy).

SPECIFIC HEAT CAPACITY

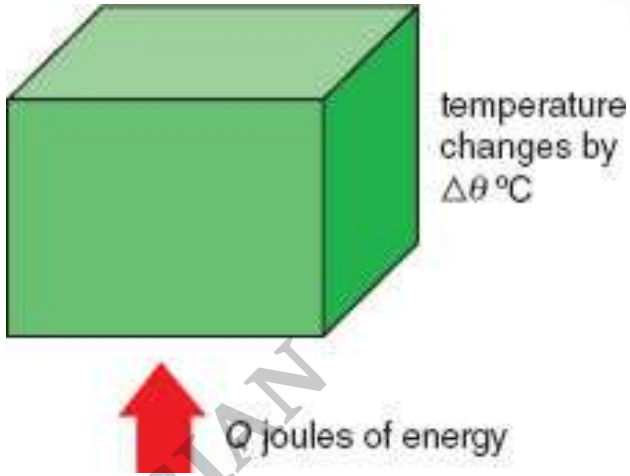
Internal Energy

- The **internal energy** of a body is the combination of the total kinetic energy (due to its motion) and potential energy (due to intermolecular forces) of the molecules in the body.
- When heat is given to a system, the atoms and molecules of gain energy, collisions between the molecules and atoms take place and they start moving faster.
- Therefore as temperature rises, there will be an increase in the internal energy of the substance.

Define the terms *heat capacity* and *specific heat capacity*.

SPECIFIC HEAT CAPACITY

Heat Capacity



- In the above figure, the transfer of energy, Q, into the body causes the internal energy to increase by ΔU, and the temperature to rise by $\Delta\theta$.
- The **heat capacity**, C, of a body is the amount of thermal energy required to raise the temperature of the body by 1 °C.

$$C = \frac{Q}{\Delta\theta}$$

Problem Solving

1. In an experiment, 100 g of water requires 12 600 J of heat to raise it from 30 ^{o}C to 60 ^{o}C.
   a) Find the heat capacity of 100 g of water.
   b) Find the heat capacity of 1000 g of water.
2. Find the heat needed to raise 1000 g of water from 30 ^{o}C to 40 ^{o}C.
3. A cup of coffee at 80 ^{o}C is left to cool to 30 ^{o}C. If the heat capacity of the cup and coffee is 2000 J/^{o}C, how much heat is released during the cooling?
4. When 800 J of energy are given to object A its temperature rises by 8 °C. When 1000 J of energy are given to object B its temperature rises by 12 °C. Explain which object has the larger heat capacity?

Specific Heat Capacity

- Heat capacity is a property of a body.
- It depends on the amount of material involved.
- As heat capacity varies with the mass of the material, therefore we should also considered the heat capacity per unit mass or specific heat capacity of the material.
- The **specific heat capacity**, c, of a material is defined as the amount of thermal energy required to raise the temperature if a unit mass of the material by 1 °C.

$$c = \frac{Q}{m\Delta\theta}$$

Material	Specific Heat Capacity	
	J kg^{-1} $°C^{-1}$	J g^{-1} $°C^{-1}$
Aluminium	900	0.90
Brass	380	0.38
Copper	400	0.40
Glass	670	0.67
Ice	2100	2.10
Iron	460	0.46
Lead	130	0.13
Mercury	140	0.14
Sea water	3900	3.90
Water	4200	4.20
Zinc	390	0.39

Recall and use the formula *thermal energy* = *mass* × *specific heat capacity* × *change in temperature*.

SPECIFIC HEAT CAPACITY

- Conversion of energy
  - **Electrical energy** from heater transformed to **heat energy.**

$$P\,t = m\,c\,\theta$$

  - **Potential energy** of falling object transformed to **heat energy.**

$$m\,g\,h = m\,c\,\theta$$

  - **Kinetic energy** of a moving object transformed into **heat energy** when it is stop due to friction.

$$\tfrac{1}{2}\,m\,v^{2} = m\,c\,\theta$$

Problem Solving

1. A domestic hot water tank contains 200 kg of water at 20 °C. How much energy must be supplied to heat this water to 70 °C? The specific heat capacity of water is 4200 J/(kg°C).
2. A copper block weighing 2 kg is dropped from a height of 20 m. What is the rise in temperature of the copper block after it hits the floor. The specific heat capacity of copper is 400 J/(kg°C).
3. Calculate the specific heat capacity of a new alloy if a 15.4 g sample absorbs 393 J when it is heated from 0.0 ^{o}C to 37.6 ^{o}C.
4. How much energy is needed to heat 100 g of water from 10 ^{o}C to 30 ^{o}C?

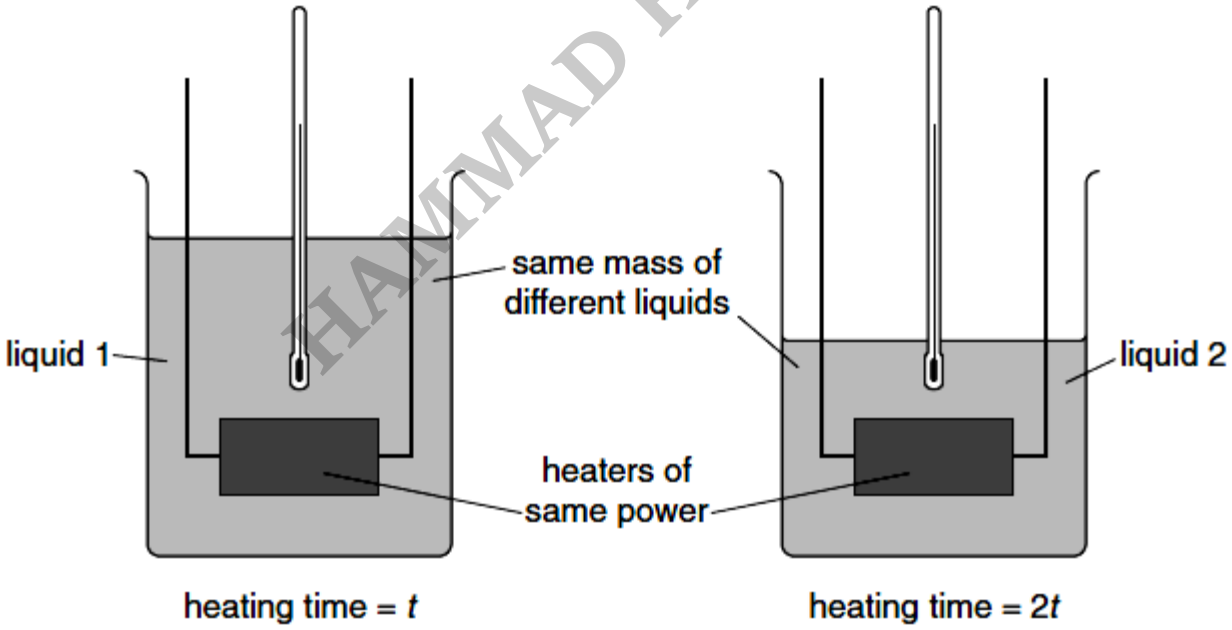
5. A 2 kg block of iron is given 10 kJ of energy and its temperature rises by 10 ^{o}C. What is the specific heat capacity of iron?
6. A 700 W electric heater is used to heat 2 kg of water for 10 minutes. Calculate the temperature rise of the water. The specific heat capacity of water is 4200 J/(kg°C).
7. A bullet traveling at 60 m/s hit a sand bag. The temperature of the bullet rises by 4.5 °C. Calculate the specific heat capacity of the bullet.
8. A 1000 W heater supplies energy for 100 s to a 2 kg metal containing 1 kg of water. The temperature rises by 20 ^{o}C. Calculate the specific heat capacity of the metal.

9. A 2 kW electric heater supplies energy to a 0.5 kg copper kettle containing 1 kg of water. Calculate the time taken to raise the temperature by 10 ^{o}C.
10. A 210 W heater is placed in 2 kg of water and switched on for 200 seconds. The specific heat capacity of water is 4200 J/(kg°C).
    a. How much energy does the heater supply?
    b. Assuming that no thermal energy is lost, what is the temperature rise of the water?

Material has a high specific heat capacity	Material has a low specific heat capacity
Smaller rise in temperature	Greater rise in temperature
It takes a longer time to be heated.	It becomes hot very quickly.
It does not lose heat easily.	It lose heat easily.
It is a heat insulator.	It is a good heat conductor.

1. What is the definition of heat capacity?
   A. the quantity of heat required to raise the temperature of an object through 1 °C
   B. the quantity of heat required to raise the temperature of 1 kg of a substance through 1 °C
   C. the quantity of heat required to convert an object from solid to liquid without a change in temperature
   D. the quantity of heat required to change 1 kg of a substance from solid to liquid without a change in temperature

2. Equal masses of two different liquids are put into identical beakers. They are heated from 20 °C to 30 °C by heaters of the same power. Liquid 2 takes twice as long to heat as liquid 1.



Which statement is correct?

A. Both liquids receive the same amount of energy.

B. Liquid 1 receives more energy than liquid 2.

C. The thermal capacity of liquid 1 is equal to the thermal capacity of liquid 2.

D. The thermal capacity of liquid 1 is less than the thermal capacity of liquid 2.

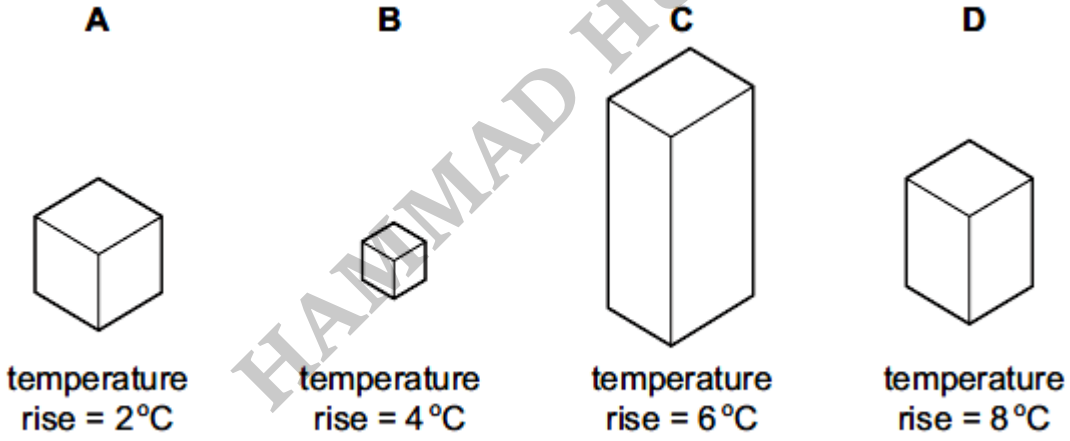
3. A knife is being sharpened on a rotating sharpening-stone. A spark flies off and lands on the operator's hand. The spark is a very hot, very small piece of metal. The operator feels nothing.

   What does this show about the piece of metal?

   A. It has a high thermal capacity.
   B. It has a low thermal capacity.
   C. It is a good conductor of heat.
   D. It is a poor conductor of heat.

4. Four blocks, made of different materials, are each given the same quantity of internal (heat) energy.

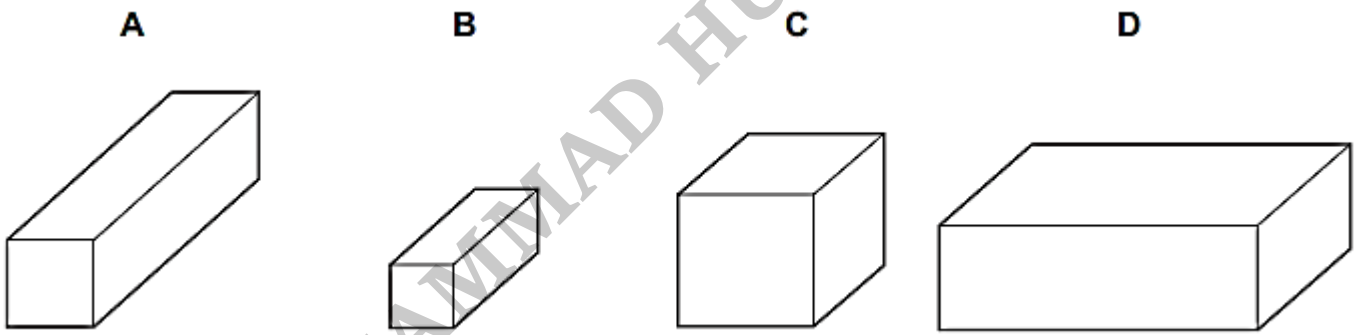
   Which block has the greatest thermal capacity?



A

5. The diagram shows four blocks of steel. The same quantity of heat is given to each block.

   Which block shows the greatest rise in temperature?



B

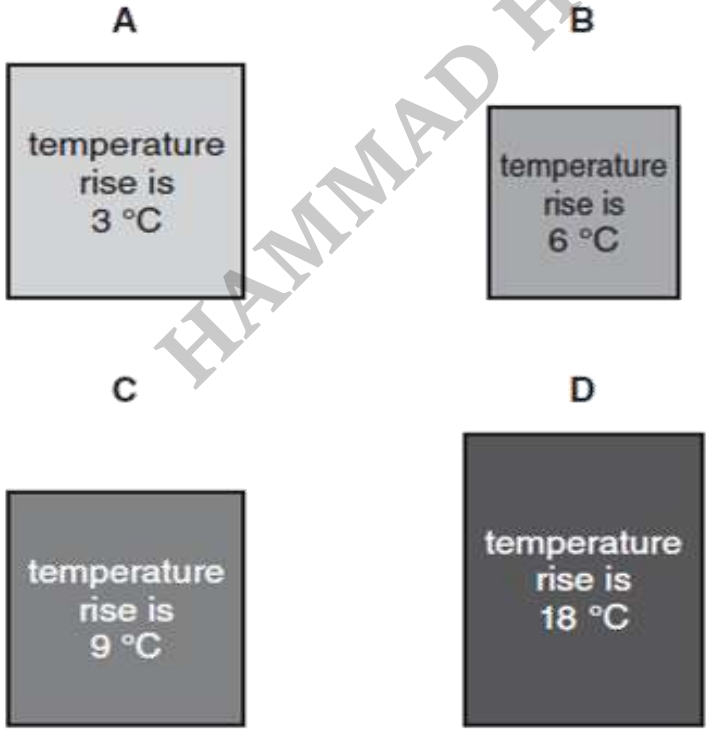
6. 1 kg of water and 1 kg of aluminium are heated to the same temperature and then allowed to cool in a room.

   Why does the aluminium cool more quickly than the water?

   A. Aluminium contracts more than water.
   B. Aluminium does not evaporate but water does.
   C. Aluminium has a higher thermal capacity than water.
   D. Aluminium has a lower thermal capacity than water.

7. The same quantity of heat energy is applied to four different blocks. The temperature rise produced is shown on each block.

   Which block has the highest thermal capacity?



A

8. In an experiment to find the specific heat capacity of a metal, it is found that 5200 J is needed to raise the temperature of a 2 kg block by 20 °C.

   What value for the specific heat capacity is given by these results?

   A. 130 J / (kg °C)
   B. 520 J / (kg °C)
   C. 52 000 J / (kg °C)
   D. 104 000 J / (kg °C)

9. Heat energy is supplied at the same rate to 100 g of paraffin and to 100 g of water in similar containers.

   Why does the temperature of the paraffin rise more quickly?

   A. The paraffin has a larger specific heat capacity than water.
   B. The paraffin has a smaller specific heat capacity than water.
   C. The paraffin is less dense than water.
   D. The paraffin is more dense than water.

10. A 2 kg mass of copper is heated for 40 s by a heater that produces 100 J/s.

    The specific heat capacity of copper is 400 J/(kg K).

    What is the rise in temperature?

    A. 5 K
    B. 10 K
    C. 20 K
    D. 50 K

11. A block of metal has a mass of 2.0 kg. Its specific heat capacity is 800 J / (kg °C).

    The block is supplied with 2400 J of energy.

    What is the rise in temperature?

    A. 0.17 °C
    B. 0.67 °C
    C. 1.5 °C
    D. 6.0 °C

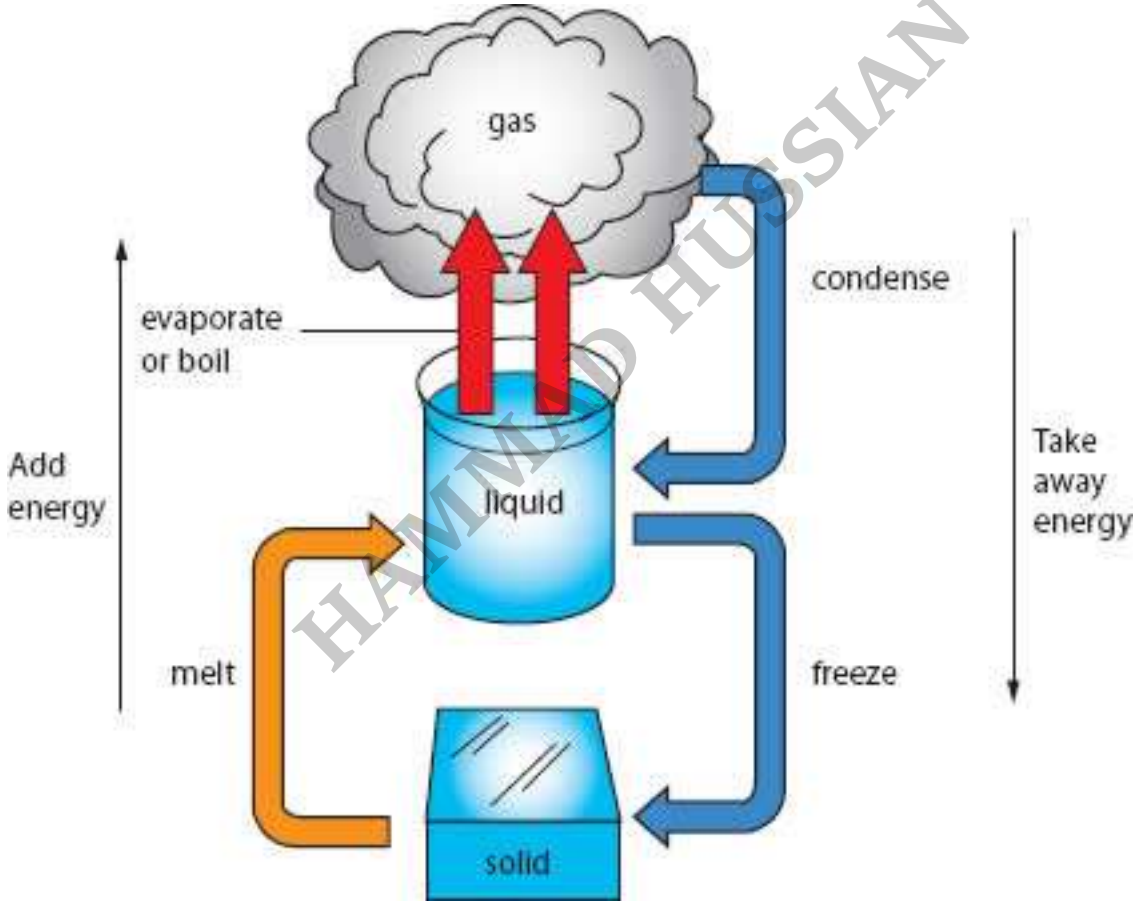
Describe melting/solidification and boiling/condensation in terms of energy transfer without a change in temperature.

MELTING AND BOILING

State the meaning of *melting point* and *boiling point*.

MELTING AND BOILING

Melting, Boiling & Evaporation



Melting & Freezing

- **Melting** is the process whereby energy supplied changes the state of a substance from solid state to liquid state, without a change in temperature.
- This temperature is called the **melting point** of the substance. For a pure substance, melting occurs at a definite temperature.
- The reverse process of changing from liquid to solid is called **freezing**.
- A pure substance will freeze at a temperature equal to its melting point.

Boiling & Condensation

- **Boiling** is process whereby energy supplied changes the state of a substance from liquid state to gaseous state without a change in temperature.
- The temperature at this change of state is called **boiling point** of the substance.
- For a pure substance, boiling occurs at a definite temperature.
- The reverse process of changing a gas to a liquid is called **condensation**.
- The same substance in its gaseous state will condense at the same temperature known as the **condensation point**.

Explain the difference between boiling and evaporation.

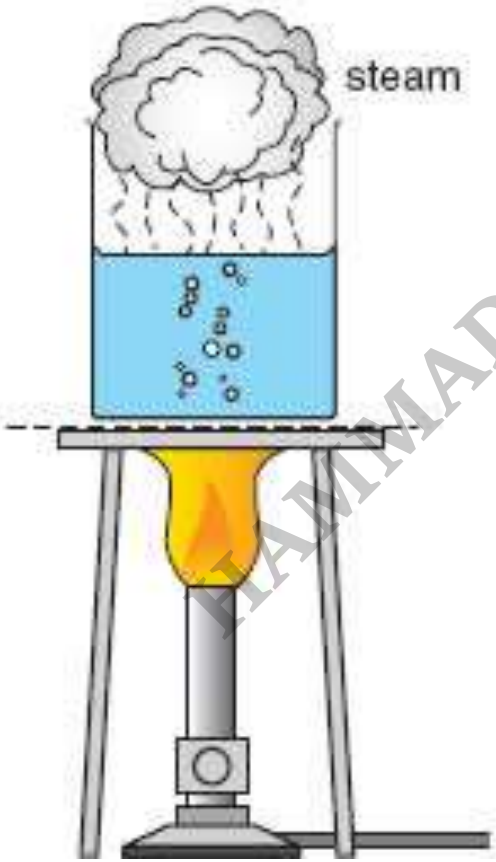
MELTING AND BOILING

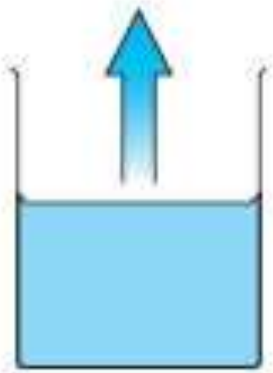
Boiling & Evaporation

- Boiling and evaporation involve a change in state from liquid to gas.
- A liquid boils at a definite temperature called **boiling point** whereas evaporation occurs at all temperature.
- Evaporation takes place only from the exposed surface of the liquid, while boiling occurs throughout the body of the liquid.

Boiling

- quick
- bubbles form
- occurs throughout the liquid
- occurs at one temperature – boiling point
- source of energy needed





Evaporation

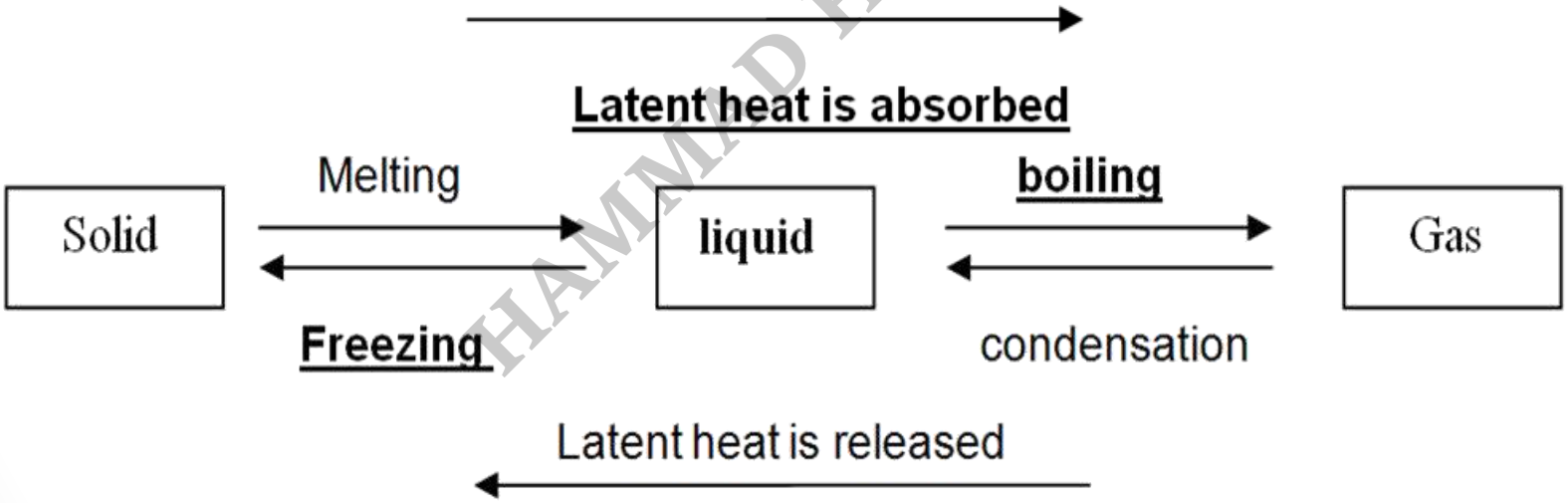
- slow
- nothing visible happens
- occurs from surface only
- occurs at all temperatures
- energy supplied by surroundings

Define the terms *latent heat* and *specific latent heat*.

MELTING AND BOILING

Latent Heat

- Matter exists in three states, that is **solid**, **liquid** and **gas**.
- The heat released or absorbed at constant temperature during a change of state of matter is known as **latent heat**.

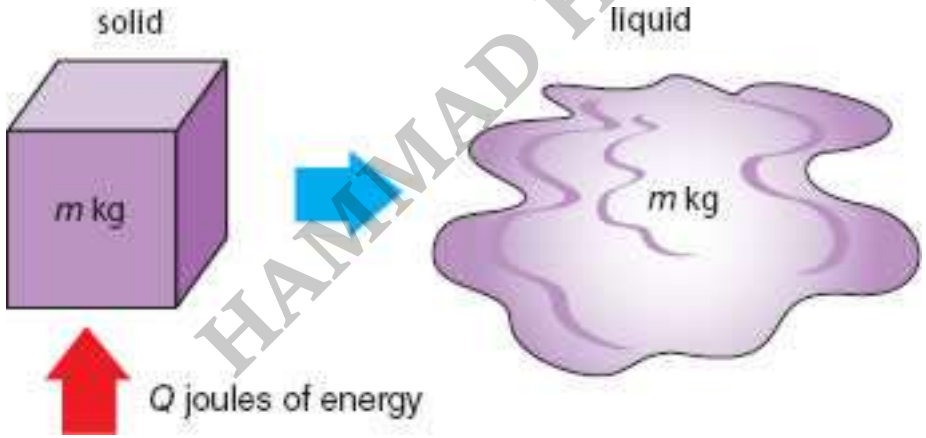


Latent Heat and Specific Latent Heat

- **Latent heat of fusion** is the energy needed to change a substance from solid to liquid without a change in temperature.
- **Latent heat of vaporisation** is the energy needed to change a substance from liquid to gas without a change in temperature.
- The latent heat or energy needed to change a substance from a solid to liquid or from liquid to gas depends on the mass of the substance.

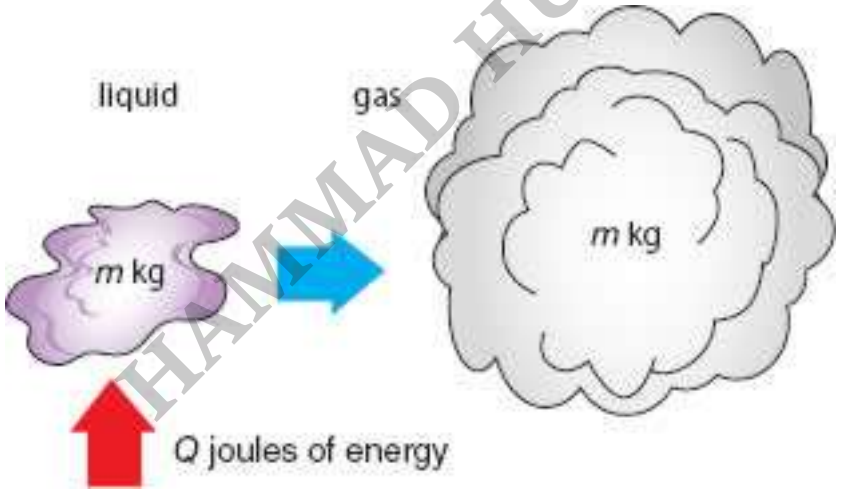
Specific Latent Heat of Fusion

- The **specific latent heat of fusion** (l_f) of a substance is the amount of energy needed to change a unit mass of the substance from solid to liquid without a change in temperature.



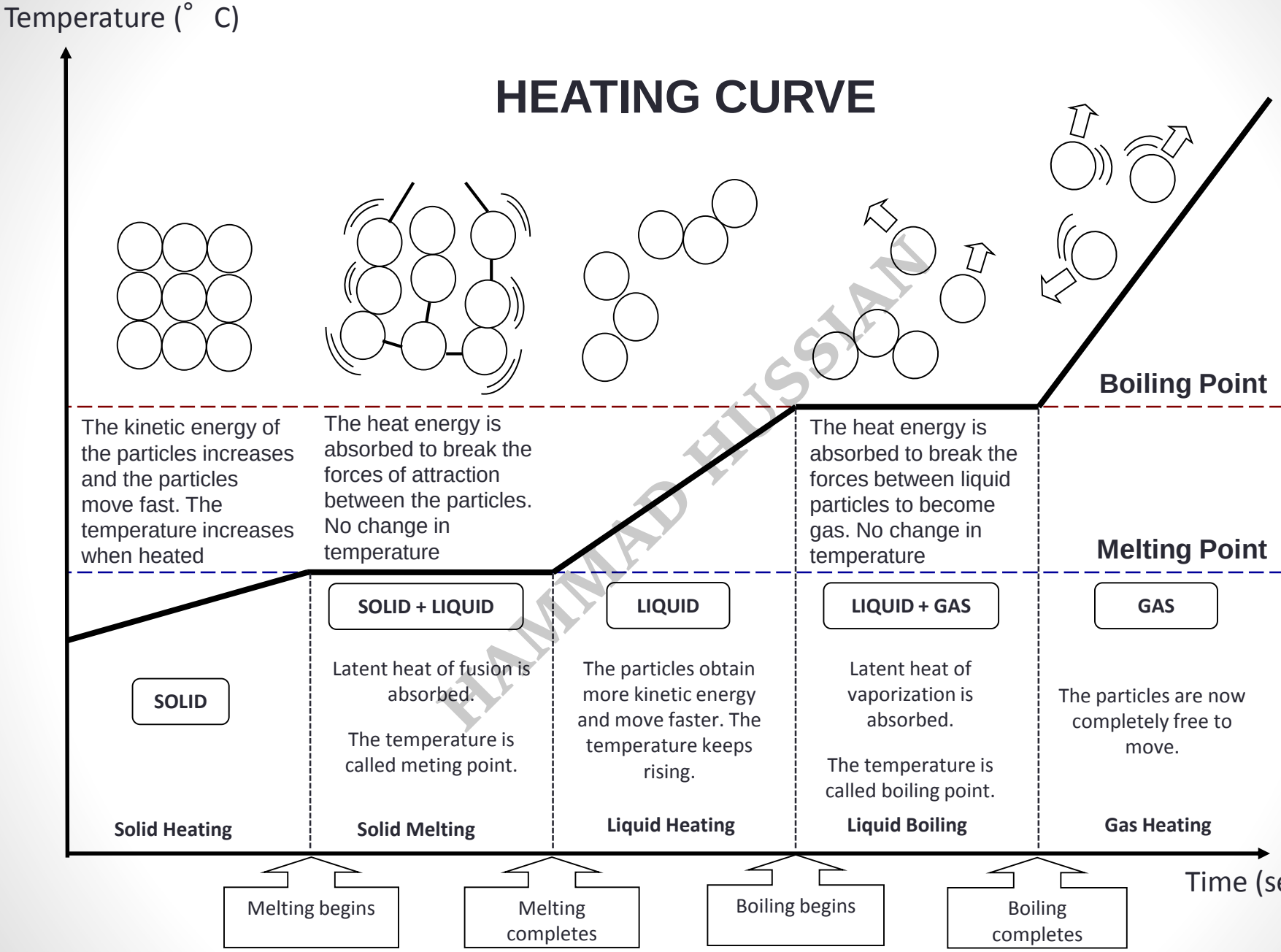
Specific Latent Heat of Vaporisation

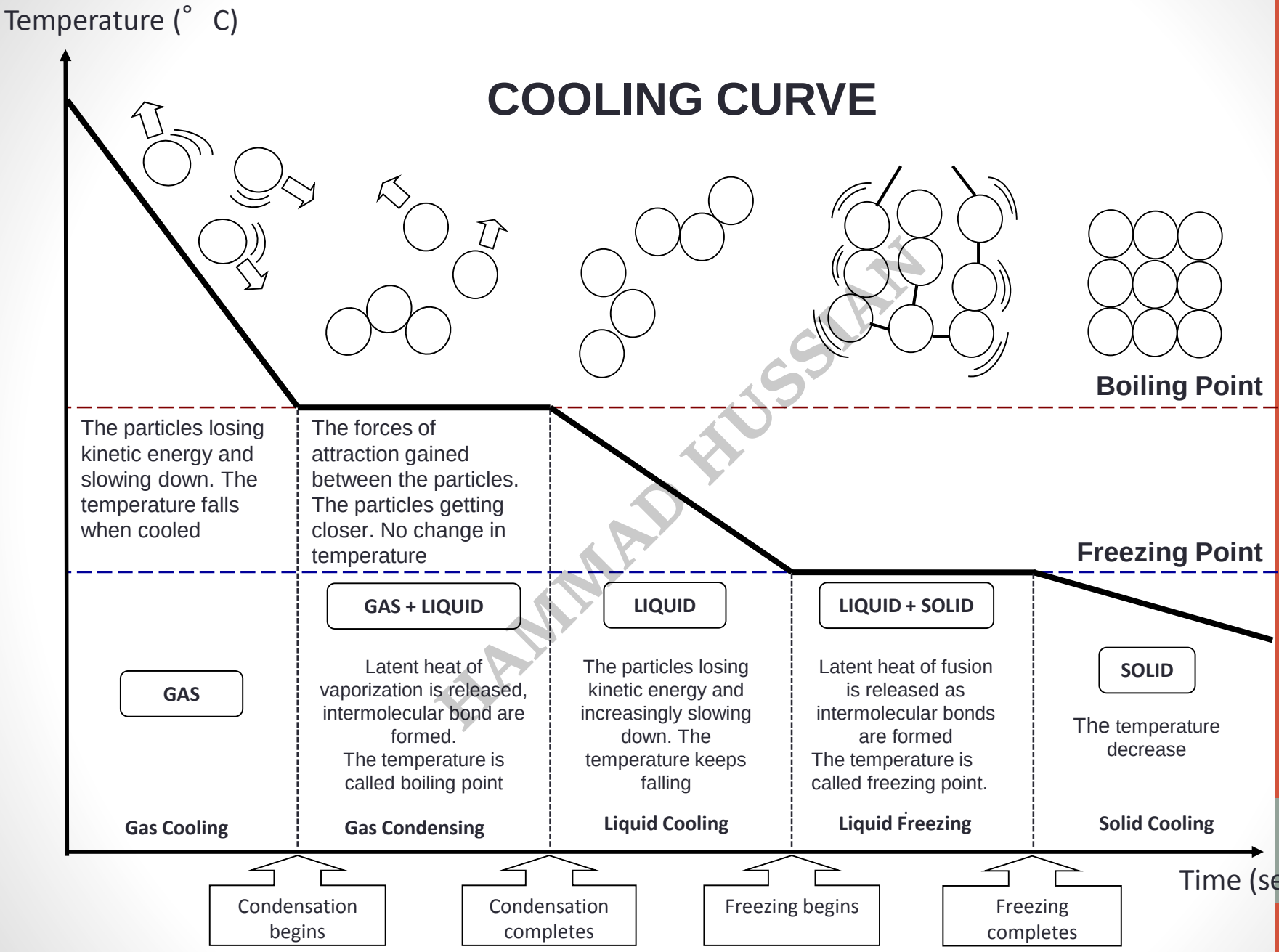
- The **specific latent heat of vaporisation** (l_v) of a substance is the amount of energy needed to change a unit mass of the substance from liquid to gas without a change in temperature.



MELTING AND BOILING

Explain latent heat in terms of molecular behaviour.





Calculate heat transferred in a change of state using the formula *thermal energy* = *mass* × *specific latent heat*.

MELTING AND BOILING

Calculating Specific Latent Heat

- **Specific latent heat** of a substance is define as the amount of energy needed to change the state of a unit mass of the substance without a change in temperature.
- In term of equation,

$$Q = ml$$

Thermal Energy = Mass × Specific Latent Heat

- The SI unit for specific latent heat is **J/kg**.

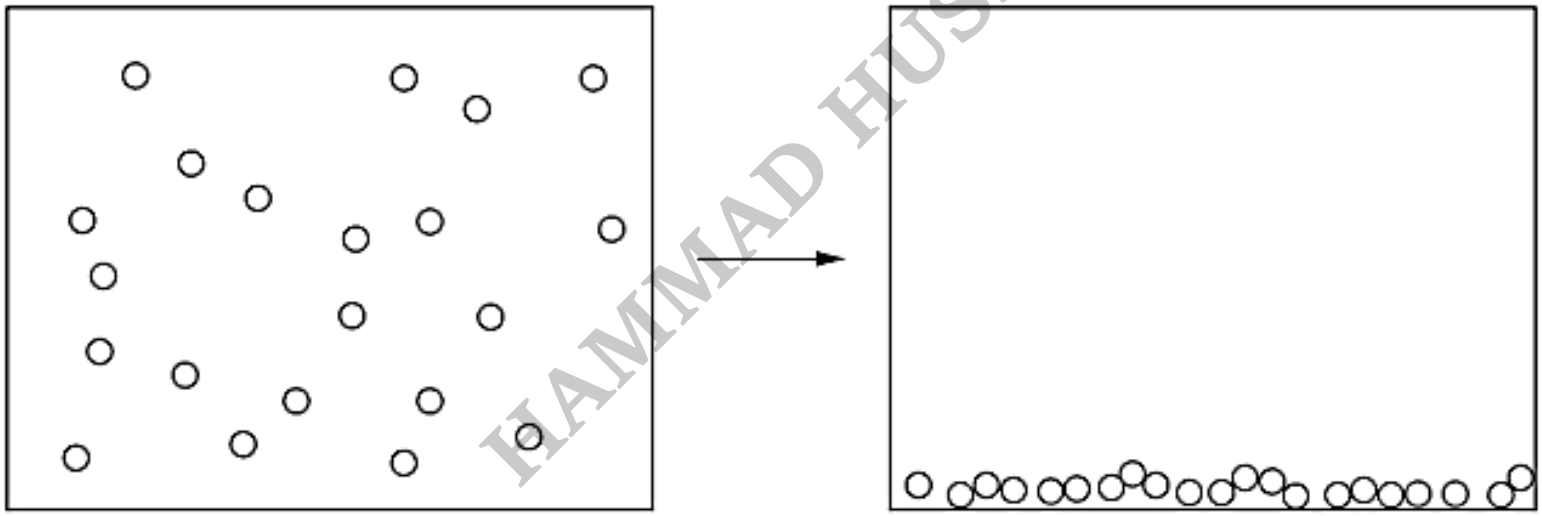
Specific heat capacity of ice	**21 00 J/(kg °C)**	**2.1 J/(g °C)**
Specific heat capacity of water	**4 200 J/(kg °C)**	**4.2 J/(g °C)**
Specific latent heat of ice	**300 000 J/kg**	**300 J/g**
Specific latent heat of steam	**2 500 000 J/kg**	**2500 J/g**

Example

1. An ice cream has a mass of 150 g. If the specific latent heat of fusion of ice is 300 J/g, find the heat required to melt the ice cream.
2. A heater which supplies heat at a constant rate of 1000 W completely immersed in a 3 kg block of ice at 0 ^{o}C. The block of ice takes 1020 s to melt completely. Calculate a value for the specific latent heat of fusion of ice.
3. A beaker containing 0.250 kg of water at 10 ^{o}C has a 2.0 kW heater immersed in it. Find the time needed to turn the water completely to steam.

4. A 460 W water heater is used to boil water. Assuming no thermal energy losses, what mass of steam will it produce in 10 minutes?
5. What is the amount of energy released when 5 g of steam at 100 ^{o}C changes to water at 80 ^{o}C? [Specific latent heat of vaporisation of steam = 2500 J/g; specific heat capacity of water = 4.2 J/(g.^{o}C)]
6. What is the amount of energy required to change 10 g of ice at 0 ^{o}C to water at 20 ^{o}C? [Specific heat latent heat of fusion of ice = 300 J/g, specific heat capacity of ice = 2.1 J/(g.^{o}C)]

1. The diagram shows how the atoms in a substance rearrange themselves during a change of state.



Which change of state is shown?

A. gas to liquid
B. liquid to gas
C. liquid to solid
D. solid to liquid

2. When ice melts to become water, which force must be overcome?
   A. the attraction between electrons and the nucleus
   B. the attraction between the atoms in a molecule
   C. the force between molecules
   D. the force of gravity

3. The energy required to change liquid water into water vapour at the same temperature is called latent heat of vaporisation.

   What does this energy do?

   A. increases the average separation of the water molecules
   B. increases the average speed of the water molecules
   C. raises the temperature of the air near the water
   D. splits the water molecules into their separate atoms

4. What is the name given to the amount of energy needed to turn 1 kg of water at 100 °C into steam at 100 °C?

   A. heat capacity
   B. latent heat
   C. specific heat capacity
   D. specific latent heat

5. A substance that is originally a solid is heated strongly for some time.

   At one stage, the energy given to the substance is used as latent heat of vaporisation.

   At this stage, what change does the energy cause?

   A. It breaks the bonds holding the molecules together. Molecules escape from the liquid.
   B. It breaks the bonds holding the molecules together. The solid becomes liquid.
   C. It makes the molecules move faster but there is still a strong attraction between them.
   D. It makes the molecules move faster and so the temperature rises.

6. Using an electric kettle, 100 g of water at 100 °C is converted into steam at 100 °C in 300 seconds.

The specific latent heat of steam is 2250 J/g.

What is the average electrical power used?

A $\frac{2250}{300 \times 100}$ W

B $\frac{100 \times 2250}{300}$ W

C $\frac{300 \times 2250}{100}$ W

D $100 \times 300 \times 2250$ W

B

7. A 2 kW kettle containing boiling water is placed on a balance. It is left there and continues to boil for 5 minutes. The balance reading changes by 0.2 kg.

   What does this information give as a value for the specific latent heat of vaporisation of water?

   A. 2000 J / kg
   B. 3000 J / kg
   C. 50 000 J / kg
   D. 3 000 000 J / kg

8. Ice is taken from a freezer and left in a room. The ice melts and eventually the water reaches room temperature.

Which energy transfers take place?

	energy transfer **during** melting	energy transfer **after** melting
A	from ice to room	from water to room
B	from ice to room	from room to water
C	from room to ice	from room to water
D	from room to ice	from water to room

C

9. A block of ice is heated until it has all melted. The water that is produced is then heated until it boils.

Which line in the table states what happens to the temperature of the ice while it is melting, and to the temperature of the water while it is boiling?

	temperature of ice while it is melting	temperature of water while it is boiling
A	increases	increases
B	increases	stays the same
C	stays the same	increases
D	stays the same	stays the same

D

10. In an experiment, some of a substance changes from a liquid to a gas. The temperature of the remaining liquid changes because of this.

    What is the name for this change of state and how does the temperature change?

	change of state	how temperature changes
A	condensation	decreases
B	condensation	increases
C	evaporation	decreases
D	evaporation	increases

C

11. The table lists the melting points and the boiling points of four different substances A, B, C and D.

Which substance is a gas at 25 °C?

substance	melting point/°C	boiling point/°C
A	–219	–183
B	–7	58
C	98	890
D	1083	2582

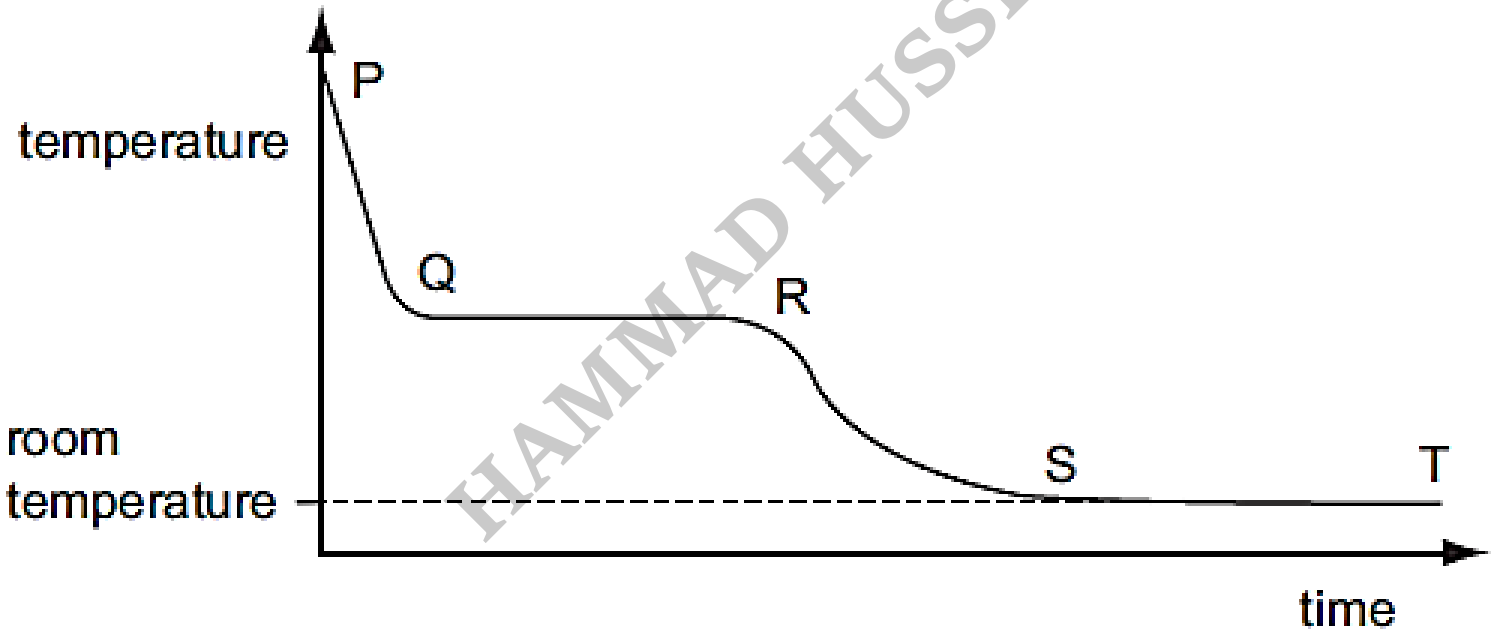
A

12. Which substance is a liquid at a room temperature of 25 °C?

substance	melting point/°C	boiling point/°C
A	–218	–183
B	–39	357
C	44	280
D	119	444

B

13. The graph shows the cooling curve of a hot substance.

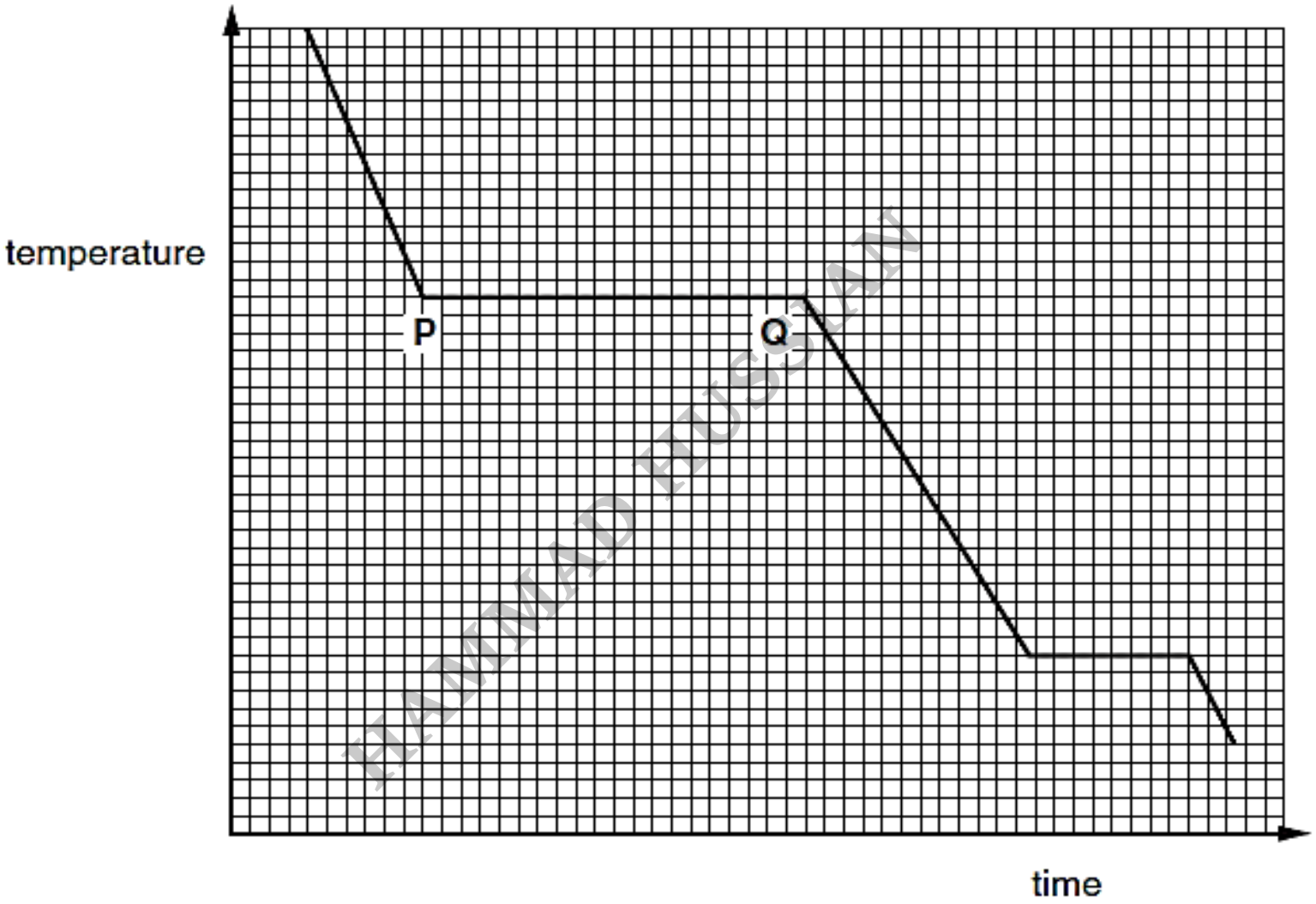


In which part of the curve is latent heat released?

A. PQ
B. QR
C. RS
D. ST

14. A substance is heated in an enclosed space until it becomes a gas.

    After the heater is removed, the temperature is recorded at regular intervals. The graph shows temperature plotted against time.

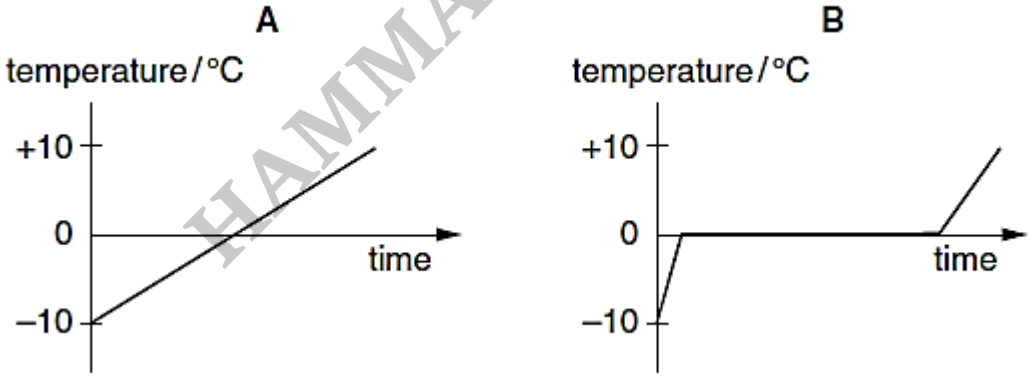


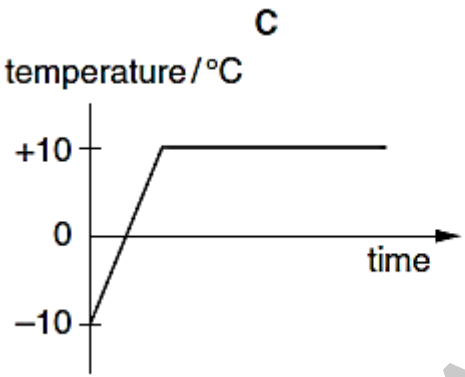
What does the section **PQ** represent?

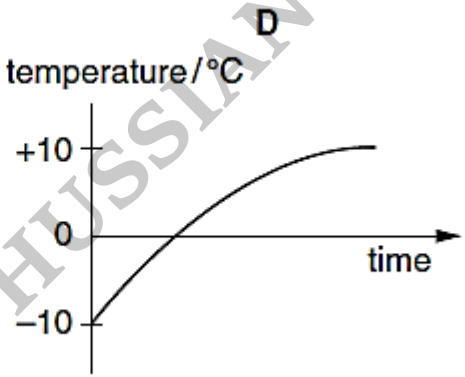
A. boiling
B. condensing
C. melting
D. solidifying

15. Ice at –10 °C is heated at a constant rate until it is water at +10 °C.

    Which graph shows how the temperature changes with time?

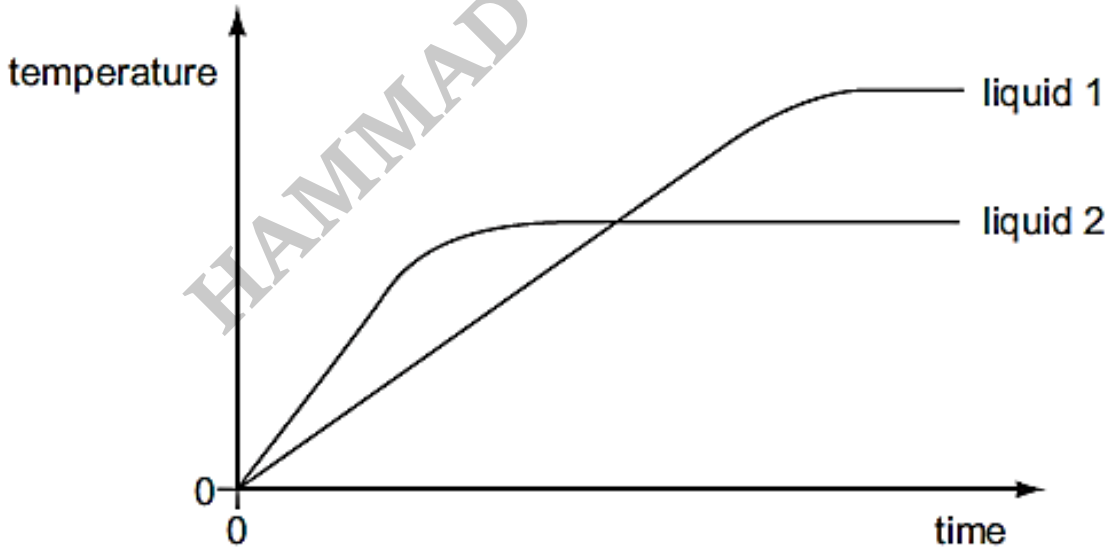






B

16. Equal masses of two different liquids are heated using the same heater. The graph shows how the temperature of each liquid changes with time.

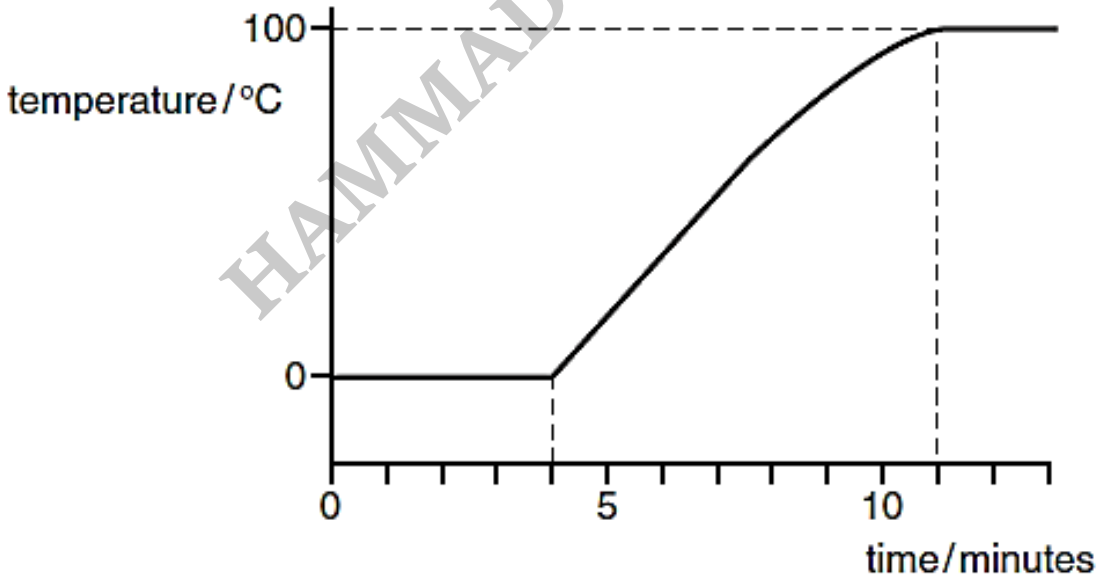


What does the graph tell us about the liquids?

A. Liquid 1 has a higher melting point than liquid 2.
B. Liquid 1 has a higher boiling point than liquid 2.
C. Liquid 1 starts to melt sooner than liquid 2.
D. Liquid 1 starts to boil sooner than liquid 2.

17. A block of ice is heated at a constant rate. Eventually the melted ice boils.

    The graph shows how the temperature changes with time.



How many minutes did it take to melt all the ice?

A. 4
B. 7
C. 11
D. 13

18. A sample of a solid is heated for 12 minutes and its temperature noted every minute.

    The results are shown in the table.

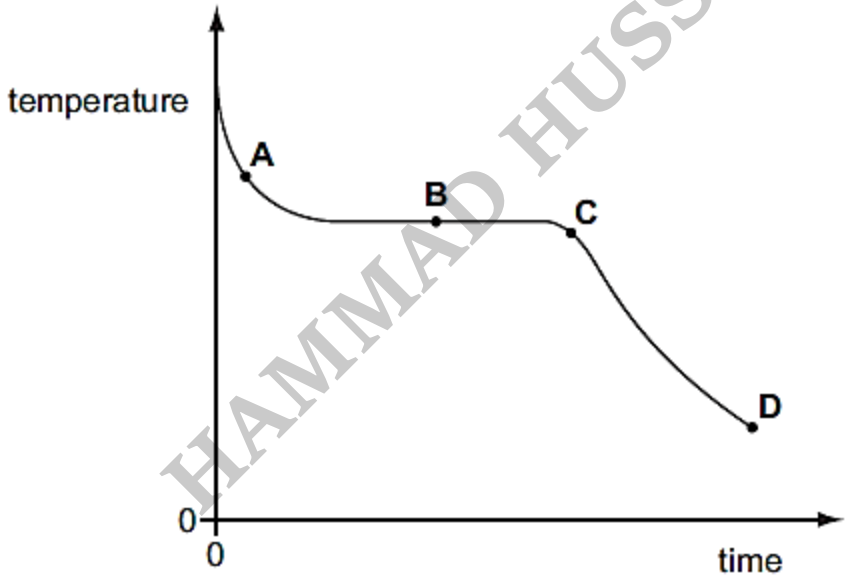
time/min	0	1	2	3	4	5	6	7	8	9	10	11	12
temperature/°C	11.5	16.1	22.1	31.0	31.1	31.1	31.1	31.3	45.0	65.2	66.2	66.3	66.3

How should the sample be described at the end of the 12 minutes?

A. all solid
B. in the process of melting
C. all liquid
D. in the process of boiling

19. The graph shows how the temperature of hot liquid wax changes with time as the wax is allowed to cool.

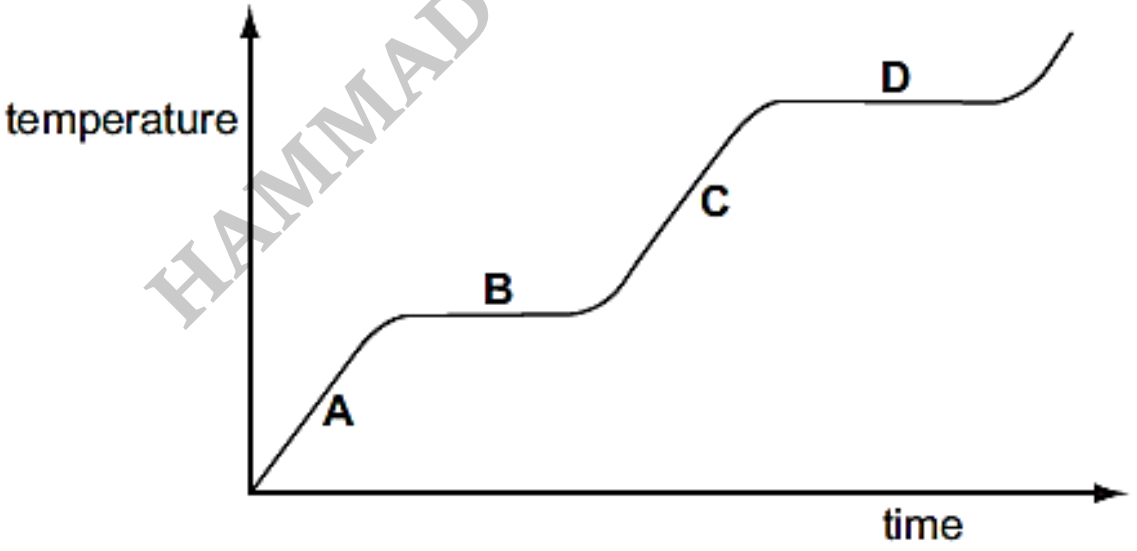
    At which labelled point on the graph are both liquid wax and solid wax present?



B

20. The graph shows the change in temperature of a material as it is heated.

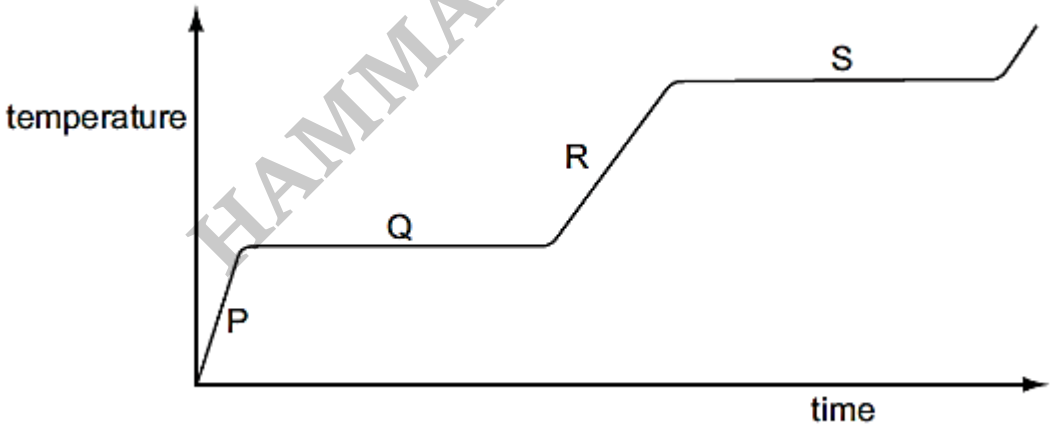
    Which part on the graph shows when the material is boiling?



D

21. A substance is heated at a steady rate. It changes from a solid to a liquid, and then to a gas.

    The graph shows how its temperature changes with time.

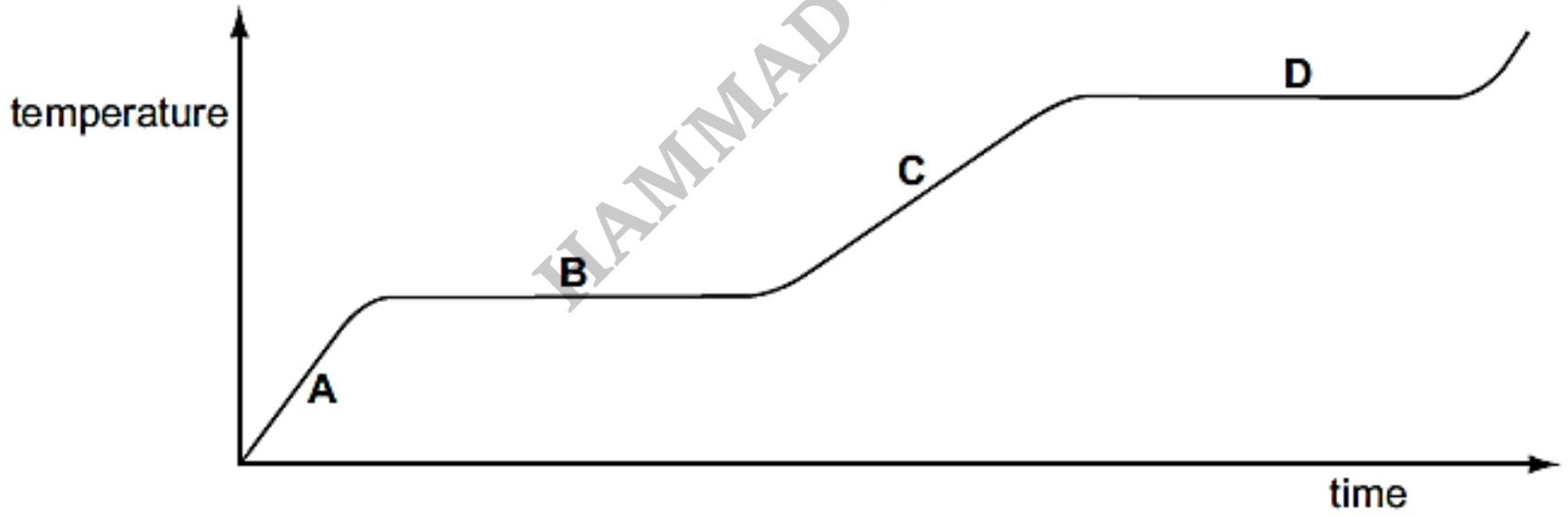


Which parts of the graph show a change of state taking place?

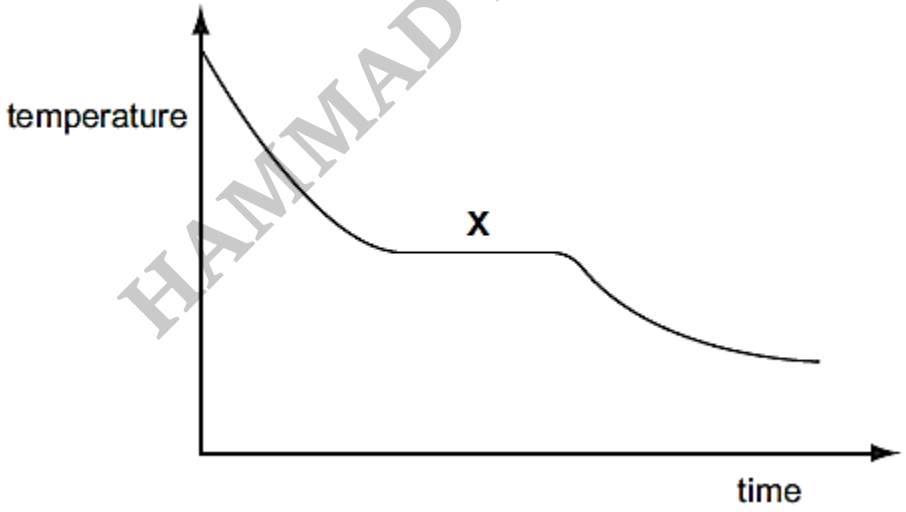
A. P and R
B. P and S
C. Q and R
D. Q and S

22. The graph shows the change in temperature of a substance as it is heated steadily.

    Which part of the graph shows when the substance is boiling?



23. A hot liquid is carefully poured into a beaker. The graph shows how its temperature changes as it cools towards room temperature.



Which processes are taking place at region X?

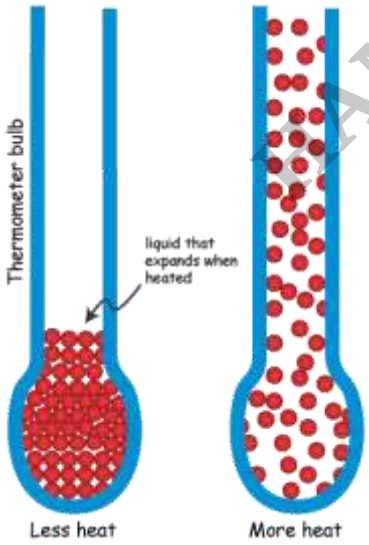
A. boiling and evaporation
B. condensation only
C. evaporation only
D. solidification and evaporation

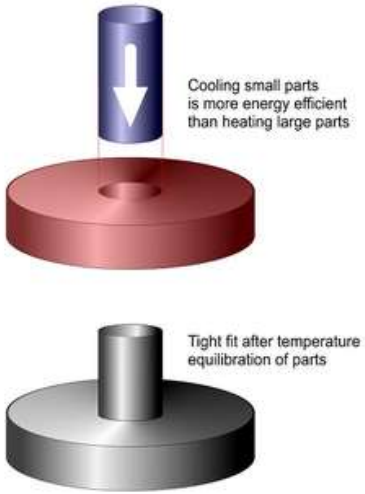
Describe qualitatively the thermal expansion of solids, liquids and gases.

THERMAL EXPANSION OF SOLIDS, LIQUIDS AND GASES

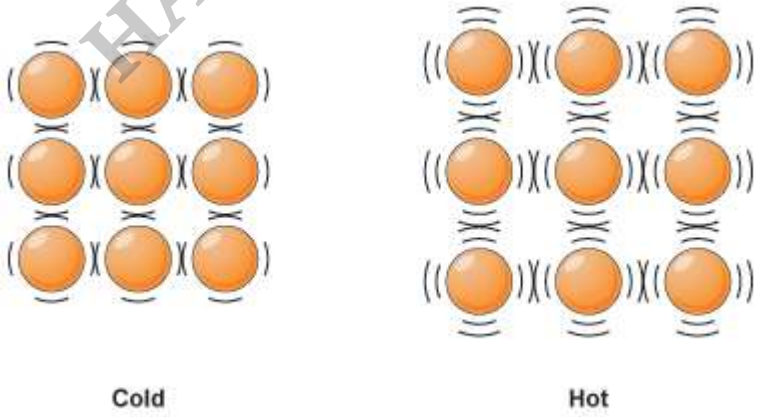
Thermal Expansion

- Substances **expand** or get bigger when they are heated up. They **contract** or get smaller when they are cooled down. This property can be useful.
  - Thermometers work because the liquid inside them expands and rises up the tube when it gets hotter.
  - Metal parts can be fitted together without welding using shrink fitting.

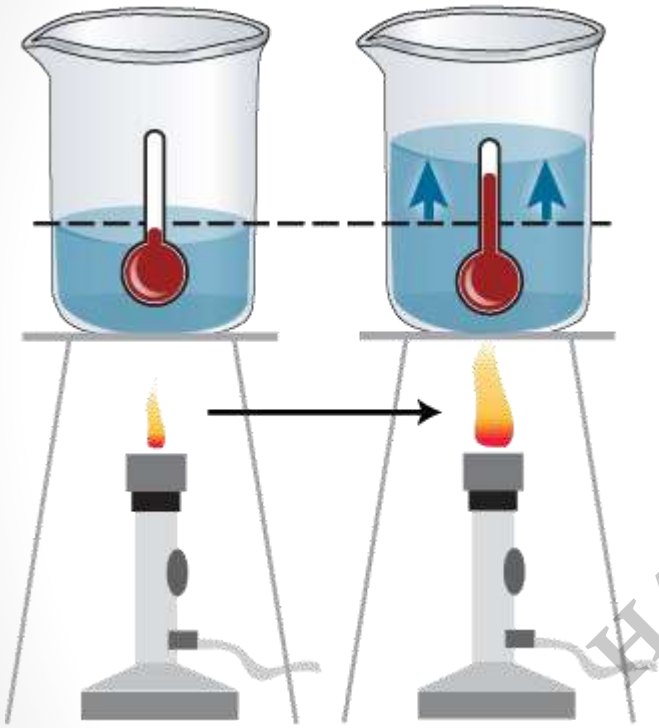




- When substances expand or contract, their particles stay the same size. It is the **space between** the particles that changes:
  - The particles in a **solid** vibrate more when it is heated, and take up more room.
  - The particles in a **liquid** move around each other more when it is heated, and take up more room.
  - The particles in a **gas** move more quickly in all directions when it is heated, and take up more room.

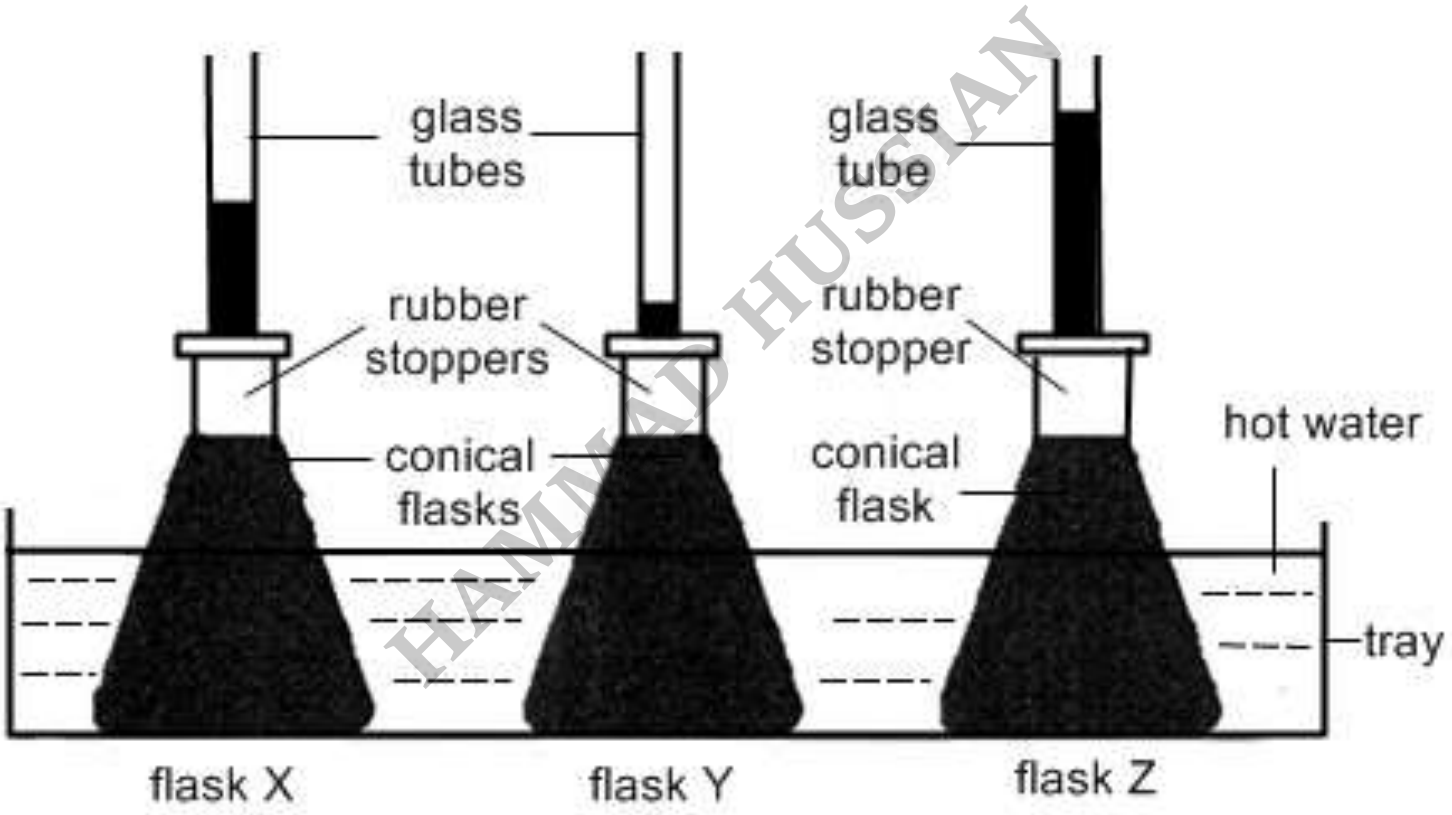


Expansion of Liquids

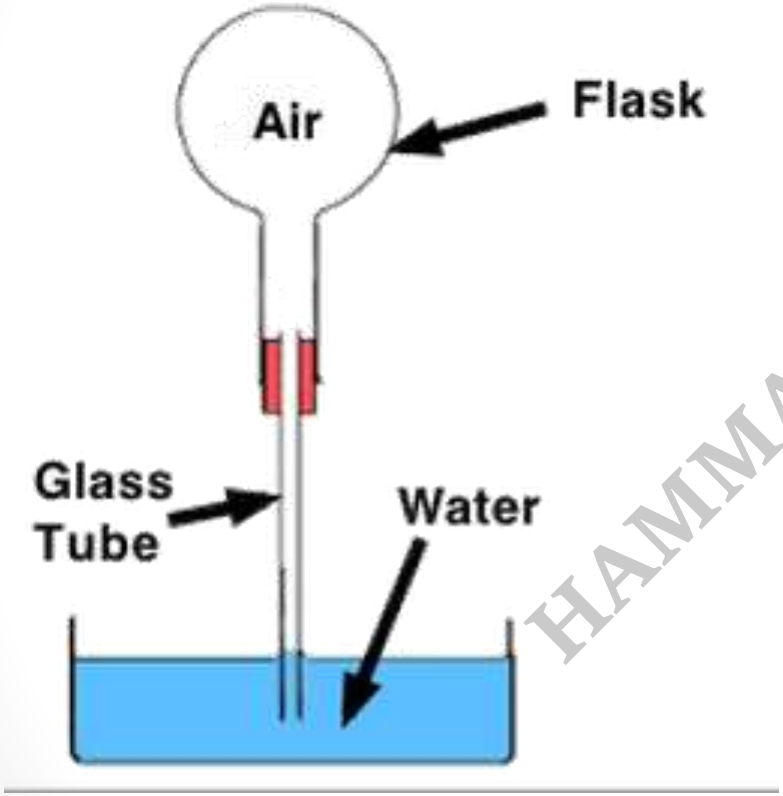


- All liquid expand on heating and contract on cooling.
- Immediately the level of water drops as the flask expands first.
- Afterwards water level rises ad goes beyond the original level A.
- This shows that
  - Water expand on heating
  - Expansion of water is more than that of glass.

- Like solids, different liquids expand unequally.



Expansion of Gases



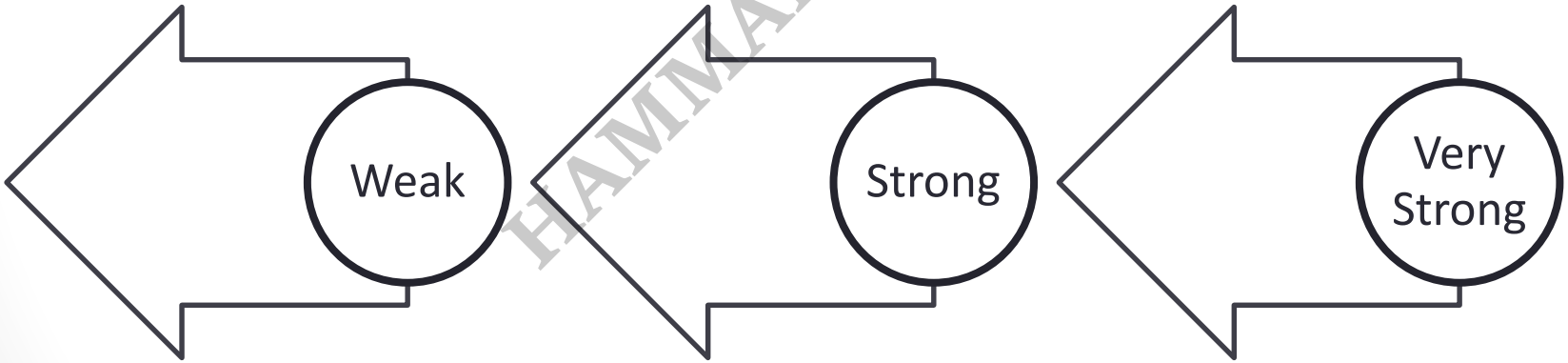
- Unlike solids and liquids, all gases expand equally.
- The expansion of a gas is much greater than that of solid or a liquid.

Describe the relative order of magnitude of the expansion of solids, liquids and gases.

THERMAL EXPANSION OF SOLIDS, LIQUIDS AND GASES

Expansion

Gases	Liquids	solid
• ~ 30 times of liquid	• ~ 20 times of solid	

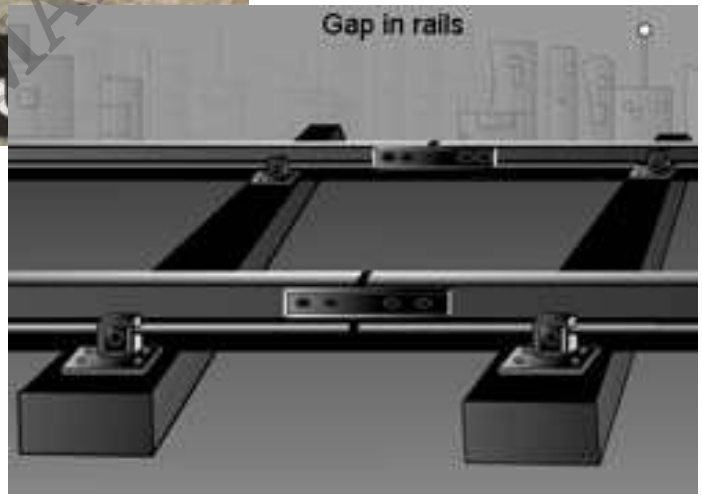


Intermolecular forces

List and explain some of the everyday applications and consequences of thermal expansion.

THERMAL EXPANSION OF SOLIDS, LIQUIDS AND GASES

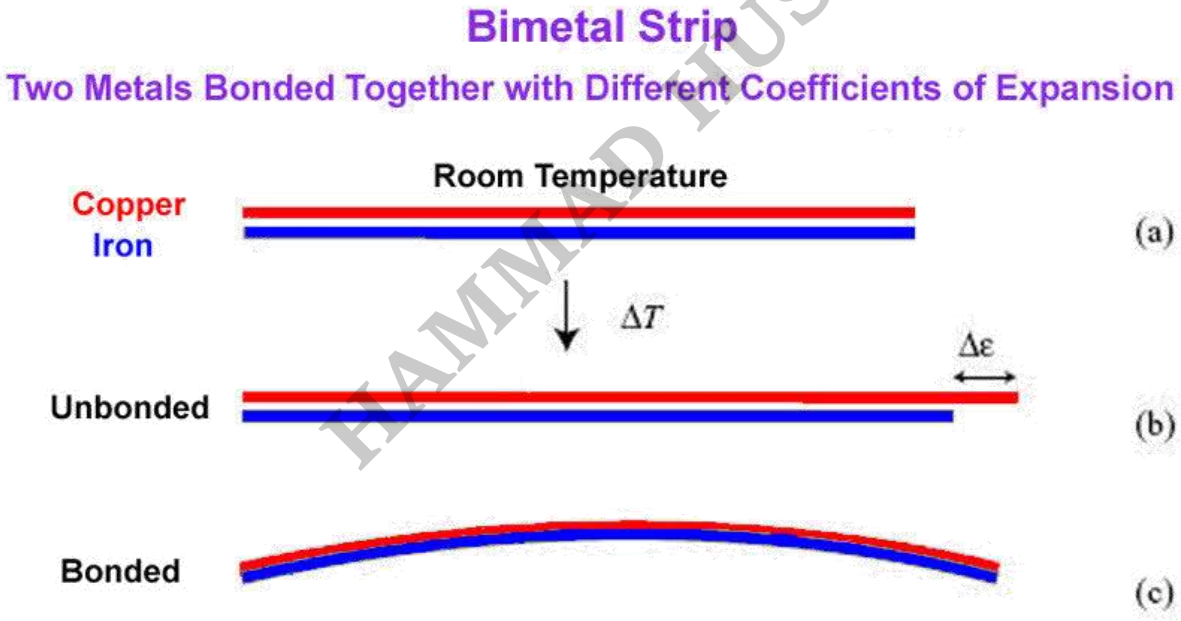
Disadvantages in Expansion of solids



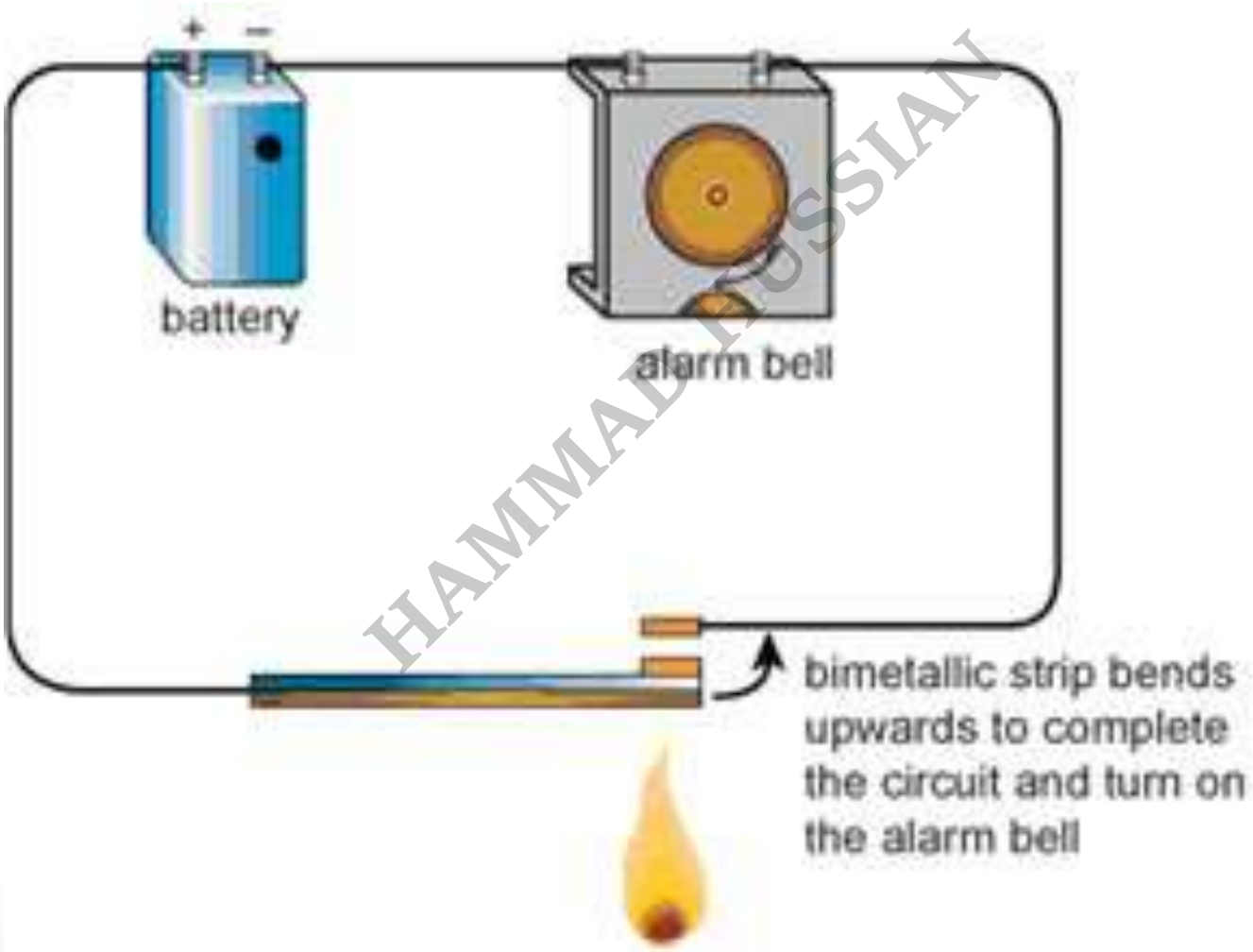
D.S. Brown Steelflex® Modular Expansion Joint System

Bimetallic Strip

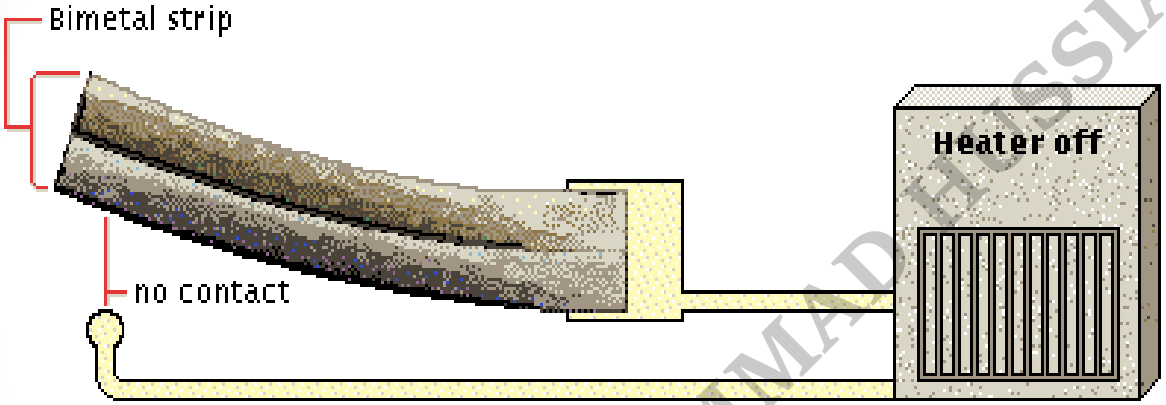
- Different metal expand unequally when heated to the same temperature.



A Simple Fire Alarm

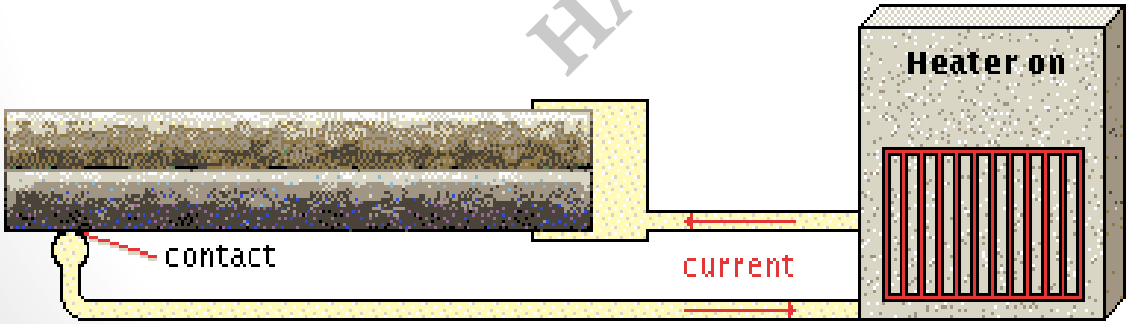


A Thermostat



Switch Open

When a bimetal strip gets hotter, it bends upward because the two metals expand at different rates. This breaks the contact and stops the flow of current so that the heater switches off.



Switch Closed

When the strip cools, it bends back and re-establishes the contact. The current passes through the wire again and the heater switches on.

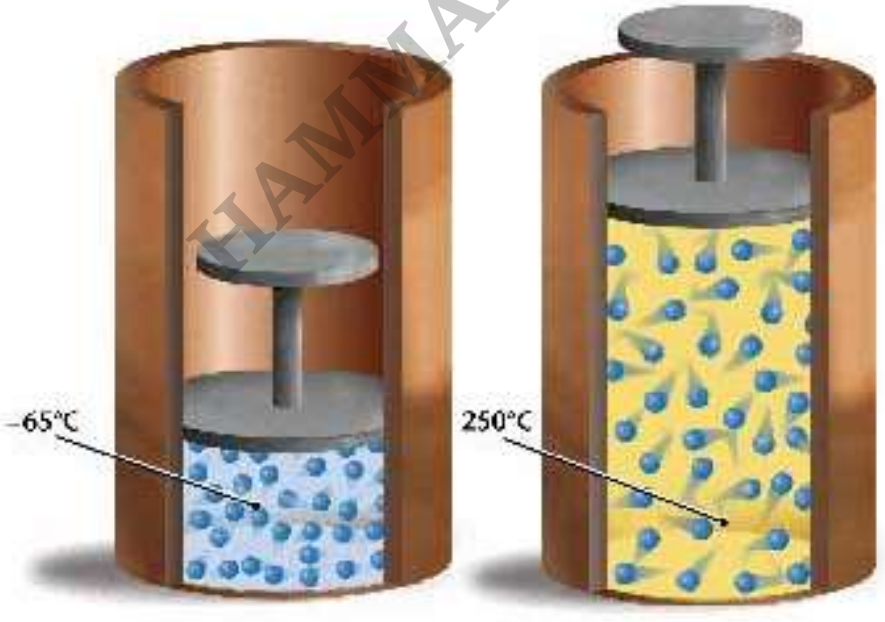
Thermometer

Describe qualitatively the effect of a change of temperature on the volume of a gas at constant pressure.

THERMAL EXPANSION OF SOLIDS, LIQUIDS AND GASES

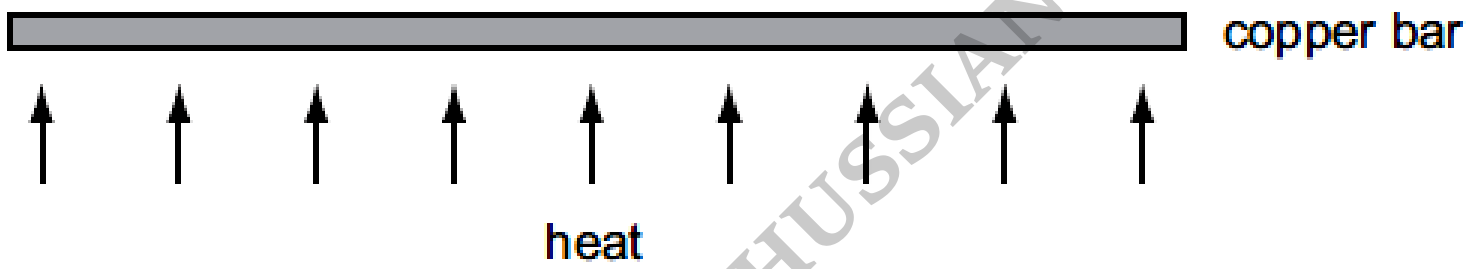
Charle's Law

- When pressure is constant, the volume of a gas is directly proportional to the temperature.
- When the temperature of a gas is increased, the molecules move faster and the collisions become more violent thus they spread away from each other causing the volume to increase.



1. What happens when a metal bar is heated?
   A. The distance between the molecules increases, making the bar longer.
   B. The molecules get larger, making the bar longer.
   C. The molecules vibrate more quickly, making the bar denser.
   D. The speed of the molecules increases, making the bar thinner.

2. A long thin bar of copper is heated evenly along its length.



What happens to the bar?

A. It becomes lighter.
B. It becomes longer.
C. It becomes shorter.
D. It bends at the ends.

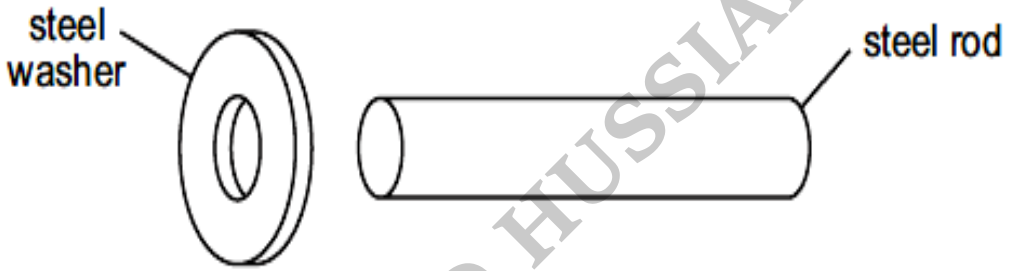
3. A glass jug is designed so that it does not break when boiling water is poured into it.

   What sort of glass should be used?

	thickness	expansion
A	thick	expands greatly when heated
B	thick	expands little when heated
C	thin	expands greatly when heated
D	thin	expands little when heated

D

4. An engineer wants to fix a steel washer on to a steel rod. The rod is just too big to fit into the hole of the washer.



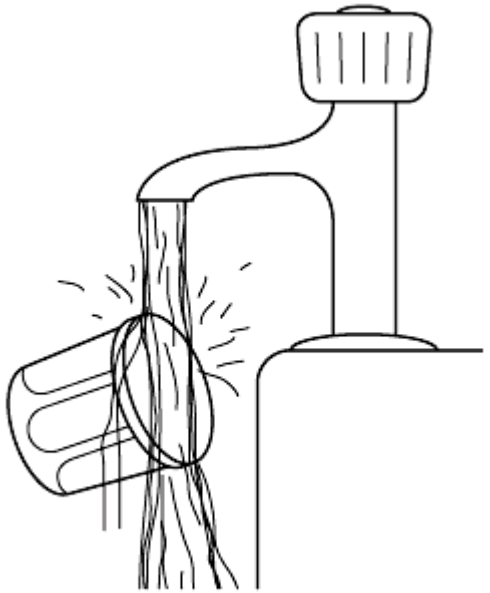
How can the engineer fit the washer onto the rod?

A. cool the washer and put it over the rod
B. cool the washer and rod to the same temperature and push them together
C. heat the rod and then place it in the hole
D. heat the washer and place it over the rod

5. A person cannot unscrew the lid of a pot of jam. He finds that the lid can be unscrewed after it has been held under hot, running water for a few seconds.

Why is this?

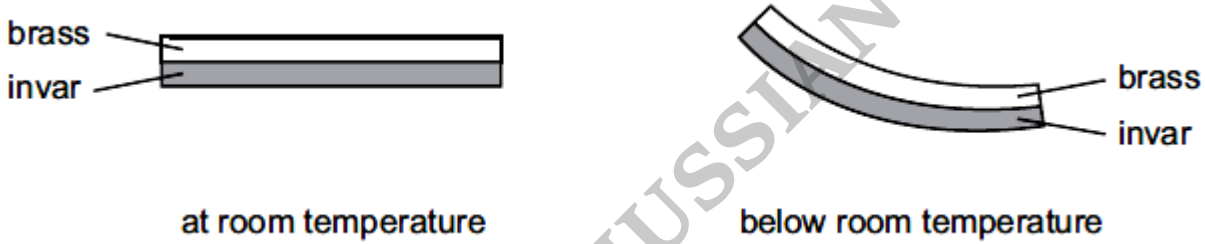
A. The air pressure in the jar falls.
B. The glass expands.
C. The jam melts.
D. The lid expands.



6. The fillings for a hole in a tooth should be made from a material that

   A. expands more than the hole in the tooth.
   B. expands by the same amount as the hole in the tooth.
   C. expands less than the hole in the tooth.
   D. does not expand when heated.

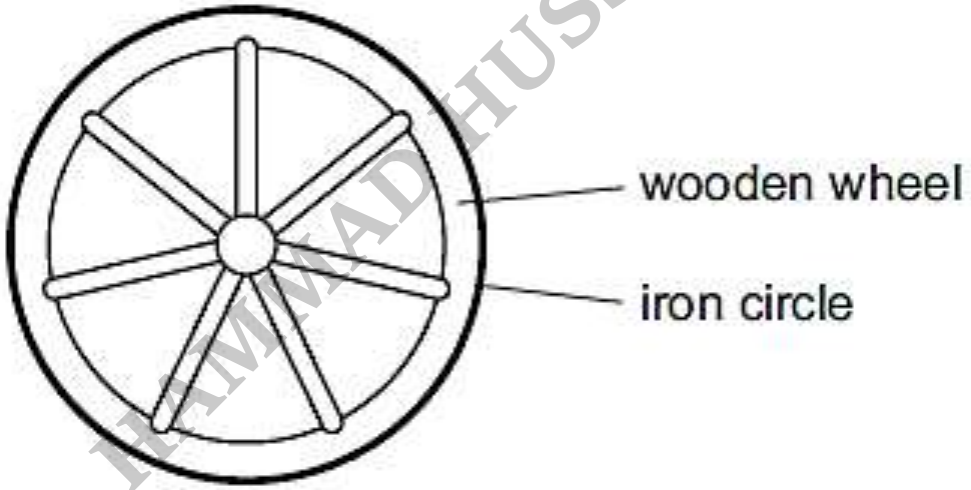
7. The diagrams show a bimetallic strip when it is at room temperature and after it has been cooled.



The change in shape occurs because

A. brass contracts more than invar.
B. brass expands when it cools down.
C. invar and brass contract by equal amounts.
D. invar contracts more than brass.

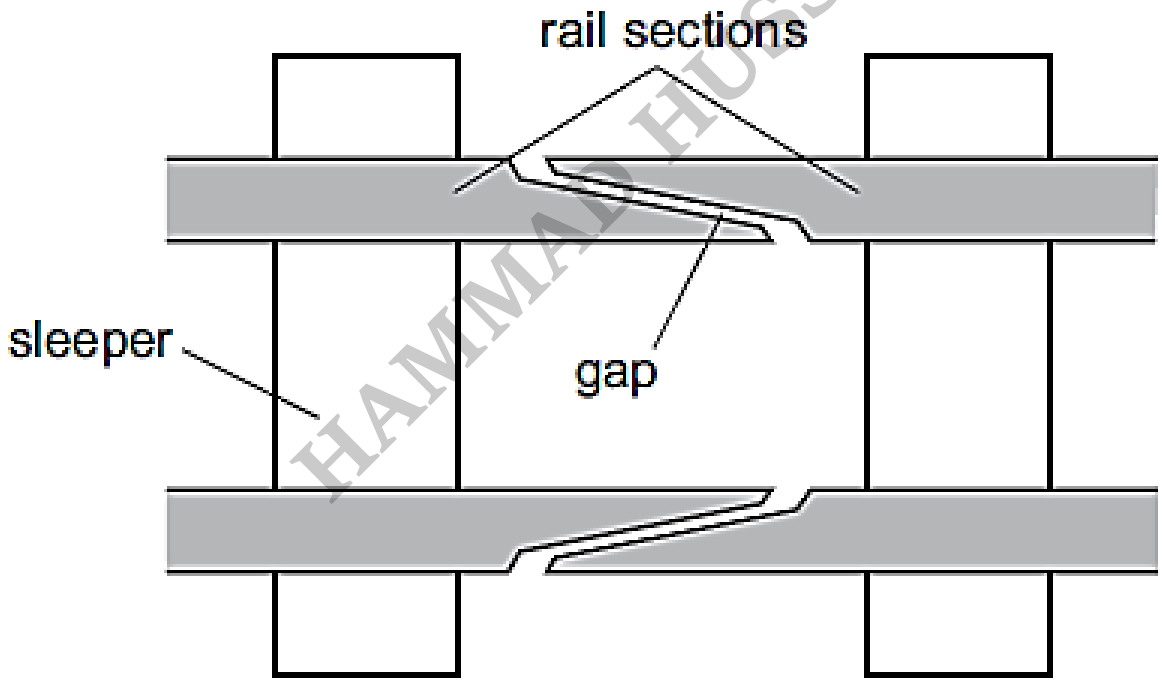
8. A wooden wheel can be strengthened by putting a tight circle of iron around it.



Which action would make it easier to fit the circle over the wood?

A. cooling the iron circle
B. heating the iron circle
C. heating the wooden wheel
D. heating the wooden wheel and cooling the iron circle

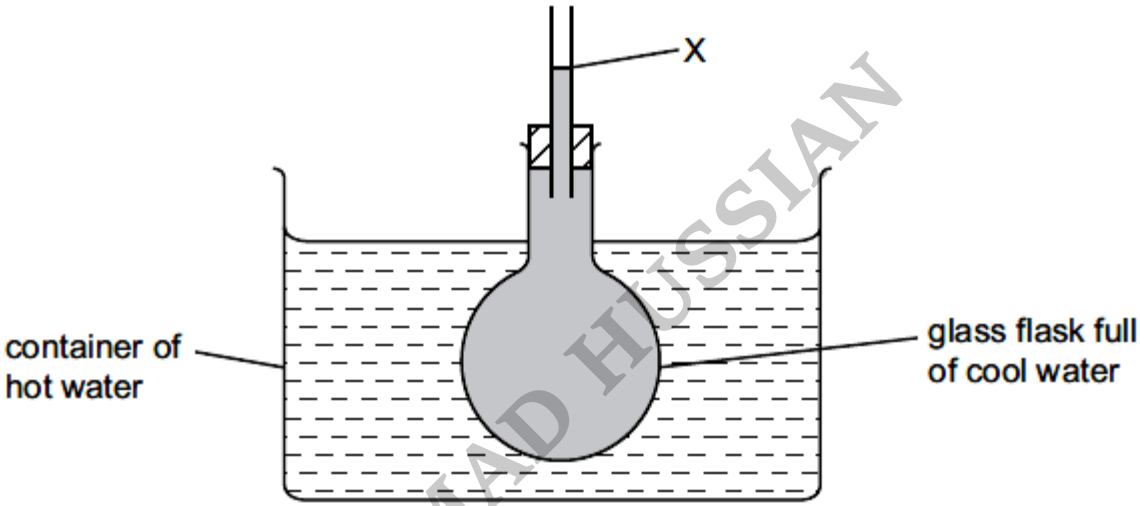
9. At regular intervals along a railway line there is a gap between the rail sections.



What is the reason for the gap between the rail sections?

A. to allow for expansion of the rail sections during hot weather
B. to allow for vibrations of the rail sections as the train passes over them
C. to allow rain water to drain from the rail sections
D. to keep the wheels of the train and carriages on the rail sections

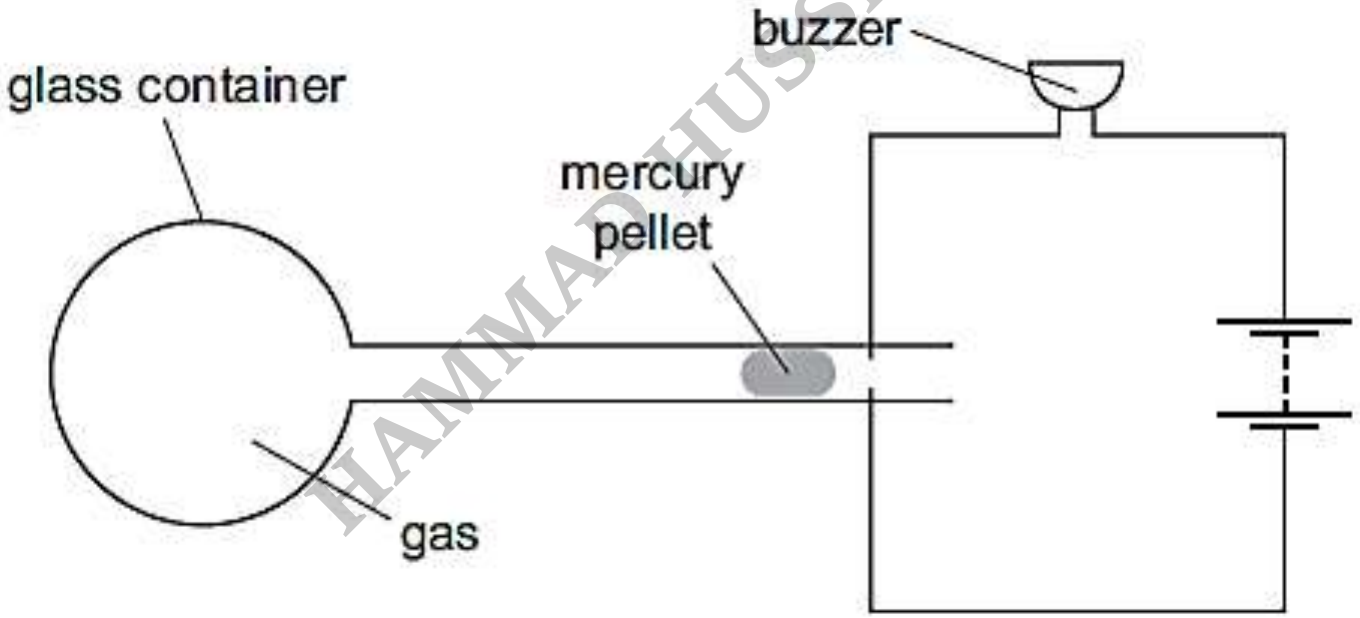
10. A glass flask full of cool water is placed in a container of hot water.



What will happen to the level of water at X as the cool water becomes warmer?

A. It will fall.
B. It will rise.
C. It will rise then fall.
D. It will stay the same.

11. The diagram shows the design for an alarm.



The mercury pellet moves and completes the circuit.

Why does this happen?

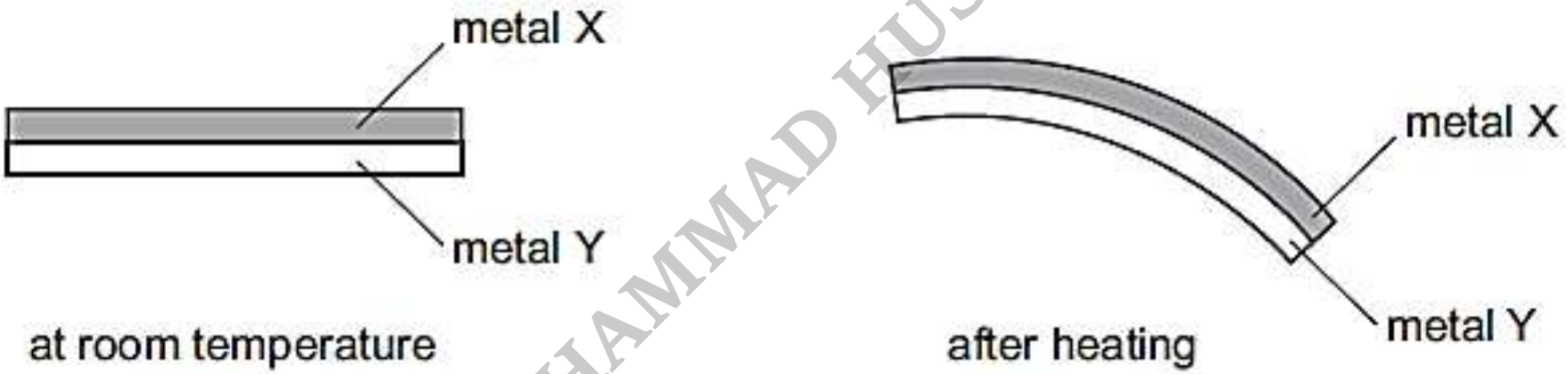
	temperature	gas
A	falls	contracts
B	falls	expands
C	rises	contracts
D	rises	expands

D

12. The table shows the increase in length of four metals when heated through the same temperature rise. Each metal initially has the same length.

metal	increase in length / m
aluminium	0.000030
copper	0.000020
platinum	0.000009
steel	0.000010

A bimetallic strip is made from two of the metals. When heated, it bends in the direction shown.



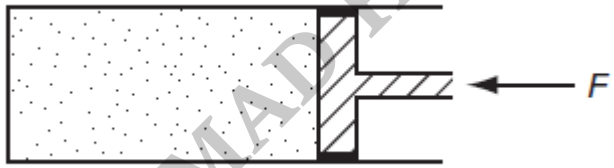
Which metals produce the above effect?

	metal X	metal Y
A	aluminium	platinum
B	copper	aluminium
C	steel	copper
D	platinum	steel

A

13. A quantity of gas is trapped in a container by a piston exerting a force F.

    The temperature of the gas is raised while F remains unchanged.



Which statement is correct?

A. The gas expands.
B. The molecules get larger.
C. The piston remains in the same place.
D. The speed of the molecules decreases.