

# Thermal Properties of Materials

## Question Paper

|                   |                                 |
|-------------------|---------------------------------|
| <b>Level</b>      | International A Level           |
| <b>Subject</b>    | Physics                         |
| <b>Exam Board</b> | CIE                             |
| <b>Topic</b>      | Thermal Properties of Materials |
| <b>Sub Topic</b>  |                                 |
| <b>Paper Type</b> | Multiple Choice                 |
| <b>Booklet</b>    | Question Paper                  |

**Time Allowed:** 33 minutes

**Score:** /27

**Percentage:** /100

Grade Boundaries:

| A*   | A     | B   | C     | D     | E   | U    |
|------|-------|-----|-------|-------|-----|------|
| >85% | 77.5% | 70% | 62.5% | 57.5% | 45% | <45% |

- 1 Which row correctly describes the ordering and motion of the molecules in liquid water and in ice when both are at a temperature of  $0^{\circ}\text{C}$ ?

|          | ordering   | motion  |
|----------|--|---|
| <b>A</b> | a regular pattern of molecules in ice but not in water | molecules in both ice and water have the same average speed |
| <b>B</b> | a regular pattern of molecules in ice but not in water | molecules in ice travel more slowly than those in water     |
| <b>C</b> | a regular pattern of molecules in both ice and water   | molecules in ice travel more slowly than those in water     |
| <b>D</b> | a regular pattern of molecules in both ice and water   | molecules in both ice and water have the same average speed |

- 2 Which statement about boiling and evaporation is correct?

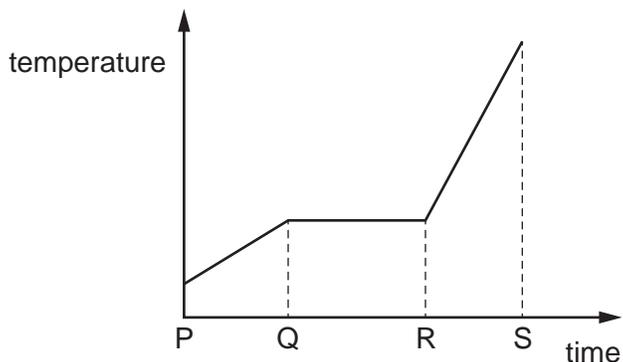
- A** Boiling can only occur at the surface of a liquid.
- B** Evaporation can only occur at a fixed temperature.
- C** Only boiling involves a change of phase.
- D** When some of a liquid evaporates, the rest of the liquid becomes cooler.

- 3 There is one temperature, about  $0.01^{\circ}\text{C}$ , at which water, water vapour and ice can co-exist in equilibrium.

Which statement about the properties of the molecules at this temperature is correct?

- A** Ice molecules are closer to one another than water molecules.
- B** The mean kinetic energy of water molecules is greater than the mean kinetic energy of ice molecules.
- C** Water vapour molecules are less massive than water molecules.
- D** Water vapour molecules have the same mean speed as both ice and water molecules.

- 4 A crystalline solid is heated at a constant rate and the change of temperature with time is shown in the graph below.



Which statement about the particles in the material is correct?

- A In the time from P to Q, the particles are arranged randomly.
  - B In the time from Q to R, some particles are arranged regularly and some particles are arranged randomly.
  - C In the time from R to S, the particles are widely spaced.
  - D The arrangement of the particles is the same in the time from P to S.
- 5 If the Universe was such that the speed of the molecules in a substance increased with temperature but at any particular temperature the speed of all the molecules in a substance was the same, which process would **not** occur?
- A boiling
  - B condensation
  - C evaporation
  - D melting
- 6 What is the internal energy of a system?
- A the amount of heat supplied to the system
  - B the random energy of the atoms of the system
  - C the total kinetic energy of the system
  - D the total potential energy of the system

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

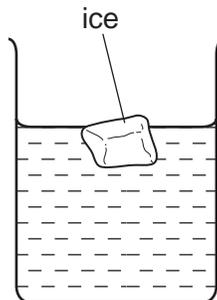
Which paragraph correctly describes the molecules?

- 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. The fastest molecules are unable to leave the surface of the water. There are attractive forces between the molecules.
- D** 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.

8 Which row correctly states the characteristics of the process of evaporation?

|          | requires heat energy | occurs only at a particular temperature | can cause a change of temperature |
|----------|----------------------|---|-----------------------------------|
| <b>A</b> | ✓                    | ✓                                       | ✗                                 |
| <b>B</b> | ✓                    | ✗                                       | ✓                                 |
| <b>C</b> | ✗                    | ✓                                       | ✗                                 |
| <b>D</b> | ✗                    | ✗                                       | ✓                                 |

- 9 The diagram shows an ice cube floating in water.



Both the ice cube and the water are at  $0^{\circ}\text{C}$ .

Which statement correctly compares the molecular properties of the ice and those of the water?

- A The mean inter-molecular potential energies are the same for both the ice molecules and the water molecules.
  - B The mean inter-molecular separations are the same for both the ice and the water.
  - C The mean kinetic energies are the same for both the ice molecules and the water molecules.
  - D The mean total energies are the same for both the ice molecules and the water molecules.
- 10 Ice at a temperature of  $0^{\circ}\text{C}$  is a rare example of a solid that floats on its liquid form, in this case water, when they are both at the same temperature.

What is the explanation for this?

- A The average speed of the molecules in the ice is greater than the average speed of the molecules in the water.
- B The average speed of the molecules in the water is greater than the average speed of the molecules in the ice.
- C The mean separation of the molecules in the ice is greater than the mean separation of the molecules in the water.
- D The mean separation of the molecules in the water is greater than the mean separation of the molecules in the ice.

- 11 Which row correctly describes the spacing, ordering and motion of the molecules in water and in ice when both are at a temperature of 0 °C?

|          | spacing  | ordering   | motion  |
|----------|--|--|---|
| <b>A</b> | molecules in ice are closer together than molecules in water | a regular pattern of molecules in both ice and water   | molecules in both ice and water have the same average speed |
| <b>B</b> | molecules in ice are closer together than molecules in water | a regular pattern of molecules in ice but not in water | molecules in ice travel more slowly than those in water     |
| <b>C</b> | molecules in ice are further apart than molecules in water   | a regular pattern of molecules in both ice and water   | molecules in ice travel more slowly than those in water     |
| <b>D</b> | molecules in ice are further apart than molecules in water   | a regular pattern of molecules in ice but not in water | molecules in both ice and water have the same average speed |

- 12 Which row correctly describes the spacing and motion of the molecules in water and in ice when both are at a temperature of 0 °C?

|          | spacing  | motion  |
|----------|--|---|
| <b>A</b> | molecules in ice are further apart than molecules in water | molecules in both ice and water have the same average speed |
| <b>B</b> | molecules in ice are further apart than molecules in water | molecules in ice travel more slowly than those in water     |
| <b>C</b> | molecules in ice are closer than molecules in water        | molecules in ice travel more slowly than those in water     |
| <b>D</b> | molecules in ice are closer than molecules in water        | molecules in both ice and water have the same average speed |

- 13 Which row correctly describes the ordering and motion of the molecules in water and in ice when both are at a temperature of  $0^{\circ}\text{C}$ ?

|          | ordering   | motion  |
|----------|--|---|
| <b>A</b> | a regular pattern of molecules in ice but not in water | molecules in both ice and water have the same average speed |
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- 14 What is the internal energy of an object?

- A** It is the energy associated with the object's movement through space.
- B** It is the energy associated with the random movement of the molecules in the object.
- C** It is the energy due to the attractions between the molecules in the object.
- D** It is the sum of all the microscopic potential and kinetic energies of the molecules in the object.

15 Which process does **not** require energy to be supplied?

- A boiling
- B evaporation
- C freezing
- D melting

16 The table summarises some descriptions 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   |

- 17 What is the internal energy of a system?
- A** the amount of heat supplied to the system
  - B** the energy of the atoms of the system
  - C** the total kinetic energy of the system
  - D** the total potential energy of the system

- 18 A student writes some statements about solids, liquids and gases.

- 1 Solids are rigid because the molecules in a solid vibrate.
- 2 Liquids flow because the molecules in a liquid are closer than in a gas.
- 3 Gases are less dense than liquids because the molecules in a gas move randomly.

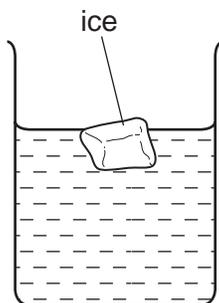
Which statements are correct?

- A** 1 only
  - B** 1 and 3 only
  - C** 2 and 3 only
  - D** none of the above
- 19 When ice melts, it contracts.

Which row is correct for ice turning into water?

|          | distance between atoms | density   |
|----------|------------------------|-----------|
| <b>A</b> | decreases              | decreases |
| <b>B</b> | decreases              | increases |
| <b>C</b> | increases              | decreases |
| <b>D</b> | increases              | increases |

20 The diagram shows an ice cube floating in water.



Both the ice cube and the water are at 0 °C.

Which statement correctly compares the molecular properties of the ice and those of the water?

- A** The mean inter-molecular potential energies are the same for both the ice molecules and the water molecules.
- B** The mean inter-molecular separations are the same for both the ice and the water.
- C** The mean kinetic energies are the same for both the ice molecules and the water molecules.
- D** The mean total energies are the same for both the ice molecules and the water molecules.

21 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

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

**A**  
atoms separated by many atomic diameters  
positions of atoms can change  
atoms vibrate

**B**  
atoms separated by many atomic diameters  
atoms are in fixed positions  
atoms are in continuous, random motion

**C**  
atoms can touch each other  
positions of atoms can change  
some random motion of atoms

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

23 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 |
|----------|--|-------------------------------|---|
| <b>A</b> | true   | true                          | true  |
| <b>B</b> | true   | false                         | true  |
| <b>C</b> | true   | false                         | false   |
| <b>D</b> | false  | true                          | false   |

24 What is the internal energy of an object?

- A** It is the energy associated with the object's movement through space.
- B** It is the energy associated with the random movement of the molecules in the object.
- C** It is the energy due to the attractions between the molecules within the object.
- D** It is the sum of all the microscopic potential and kinetic energies of the molecules.

25 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

26 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.

27 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    |