

# Ideal Gases & Thermal Properties of Materials

## TOPIC QUESTIONS (1&2)

<b>Level</b>	<b>AS Level</b>
<b>Subject</b>	<b>Physics</b>
<b>Exam Board</b>	<b>CIE</b>
<b>Paper Type</b>	<b>Multiple Choice</b>

Time Allowed : 60min

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- 1 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

- 2 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.

- 3 In the kinetic model of gases, what is pressure equal to?

- A the number of atoms hitting and rebounding from a surface of the gas container
- B the number of atoms hitting and rebounding from a unit area of the gas container surface
- C the force exerted by the atoms hitting and rebounding from a surface of the gas container
- D the force exerted by the atoms hitting and rebounding from a unit area of the gas container surface

4 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

5 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.

6. 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
A	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	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
C	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
D	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

7. 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



A	molecules in ice are further apart than molecules in water	molecules in both ice and water have the same average speed
B	molecules in ice are further apart than molecules in water	molecules in ice travel more slowly than those in water
C	molecules in ice are closer than molecules in water	molecules in ice travel more slowly than those in water
D	molecules in ice are closer than molecules in water	molecules in both ice and water have the same average speed



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8. 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
A	a regular pattern of molecules in ice but not in water	molecules in both ice and water have the same average speed
B	a regular pattern of molecules in ice but not in water	molecules in ice travel more slowly than those in water
C	a regular pattern of molecules in both ice and water	molecules in ice travel more slowly than those in water
D	a regular pattern of molecules in both ice and water	molecules in both ice and water have the same average speed

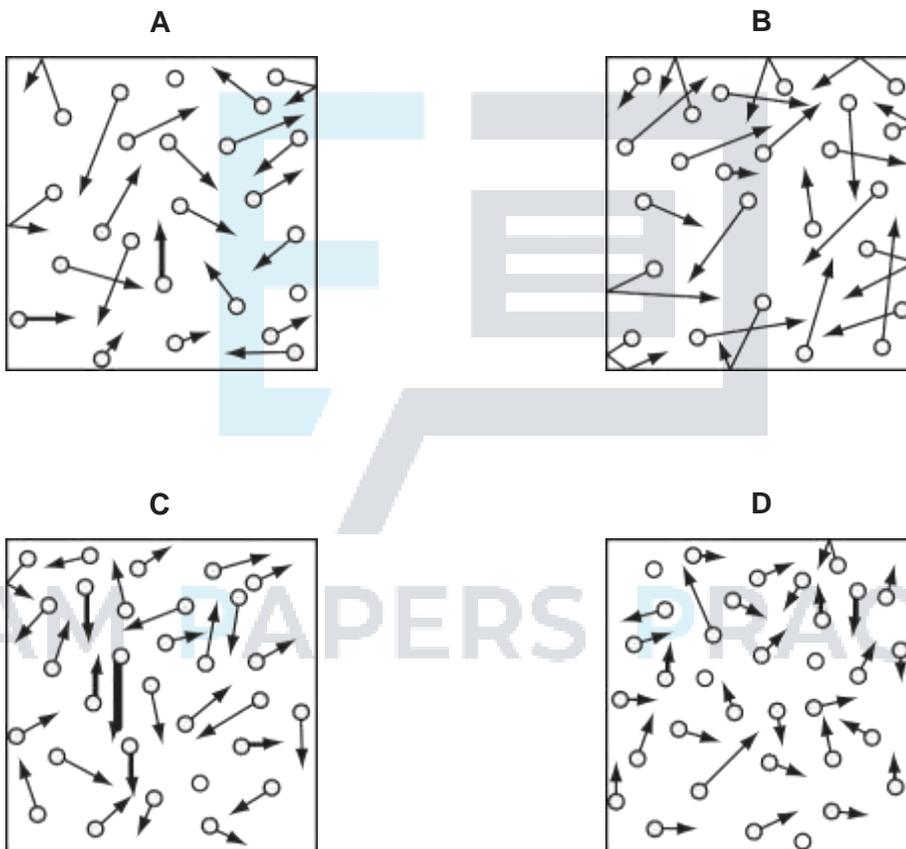
9. What is the internal energy of an object?
- A It is the energy associated with the object's movement through space.
  - B It is the energy associated with the random movement of the molecules in the object.
  - C It is the energy due to the attractions between the molecules in the object.
  - D It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

10. Which process does not require energy to be supplied?

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

11. Each box shows identical molecules of a gas represented by circles with arrows to show the direction of travel and the speed of the molecule. A longer arrow represents a higher speed.

Which box contains a gas of the highest density and the lowest temperature?



12. A mass of gas enclosed in a cylinder by a piston is heated gently. At the same time, the piston is moved so that the pressure remains constant.

As a result of this, what will not occur?

- A The average velocity of the molecules will increase.
- B The mean separation of the molecules will increase.
- C The molecules will travel greater distances between collisions.
- D The number of collisions per second of the molecules on the piston will increase.

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13. In an experiment to demonstrate Brownian motion, a transparent container is filled with smoke particles suspended in air.

What can be seen when the contents of the container are strongly illuminated and viewed through a microscope?

- A air molecules that are colliding with smoke particles
- B air molecules that are moving in straight lines
- C smoke particles that are moving in random zigzag paths
- D smoke particles that are moving in straight lines

14. 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.

15. 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

16. 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

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

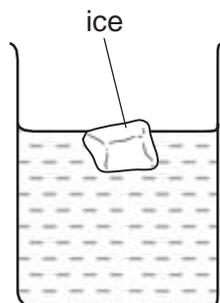
Which paragraph correctly describes the molecules?

- 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.

18. 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
A	✓	✓	C
B	✓	C	✓
C	C	✓	C
D	C	C	✓

19. 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.

20. 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.

21. Why does an ideal gas exert pressure on its container?

- A The molecules of the gas collide continually with each other.
- B The molecules of the gas collide continually with the walls of the container.
- C The molecules of the gas collide inelastically with the walls of the container.
- D The weight of the molecules exerts a force on the walls of the container.

22. 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.

23. 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

24. 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.

25. 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

26. 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

27. 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

28. 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?

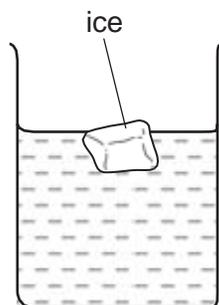
- A 1 only
- B 1 and 3 only
- C 2 and 3 only
- D none of the above

29. When ice melts, it contracts.

Which row is correct for ice turning into water?

	distance between atoms	density
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

30. 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.

31. Which statement about molecules in a gas is correct?

- a. In Brownian motion experiments, the molecules can be seen moving randomly in all directions.
- b. The pressure exerted by a gas is caused by molecules bouncing against each other and changing kinetic energy.
- c. The pressure exerted by a gas is caused by molecules rebounding from the walls of a container and changing momentum.
- d. When the average speed of the molecules in a closed container increases, the density must also increase.

32. A student is studying Brownian motion.

Using a microscope, she observes particles of smoke in a glass container, illuminated by a strong light. The particles of smoke have a zig-zag path, constantly changing speed and direction.

What happens to the smoke particles if the air in the container is heated?

- A The smoke particles become easier to see.
- B The smoke particles change direction more frequently.
- C The smoke particles increase in volume.

D The smoke particles move further apart.

33. The graph shows the distribution of speeds for the molecules of a gas at a particular temperature.



Which statement is correct?

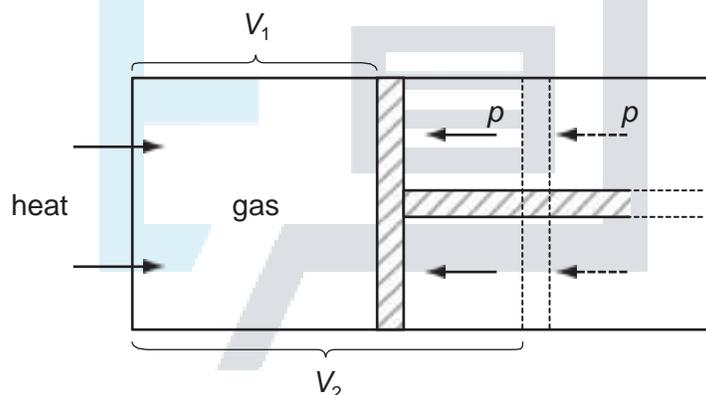
- A All the molecules have the same kinetic energy.
- B The commonest value of speed is also the average speed.
- C The graph shows that the molecules of a gas are widely spaced apart.
- D The peak value of the graph would move to the right if the temperature is increased.

34. In an experiment to demonstrate Brownian motion, a transparent container is filled with smoke particles suspended in air.

What can be seen when the contents of the container are strongly illuminated and viewed through a microscope?

- A molecules in random motion
- B molecules vibrating regularly
- C smoke particles in random motion
- D smoke particles vibrating regularly

35. A gas is enclosed inside a cylinder which is fitted with a frictionless piston.



Initially, the gas has a volume  $V_1$  and is in equilibrium with an external pressure  $p$ . The gas is then heated slowly so that it expands, pushing the piston back until the volume of the gas has increased to  $V_2$ .

How much work is done by the gas during this expansion?

- A  $p(V_2 - V_1)$
- B  $\frac{1}{2}p(V_2 - V_1)$
- C  $p(V_2 + V_1)$
- D  $\frac{1}{2}p(V_2 + V_1)$

36. 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
A	a regular pattern of molecules in ice but not in water	molecules in both ice and water have the same average speed
B	a regular pattern of molecules in ice but not in water	molecules in ice travel more slowly than those in water
C	a regular pattern of molecules in both ice and water	molecules in ice travel more slowly than those in water
D	a regular pattern of molecules in both ice and water	molecules in both ice and water have the same average speed

37. Which statement about boiling and evaporation is correct?

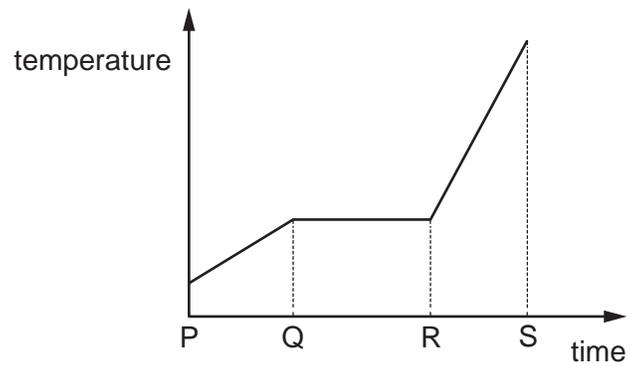
- Boiling can only occur at the surface of a liquid.
- Evaporation can only occur at a fixed temperature.
- Only boiling involves a change of phase.
- When some of a liquid evaporates, the rest of the liquid becomes cooler.

38. There is one temperature, about  $0.01\text{ }^{\circ}\text{C}$ , 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?

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

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



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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.

40. 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

41. 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.

42. 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

43. 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

44. 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.

45. 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

46. 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

47. 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

48. 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

49. 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.

50. When white sugar granules are heated, they melt. When the melt is cooled quickly, a brittle solidform 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



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