2. Thermal physics

2.1 Kinetic particle model of matter

Paper 1 and 2

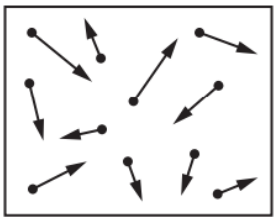
Question Paper

Paper 1

Questions are applicable for both core and extended candidates

1 The diagram represents gas particles moving around in a sealed container.

The gas particles collide with the walls of the container.

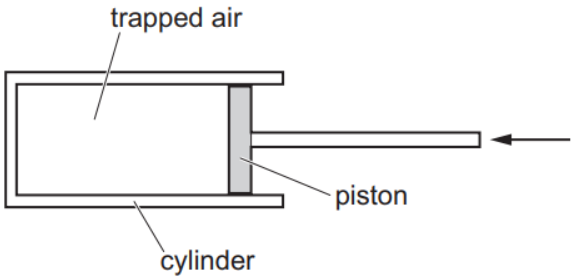


The temperature of the gas is increased.

What happens to the average speed of the gas particles and what happens to the number of collisions by the gas particles with the walls of the container?

	average speed of gas particles	the number of collisions with the walls of the container
A	increases	less frequent collisions
B	increases	more frequent collisions
C	stays the same	less frequent collisions
D	stays the same	more frequent collisions

2 A fixed mass of air is trapped inside a cylinder fitted with a moveable piston. The piston is slowly pushed in.



What happens to the pressure and the volume of the trapped air?

	pressure	volume
A	decreases	decreases
B	decreases	does not change
C	increases	decreases
D	increases	increases

3 Brownian motion is the random motion of particles.

In which states of matter is Brownian motion observed?

A gases, liquids and solids

B gases and liquids only

C gases and solids only

D liquids and solids only

4 Diagram 1 shows apparatus being used to observe smoke particles.

Diagram 2 shows how a smoke particle moves randomly.

diagram 1

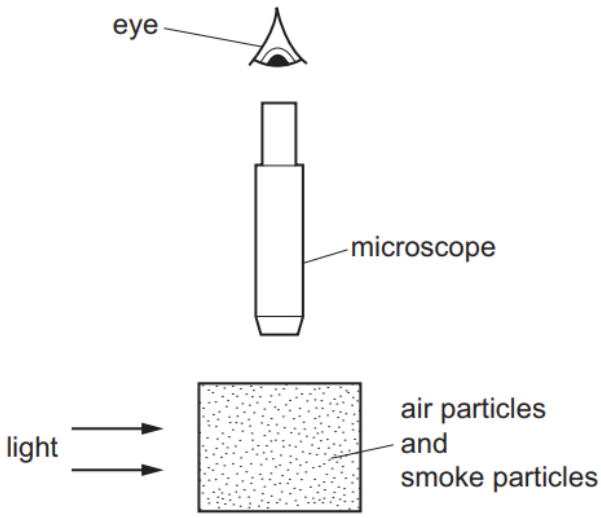
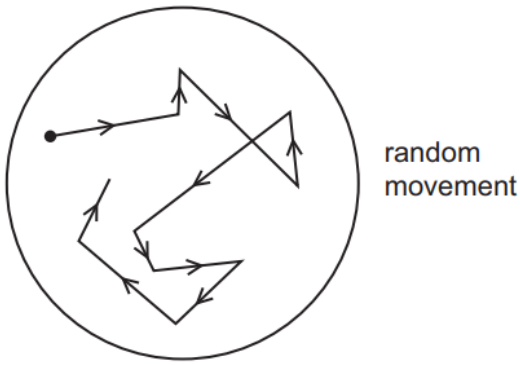


diagram 2



Why do the smoke particles move randomly?

A They are hit by air particles.

B They are less dense than air.

C They are moved by convection currents.

D They gain energy from the light.

5 How is a temperature in degrees Celsius (°C) converted to a temperature in kelvin (K)?

A Add 273 to the temperature in °C.

B Divide the temperature in °C by 273.

C Multiply the temperature in °C by 273.

D Subtract 273 from the temperature in °C.

6 Which row correctly describes the state of water at the temperatures shown?

	250 K	300 K	350 K	400 K
A	liquid	liquid	gas	gas
B	solid	solid	liquid	liquid
C	solid	liquid	liquid	gas
D	solid	liquid	gas	gas

7 Why can a gas be compressed easily into a smaller volume?

A The particles are far apart.

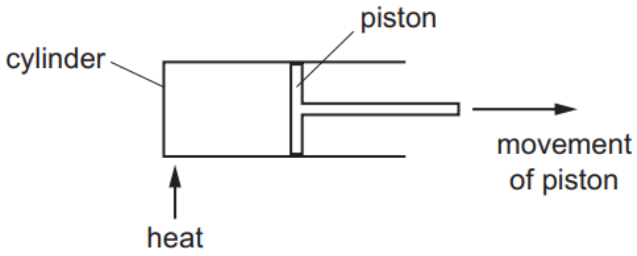
B The particles do not attract each other.

C The particles move randomly.

D The volume of each particle can be reduced.

8 The diagram shows a frictionless piston inside a cylinder.

The air inside the cylinder is heated. The piston moves in the direction shown.



Which statement about the air inside the cylinder is correct?

A The temperature and volume increase at constant pressure.

B The temperature and pressure increase at constant volume.

C The temperature, volume and pressure all increase.

D The volume and pressure increase at constant temperature.

9 A student investigates the relationship between the pressure of a gas and its volume at constant temperature. He records his results in the table.

reading	pressure / N/cm^2	volume /cm^3
1	10.0	24
2	7.4	32
3	4.0	63
4	13.0	19

What is the correct conclusion from the experiment?

A The volume decreases when the pressure increases.

B The volume increases when the pressure increases.

C The volume initially increases when the pressure increases, but then decreases.

D The volume is independent of the pressure.

10 Gases, liquids and solids are made up of small particles.

Which row gives the relative separation of the particles?

	gas	liquid	solid
A	far apart	far apart	far apart
B	far apart	far apart	close together
C	far apart	close together	close together
D	close together	close together	far apart

11 Four students describe the phrase ‘absolute zero’ during a lesson on the particle model.

Which student is correct?

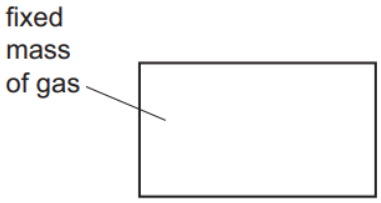
A This is the lowest possible temperature.

B Particles in a solid start vibrating.

C Particles do not have any weight.

D Particles have the least gravitational potential energy.

12 A fixed mass of gas is trapped in a container. The temperature of the gas is increased but the volume of the gas is kept constant.



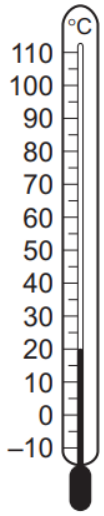
How does this change affect the average kinetic energy of the molecules and the pressure on the walls of the container?

	average kinetic energy	pressure
A	increases	increases
B	stays the same	increases
C	increases	decreases
D	decreases	increases

13 Which row correctly describes the arrangement and the motion of particles in a solid?

	arrangement of particles	motion of particles
A	far apart	moving randomly from place to place
B	far apart	vibrating about one position
C	tightly packed	moving randomly from place to place
D	tightly packed	vibrating about one position

14 The diagram shows a thermometer calibrated in degrees Celsius.



What are the values of the lower fixed point and of the upper fixed point on the Celsius scale?

	lower fixed point / °C	upper fixed point / °C
A	–10	110
B	0	20
C	0	100
D	20	100

15 The list gives three properties of different states of matter.

1 They cannot be compressed significantly.

2 They can flow.

3 They always completely fill their container.

Which properties are correct for liquids?

A 1 and 2 only **B** 2 and 3 only **C** 1 and 3 only **D** 1, 2 and 3

16 A particular state of matter consists of molecules that move freely in random directions at high speed. The average speed of the molecules is decreasing.

Which state of matter is being described?

A a gas cooling

B a gas being heated

C a solid cooling

D a liquid being heated

17 Small pollen particles are suspended in water.

When viewed with a microscope, the pollen particles can be seen to be moving about irregularly.

What causes this movement?

A The pollen particles are being bombarded by the heavier particles of the water.

B The pollen particles are being bombarded by the lighter particles of the water.

C The temperature of the water is higher than that of the pollen particles.

D The temperature of the water is lower than that of the pollen particles.

18 Which row correctly describes the movement of particles in solids and liquids?

	solids	liquids
A	no movement	move around each other
B	no movement	vibration only
C	vibration only	move around each other
D	vibration only	vibration only

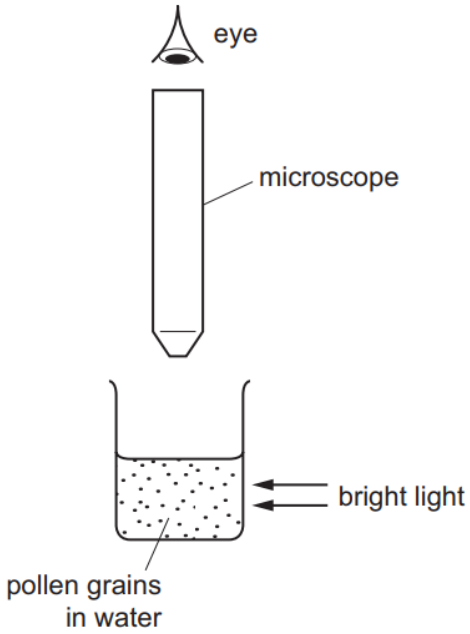
19 Air trapped in a sealed bottle increases in temperature.

Which row shows the changes that occur to the trapped air?

	pressure of the air	average speed of molecules in the air
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

20 Very small pollen grains are suspended in water. A bright light shines from the side.

When looked at through a microscope, small specks of light are seen to be moving in a random, jerky manner.



What are the moving specks of light?

A pollen grains being hit by other pollen grains

B pollen grains being hit by water molecules

C water molecules being hit by other water molecules

D water molecules being hit by pollen grains

21 All thermometers require a physical property that changes with temperature.

Which property would **not** be suitable for use in a thermometer?

A pressure

B volume

C electrical resistance

D mass

22 A gas is heated in a sealed container.

The volume of the container does not change.

What happens to the molecules of the gas?

A The average distance between molecules increases.

B The average kinetic energy of the molecules increases.

C The mass of each molecule increases.

D The volume of each molecule increases.

23 A gas, in a sealed container, is compressed slowly so that its temperature does not change.

What happens to the molecules of the gas as a result of this compression?

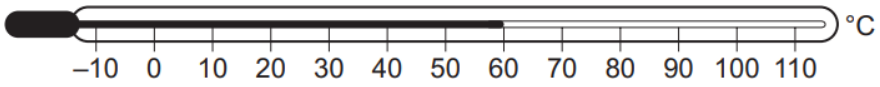
A The average speed of the molecules increases.

B The average force in a collision between a molecule and the container increases.

C There are more frequent collisions between molecules and the container.

D The volume of each molecule decreases.

24 The diagram shows a liquid-in-glass thermometer.



What is the temperature difference between the two fixed points on the Celsius scale?

A 10 °C **B** 100 °C **C** 110 °C **D** 120 °C

25 A test-tube contains 1.0 cm^3 of liquid water at 100 °C. The liquid water boils to form 1600 cm^3 of steam.

What is the reason for the large increase in volume?

A Steam molecules are bigger than water molecules.

B The average distance between the molecules is much greater in the steam.

C The molecules do not move until the water turns into a gas.

D There are more steam molecules than there were water molecules.

26 Which row describes the arrangement and the motion of the molecules in a gas?

	arrangement	motion
A	far apart	move freely
B	far apart	vibrate only
C	tightly packed	move freely
D	tightly packed	vibrate only

27 A driver of a car measures the pressure of the air in the tyres. He measures the pressure again after a long journey. The pressure reading has increased.

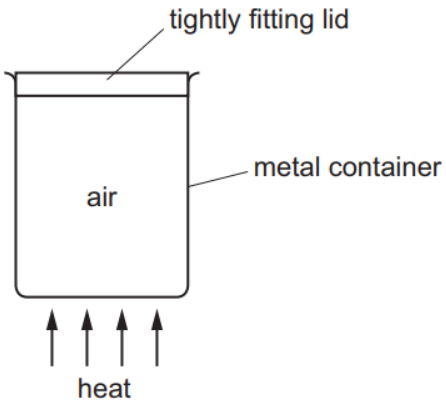
Which row states what has happened to the speed of the air molecules and the temperature of the air in the tyres?

	speed of molecules	temperature
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Paper 2

Questions are applicable for both core and extended candidates unless indicated in the question

28 Some air is trapped inside a metal container with a tightly fitting lid.



The container is heated strongly behind a safety screen. The lid is blown off by the increased pressure of the air inside the container.

What causes the increase in pressure of the air inside the container?

A Each air particle expands and takes up more room.

B The air particles move more quickly.

C The number of particles inside the container increases.

D The volume occupied by the air decreases.

29 Water can exist in three states: solid (ice), liquid (liquid water) and gas (steam).

In which states is the motion of the water particles **only** vibrational?

A liquid water and ice

B liquid water only

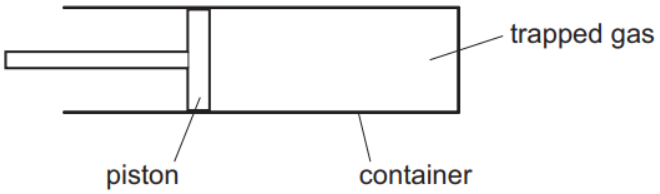
C ice only

D steam only

30 Gas of volume 200 cm^3 is trapped inside a container by a piston. **(extended only)**

The piston is pushed to the right and the volume of the gas decreases to 100 cm^3.

The temperature of the gas remains constant.



Which row states the effect that this has on the kinetic energy of the gas particles and the force per unit area exerted by the particles colliding with the inside walls of the container?

	kinetic energy	force per unit area
A	doubles	doubles
B	doubles	stays the same
C	stays the same	doubles
D	stays the same	stays the same

31 Extremely small pollen grains in water are viewed through a microscope. The grains are seen to move continually and randomly.

What is the reason for this random movement?

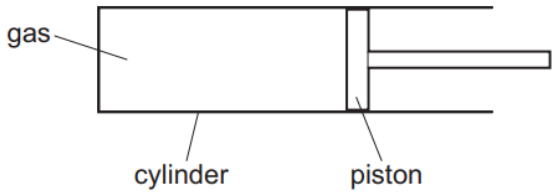
A The grains are moved by randomly moving water molecules.

B The grains are moved by random convection currents in the water.

C The grains are moved by random rays of light reflecting off them.

D The grains are moved by the random motion of their own atoms.

32 A gas is contained in a cylinder by a movable piston. **(extended only)**



The gas is heated so that it expands at **constant pressure**.

How is the force of each collision of a gas particle with the piston affected and how does the frequency of collisions between the gas particles and the piston change?

	force	frequency
A	increases	decreases
B	increases	increases
C	stays the same	decreases
D	stays the same	increases

33 A student uses a microscope to observe pollen moving on the surface of water.

Which statement describes the reason for this movement?

A Water molecules are moved by microscopic pollen particles.

B Water molecules are moved by pollen molecules.

C Microscopic pollen particles are moved by water molecules.

D Pollen molecules are moved by water molecules.

34 The diagram shows a liquid-in-glass thermometer.

Which change increases the sensitivity of the thermometer?

A a narrower capillary tube

B a wider capillary tube

C thicker glass around the bulb

D thinner glass around the bulb

35 Which change in the design of a liquid-in-glass thermometer makes it more sensitive?

A a larger liquid reservoir

B a longer tube

C a smaller liquid reservoir

D a wider tube

36 A sealed rigid container has a fixed volume. The container is filled with air.

The container is placed in a freezer cabinet and the temperature of the air in the container decreases.

Which row correctly describes what happens to the air in the container?

	average distance between air particles	average speed of air particles
A	decreases	increases
B	decreases	decreases
C	no change	increases
D	no change	decreases

37 The conditions of a sample of gas change in two stages.

stage 1 increase of temperature at constant volume

stage 2 increase of volume with no further change of temperature

Which row about the pressure after each stage is correct?

	stage 1 pressure compared to original pressure	stage 2 pressure compared to pressure after stage 1
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

38 A gas is contained in a sealed container in a laboratory. The temperature of the gas increases.

What happens to the average speed and what happens to the total kinetic energy of the gas molecules?

	average speed	total kinetic energy
A	does not change	does not change
B	does not change	increases
C	increases	does not change
D	increases	increases

39 The table gives information about molecules.

Which row describes a gas?

	force between molecules	distance between molecules
A	strong	close together
B	strong	far apart
C	negligible	far apart
D	negligible	close together

40 Which row describes the forces between the molecules and the motion of the molecules in a gas?

	forces between molecules	motion of molecules
A	strong	move freely
B	strong	vibrate only
C	weak	move freely
D	weak	vibrate only

41 A stationary smoke particle is hit by a fast-moving nitrogen molecule. **(extended only)**

Which row describes the motion of the smoke particle and of the nitrogen molecule after the collision?

	smoke particle	nitrogen molecule
A	moves	rebounds
B	moves	stops
C	remains stationary	rebounds
D	remains stationary	stops

42 At room temperature, iron is difficult to compress.

At the same temperature, oxygen is much easier to compress.

Which comparison of the structures of iron and oxygen explains this?

A The iron particles are closer together.

B The iron particles have a greater mass.

C The iron particles can be magnetised.

D The iron particles have less average kinetic energy.

43 A closed container of gas is heated. The pressure of the gas increases. **(extended only)**

Which statement explains this increase in pressure?

A The changes in the momentum of the gas molecules striking the walls of the container increase.

B The forces of attraction between the gas molecules and the walls of the container increase.

C The gas molecules collide with each other more frequently.

D The gas molecules lose more energy when they strike the walls of the container.

44 When molecules of a gas rebound from a wall of a container, the wall experiences a pressure.

What is the cause of this pressure? **(extended only)**

A the change in energy of the molecules

B the change in momentum of the molecules

C the change in power of the molecules

D the change in speed of the molecules