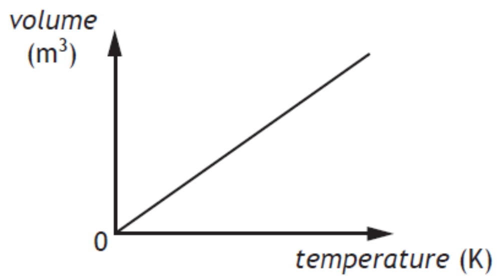
Homework 2 – Gas Laws and the Kinetic Model

1. The pressure of a fixed mass of gas is $6{\cdot}0 \times 10^5$ Pa. The temperature of the gas is 27 °C and the volume of the gas is $2{\cdot}5$ m^3. The temperature of the gas increases to 54 °C and the volume of the gas increases to $5{\cdot}0$ m^3. Calculate the new pressure of the gas.

   A $2{\cdot}8 \times 10^5$ Pa
   B $3{\cdot}3 \times 10^5$ Pa
   C $6{\cdot}0 \times 10^5$ Pa
   D $1{\cdot}1 \times 10^6$ Pa
   E $1{\cdot}3 \times 10^6$ Pa

2. A student is investigating the relationship between the volume and the kelvin temperature of a fixed mass of gas at constant pressure.
   Identify which graph shows this relationship.

A


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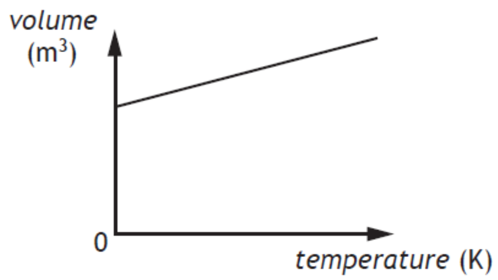

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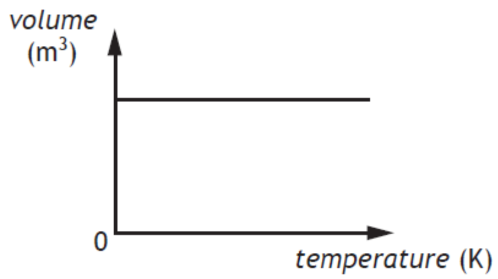

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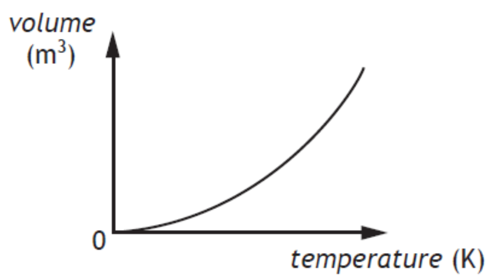

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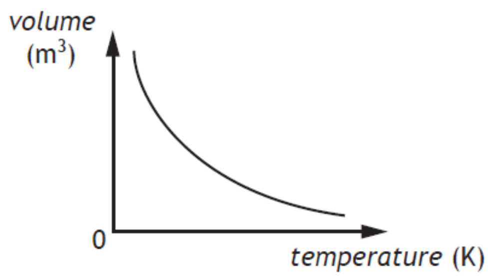
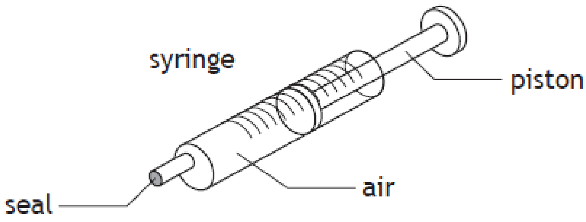


3. A liquid is heated from 17 °C to 50 °C. Determine the temperature rise in kelvin.

A 33 K
B 67 K
C 306 K
D 340 K
E 579 K

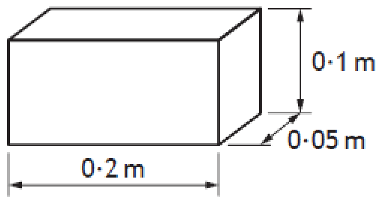
4. A syringe containing air is sealed at one end as shown.



The piston is pushed in slowly.
There is no change in temperature of the air inside the syringe.
Identify which of the following statements describes and explains the change in pressure of the air in the syringe.

A The pressure increases because the air particles have more kinetic energy.
B The pressure increases because the air particles hit the sides of the syringe more frequently.
C The pressure increases because the air particles hit the sides of the syringe less frequently.
D The pressure decreases because the air particles hit the sides of the syringe with less force.
E The pressure decreases because the air particles have less kinetic energy.

5. A block has the dimensions shown below.

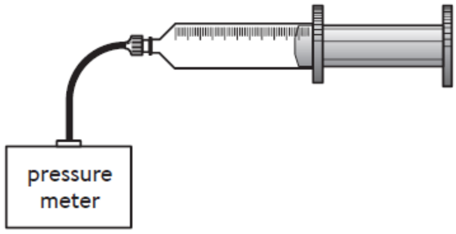


The block is placed so that one of the surfaces is in contact with a smooth table top.
The weight of the block is 4·90 N.

Calculate the minimum pressure exerted by the block on the table top.

A 25 Pa
B 245 Pa
C 490 Pa
D 980 Pa
E 4900 Pa

6. A syringe is connected to a pressure meter as shown.



The syringe contains a fixed mass of air of volume 150 mm^3.
The reading on the pressure meter is 120 kPa.
The volume of air inside the syringe is now changed to 100 mm^3.
The temperature of the air in the syringe remains constant.

Calculate the new reading on the pressure meter.

A 80 kPa
B 125 kPa
C 180 kPa
D 80 000 kPa
E 180 000 kPa

7. A solid is heated from -15 °C to 60 °C. Determine the temperature change of the solid in kelvin.

A 45 K
B 75 K
C 258 K
D 318 K
E 348 K

8. The mass of a spacecraft is 1200 kg.
The spacecraft lands on the surface of a planet.
The gravitational field strength on the surface of the planet is 5·0 N kg^{-1}.
The spacecraft rests on three pads. The total area of the three pads is 1·5 m^2.

Calculate the pressure exerted on the surface of the planet by the pads.

A $1{\cdot}2 \times 10^4$ Pa
B $9{\cdot}0 \times 10^3$ Pa
C $7{\cdot}8 \times 10^3$ Pa
D $4{\cdot}0 \times 10^3$ Pa
E $8{\cdot}0 \times 10^2$ Pa

9. The pressure of a fixed mass of gas is 150 kPa at a temperature of 27 ºC.
The temperature of the gas is now increased to 47 ºC.
The volume of the gas remains constant.

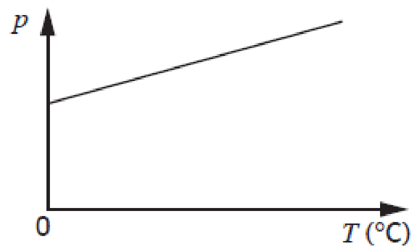
Calculate the new pressure of the gas.

A 86 kPa
B 141 kPa
C 150 kPa
D 160 kPa
E 261 kPa

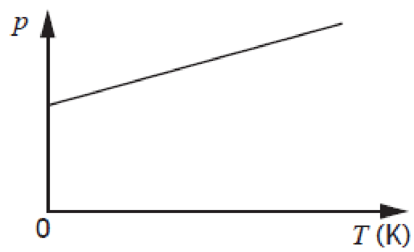
10. A sample of an ideal gas is enclosed in a sealed container.

Identify which graph shows the relationship between the pressure *p* and the temperature *T* of the gas.

A



B



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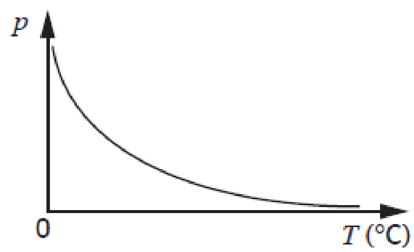

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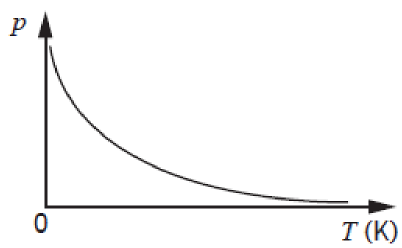
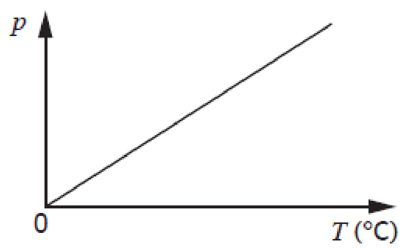
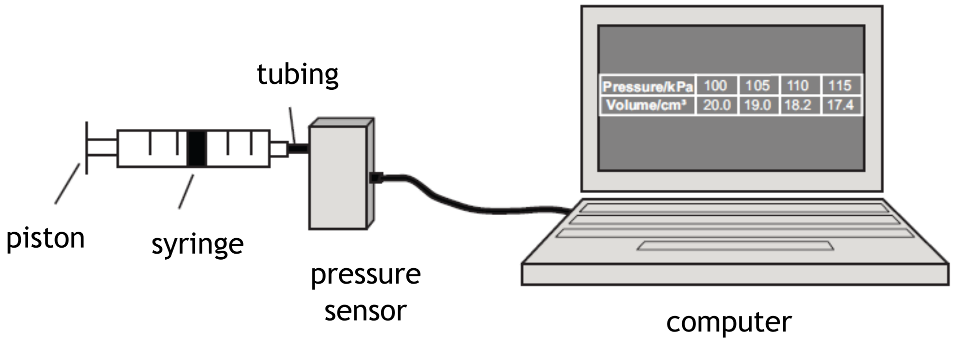


E



11. A student is training to become a diver.
The student carries out an experiment to investigate the relationship between the pressure and volume of a fixed mass of gas using the apparatus shown.



The pressure of the gas is recorded using a pressure sensor connected to a computer. The volume of the gas is also recorded.
The student pushes the piston to alter the volume and a series of readings is taken.
The temperature of the gas is constant during the experiment.
The results are shown.

Pressure / kPa	100	105	110	115
Volume / cm^3	20·0	19·0	18·2	17·4

(a) Using **all** the data, establish the relationship between the pressure and volume of the gas.

(b) Use the kinetic model to explain the change in pressure as the volume of gas decreases.

(c) Atmospheric pressure at the surface of the loch is $1{\cdot}01 \times 10^5$ Pa.
The **total** pressure at a depth of 12.0 m in this loch is $2{\cdot}21 \times 10^5$ Pa.
At the surface of the loch, the student breathes in a volume of $1{\cdot}50 \times 10^{-3}$ m^3 of air.

(i) Calculate the volume this air would occupy at a depth of 12·0 m.

The mass and temperature of the air are constant.

(ii) At a depth of 12.0 m, the diver fills her lungs with air from her breathing apparatus.
She then swims to the surface.
Explain why it would be dangerous for her to hold her breath while doing this.

12. A garden spray consists of a tank, a pump and a spray nozzle.

The tank is partially filled with water.

The pump is then used to increase the pressure of the air above the water.

The volume of the compressed air in the tank is $1{\cdot}60 \times 10^{-3}$ m^3.

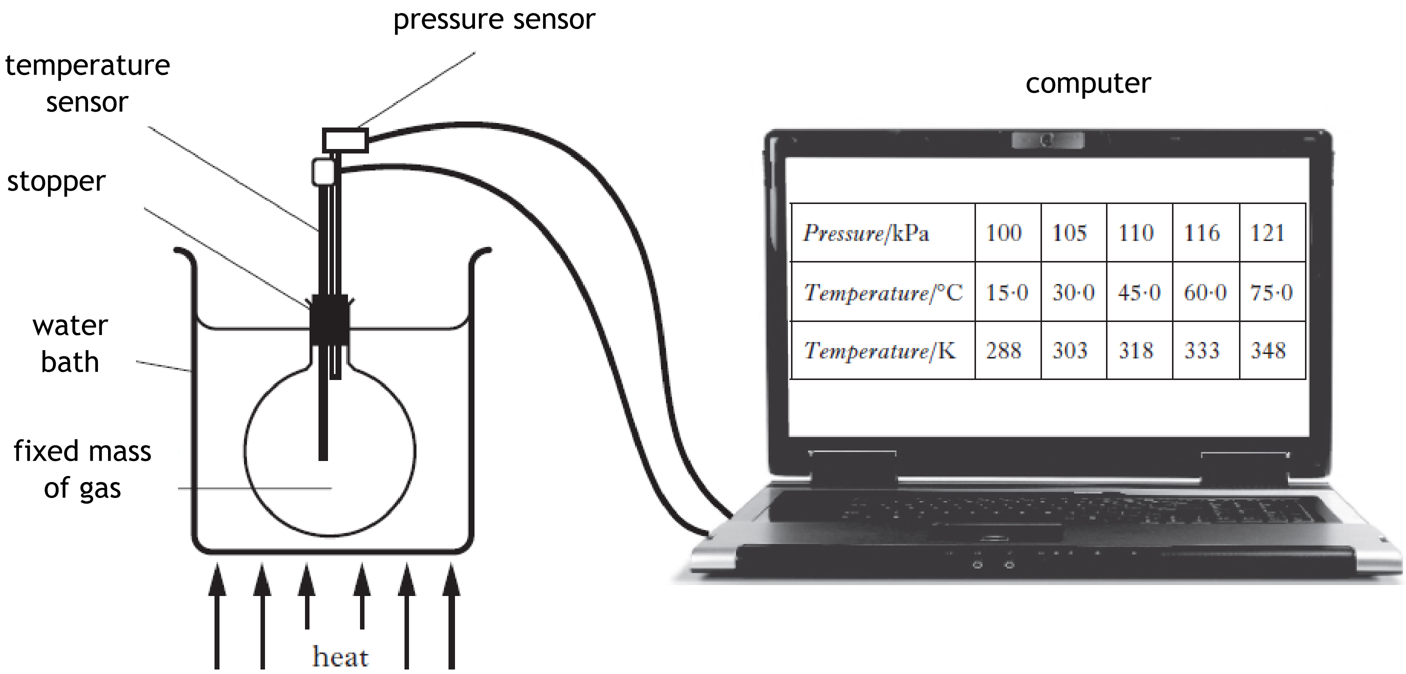
The surface area of the water is $3{\cdot}00 \times 10^{-2}$ m^2.

The pressure of the air in the tank is $4{\cdot}60 \times 10^{5}$ Pa.

(a) Calculate the force on the surface of the water.

(b) The spray nozzle is operated and water is pushed out until the pressure of the air in the tank is $1{\cdot}00 \times 10^{5}$ Pa.
Calculate the volume of water expelled.

13. A student carries out an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas.
The apparatus used is shown below.



The pressure and temperature of the gas are recorded using sensors connected to a computer. The gas is heated slowly in the water bath and a series of readings is taken.
The volume of the gas remains constant during the experiment.
The results are shown.

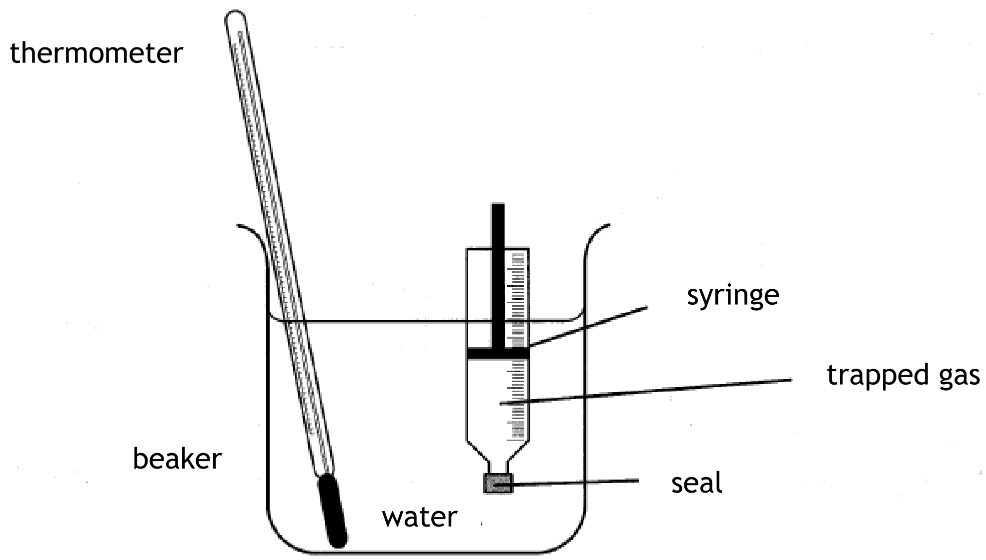
Pressure / kPa	100	105	110	115	120
Temperature / °C	15·0	30·0	45·0	60·0	75·0
Temperature / K	288	303	318	333	348

(a) Using **all** the relevant data, establish the relationship between the pressure and the temperature of the gas.

(b) Use the kinetic model to explain the change in pressure as the temperature of the gas increases.

(c) Explain why the level of water in the water bath should be above the bottom of the stopper.

14. The apparatus used to investigate the relationship between volume and temperature of a fixed mass of gas is shown.



The volume of the trapped gas is read from a scale on the syringe.

The temperature of the trapped gas is altered by heating the water in the beaker. It is assumed that the temperature of the gas in the syringe is the same as that of the surrounding water.
The pressure of the trapped gas in the syringe is constant during the investigation.

Measurements of volume and temperature for the trapped gas are shown.

Temperature / °C	25	50	75	100
Volume / ml	20·6	22·6	24·0	25·4

(a) Using **all** of the data, establish the relationship between temperature and volume of a fixed mass of gas at a constant pressure.

(b) Calculate the volume of the trapped gas when the temperature of the water is 65 °C.

(c) Use the kinetic model of gases to explain the change in volume of the gas as the temperature increases in this investigation.