National 5 Tutorials on GAS LAWS

**Gas Laws**

**Useful Equation:**

= constant

P V

T(K)

where: P is the pressure caused by a fixed mass of a gas (Pa or N/m2)

V is the volume of a fixed mass of gas (m3)

T is the temperature of a fixed mass of gas (K)

1. Explain, using the kinetic theory of particles, what happens to the particles in a liquid when it melts and becomes a gas.

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1. Explain, using kinetic theory, how the air in a bicycle tyre creates pressure on the inside surface of the tyre.
2. Why does the Kelvin temperature scale start at -273 °C?
3. Convert these temperatures from degrees Celsius to Kelvin.
4. ![C:\Documents and Settings\stephen.belford\Local Settings\Temporary Internet Files\Content.IE5\YGV8RG29\MC900199360[1].wmf]()0 °C
5. 20 °C
6. -273 °C
7. 100 °C
8. A conical flask is sealed with air inside, and is placed in a heat bath. The temperature of the gas increases from 20 °C to 70°C. After every 10 °C temperature increase, the pressure of the gas is measured using a Bourdon gauge. The results are shown.

|  |  |
| --- | --- |
| ***Temperature /* °C** | ***Pressure* / x 105 Pa** |
| 20 | 1.01 |
| 30 | 1.04 |
| 40 | 1.08 |
| 50 | 1.11 |
| 60 | 1.15 |
| 70 | 1.18 |

Bourdon Gauge

Thermometer

Heat Bath

Air

1. Using the data, draw a line graph of pressure against temperature (in degrees Celsius). Make sure that your temperature axis goes from -300 °C to 70 °C.
2. On your graph from part (a), continue your straight line back until it crosses through the x-axis. At what temperature is the pressure of the gas zero?
3. Using the data, draw a line graph of pressure against temperature (in Kelvin).
4. What do these two graphs tell you about the relationship between the pressure and temperature of a fixed mass of gas?
5. Explain this relationship in terms of the kinetic theory of particles.
6. Explain, using the appropriate gas law, why it is important that car tyres are not filled up with so much air that the air pressure is above the car manufacturer’s guidelines?

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1. At a temperature of 20 °C, the pressure of a fixed mass of gas in a sealed container is found to be 104 kPa. The gas is heated to a uniform temperature of 90 °C using a heat bath.

What is the pressure of the gas at a temperature of 90 °C?

1. ![C:\Documents and Settings\stephen.belford\Local Settings\Temporary Internet Files\Content.IE5\YGV8RG29\MP900401483[1].jpg]()The pressure of the air in a lorry tyre is found to be 2.58 x 105 Pa at the end of a journey.

Once the tyre has cooled down, the temperature of the air inside the tyre is found to be 10 °C with the pressure decreasing to 2.41 x 105 Pa.

What was the temperature of the air in the tyre at the end of the journey? Give your answer in degrees Celsius.

1. In an experiment, the volume of a fixed mass of gas is decreased by trapping the gas at the top of a glass tube with a quantity of oil and then using a pump to push the oil up the tube.

The pressure of the gas is measured with a Bourdon gauge and the volume of gas is measured using a calibrated scale next to the glass tube. The results are shown.

Pump

Fixed Mass of Gas

Bourdon Gauge

Oil

|  |  |
| --- | --- |
| ***Volume / cm3*** | ***Pressure* / x 105 Pa** |
| 1.5 | 1.57 |
| 1.6 | 1.48 |
| 1.7 | 1.39 |
| 1.8 | 1.31 |
| 1.9 | 1.24 |
| 2.0 | 1.18 |

1. Using the data, draw a line graph of volume against 1 / pressure.
2. What does this graph tell you about the relationship between the volume and pressure of a fixed mass of gas?
3. Explain this relationship in terms of the kinetic theory of particles.
4. ![C:\Users\Stephen\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\32QT04MX\MP900431327[1].jpg]()Explain, using the appropriate gas law, why a balloon will burst if you squeeze it.
5. A 5 cm3 syringe is filled with air and the pressure of the air is found to be 1.01 x 105 Pa. The syringe plunger is then pushed until there is 3 cm3 of air. What is the new air pressure?

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1. A scuba diving air tank has a volume of 7.5 litres and is filled with air at a pressure of 1.21 x 107 Pa. What volume of air will be released by the tank at atmospheric pressure (1.01 x 105 Pa)?
2. In an experiment, an open capillary tube with a mercury thread is placed in to a heat bath.

As the temperature of the gas increases, the mercury thread moves up the capillary tube. The pressure of the gas remains constant because the capillary tube is open.

The temperature of the gas is measured with a thermometer and the volume of the gas is measured using a scale next to the open capillary tube. The results of the experiment are shown.

|  |  |
| --- | --- |
| ***Temperature / °C*** | ***Volume* / cm3** |
| 20 | 1.50 |
| 25 | 1.88 |
| 30 | 2.25 |
| 35 | 2.63 |
| 40 | 3.00 |
| 45 | 3.38 |

Open Capillary Tube

Thermometer

Heat Bath

Mercury Thread

1. Using the data, draw a line graph of volume against temperature (in degrees Celsius). Make sure that your temperature axis goes from -300 °C to 45 °C.
2. Using the data, draw a line graph of volume against temperature (in Kelvin).
3. What do these two graphs tell you about the relationship between the volume and temperature of a fixed mass of gas?
4. Explain this relationship in terms of the kinetic theory of particles.
5. The volume of a fixed mass of gas is 30.0 cm3 at 30 °C. The temperature of the gas is increased to 60 °C without changing the pressure.

A student makes this statement:

‘*As the temperature of the gas has doubled, the volume of the gas will also double. Therefore, the volume of the gas at 60 °C will be 60.0 cm3*.’

1. Explain why this statement is incorrect.
2. Calculate what the volume of the gas would actually be at 60 °C.
3. Air is trapped in a glass capillary tube by a bead of mercury. The volume of air is found to be 0.15 cm3 at a temperature of 27 °C.

Assuming that the pressure of the air remains constant, what is the volume of the air at a temperature of 87 °C?

1. ![C:\Users\Stephen\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\208GXVS7\MP900315517[1].jpg]()A fixed mass of gas is trapped in to a syringe. The gas has a pressure of 1.63 x 105 Pa when it has a volume of 3.0 cm3 and a temperature of 22 °C.

The gas is then heated until it has a uniform temperature of 57 °C. What will be the pressure of the gas if the volume of the gas is increased to 5.0 cm3?