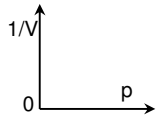
5 The relationship between the pressure and volume of a gas, at constant temperature, is known as …

A Charles's Law B Guy-Lussac's Law C Boyle's Law D Avogadro's Law (2)

6 You investigate the relationship between the volume and pressure of a mass of helium gas, first at constant temperature of 10 ºC and then at constant temperature of 30 ºC. Draw the two sketch graphs which represent the above relationship at the two different temperatures on the same system of axes. Write the appropriate temperature clearly next to each graph. (6)



7 A rubber (elastic) balloon is filled with 50 g of chlorine gas which has a volume of 1,67 X 10^{-5} m^3 at atmospheric pressure and a temperature of 10 ºC. (The chlorine does not react with the rubber.) The balloon is now attached to a submarine and taken to a depth of approximately 150 m below the surface of the sea, where the pressure is 1,5 x 10^3 kPa and the temperature is also 10 ºC.

7.1 Name the law that describes the balloon's change in volume as it moves down. (2)
7.2 Draw a graph of volume versus pressure to illustrate the law mentioned in the previous question. (3)

8 Two gas syringes X and Y each has a volume of 1,5 dm^3.
Syringe X is filled with 8 g of sulphur dioxide gas (SO_2) at a temperature of 77 ºC.
Syringe Y is filled with 8 g of helium gas (He) at a temperature of 77 ºC.
The volume of the gas in syringe X is now gradually decreased at 77 ºC.

8.1 What other physical quantity changed when the volume was decreased? (2)
8.2 Sketch a graph to illustrate the relationship between the volume of the gas and the quantity mentioned in the previous question. (2)

9 Two learners investigate the effect that changing the pressure **p** of an enclosed gas will have on its volume **V**. Some of their results are shown in the table.

Pressure (**p**) (kPa)	Volume (**V**) (cm^3)
X	23
150	20
200	15

9.1 Name the law the students were investigating. (1)
9.2 Write down for the learners' investigation the
9.2.1 independent variable; (1)
9.2.2 dependent variable; (1)
9.2.3 variables they kept constant. (2)
9.3 Calculate the value of **X** in the table. (4)
9.4 The learners use a graph to interpret the relationship between **p** and **V**.
9.4.1 Sketch the graph they obtained. (2)
9.4.2 Write down their findings. (2)

10 As a science learner Sono always wanted to do an investigation to study the change in volume with pressure for a sample of air. He decided to conduct an investigation by taking measurements of volume and pressure of an enclosed amount of air.

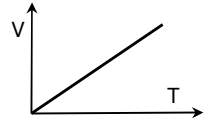
10.1 Write down an investigative question for Sono's experiment. (2)
10.2 Sono hypothesises this investigation before doing it. There are many possibilities. Give only ONE hypothesis. (2)
10.3 During this investigation ONE factor, that can change, is deliberately kept constant. Name that factor. (2)
10.4 Name ONE piece of equipment you need to conduct this investigation. (2)
10.5 Sono made 7 such measurements of pressure and the corresponding volume. He also made certain calculations and it is recorded in the table.

Pressure (p) of air in kPa	Volume of air (V) in cm^3	1/V in cm^{-3}	pV in J
150	20	0,0500 = 5,00 x 10^{-2}	3 000 x 10^{-3}
157,9	19	0,0526 = 5,26 x 10^{-2}	3 000 x 10^{-3}
166,67	18	0,0556 = 5,56 x 10^{-2}	3 000 x 10^{-3}
176,48	17	0,0588 = 5,88 x 10^{-2}	3 000 x 10^{-3}
142,9	21	0,0476 = 4,76 x 10^{-2}	3 000 x 10^{-3}
136,38	22	0,0455 = 4,55 x 10^{-2}	3 000 x 10^{-3}

Draw a graph of p vs 1/V taking p on the X-axis. (3)
10.6 What can you conclude about the values of pV in the last column in the table? (1)
10.7 Establish a mathematical relationship between p and 1/V from your graph. (2)
10.8 Name the law which describes the relationship in the previous question. (2)
10.9 State the law in words which you named in the previous question. (3)

Ideal Gases: Relationship Between V and T (Charles's Law)

- **Charles's Law**: The **volume** of an enclosed amount gas is **directly proportional** to the **kelvin temperature (and not celsius temperature), if pressure remains constant**.
- $V \alpha T$, if **pressure remains constant**.
- The **graphical representation** of the relationship between volume and kelvin temperature:
- **Charles's Law explained** using the Kinetic Theory:
From $T \alpha E_k = \frac{1}{2}mv^2$ with m constant, $T \alpha v^2$. As the temperature increases, the molecules move faster and collide harder and more often, which would tend to increase pressure. But pressure remains constant, therefore they have to move further apart, increasing the volume, in order to keep the pressure the same.



Exercise 34:

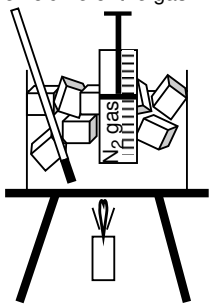
1 Give ONE word/term for

1.1 the law relating the relationship between volume and temperature at constant pressure. (1)
1.2 the quantity that has to be kept constant during an experiment illustrating Charles's Law. (1)
1.3 the mathematical relationship between temperature and volume at constant pressure. (1)

2 Which ONE of the following statements does **not** describe the property of an ideal gas?

A The molecules move spontaneously at temperatures above –273 ºC.
B The volume of the gas will double if the temperature changes from 180 ºC to 360 ºC at constant pressure.
C The molecules do not exert forces on each other, except when they collide.
D One mole of gas at STP has a volume of 0,0224 m^3. (2)

3 A fixed mass of pure nitrogen gas is placed in a calibrated syringe. The plunger of the syringe is free to move. The syringe is now placed in a beaker with ice. The temperature and the volume of the gas in the syringe are noted after 10 minutes. Thereafter the contents of the beaker are slowly heated with a Bunsen flame. The temperature and volume readings are recorded at 10-minute intervals. A graph of volume versus temperature is plotted. The boiling point of nitrogen is –196 ºC.



3.1 Write down the name of the forces that exist between the following:
3.1.1 The water molecules (1)
3.1.2 The molecules of nitrogen gas. (1)
3.2 Which factor was kept constant during this experiment? Choose ONE from temperature, pressure or volume. (1)
3.3 How does the factor in the previous question remain constant? (2)
3.4 Explain why the volume and temperature are noted at 10-minute intervals and not at 1-minute intervals. (2)
3.5 The following graph was drawn from the results obtained: At which temperature was the volume of the gas 40 cm^3? (1)
3.6 A learner argued that the volume of the gas at 80 ºC can be obtained by extrapolating from the graph.
3.6.1 Why is it reasonable to assume that extrapolation will give the correct volume at 80 ºC? (2)
3.6.2 Explain why it will not be reasonable to assume that the volume of the gas at –210 ºC can be obtained by extrapolation from the graph. (2)
3.6.3 The learner found the volume of the gas at 80 ºC to be approximately 52 cm^3 by extrapolation. Perform a calculation to verify the learner's answer. (4)