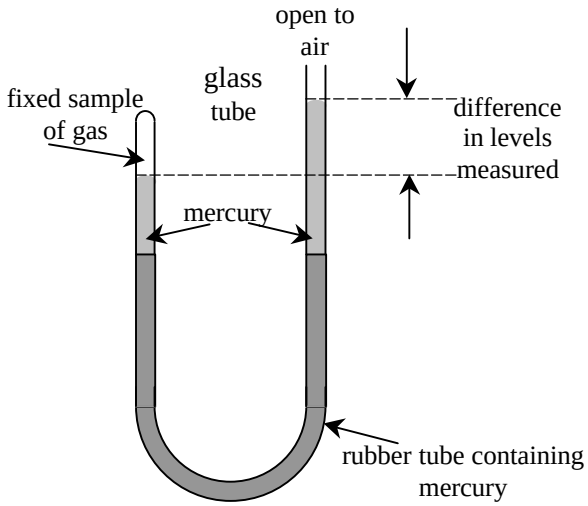
Boyle's Law	***Data***

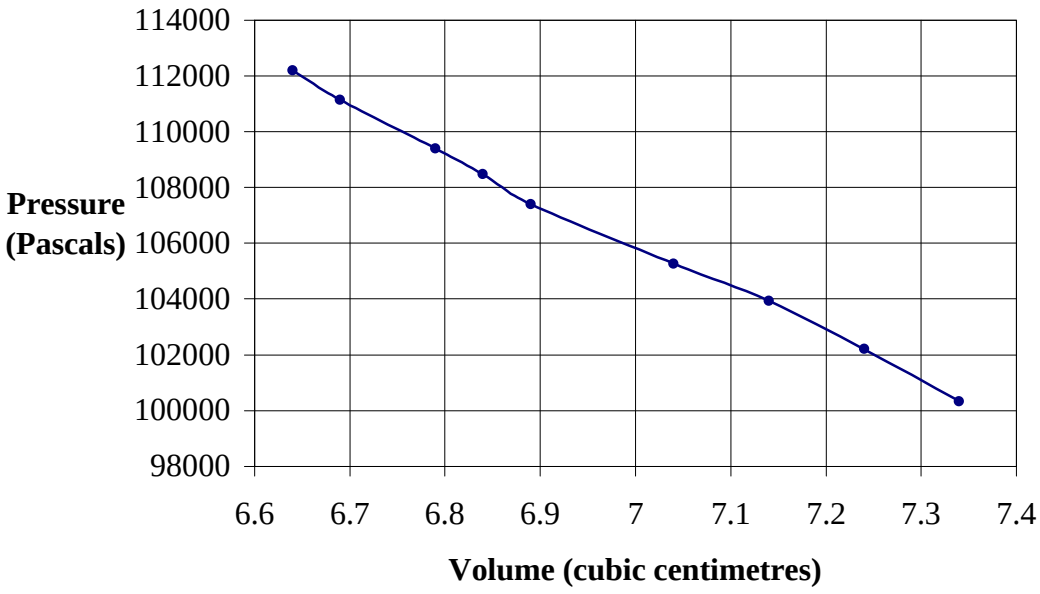
An experiment to investigate Boyle's law is carried out with the apparatus shown in the diagram. The pressure and volume of the gas (air) trapped in the closed end can be varied by raising or lowering the other end. By measuring the difference in levels of mercury in the two tubes the pressure of the gas in the closed end can be calculated. The volume of gas in this end can be calculated by assuming that the glass tube is a cylinder.

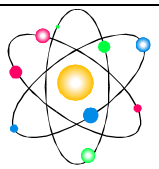
Experimental results

Volume (cubic centimetres)	Pressure (Pascals)
7.34	100330
7.24	102200
7.14	103930
7.04	105270
6.89	107400
6.84	108470
6.79	109400
6.69	111140
6.64	112200



Graph showing Pressure plotted against Volume for a sample of air in a Boyle's law experiment



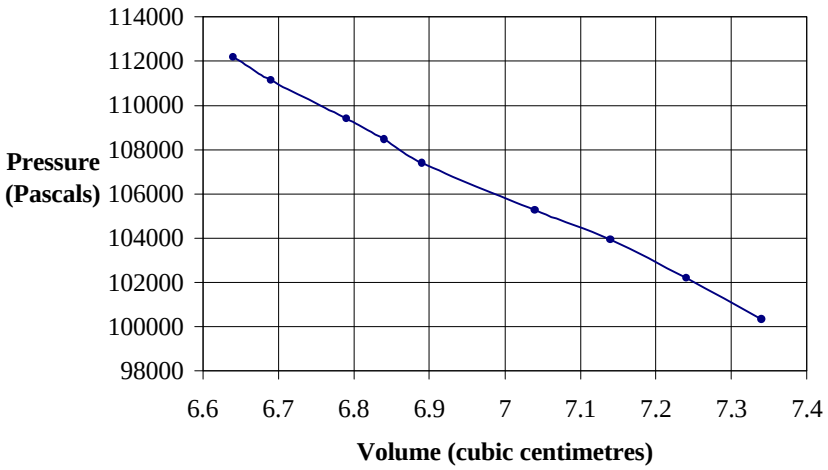
Boyle's Law	***Discussion*** 

Can we use a linear function to model the experimental data?

What do science books tell us about Boyle's Law?

Does our data fit this law?

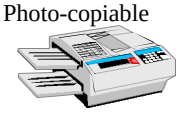
Graph showing Pressure plotted against Volume for a sample of air in a Boyle's law experiment



Can we find a function to fit our data?

What would happen where the pressure was very small? What would happen where the volume was very small? Is this realistic?

What does the gradient of the graph tell us?

Photo-copiable 

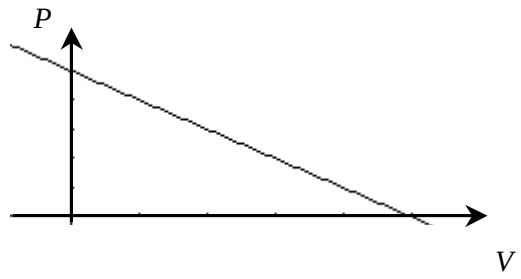
Boyle's Law	***Sample assessment question***

Throughout this question refer to the Boyle's Law Data.

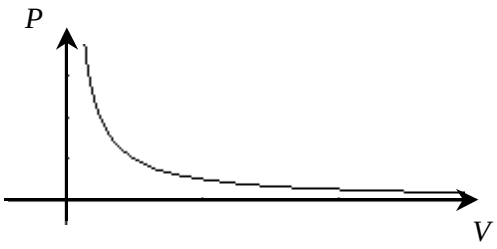
a Boyle's Law states that the pressure of a fixed sample of gas is inversely proportional to its volume. That is, $P \propto \frac{1}{V}$, and therefore $P = \frac{k}{V}$.

(i) Indicate which of the graphs below could be of a gas that obeys Boyle's Law.

A

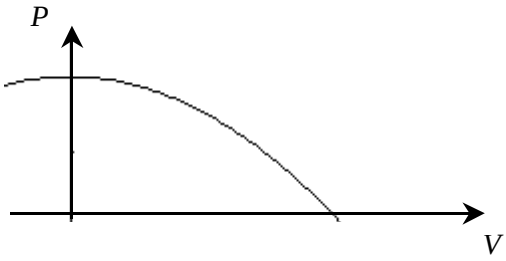


B



C

D



(ii) Explain your choice of graph by explaining what happens to the pressure of the gas when the volume is very small and very large.

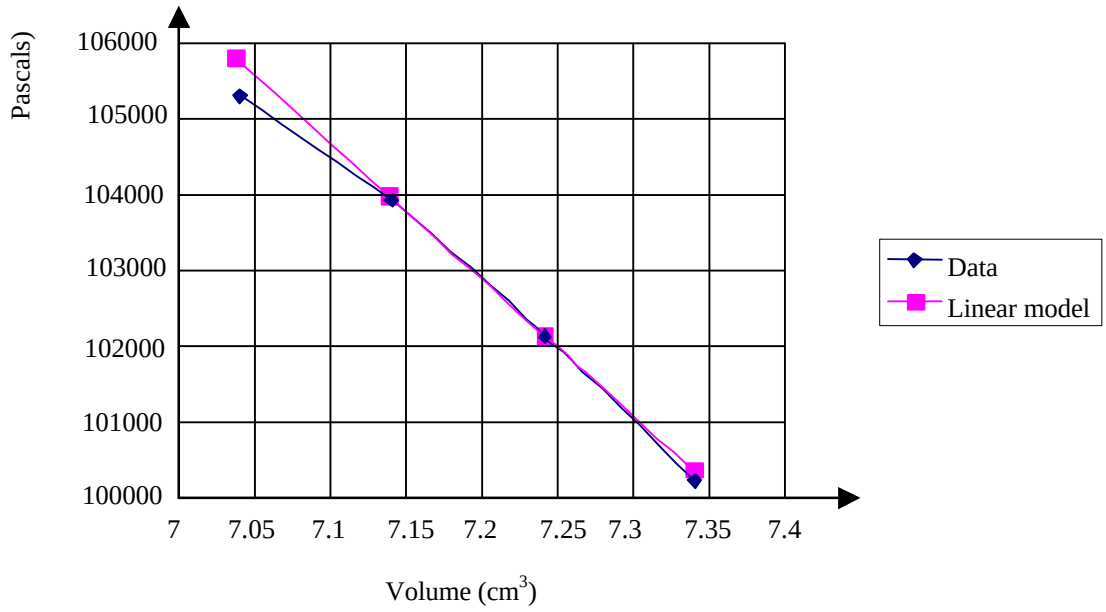
(iii) The gas used in the experiment of the data sheet is taken to obey Boyle's Law, $P = \frac{k}{V}$.

Calculate the value of k if it is assumed that the law is true when the volume of the gas is 7.04 cubic centimetres.

(iv) Use the value of k you found in part (iii) in Boyle's law to find the volume of gas when its pressure is 100000 Pascals.

b The graph below shows the first four data points plotted and a straight line that may be used to model this.

Graph showing Pressure plotted against Volume for a sample of air



(i) The straight line has the same gradient as another straight line joining the points (7.34, 100330) and (7.14, 103930).
Find the gradient of the line stating clearly its units.

(ii) The straight line passes through the point (7.24, 102200).
find the equation of the line in the form $P = aV + b$ where a and b are constants that you find.

(iii) Explain why this linear model would not be suitable for a wide range of gas pressures by referring to what it predicts at very large and small volumes.

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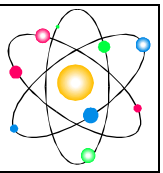
Boyle's Law	***Assignment*** 

Refer to the Boyle's Law Data.
Check calculations.

1. Draw an accurate graph showing the given data.

2. Draw the line of best fit (linear).

3. Calculate the gradient of the line and explain what information it gives.

4. Determine the equation of the line.

5. Use a graphic calculator or computer to check the equation of your line of best fit.

6. Why is the linear model not a good model in this case?

7. Consider the following models:

$P = kV^2 + c$ $P = aV^3$ $P = \frac{k}{V}$

Which of these equations could also be used to model the data?
Explain your answer carefully, using sketches of the suggested models.

8. Assuming that your chosen model is correct, estimate the value of k using the experimental value for the pressure when the volume of the gas is 7.04 cubic centimetres.

9. Use the model you have chosen and your estimate of k to

a) predict the pressure for various values of the volume (to be chosen by you)

b) draw a graph for volumes between 6.6 cm^3 and 7.4 cm^3
(by hand or using a computer)

Comment on your results.

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