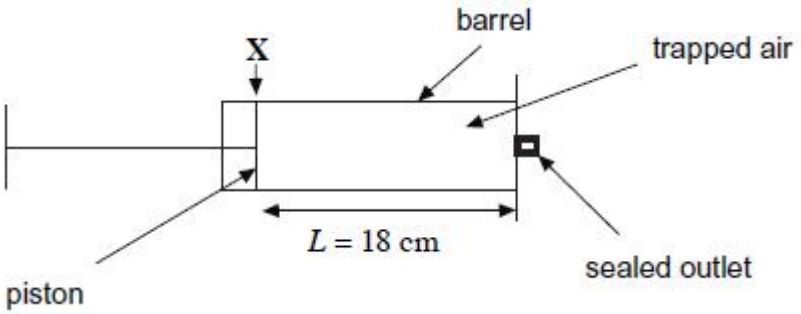
Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Q1.

Figure 1 shows the cross-section of a bicycle pump with a cylindrical barrel. The piston has been pulled to the position marked **X** and the outlet of the pump sealed.

Figure 1



The length L of the column of trapped air is 18 cm and the volume of the gas is $1.7 \times 10^{-4} m^3$ when the piston is at position **X**. Under these conditions the trapped air is at a pressure p of 1.01×10^5 Pa and its temperature is 19°C.

Assume the trapped air consists of identical molecules and behaves like an ideal gas in this question.

(a) (i) Calculate the internal diameter of the barrel.

diameter _____ m

(2)

(ii) Show that the number of air molecules in the column of trapped air is approximately 4×10^{21}.

(3)

(iii) The ratio $\frac{\text{total volume of the air molecules}}{\text{volume occupied by the column of trapped air}}$ equals 7.0×10^{-4}.

Calculate the volume of one air molecule.

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volume _____ m^3

(2)

(iv) The ratio in part **(a)(iii)** is important in supporting assumptions made in the kinetic theory of ideal gases.

Explain how the value of the ratio supports **two** of the assumptions made in the kinetic theory of ideal gases.

_____

_____

_____

_____

_____

_____

(3)

(b) The mass of each air molecule is 4.7×10^{-26} kg.

Calculate the mean square speed of the molecules of trapped air when the length of the column of trapped air is 18.0 cm.
Give an appropriate unit for your answer.

mean square speed _____ unit _____

(4)

(c) The piston is pushed slowly inwards until the length L of the column of trapped air is 4.5 cm.

Figure 2 shows how the pressure p of the trapped air varies as L is changed during this process.

Figure 2

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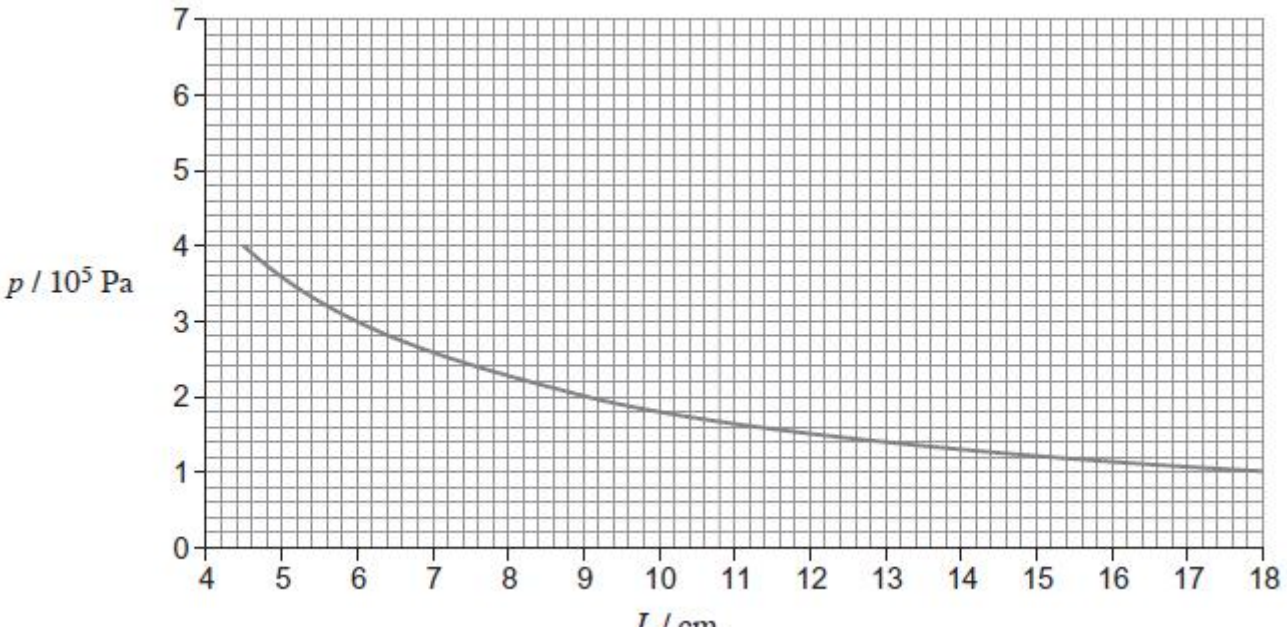

(i) Use data from **Figure 2** to show that p is inversely proportional to L.

(3)

(ii) Name the physical property of the gas which must remain constant for p to be inversely proportional to L.

_____

(1)

(d) Explain how the relationship between p and L shown in **Figure 2** can be predicted using the kinetic theory for an ideal gas.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 22 marks)

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