Oxford Cambridge and RSA

A level Physics B

H557/03 Practical skills in physics

Question Set 12

1 This question is about the behaviour of gases.

(a) The pressure p and volume V of an ideal gas are related by the equation $pV = \frac{1}{3}Nm\overline{c^2}$.

(i) Explain what is meant by an *ideal gas*.

[3]

(ii) The average kinetic energy of the particles (atoms) in an ideal gas at absolute (kelvin) temperature T is given by the equation

$$\text{average kinetic energy} = \frac{3}{2}kT$$

where k is the Boltzmann constant.

Use this equation and the equation $pV = \frac{1}{3}Nm\overline{c^2}$ to show that the pressure p of a fixed mass of an ideal gas at constant volume is directly proportional to its absolute (kelvin) temperature T.

Explain your reasoning.

[3]

(b) Argon is a gas at room temperature. You may assume that it behaves as an ideal gas at this temperature.

The molar mass of argon is 0.0399 kg mol^{-1}.

Calculate the root mean square speed of argon atoms when the gas is at a temperature of 293 K.

root mean square speed =……m s^{-1} **[3]**

(c) A student performs an experiment to investigate if the pressure of a constant volume of air is directly proportional to its absolute (kelvin) temperature.

Fig.1.1 shows the apparatus used.

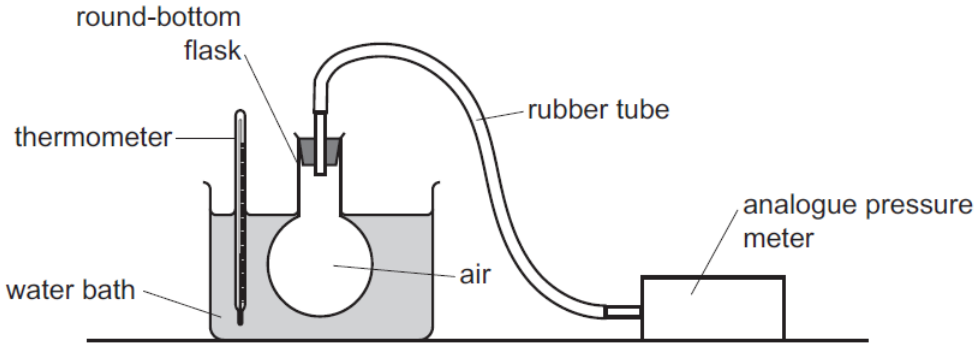

Fig.1.1

Fifteen apparently identical thermometers are available.

(i) Describe how the student can determine the uncertainty in the reading of the temperature by using all the available thermometers. **[2]**

Fig. 1.2 shows the graph of the data collected, including the uncertainty in the pressure readings.

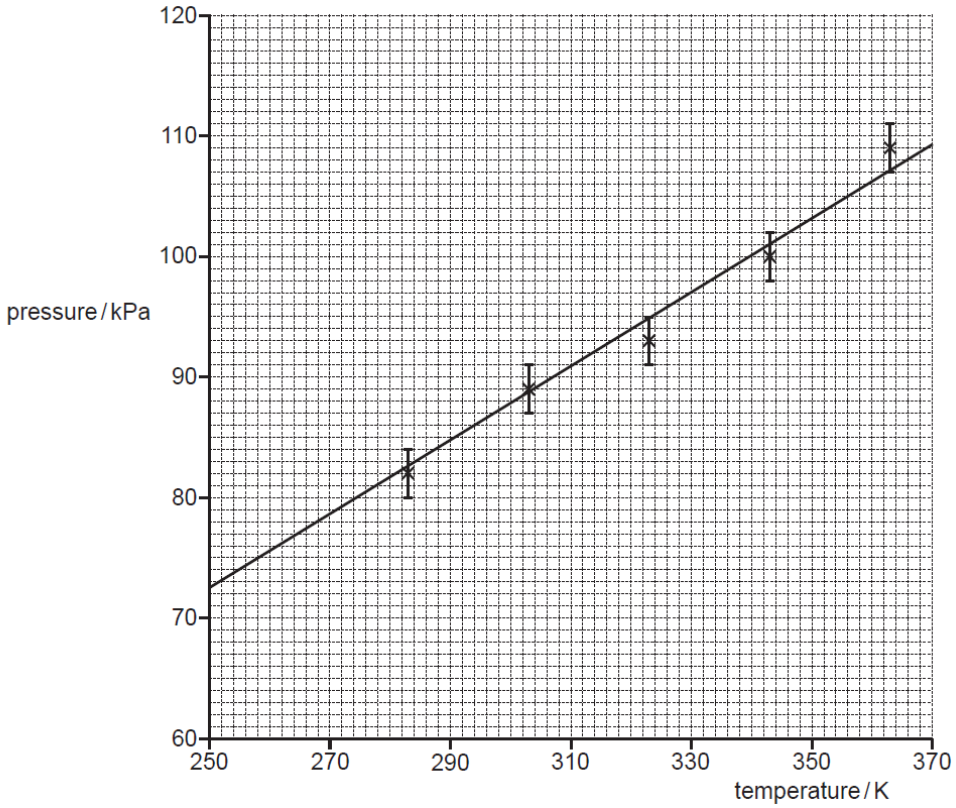

Fig. 1.2

The best-fit straight line is shown.

(ii) On **Fig. 1.2**, add a worst-fit straight line that gives the **maximum** gradient.

(iii) The gradient of the best-fit straight line suggests that the pressure of the gas will fall to zero at a temperature of about 10 K. **[1]**

Determine the gradient of your worst-fit straight line.
Use your gradient value to calculate the temperature at which the pressure falls to zero, assuming the change in pressure per unit kelvin is constant.
Show all your working.

temperature at which pressure falls to zero =.....K

[5]

(d) The student notices that the top of the round-bottom flask is above the level of the liquid in the water bath and suggests that this will produce a systematic error in the data which could account for the incorrect value for the temperature at which the gas pressure falls to zero.

The temperature of the laboratory at the time of the experiment was 25 °C

Explain what is meant by a *systematic error*. Explain how the low level of liquid in the waterbath could lead to a systematic error and assess if the error is likely to be significant.

[4]

Total Marks for Question Set 12: 21