Q1.(a) State **two** assumptions made about the **motion** of the molecules in a gas in the derivation of the kinetic theory of gases equation.

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(2)

(b) Use the kinetic theory of gases to explain why the pressure inside a football increases when the temperature of the air inside it rises. Assume that the volume of the ball remains constant.

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(3)

(c) The 'laws of football' require the ball to have a circumference between 680 mm and 700 mm. The pressure of the air in the ball is required to be between 0.60×10^5 Pa and 1.10×10^5 Pa above atmospheric pressure.

A ball is inflated when the atmospheric pressure is 1.00×10^5 Pa and the temperature is 17 °C. When inflated the mass of air inside the ball is 11.4 g and the circumference of the ball is 690 mm.

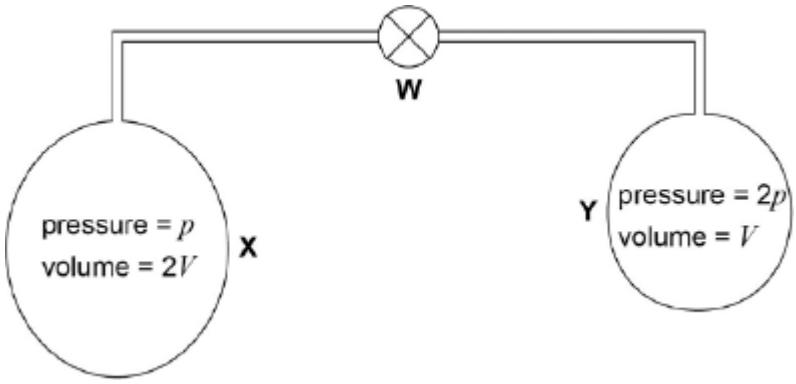
Assume that air behaves as an ideal gas and that the thickness of the material used for the ball is negligible.

Deduce if the inflated ball satisfies the law of football about the pressure.

molar mass of air = 29 g mol^{-1}

(6)
(Total 11 marks)

Q2. **X** and **Y** are two gas bottles that are connected by a tube that has negligible volume compared with the volume of each bottle.



Initially the valve **W** is closed.

X has a volume $2V$ and contains hydrogen at a pressure of p.
Y has a volume V and contains hydrogen at a pressure of $2p$.
X and **Y** are both initially at the same temperature.

W is now opened. Assuming that there is no change in temperature, what is the new gas pressure?

A $\frac{2}{3}p$ ○

B $\frac{5}{3}p$ ○

C $\frac{4}{3}p$ ○

D $\frac{3}{2}p$ ○

(Total 1 mark)

Q3.(a) Define the Avogadro constant.

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(1)

(b) (i) Calculate the mean kinetic energy of krypton atoms in a sample of gas at a temperature of 22 °C.

mean kinetic energy ..... J

(1)

(ii) Calculate the mean-square speed, $(c_{rms})^2$, of krypton atoms in a sample of gas at a temperature of 22 °C.
State an appropriate unit for your answer.

mass of 1 mole of krypton = 0.084 kg

mean-square speed..... unit .....

(3)

(c) A sample of gas consists of a mixture of krypton and argon atoms.
The mass of a krypton atom is greater than that of an argon atom.
State and explain how the mean-square speed of krypton atoms in the gas compares with that of the argon atoms at the same temperature.

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(2)
(Total 7 marks)

Q4.(a) Outline what is meant by an *ideal gas*.

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(2)

(b) An ideal gas at a temperature of 22 °C is trapped in a metal cylinder of volume 0.20 m^3 at a pressure of 1.6×10^6 Pa.

(i) Calculate the number of moles of gas contained in the cylinder.

number of moles ..... mol

(2)

(ii) The gas has a molar mass of 4.3×10^{-2} kg mol^{-1}.

Calculate the density of the gas in the cylinder.

State an appropriate unit for your answer.

density ..... unit .....

(3)

(iii) The cylinder is taken to high altitude where the temperature is −50 °C and the pressure is 3.6×10^4 Pa. A valve on the cylinder is opened to allow gas to escape.

Calculate the mass of gas remaining in the cylinder when it reaches equilibrium with its surroundings.

Give your answer to an appropriate number of significant figures.

mass ..... kg

(3)

(Total 10 marks)

Q5. The pressure inside a bicycle tyre of volume 1.90×10^{-3} m^3 is 3.20×10^5 Pa when the temperature is 285 K.

(i) Calculate the number of moles of air in the tyre.

answer = ... mol

(1)

(ii) After the bicycle has been ridden the temperature of the air in the tyre is 295

K.
Calculate the new pressure in the tyre assuming the volume is unchanged.
Give your answer to an appropriate number of significant figures.

answer = ... Pa

(3)

(b) Describe **one** way in which the motion of the molecules of air inside the bicycle tyre is similar and **one** way in which it is different at the two temperatures.

similar .....

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different .....

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(2)
(Total 6 marks)