SL HL Paper 3 Section A Experimental work (1)

A student devised an experiment to determine the molar mass of an unknown gas **X**.

Firstly, he filled a glass gas syringe (accurate to ± 0.5 cm^3) with 100 cm^3 of air then placed a rubber seal over the nozzle and weighed the syringe.
He then emptied the gas syringe, refilled it with 100 cm^3 of the unknown gas **X**, replaced the rubber seal and reweighed the syringe.
Finally, he measured the temperature of the room.

He obtained the following data:

Mass of syringe + 100 cm^3 of air	186.293 ± 0.001 g
Mass of syringe + 100 cm^3 of unknown gas **X**	186.358 ± 0.001 g
Temperature	20.0 ± 0.5 °C

In order to calculate the mass of the unknown gas **X** the student made the following assumptions:

The atmospheric pressure = 100 kPa
Air contains 80% nitrogen and 20% oxygen by volume so has a 'molar mass' equivalent to 28.8 g mol^{-1}.

Due to Archimedes' Principle, a syringe containing 100 cm^3 of air appears to have the same mass as a syringe containing 0 cm^3 of air.

(a) Determine the mass of 100 cm^3 of air at 20 °C. ***[2]***

(b) Determine the mass of 100 cm^3 of **X** at 20 °C. ***[1]***

(c) Show that the molar mass of **X** is equal to 44.7 g mol^{-1} ***[1]***

(d) The accepted value for the molar mass of **X** is 44.0 g mol^{-1}. Calculate the percentage error in the student's result. ***[1]***

(e) Identify, with a reason, the piece of equipment used that had the largest percentage uncertainty associated with the result. ***[1]***

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