Gas Laws Test Answers

Q1.

(a) **easily changed to gas / easily vaporised / low boiling point** (5)

(b) **diagram** (3) **mass** (4 × 3) **volume** (3) **temperature** (3)

<u>Method 1</u>

diagram: flask, sealed (covered) with foil with small hole (pinhole)* , immersed so that at least half is under water. ** Accept if hole mentioned in account of experiment.* Label required: any <u>one</u> correct label. (3)

mass: get mass of flask and foil (3)
[add liquid and arrange as in diagram]
heat until liquid gone / heat until flask appears empty / vaporised (3)
cool (dry) and reweigh (3)
get mass of sample by subtraction (Get difference) (3)

volume: fill flask and empty into graduated (measuring) cylinder (3) *Accept method using mass & density*

temperature: use thermometer (probe, sensor) to read temperature of water (or got from diagram). (3)
Note: temperature of water or steam cannot be assumed to be 100 °C.

<u>Method 2</u>.

diagram: gas syringe with self-sealing cap (septum cap, can be shown sealed), surrounded by heating device (oven, steam jacket, beaker of water). Label required: any <u>one</u> correct label. (3)

mass: get mass of hypodermic (syringe) containing liquid (3)
inject some liquid into gas syringe (3)
reweigh hypodermic (syringe) (3)
get mass by subtraction (Get difference) (3)

volume: read from gas syringe. (3)

temperature: read from thermometer (probe, sensor) in heating device (or got from diagram). (3)
Note: temperature of water or steam cannot be assumed to be 100 °C.

(c) **barometer / bourdon guage / barograph (barothermograph) / pressure sensor (not probe)** (6)
"pressure gauge" not acceptable.

(d) **0.0031 / 0.00309** mol (12)

$T = 97 + 273 = 370$ (3)

$V = 95 \times 10^{-6}\ \text{m}^3 / 0.000095\ \text{m}^3$ (3)

$n = \dfrac{PV}{RT} = \dfrac{1 \times 10^5 \times 95 \times 10^{-6}}{8.3 \times 370}$ (3)

$= 0.00309 / 0.0031$ (3)

$T = 97 + 273 = 370$ (3)

$\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2} \Rightarrow \dfrac{1 \times 10^5 \times 95}{370} = \dfrac{1.013 \text{ (or 1)} \times 10^5 \times V_2}{273}$ (3)

$V_2 = 69.2 / 69.19$ (or $70.1 / 70.09$) cm^3 (3)

$\dfrac{69.2 / 69.19 \text{ (or } 70.1 / 70.09)}{22400} = 0.00309 / 0.00313 / 0.0031$ (3)

(e) M_r = **89** [or any answer that gives 87.5 – 90] (6)

$M_r = \dfrac{0.275^*}{0.0031}$ (3) $= 89$ (3)

**If this fraction is incorrect, both (3)s are lost. If clear that an error was made in taking down 0.275 from paper (e.g. 0.27), treat as slip (–1).*

Q2

(a) (i) WHAT: perfectly **obeys the gas laws (Boyle's law, kinetic theory, *PV = nRT*)** under all conditions of temperature and pressure (4)

(ii) GIVE: **intermolecular forces (attractions between molecules, named correct intermolecular force) / molecules have volume (molecules take up space, volume of molecules not negligible) / collisions not** perfectly **elastic** ANY ONE: (3)

(iii) MOLES: **0.03** mol (9)

$PV = nRT$	$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}$
$1 \times 10^5 \times \mathbf{720 \times 10^{-6}} = n \times 8.3 \times \mathbf{283}$ (2 x 3)	$\frac{1 \times 10^5 \times 720}{\mathbf{283}} = \frac{1 \times 10^5 \text{ (or } 1.013 \times 10^5) \times V_2}{273}$
$n = \mathbf{0.03}$ (3)	$V_2 = 685 \text{ to } 695$ (2 x 3)
	$\div$ **22400** = **0.03** (3)

[Marks in context of correct operations. *Not given correct to one significant figure* (–1)]

(iv) MOLECULES: $\mathbf{1.8 \times 10^{22}}$ | $0.03 \times 6 \times 10^{23} = 1.8 \times 10^{22}$ (3) | (3)

(v) MASS: **2.22** g (6)

0.03 mol CO_2 ≡ 0.03 mol $Ca(OH)_2$ (3)** 0.03 x 74* = 2.22 (3)
[* *Addition must be shown for error to be treated as a slip.*]

** *Can be given for 1 : 1 ratio or for 0.03 mol* $Ca(OH)_2$