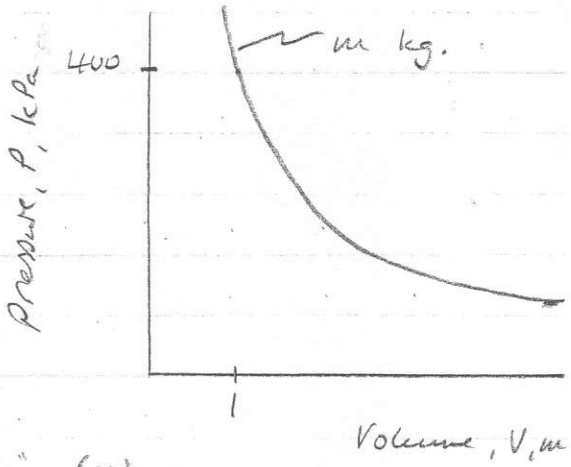
The Gas Laws – all 3 of them.

errors sorted Feb. '00

AT Physics

Data ... – 1 mole of gas = 6×10^{23} molecules – $T(K) = \theta + 273°C$ – Molar gas constant $R = 8.3$ J/K – 1 atmosphere = 100 kPa = 1×10^5 Pa

1. The graph shows how p and V change for a mass m kg of a gas. Sketch and explain curves for $m/2$ kg and $2m$ kg of the gas (4)



2. a) What are the key assumptions about an ideal gas? (2)

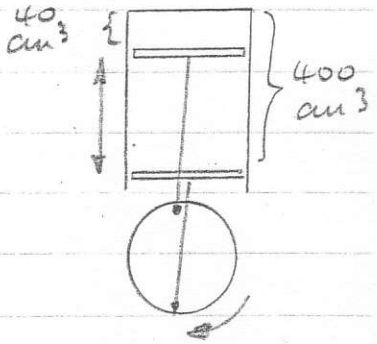
b) When do real gases not behave like ideal gases, and why? (4)

3. a) A car tyre when cold at 5 °C has a pressure of 220 kPa. What is the pressure in atmospheres? (1)

b) After a long journey the tyre temperature is 20 °C. What is the new pressure? (2)

c) The tyre blows out at a pressure of 265 kPa – What temperature? (2)

4. (a) In the cylinder of the car engine, 400 cm^3 of air/petrol is drawn in at 20 °C and 1 atmosphere. It is compressed to 40 cm^3 and burnt, heating up to 400 °C. What is the new pressure of the hot compressed gas? (3)

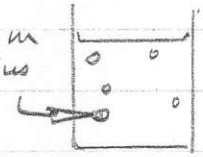


(b) The gas is allowed to expand back to 400 cm^3 and cool to 200 °C. New pressure? (2)

5. How many moles of air particles are in 1 m^3 at 20 °C & 1 atm.?

6. Bubbles of CO_2 form in a glass of cola.

a) What is the volume (in m^3) of a 1 mm radius bubble? ($V_{sphere} = 4/3 \pi r^3$) (2)



b) How many molecules of CO_2 are in a bubble at 20 °C, 1 atm? (4)

7. Richard Branson's or another balloon trip

a) moles of air? (2) b) Volume at high altitude? (2). If the balloon's safe maximum volume is 3000 m^3 and T stays at -10 °C, what is the minimum pressure the balloon can stand? (3)

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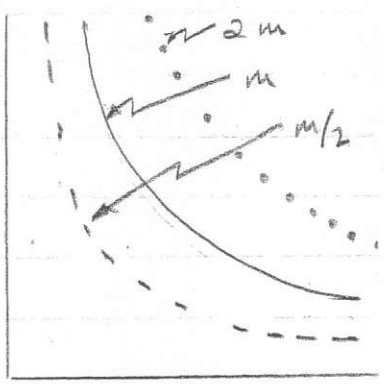
Gas Laws — Answers

Physics

1 m/2 : half the no. of particles, so pressure or volume is halved (2)
2m : vice versa (2) [4]



2. a) – particles/molecules have no size
– particles have no mutual attraction

b) Real gases...
– at high pressures (1) – when particles are forced close together (1)
– at low temp (1) – when particles have little K.E. (1) and even a weak attraction can have an effect (1) [6]

3. a) 220 kPa = 220/100 = 2.2 atm. (1)

b) constant volume... so $P_1/T_1 = P_2/T_2$ (1) $\rightarrow P_2 = P_1 \times \frac{T_2}{T_1} = 2.2 \times \frac{(273+20)}{(273+5)} = 2.32$ atm (1)

Since the T has increased by 1.05×, then P must ↑ by the same ratio

c) Blow out.... $P_1/T_1 = P_2/T_2 \rightarrow T_2 = \frac{P_2}{P_1} \times T_1 = \frac{265}{220} \times (273+5) = 335\,K = 62\,^\circ C$ (2) [5]

4. a) Use $P_1V_1/T_1 = P_2V_2/T_2$ (1) $\Rightarrow P_2 = P_1 \times \frac{V_1}{V_2} \times \frac{T_2}{T_1} = 1 \times \frac{400}{40} \times \frac{673}{293}$ (1) $= 23$ atm. (1) (3

b) Once more...

now $P_2 = P_1 \times \frac{V_1}{V_2} \times \frac{T_2}{T_1} = 23 \times \frac{40}{400} \times \frac{473}{673} = 1.6$ atm

{ condition 1 = hot, compressed
condition 2 = cooler expanded }

5. use $PV = nRT$ (1) $\rightarrow n = PV/RT = 1\times10^5 \times 1/8.3\times293 = 41$ (1) moles (2)

($r = 1\times10^{-3}$ m (1))

6. a) Bubbles.... $V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi \times 1\times10^{-9} = 4.2\times10^{-9}\,m^3$

b) $PV = nRT$ (1) $\rightarrow n = PV/RT = 1\times10^5 \times 4.2\times10^{-9} / 8.3\times293$ (1) $= 1.7\times10^{-7}$ (1) moles

Since 1 mole = 6×10^{23} particles, this is (only) 1.0×10^{17} (1) CO_2 molecules

7. Richard Branson...

a) $PV = nRT \rightarrow n = PV/RT = 1\times10^5 \times 500/8.3\times288$ (1) $= 20{,}917$ moles (2)

b) high altitude... can use $PV = nRT \rightarrow V = nRT/p = 20{,}917 \times 8.3 \times 263$ (1) $/ 0.2\times10^5$

or... use $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow V_2 = \frac{P_1}{P_2}\frac{T_2}{T_1} \times V_1$ = Same! $= 22.82\ m^3$

c) minimum pressure.... use $PV = nRT$ (1)

so $P_{min} = nRT/V_{max} = 20{,}917 \times 8.3 \times 263/3000 = 15{,}220$ (1) Pa (1)

(0.15 atm)

phew!

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Q...	1	2	3	4	5	6	7	Total
	/4	/6	/5	/5	/2	/6	/7	/35 (hard earned!)

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