# Chapter G

# Gases and Thermal Physics

$^{7}/_{8}$

## G1 Kelvin Scale of Temperature

Convert the following temperatures into the 'other' unit. Remember that $0\ ^\circ$C = $273$ K (no $^\circ$ in K).

G1.1 $23\ ^\circ$C

G1.2 $90$ K

G1.3 $4$ K

G1.4 $300$ K

G1.5 $600\ ^\circ$C

G1.6 $-90\ ^\circ$C

G1.7 $37\ ^\circ$C

G1.8 $1.5 \times 10^7\ ^\circ$C

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## G2 Gas Laws

Don't forget that one mole of gas contains $6.02 \times 10^{23}$ molecules, and that the mass of this number of molecules is called the 'molar mass'. Take the gases to be ideal.

G2.1 What is the volume of a mole of gas at atmospheric pressure ($1.01 \times 10^5$ Pa) and at $20\ ^\circ$C?

G2.2 Calculate the density of nitrogen gas at atmospheric pressure and at $20\ ^\circ$C if the mass of a mole of nitrogen molecules is $0.028$ kg.

G2.3 How many molecules of gas do you need in a $100$ cm$^3$ cylinder to exert a pressure of $1.0 \times 10^8$ Pa at a temperature of $800\ ^\circ$C?

G2.4 In the table fill out the missing initial ('$_1$') or final ('$_2$') values:

| $P_1$ /Pa | $V_1$ /cm$^3$ | $T_1$ /K | $P_2$ /Pa | $V_2$ /cm$^3$ | $T_2$ /K |
|---|---|---|---|---|---|
| $1.01 \times 10^5$ | 30 | 300 | (a) | 20 | 300 |
| $1.01 \times 10^5$ | 30 | 300 | (b) | 30 | 373 |
| $1.01 \times 10^7$ | 2.0 | 600 | $1.01 \times 10^5$ | (c) | 300 |
| $1.01 \times 10^5$ | 500 | (d) | $1.01 \times 10^7$ | 10 | 4.0 |

G2.5 A tyre contains $800$ cm$^3$ of air at a pressure of about $5.0 \times 10^5$ Pa at $9.0$ °C. After a cycle ride, the volume is $810$ cm$^3$ and the temperature is now $25$ °C. Assuming that none of the gas has leaked, what is the new pressure?

G2.6 A tyre contains $800$ cm$^3$ of air at a pressure of about $5.0 \times 10^5$ Pa at $9.0$ °C. After a cycle ride, the volume is $760$ cm$^3$, the temperature is now $25$ °C, and the pressure is $4.0 \times 10^5$ Pa. What percentage of the gas molecules have leaked out?

G2.7 A water fire extinguisher contains $4.0$ litres of air at $10^7$ Pa and $20$ °C. When the extinguisher is used, this gas forces the water out. Calculate the pressure when the volume has increased to $10$ litres and the temperature has dropped to $3.0$ °C.

## G3 Heat Capacity

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Data: Specific heat capacity of water = $4180$ J kg$^{-1}$ K$^{-1}$
Specific heat capacity of aluminium = $880$ J kg$^{-1}$ K$^{-1}$
Specific heat capacity of iron = $435$ J kg$^{-1}$ K$^{-1}$
Specific heat capacity of paraffin = $2130$ J kg$^{-1}$ K$^{-1}$

G3.1 Complete the values in the table :

| Energy /J | Material | Mass /kg | Initial temperature | Final temperature |
|---|---|---|---|---|
| (a) | Aluminium | 0.290 | 15 °C | 82 °C |
| 45 200 | Paraffin | 2.30 | 3.0 °C | (b) |
| 81 000 | Water | 1.50 | 11 °C | (c) |