Gas Temperature

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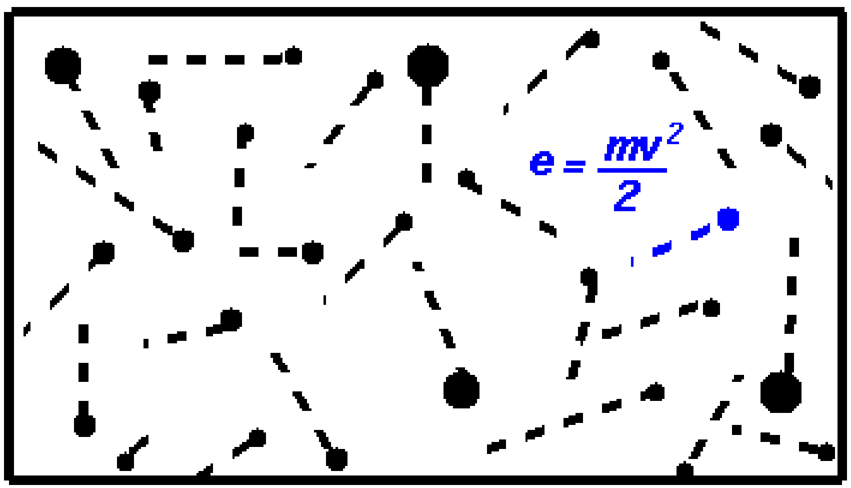
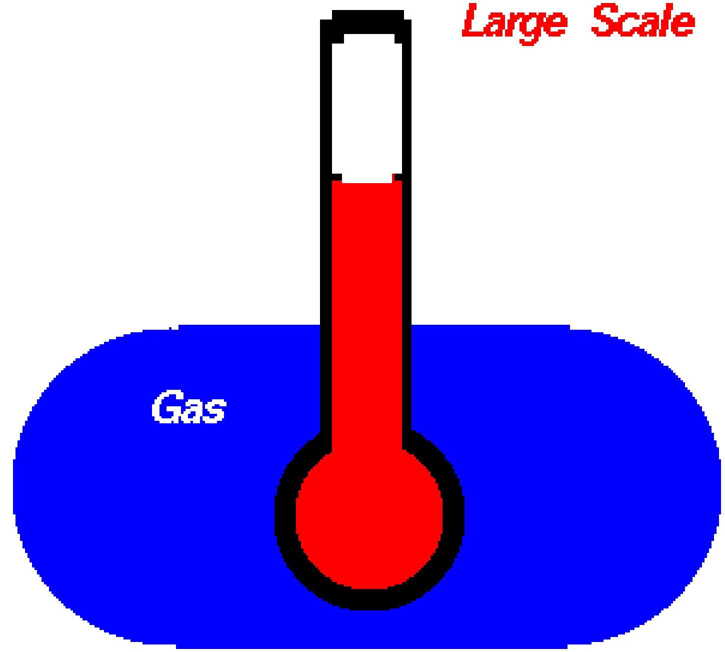
Small Scale

m = mass   v = velocity
e = kinetic energy



Temperature is a measure of the average kinetic energy of translation of the gas molecules.

Large Scale



Objects in thermal equilibrium have the same temperature.

Temperature is a scalar quantity.
(magnitude, no direction)

Gas Pressure

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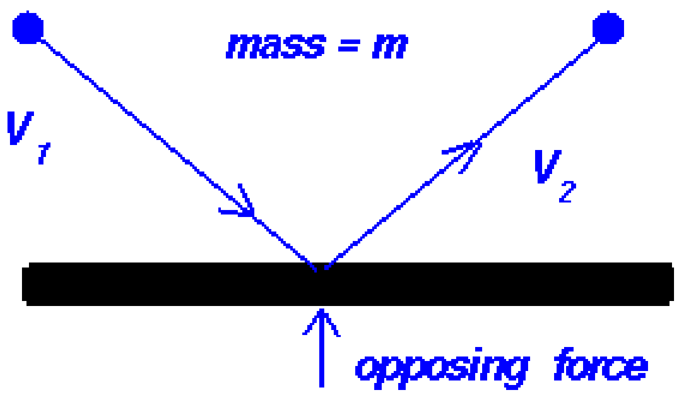
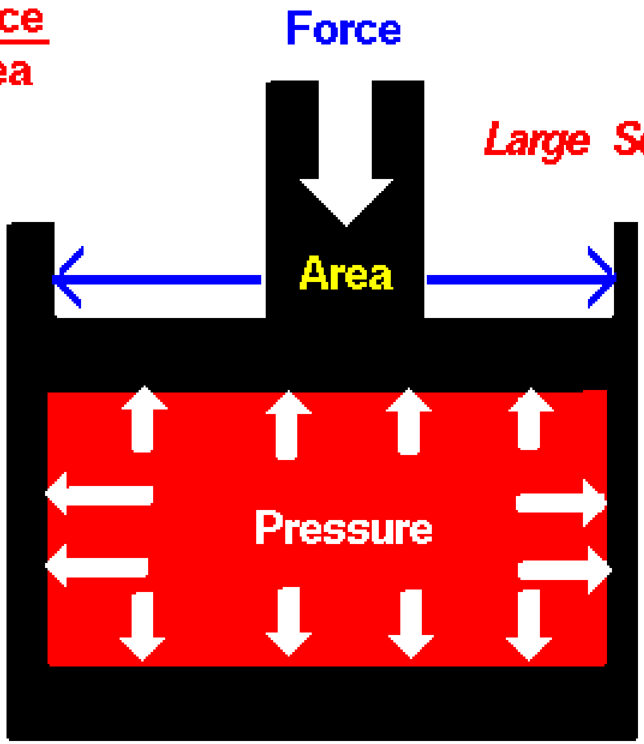
Pressure is $\dfrac{\text{Force}}{\text{Area}}$

Small Scale



Large Scale



Pressure is a measure of the linear momentum of the gas molecules.

Pressure force acts perpendicular to enclosing surfaces.

Pressure is a scalar quantity.
(magnitude, no direction)

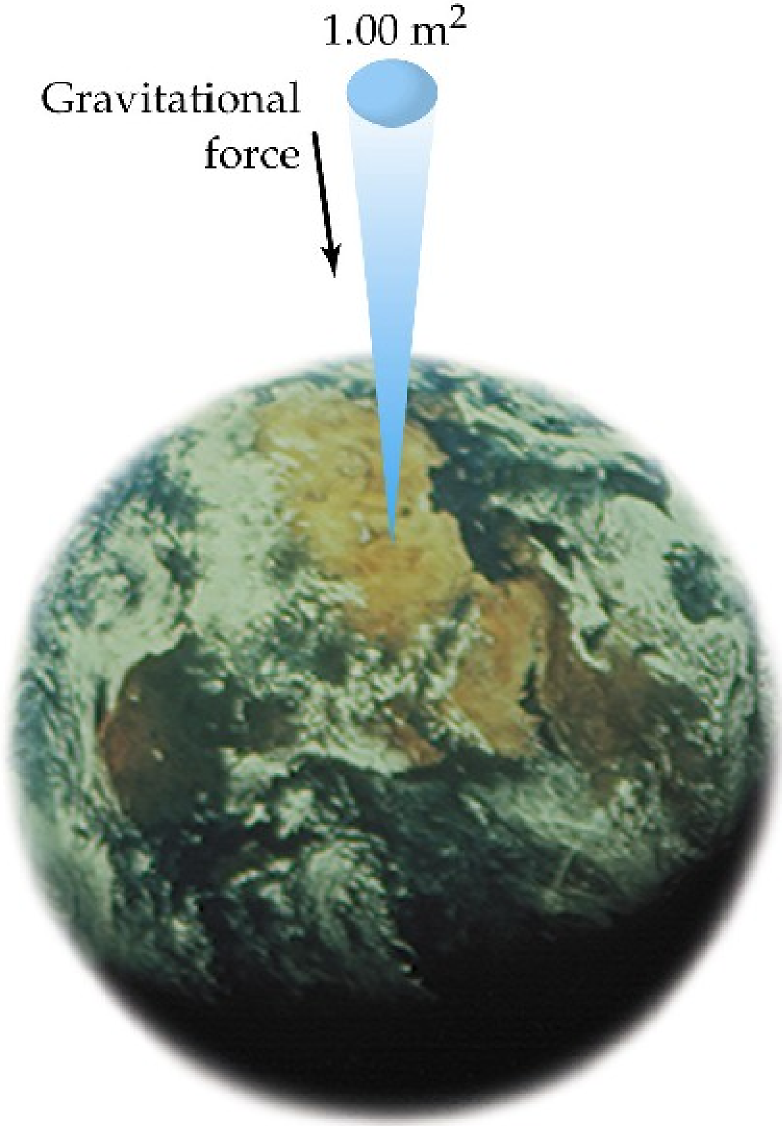

1.00 m^2
Gravitational force

Table 1.1 Pressure units

Name	Symbol	Value
pascal	1 Pa	$1\ N\ m^{-2}$, $1\ kg\ m^{-1}\ s^{-2}$
bar	1 bar	10^5 Pa
atmosphere	1 atm	101.325 kPa
torr	1 Torr	(101 325/760) Pa = 133.32 . . . Pa
millimetres of mercury	1 mmHg	133.322 . . . Pa
pound per square inch	1 psi	6.894 757 . . . kPa

Table 1-1
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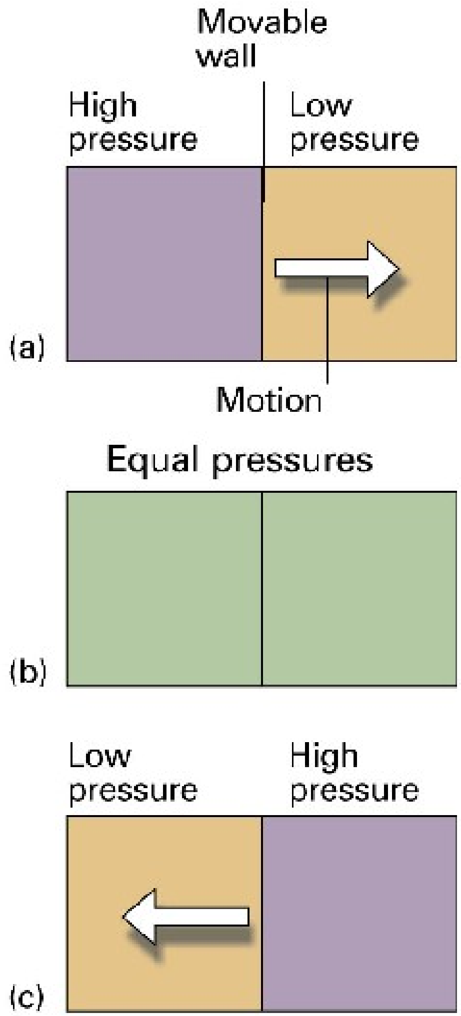

Fig. 1.1 When a region of high pressure is separated from a region of low pressure by a movable wall, the wall will be pushed into one region or the other, as in (a) and (c). However, if the two pressures are identical, the wall will not move (b). The latter condition is one of mechanical equilibrium between the two regions.

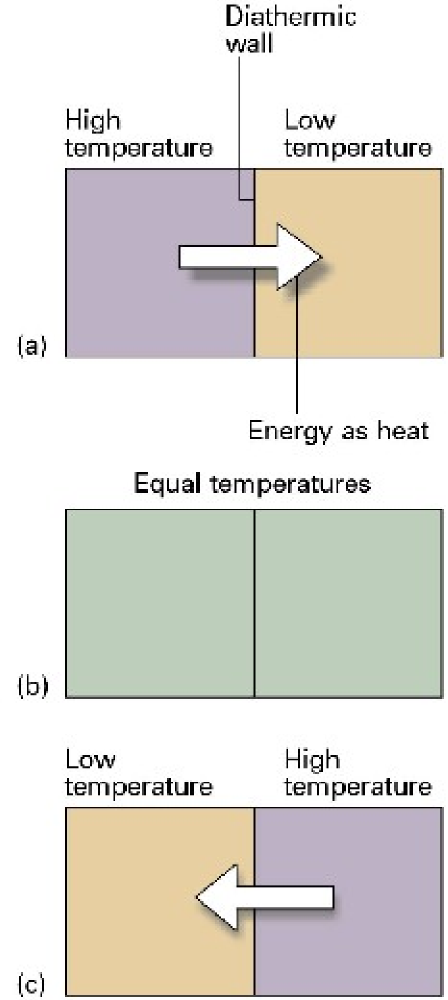

Fig. 1.2 Energy flows as heat from a region at a higher temperature to one at a lower temperature if the two are in contact through a diathermic wall, as in (a) and (c). However, if the two regions have identical temperatures, there is no net transfer of energy as heat even though the two regions are separated by a diathermic wall (b). The latter condition corresponds to the two regions being at thermal equilibrium.

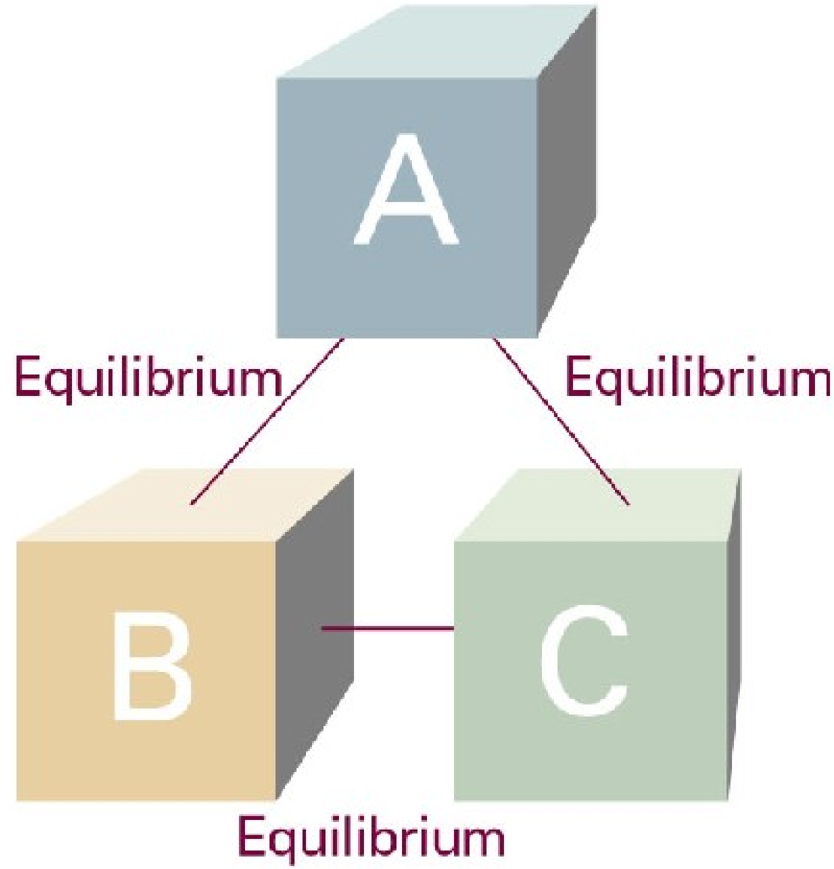

Fig. 1.3 The experience summarized by the Zeroth Law of thermodynamics is that, if an object A is in thermal equilibrium with B and B is in thermal equilibrium with C, then C is in thermal equilibrium with A.

Table 1.2 The gas constant

R	
8.314 47	$J\ K^{-1}\ mol^{-1}$
$8.205\ 74 \times 10^{-2}$	$dm^3\ atm\ K^{-1}\ mol^{-1}$
$8.314\ 47 \times 10^{-2}$	$dm^3\ bar\ K^{-1}\ mol^{-1}$
8.314 47	$Pa\ m^3\ K^{-1}\ mol^{-1}$
1 62.364	$dm^3\ Torr\ K^{-1}\ mol^{-1}$
1.987 21	$cal\ K^{-1}\ mol^{-1}$

Table 1-2
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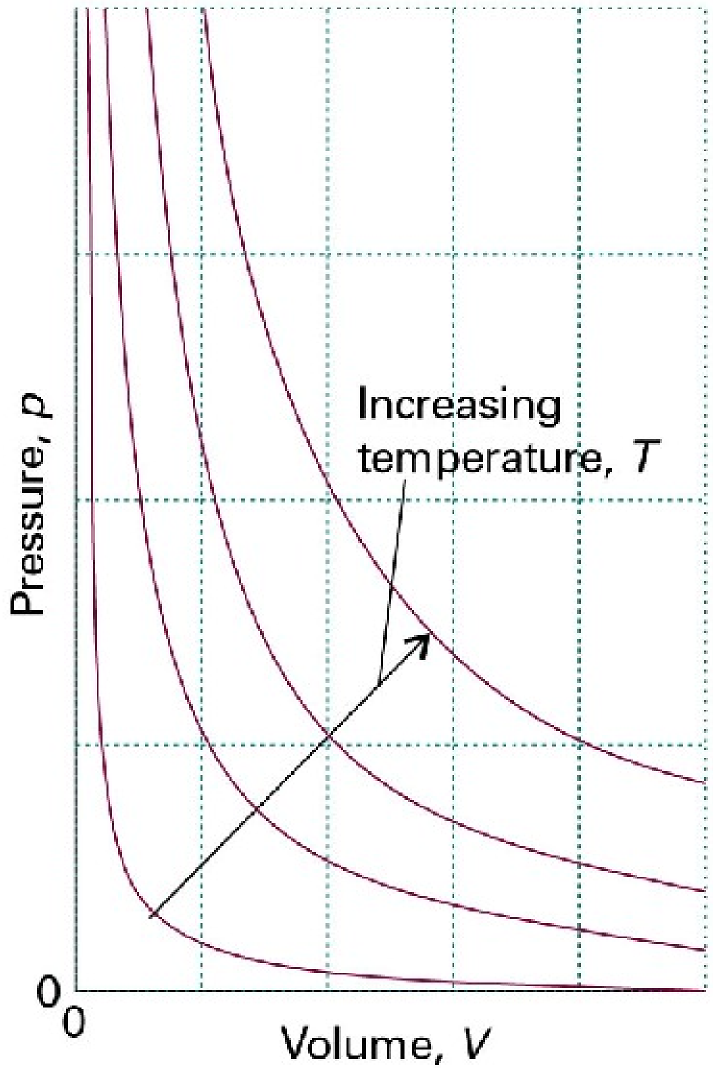

Fig. 1.4 The pressure–volume dependence of a fixed amount of perfect gas at different temperatures. Each curve is a hyperbola (pV = constant) and is called an *isotherm*.

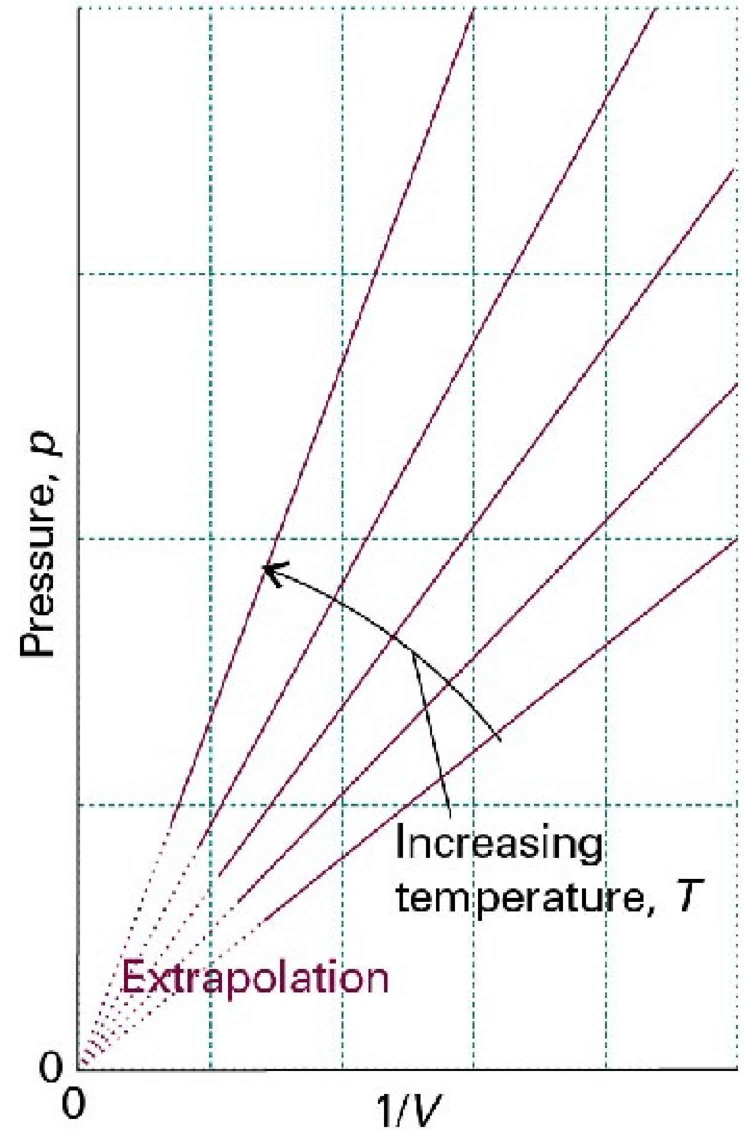

Fig. 1.5 Straight lines are obtained when the pressure is plotted against $1/V$ at constant temperature.

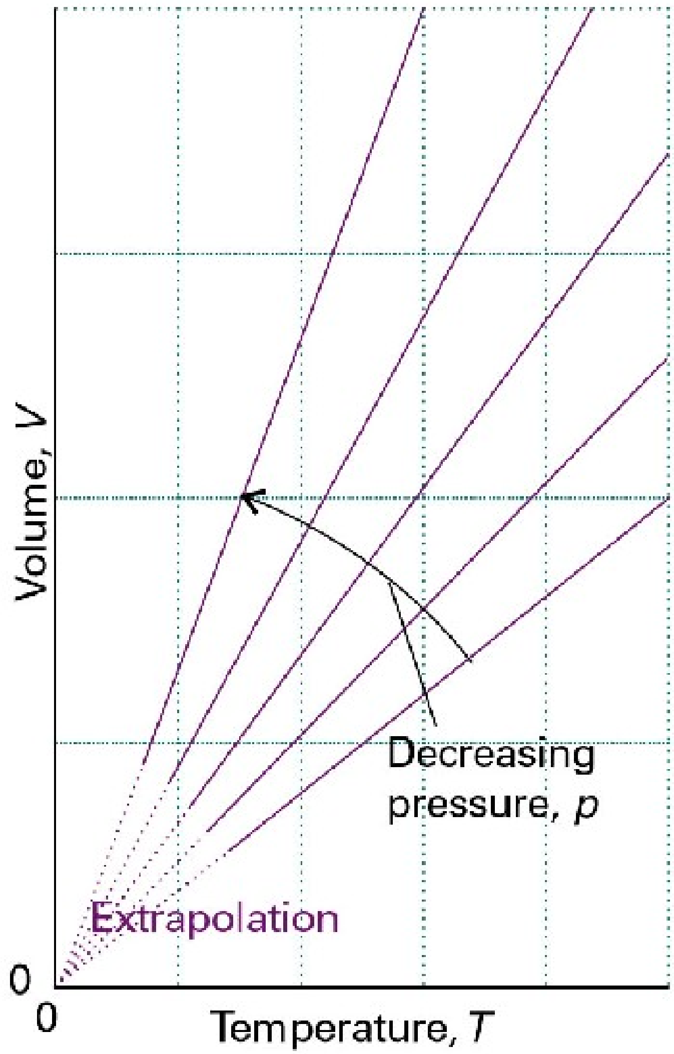

Fig. 1.6 The variation of the volume of a fixed amount of gas with the temperature at constant pressure. Note that in each case the isobars extrapolate to zero volume at $T = 0$, or $\theta = -273°C$.

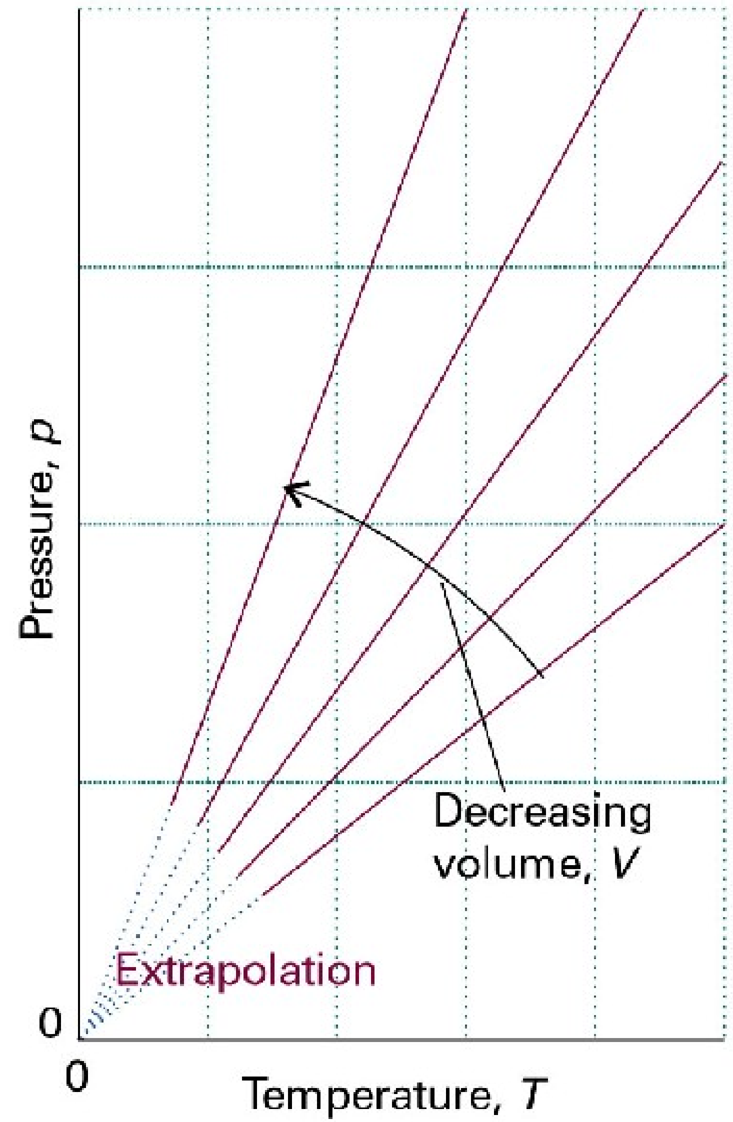

Fig. 1.7 The pressure also varies linearly with the temperature at constant volume, and extrapolates to zero at $T = 0$ ($-273°C$).

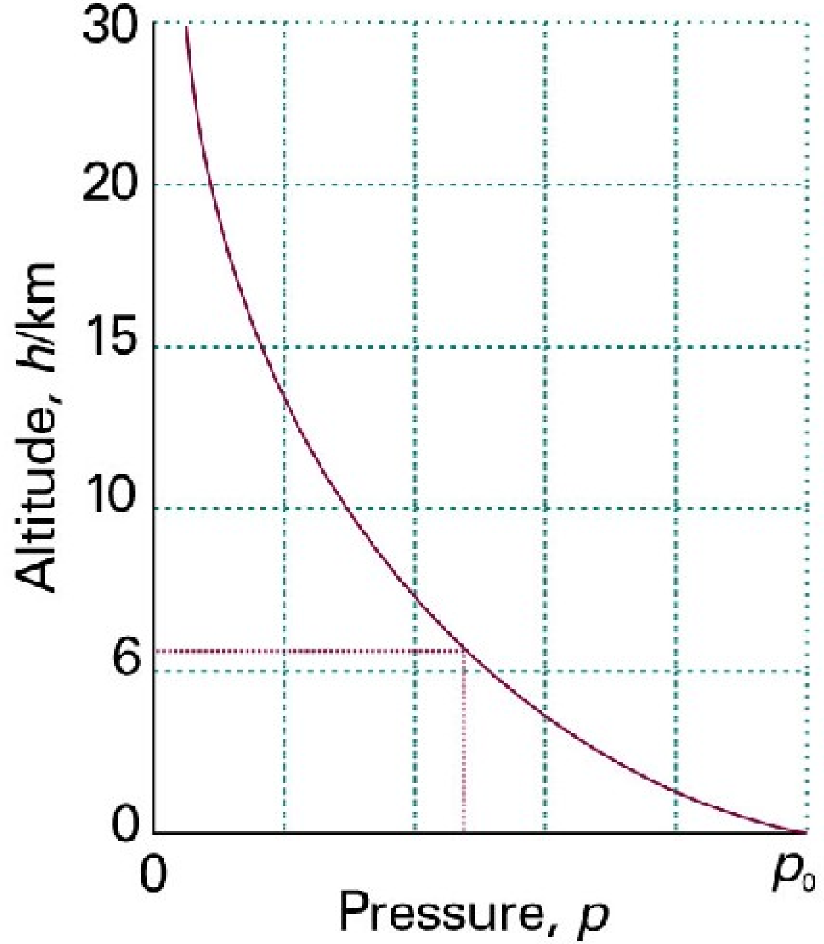

Fig. 1.10 The variation of atmospheric pressure with altitude, as predicted by the barometric formula and as suggested by the 'US Standard Atmosphere', which takes into account the variation of temperature with altitude.

Table 1.3 The composition of dry air at sea level

Component	Percentage	
	By volume	By mass
Nitrogen, N_2	78.08	75.53
Oxygen, O_2	20.95	23.14
Argon, Ar	0.93	1.28
Carbon dioxide, CO_2	0.031	0.047
Hydrogen, H_2	5.0×10^{-3}	2.0×10^{-4}
Neon, Ne	1.8×10^{-3}	1.3×10^{-3}
Helium, He	5.2×10^{-4}	7.2×10^{-5}
Methane, CH_4	2.0×10^{-4}	1.1×10^{-4}
Krypton, Kr	1.1×10^{-4}	3.2×10^{-4}
Nitric oxide, NO	5.0×10^{-5}	1.7×10^{-6}
Xenon, Xe	8.7×10^{-6}	1.2×10^{-5}
Ozone, O_3: summer	$7.0 \quad 10^{-6}$	$1.2 \quad 10^{-5}$
winter	$2.0 \quad 10^{-6}$	$3.3 \quad 10^{-6}$

Table 1-3
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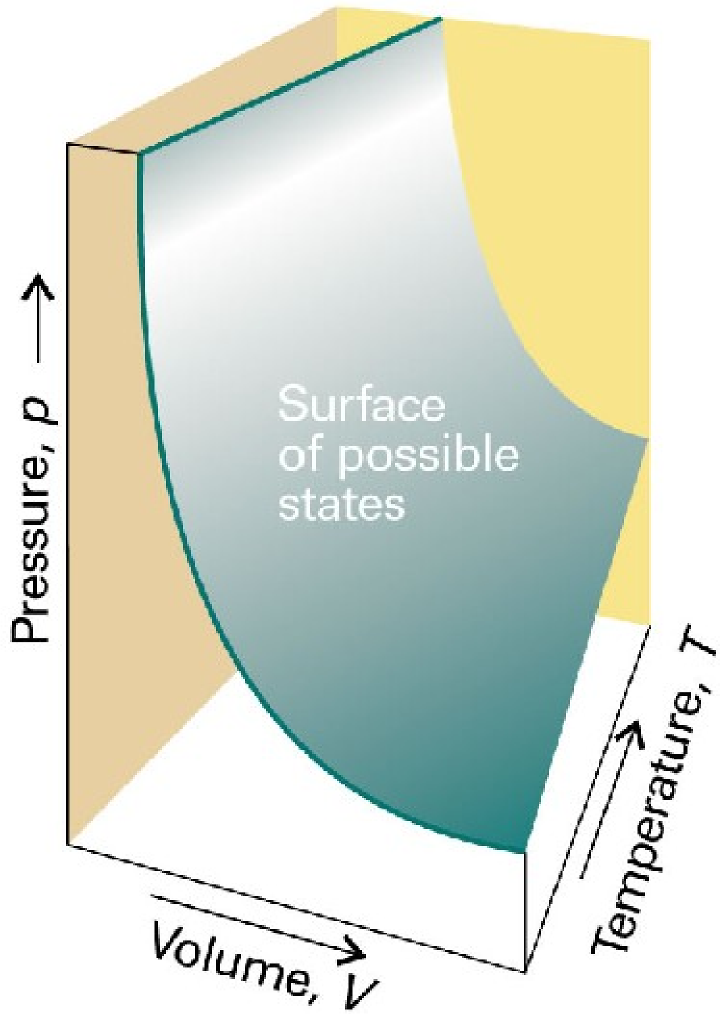

Fig. 1.8 A region of the p,V,T surface of a fixed amount of perfect gas. The points forming the surface represent the only states of the gas that can exist.

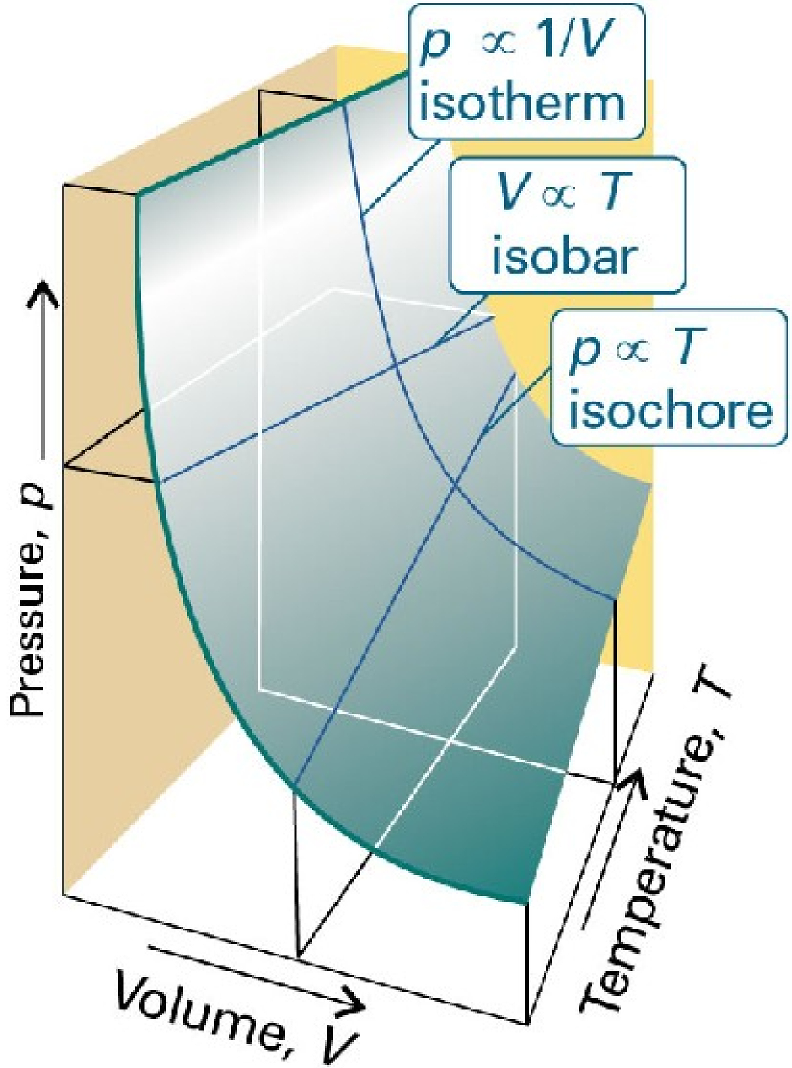

Fig. 1.9 Sections through the surface shown in Fig. 1.8 at constant temperature give the isotherms shown in Fig. 1.4 and the isobars shown in Fig. 1.6.