

Molybdenum

Mo

General Information

Discovery

Molybdenum was discovered by P.J. Hjelm in 1781 in Uppsala, Sweden.

Appearance

The metal is silver-white and fairly soft when pure. It is usually obtained as a grey powder.

Source

The main source of this element is the ore molybdenite. Molybdenum can be obtained from this ore, but most commercial production is as a by-product of copper production.

Uses

Molybdenum is a valuable alloying agent, as it contributes to the hardness and toughness of quenched and tempered steels. It is also used in certain nickel-based alloys which are heat-resistant and corrosion-resistant to chemical solutions. It has found use in electrical and nuclear applications, and as a catalyst in the refining of petroleum.

Biological Role

Although it is toxic in anything other than small quantities, molybdenum is an essential element for animals and plants. If soil lacks this element the land is barren. Leguminous plants use the nitrogen-fixing enzyme nitrogenase, which contains molybdenum.

Physical Information

| | |
|--|-------------------------------------|
| Atomic Number | 42 |
| Relative Atomic Mass ($^{12}\text{C}=12.000$) | 95.94 |
| Melting Point/K | 2890 |
| Boiling Point/K | 4885 |
| Density/kg m ⁻³ | 10220 (293K) |
| Ground State Electron Configuration | [Kr]4d ⁵ 5s ¹ |
| Electron Affinity (M-M ⁻)/kJ mol ⁻¹ | -114 |

Key Isotopes

| Nuclide | ⁹² Mo | ⁹⁴ Mo | ⁹⁵ Mo | ⁹⁶ Mo | ⁹⁷ Mo | ⁹⁸ Mo |
|-------------------|------------------|-------------------|------------------|------------------|------------------|------------------|
| Atomic mass | 91.91 | 93.90 | 94.91 | 95.90 | 96.91 | 97.91 |
| Natural abundance | 14.84% | 9.25% | 15.92% | 16.68% | 9.55% | 24.13% |
| Half-life | stable | stable | stable | stable | stable | stable |
| Nuclide | ⁹⁹ Mo | ¹⁰⁰ Mo | | | | |
| Atomic mass | | 99.91 | | | | |
| Natural abundance | 0% | 9.63% | | | | |
| Half-life | 66.69 h | stable | | | | |

Ionisation Energies/kJ mol⁻¹

| | |
|------------------------------------|-------|
| M - M ⁺ | 685 |
| M ⁺ - M ²⁺ | 1558 |
| M ²⁺ - M ³⁺ | 2621 |
| M ³⁺ - M ⁴⁺ | 4480 |
| M ⁴⁺ - M ⁵⁺ | 5900 |
| M ⁵⁺ - M ⁶⁺ | 6560 |
| M ⁶⁺ - M ⁷⁺ | 12230 |
| M ⁷⁺ - M ⁸⁺ | 14800 |
| M ⁸⁺ - M ⁹⁺ | 16800 |
| M ⁹⁺ - M ¹⁰⁺ | 19700 |

Other Information

| | |
|---|--|
| Enthalpy of Fusion/kJ mol ⁻¹ | 27.6 |
| Enthalpy of Vaporisation/kJ mol ⁻¹ | 589.9 |
| Oxidation States | |
| Main | Mo ⁺⁶ |
| Others | Mo ⁻² , Mo ⁰ , Mo ⁺¹ , Mo ⁺² , Mo ⁺³ , Mo ⁺⁴ , Mo ⁺⁵ |