75 RHENIUM Re

General Information

Categories
Class: *Transition Metals* **Period:** *6* **IUPAC group:** *7* **Traditional:** *VIIa*

History
Discovered in: *1925* **by** *Noddack et. al.*
Origin of name: *Latin: Rhenus, (the Rhine)*
Historical or alternate name:

Abundances

Atmosphere:	*~0.0 ppm*	**Primitive mantle:**	*0.00025 ppm*
Sea water:	*1e-10 ppm*	**Metallic meteorite:**	*0.0369 ppm*
Continental crust:	*0.0005 ppm*	**Solar photosphere:**	*< 0.3 log of abundance*
Oceanic crust:	*0.0009 ppm*	**Solar system:**	*0.0507 relative to Si=1.0e6*

Description
Silvery metal or grey powder. Tarnishes in moist air. Resists corrosion and oxidation. Dissolves in nitric and sulfuric acids.

Common natural occurrences
Molybdenite, gadolinite, columbite & platinum ores

Hazards and Tolerances
Hazards
Radioactive.
Human daily limits **Lower:** **Upper:** *0.01*

Physical Properties

Transitional Data
State: *Solid* **Density:** *20.53 g/cm3*

Molar enthalpy
Atomization: *769.0 kJ mol-1* **Fusion:** *33.1 kJ mol-1* **Vaporization:** *704.25 kJ mol-1*

Transition points
Melting point: *3453.0 K* **Boiling point:** *5900.0 K* **Critical temperature:** *20500.0 K*

Molar properties
Atomic weight: *186.207 g/mole* **Molar volume:** *8.916 cm3 mol-1*

Crystal structure sequence
hexagonal-close-packed

Thermodynamics

State:	Enthalpy	Gibbs function	Entropy	Heat Capacity
solid	*0*	*0*	*36.86*	*25.48*
gas	*769.9*	*724.6*	*188.938*	*20.786*

Miscellaneous physical
Electrical resistivity: *19.3 µ-ohms/cm* **Debye temperature:** *430.0 K*
Thermal conductivity: *47.9 W / m / K* **Coefficient of linear expansion:** *6.2 Coef. per K*
Mass magnetic susceptibility: *4.56e-9*
X-ray diffraction mass absorption coefficients:
CuK: *179 (µ/p)/cm2 g-1* **MoK:** *103 (µ/p)/cm2 g-1*

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Chemical Properties

Chemical basics:

Oxidation states: *+4 +5 +6 +7*
Molecular wt: *186.207 g/mole*

Standard reactions

oxidation		reduction	potential
ReO4- + 2H+ + e-	=>	*ReO3 + H2O*	*0.77*
ReO4- + 4H+ + 3e-	=>	*ReO2 + 2H2O*	*0.51*
Re+3 + 3e-	=>	*Re*	*0.3*
ReO2 + 4H+ + 4e-	=>	*Re + 2H2O*	*0.25*

Radii

Covalent: *128 pm*
Atomic: *137.0 pm*
Van der Waals: *pm*

Ions: ion:	pm
+4	*63.0*
+5	*58.0*
+6	*55.0*
+7	*54.0*

Covalent bonds

Bond:	Radius	Energy

Effective nuclear charge

Slater: *3.60*
Clementi: *10.12*
Froese-Fischer: *14.62*

Electronegativity

Pauling: *1.9*
Allred-Rochow: *1.46*

Nuclear Properties

Isotopes

	Known	Listed
Number of isotopes:	*20*	*5*
Isotope range:	*177 - 192*	*183 - 187*

Nuclide	183	184	185	186
Natural % Occ.:			*37.40%*	
Mossbauer NRA:				
Nuclear spin/Quantum no.:			*5/2*	
Radioisotopes:				
Half-life:	*71.0 days*	*38.0 days*		*0.2 E6 years*
Decay mode:	*E.C.,*	*E.C.,*		*Beta- E.C.,*
Source:				
Notes				*med*

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Nuclide	*187*
Natural % Occ.:	*62.60%*
Mossbauer NRA:	*21.5*
Nuclear spin/Quantum no.:	*5/2*
Radioisotopes:	
Half-life:	*45.6 E9 years*
Decay mode:	*Beta-*
Source:	
Notes	*date*

Thermal neutron capture

Isotope	**Cross-section**
	85±5 barns

Nuclear magnetic resonance

Nuclide:	*185*	
Absolute sensitivity:	*4.93e-2*	*1H=1.0*
Relative sensitivity:	*0.13*	*1H=1.0*
Receptivity:	*280*	*13C=1.0*
Magnetogyric ratio:	*6.0255e7*	*rad / T / s*
Quadropole moment:	*2.8e-28*	*m2*
Frequency:	*22.513*	*MHz*
Reference:	*NaReO4*	

Energy Properties

Electrons

Ground state electron configuration:	*[Xe] 4f14 5d5 6s2*
Electron affinity:	*37 kJ mol-1*
Filling orbitals:	

Spectral lines

Wave length	*2274.62*	*2287.51*	*2294.49*	*3451.88*
Relative intensity				*10*
Detection limits				
Arc *(ug/g)*				
Spark *(ug/ml)*				*11 OAn*
Flame emission *(ug/ml)*	*29 NA*	*20 NA*	*25 NA*	*29 NA*
Atomic absorption *(ug/ml)*				

Wave length	*3460.46*	*3464.73*	*4889.14*	*5275.56*
Relative intensity	*1*			
Detection limits				
Arc *(ug/g)*	*10*	*5*		
Spark *(ug/ml)*	*3 OAn*	*5 OAn*	*8 OAn*	*12 OAn*
Flame emission *(ug/ml)*	*11 NA*	*19 NA*		
Atomic absorption *(ug/ml)*				

Ionization energies

Ionization level	**Ionization potential**
Re -> Re+	*760*
Re+ -> Re+2	*1260*

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Atomic energy levels

Orbital	Energy
ns	*1.0958 aJ*
(n-1)d	*1.7016 aJ*
(n-1)p	*7.9746 aJ*