

Revised: June 21, 2016 Mars
 499 / 4

PHYSICAL DATA (updated 2019-Oct-29):

Vol. mean radius (km) = 3389.92+-0.04	Density (g/cm ³) = 3.933(5+-4)	
Mass x10 ²³ (kg) = 6.4171	Flattening, f = 1/169.779	
Volume (x10 ¹⁰ km ³) = 16.318	Equatorial radius (km)= 3396.19	
Sidereal rot. period = 24.622962 hr	Sid. rot. rate, rad/s = 0.0000708822	
Mean solar day (sol) = 88775.24415 s	Polar gravity m/s ² = 3.758	
Core radius (km) = ~1700	Equ. gravity m/s ² = 3.71	
Geometric Albedo = 0.150		
GM (km ³ /s ²) = 42828.375214	Mass ratio (Sun/Mars) = 3098703.59	
GM 1-sigma (km ³ /s ²) = +- 0.00028	Mass of atmosphere, kg= ~ 2.5 x 10 ¹⁶	
Mean temperature (K) = 210	Atmos. pressure (bar) = 0.0056	
Obliquity to orbit = 25.19 deg	Max. angular diam. = 17.9"	
Mean sidereal orb per = 1.88081578 y	Visual mag. V(1,0) = -1.52	
Mean sidereal orb per = 686.98 d	Orbital speed, km/s = 24.13	
Hill's sphere rad. Rp = 319.8	Escape speed, km/s = 5.027	
	Perihelion	Aphelion
Mean Solar Constant (W/m ²)	717	493
Maximum Planetary IR (W/m ²)	470	315
Minimum Planetary IR (W/m ²)	30	30

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Ephemeris / WWW_USER Mon Mar 10 14:08:03 2025
Pasadena, USA / Horizons
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Target body name: Mars (499)
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{source: mar097}
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Center body name: Solar System Barycenter (0)
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```
{source: DE441}
```

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Center-site name: BODY CENTER
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Start time      : A.D. 2025-Mar-10 00:00:00.0000 TDB
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Stop time       : A.D. 2025-Apr-09 00:00:00.0000 TDB
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Step-size       : 1440 minutes
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```
Center geodetic : 0.0, 0.0, 0.0 {E-
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lon(deg),Lat(deg),Alt(km)}
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Center cylindric: 0.0, 0.0, 0.0 {E-
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```
lon(deg),Dxy(km),Dz(km)}
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Center radii    : (undefined)
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Output units     : KM-S
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Calendar mode    : Mixed Julian/Gregorian
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Output type      : GEOMETRIC cartesian states
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Output format    : 3 (position, velocity, LT, range,
range-rate)
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Reference frame  : Ecliptic of J2000.0
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JDTDB
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X	Y	Z
VX	VY	VZ
LT	RG	RR

\$\$SOE

2460744.500000000 = A.D. 2025-Mar-10 00:00:00.0000 TDB
X = -1.895648544994110E+08 Y = 1.601275316244471E+08 Z
= 8.026785557073921E+06

VX = -1.479251714253032E+01 VY = -1.637822455016202E+01
VZ = 1.972554752345790E-02

LT = 8.281536650607126E+02 RG = 2.482742228502597E+08
RR = 7.318320075660405E-01

2460745.500000000 = A.D. 2025-Mar-11 00:00:00.0000 TDB
X = -1.908367970531444E+08 Y = 1.587072561295805E+08 Z
= 8.028230558080420E+06

VX = -1.465045422740737E+01 VY = -1.649833213653724E+01
VZ = 1.372403581635862E-02

LT = 8.283621481781436E+02 RG = 2.483367245164859E+08
RR = 7.149603672079967E-01

2460746.500000000 = A.D. 2025-Mar-12 00:00:00.0000 TDB
X = -1.920964283404827E+08 Y = 1.572766528595480E+08 Z
= 8.029157157318667E+06

VX = -1.450753548429674E+01 VY = -1.661729272973566E+01
VZ = 7.725574679720459E-03

LT = 8.285657641870146E+02 RG = 2.483977670602735E+08
RR = 6.980561956792941E-01

2460747.500000000 = A.D. 2025-Mar-13 00:00:00.0000 TDB
X = -1.933436747603378E+08 Y = 1.558358210968693E+08 Z
= 8.029565631019764E+06

VX = -1.436376880952893E+01 VY = -1.673510215330384E+01
VZ = 1.730440920104215E-03

LT = 8.287645038415285E+02 RG = 2.484573477098023E+08
RR = 6.811203455683432E-01

2460748.500000000 = A.D. 2025-Mar-14 00:00:00.0000 TDB
X = -1.945784633939677E+08 Y = 1.543848604827919E+08 Z
= 8.029456279601254E+06

VX = -1.421916209994289E+01 VY = -1.685175624882146E+01
VZ = -4.261082704385188E-03

LT = 8.289583581409971E+02 RG = 2.485154637667338E+08
RR = 6.641536832893463E-01

2460749.500000000 = A.D. 2025-Mar-15 00:00:00.0000 TDB
X = -1.958007220041148E+08 Y = 1.529238710146705E+08 Z
= 8.028829427643090E+06

VX = -1.407372324669255E+01 VY = -1.696725089042940E+01
VZ = -1.024871121233861E-02

LT= 8.291473183292193E+02 RG= 2.485721126060251E+08
RR= 6.471570744852754E-01
2460750.500000000 = A.D. 2025-Mar-16 00:00:00.0000 TDB
X =-1.970103790341953E+08 Y = 1.514529530435336E+08 Z
= 8.027685423883967E+06
VX=-1.392746013325345E+01 VY=-1.708158199950237E+01
VZ=-1.623215963479652E-02
LT= 8.293313758942242E+02 RG= 2.486272916758515E+08
RR= 6.301313730632773E-01
2460751.500000000 = A.D. 2025-Mar-17 00:00:00.0000 TDB
X =-1.982073636073518E+08 Y = 1.499722072717622E+08 Z
= 8.026024641147472E+06
VX=-1.378038063185280E+01 VY=-1.719474554523301E+01
VZ=-2.221114546345593E-02
LT= 8.295105225677020E+02 RG= 2.486809984974358E+08
RR= 6.130774179404659E-01
2460752.500000000 = A.D. 2025-Mar-18 00:00:00.0000 TDB
X =-1.993916055253895E+08 Y = 1.484817347507146E+08 Z
= 8.023847476192676E+06
VX=-1.363249259356729E+01 VY=-1.730673752550469E+01
VZ=-2.818539286589683E-02
LT= 8.296847503238155E+02 RG= 2.487332306646929E+08
RR= 5.959960363662342E-01
2460753.500000000 = A.D. 2025-Mar-19 00:00:00.0000 TDB
X =-2.005630352678107E+08 Y = 1.469816368783160E+08 Z
= 8.021154349586733E+06
VX=-1.348380384450890E+01 VY=-1.741755394566721E+01
VZ=-3.415463343118397E-02
LT= 8.298540513780254E+02 RG= 2.487839858438765E+08
RR= 5.788880525606463E-01
2460754.500000000 = A.D. 2025-Mar-20 00:00:00.0000 TDB
X =-2.017215839910702E+08 Y = 1.454720153967941E+08 Z
= 8.017945705668367E+06
VX=-1.333432219641269E+01 VY=-1.752719081895257E+01
VZ=-4.011860090525232E-02
LT= 8.300184181866324E+02 RG= 2.488332617734424E+08
RR= 5.617542947046275E-01
2460755.500000000 = A.D. 2025-Mar-21 00:00:00.0000 TDB
X =-2.028671835279066E+08 Y = 1.439529723906235E+08 Z
= 8.014222012548462E+06
VX=-1.318405546203444E+01 VY=-1.763564418104288E+01

VZ=-4.607702470440511E-02
LT= 8.301778434467700E+02 RG= 2.488810562640463E+08
RR= 5.445955980058922E-01
2460756.500000000 = A.D. 2025-Mar-22 00:00:00.0000 TDB
X =-2.039997663865818E+08 Y = 1.424246102845221E+08 Z
= 8.009983762056746E+06
VX=-1.303301146343736E+01 VY=-1.774291009747320E+01
VZ=-5.202962655965848E-02
LT= 8.303323200960536E+02 RG= 2.489273671984387E+08
RR= 5.274128068866908E-01
2460757.500000000 = A.D. 2025-Mar-23 00:00:00.0000 TDB
X =-2.051192657500761E+08 Y = 1.408870318413121E+08 Z
= 8.005231469643191E+06
VX=-1.288119802722955E+01 VY=-1.784898466381595E+01
VZ=-5.797612285886533E-02
LT= 8.304818413116642E+02 RG= 2.489721925311898E+08
RR= 5.102067708280834E-01
2460758.500000000 = A.D. 2025-Mar-24 00:00:00.0000 TDB
X =-2.062256154754114E+08 Y = 1.393403401596825E+08 Z
= 7.999965674309321E+06
VX=-1.272862296870881E+01 VY=-1.795386400922781E+01
VZ=-6.391623257902612E-02
LT= 8.306264005094173E+02 RG= 2.490155302884107E+08
RR= 4.929783288660914E-01
2460759.500000000 = A.D. 2025-Mar-25 00:00:00.0000 TDB
X =-2.073187500931007E+08 Y = 1.377846386720790E+08 Z
= 7.994186938585021E+06
VX=-1.257529407731809E+01 VY=-1.805754429823910E+01
VZ=-6.984968503065225E-02
LT= 8.307659913432856E+02 RG= 2.490573785676103E+08
RR= 4.757282958911459E-01
2460760.500000000 = A.D. 2025-Mar-26 00:00:00.0000 TDB
X =-2.083986048065597E+08 Y = 1.362200311428493E+08 Z
= 7.987895848483577E+06
VX=-1.242121911941398E+01 VY=-1.816002171813933E+01
VZ=-7.577621866767537E-02
LT= 8.309006077051184E+02 RG= 2.490977355376112E+08
RR= 4.584574712961393E-01
2460761.500000000 = A.D. 2025-Mar-27 00:00:00.0000 TDB
X =-2.094651154914173E+08 Y = 1.346466216664928E+08 Z
= 7.981093013400733E+06

VX=-1.226640585614281E+01 VY=-1.826129246179919E+01
VZ=-8.169557172064490E-02
LT= 8.310302437240845E+02 RG= 2.491365994383824E+08
RR= 4.411666626564688E-01
2460762.500000000 = A.D. 2025-Mar-28 00:00:00.0000 TDB
X =-2.105182186948828E+08 Y = 1.330645146658062E+08 Z
= 7.973779066014983E+06
VX=-1.211086205447668E+01 VY=-1.836135272442385E+01
VZ=-8.760747627374688E-02
LT= 8.311548937658808E+02 RG= 2.491739685808024E+08
RR= 4.238566958897715E-01
2460763.500000000 = A.D. 2025-Mar-29 00:00:00.0000 TDB
X =-2.115578516353210E+08 Y = 1.314738148899497E+08 Z
= 7.965954662259310E+06
VX=-1.195459548461920E+01 VY=-1.846019871563432E+01
VZ=-9.351165989496302E-02
LT= 8.312745524322212E+02 RG= 2.492098413465055E+08
RR= 4.065284056754876E-01
2460764.500000000 = A.D. 2025-Mar-30 00:00:00.0000 TDB
X =-2.125839522019800E+08 Y = 1.298746274126335E+08 Z
= 7.957620481350549E+06
VX=-1.179761391703096E+01 VY=-1.855782667650439E+01
VZ=-9.940784829106697E-02
LT= 8.313892145608189E+02 RG= 2.492442161878773E+08
RR= 3.891826233335665E-01
2460765.500000000 = A.D. 2025-Mar-31 00:00:00.0000 TDB
X =-2.135964589546618E+08 Y = 1.282670576304629E+08 Z
= 7.948777225785606E+06
VX=-1.163992512280677E+01 VY=-1.865423288900553E+01
VZ=-1.052957663008280E-01
LT= 8.314988752253263E+02 RG= 2.492770916280358E+08
RR= 3.718201721157139E-01
2460766.500000000 = A.D. 2025-Apr-01 00:00:00.0000 TDB
X =-2.145953111232504E+08 Y = 1.266512112612688E+08 Z
= 7.939425621251546E+06
VX=-1.148153686680512E+01 VY=-1.874941366896466E+01
VZ=-1.111751414575837E-01
LT= 8.316035297346532E+02 RG= 2.493084662606278E+08
RR= 3.544418649354583E-01
2460767.500000000 = A.D. 2025-Apr-02 00:00:00.0000 TDB
X =-2.155804486072409E+08 Y = 1.250271943423347E+08 Z

= 7.929566416505381E+06
VX=-1.132245689508259E+01 VY=-1.884336534568066E+01
VZ=-1.170457092898483E-01
LT= 8.317031736319300E+02 RG= 2.493383387495171E+08
RR= 3.370485033946820E-01
2460768.500000000 = A.D. 2025-Apr-03 00:00:00.0000 TDB
X =-2.165518119754554E+08 Y = 1.233951132286746E+08 Z
= 7.919200383318476E+06
VX=-1.116269293503706E+01 VY=-1.893608424805456E+01
VZ=-1.229072125283350E-01
LT= 8.317978026939375E+02 RG= 2.493667078286145E+08
RR= 3.196408837449571E-01
2460769.500000000 = A.D. 2025-Apr-04 00:00:00.0000 TDB
X =-2.175093424659257E+08 Y = 1.217550745915305E+08 Z
= 7.908328316492409E+06
VX=-1.100225271192791E+01 VY=-1.902756671080280E+01
VZ=-1.287593934943176E-01
LT= 8.318874129312281E+02 RG= 2.493935723019139E+08
RR= 3.022198070022401E-01
2460770.500000000 = A.D. 2025-Apr-05 00:00:00.0000 TDB
X =-2.184529819857558E+08 Y = 1.201071854170066E+08 Z
= 7.896951033859424E+06
VX=-1.084114396465828E+01 VY=-1.911780908617862E+01
VZ=-1.346019873296607E-01
LT= 8.319720005882414E+02 RG= 2.494189310435263E+08
RR= 2.847860863476050E-01
2460771.500000000 = A.D. 2025-Apr-06 00:00:00.0000 TDB
X =-2.193826731109074E+08 Y = 1.184515530046176E+08 Z
= 7.885069376223609E+06
VX=-1.067937444839253E+01 VY=-1.920680774706057E+01
VZ=-1.404347210362156E-01
LT= 8.320515621428544E+02 RG= 2.494427829975461E+08
RR= 2.673405476825739E-01
2460772.500000000 = A.D. 2025-Apr-07 00:00:00.0000 TDB
X =-2.202983590860560E+08 Y = 1.167882849656721E+08 Z
= 7.872684207301587E+06
VX=-1.051695192395351E+01 VY=-1.929455908914100E+01
VZ=-1.462573187214939E-01
LT= 8.321260943057074E+02 RG= 2.494651271778478E+08
RR= 2.498840189256496E-01
2460773.500000000 = A.D. 2025-Apr-08 00:00:00.0000 TDB

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X =-2.211999838246189E+08 Y = 1.151174892216611E+08 Z
= 7.859796413717940E+06
VX=-1.035388414236113E+01 VY=-1.938105953822391E+01
VZ=-1.520695098191664E-01
LT= 8.321955940198957E+02 RG= 2.494859626679946E+08
RR= 2.324173124146826E-01
2460774.500000000 = A.D. 2025-Apr-09 00:00:00.0000 TDB
X =-2.220874919088295E+08 Y = 1.134392740028488E+08 Z
= 7.846406905011311E+06
VX=-1.019017883678119E+01 VY=-1.946630554904836E+01
VZ=-1.578710338072176E-01
LT= 8.322600584609672E+02 RG= 2.495052886212370E+08
RR= 2.149412178318210E-01
$$$EOE
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TIME

Barycentric Dynamical Time ("TDB" or T_{eph}) output was requested. This continuous coordinate time is equivalent to the relativistic proper time of a clock at rest in a reference frame co-moving with the solar system barycenter but outside the system's gravity well. It is the independent variable in the solar system relativistic equations of motion.

TDB runs at a uniform rate of one SI second per second and is independent of irregularities in Earth's rotation.

CALENDAR SYSTEM

Mixed calendar mode was active such that calendar dates after AD 1582-Oct-15 (if any) are in the modern Gregorian system. Dates prior to 1582-Oct-5 (if any) are in the Julian calendar system, which is

automatically extended for dates prior to its adoption on 45-Jan-1 BC. The Julian calendar is useful for matching historical dates. The Gregorian calendar more accurately corresponds to the Earth's orbital motion and seasons. A "Gregorian-only" calendar mode is available if such physical events are the primary interest.

REFERENCE FRAME AND COORDINATES

Ecliptic at the standard reference epoch

Reference epoch: J2000.0

X-Y plane: adopted Earth orbital plane at the reference epoch

Note: IAU76 obliquity of 84381.448 arcseconds wrt ICRF X-Y plane

X-axis : ICRF

Z-axis : perpendicular to the X-Y plane in the directional (+ or -) sense of Earth's north pole at the reference epoch.

Symbol meaning:

JDTDB	Julian Day Number, Barycentric Dynamical Time
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X	X-component of position vector (km)
Y	Y-component of position vector (km)
Z	Z-component of position vector (km)
VX	X-component of velocity vector (km/sec)
VY	Y-component of velocity vector (km/sec)
VZ	Z-component of velocity vector (km/sec)
LT	One-way down-leg Newtonian light-time (sec)
RG	Range; distance from coordinate center (km)
RR	Range-rate; radial velocity wrt coord. center (km/sec)

ABERRATIONS AND CORRECTIONS

Geometric state vectors have NO corrections or aberrations applied.

Computations by ...

Solar System Dynamics Group, Horizons On-Line
Ephemeris System
4800 Oak Grove Drive, Jet Propulsion Laboratory
Pasadena, CA 91109 USA

General site: <https://ssd.jpl.nasa.gov/>
Mailing list: [https://ssd.jpl.nasa.gov/
email_list.html](https://ssd.jpl.nasa.gov/email_list.html)
System news : [https://ssd.jpl.nasa.gov/horizons/
news.html](https://ssd.jpl.nasa.gov/horizons/news.html)
User Guide : [https://ssd.jpl.nasa.gov/horizons/
manual.html](https://ssd.jpl.nasa.gov/horizons/manual.html)
Connect : browser [https://
ssd.jpl.nasa.gov/horizons/app.html#/x](https://ssd.jpl.nasa.gov/horizons/app.html#/x)
API [https://ssd-
api.jpl.nasa.gov/doc/horizons.html](https://ssd-api.jpl.nasa.gov/doc/horizons.html)
command-line telnet
[ssd.jpl.nasa.gov 6775](https://ssd.jpl.nasa.gov/6775)
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ssd.jpl.nasa.gov/ftp/ssd/hrzn_batch.txt](https://ssd.jpl.nasa.gov/ftp/ssd/hrzn_batch.txt)
scripts [https://
ssd.jpl.nasa.gov/ftp/ssd/SCRIPTS](https://ssd.jpl.nasa.gov/ftp/ssd/SCRIPTS)
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