



## LESSON PLAN: ROVERS ON MARS

### Online Investigation Questions

#### Teacher Key

1. How fast does the Rover send/receive data (baud rate or bytes per second)? **About a third as fast as a dial up modem to your home computer, the rovers can transmit data at 12000 baud rate and down to about 3500 bits per second.**
2. How fast can the Mars Orbiters send/receive data? **The five orbiters around Mars at this time can transmit data about four times faster than dialup services can to our home computers, at a constant rate of 128000 bits per second.**
3. How fast can the Earth Deep Space Network send/receive data? **The Deep Space Network is powerful enough to handle any rate thrown at it - the system is not limited so much by its own power as it is by the incoming transmissions rates.**
4. How many hours each day can the Rover communicate with Earth? **The rovers can communicate directly with Earth for only about three Earth hours per day due to power and thermal limitations and small antenna. About 60 Megabytes of data can be sent during this time.**
5. How many hours each day can the Rover communicate with Mars Orbiters? **The rovers can communicate with an orbiter for about 8 Earth minutes as it passes over each day. About 60 Megabytes of data can be sent during this time.**
6. How many hours each day can the Mars Orbiters communicate with Earth? **The orbiters cannot communicate when on the other side of Mars, but that still allows for communication in 2/3 of an orbit or about 16 Earth hours every day. The increased time is due to three factors: longer time in position for connection, greater power generated by the solar panels, and larger antennas for transmissions.**
7. How fast in kilometers per hour is the speed of radio waves carrying data? **The speed of radio waves, microwaves, infrared, visible light, ultraviolet light, x-rays, and gamma rays (namely all forms of electromagnetic energy) travel at the speed of light = 299792 Km/s.**
8. How far apart are Earth and Mars at their closest orbital points? **Earth perihelion is 147090000 Km and aphelion is 152100000 km. Mars perihelion is 206620000 Km and aphelion is**

**249230000 km. Assuming circular orbits, if the planets are closest on the same side of the Sun in a straight line, when Earth is at aphelion and Mars is at perihelion they would be only  $249230000 - 152100000 = 97130000$  Km apart. Because of the elliptical nature of their orbits, in August of 2003 the two planets were much closer at 55800000 Km ... the closest in 100000 years!!**

- 9. How far apart are Earth and Mars at their farthest orbital points? Earth perihelion is 147090000 Km and aphelion is 152100000 km. Mars perihelion is 206620000 Km and aphelion is 249230000 km. Assuming circular orbits, if the planets are farthest on the opposite sides of the Sun in a straight line, when Earth is at perihelion and Mars is at perihelion they would be  $249230000 + 206620000 = 455850000$  Km apart.**
- 10. How far apart are Earth and Mars right now? This changes moment to moment, of course. When rounded to the nearest ten million kilometers, Mars and Earth are 60000000 Km apart.**