



The InSight Lander will arrive at Mars on September 20, 2016 according to Earth Time, but when will it arrive according to Mars Time?

One Earth Day is exactly 24 hours long, so that the time between two High Noons is exactly 24 hours. But Mars rotates a bit more slowly and by Earth units, one Mars Day is 24 hours and 40 minutes long.

Since the first Viking Lander touched down on Mars in July 20, 1976, NASA scientists use the convention that the first day of operations of a Lander is called Sol 0, and each Mars solar day, called a Sol is 24 hours and 40 minutes long.

This image was taken by the Phoenix lander at sunrise on Sol 86 which corresponded to Earth date August 21, 2008.

**Problem 1** - Draw two clock faces for John and Johanna. They live in the same town, but Johanna's clock runs 40 minutes later than John's clock. John says that it is 12:00 Noon. Draw the hour and minute hands for each clock that show when 12:00 Noon happens on Johanna's clock according to John's clock.

**Problem 2** - After 10 days, Johanna's clock says that it is 12:00 Noon. What does John's clock say?

**Problem 3** - Suppose Johanna is a colonist on Mars and John is back on Earth. On a particular date, time and place on Mars where Johanna was living, it was 12:00 Noon at exactly the same time as it was on Earth where John was living. When John calls Johanna the next Earth day he says that he is having lunch because it is 12:00 Noon by his clock. What time does Johanna's clock read?

**Problem 4** - After how many Mars days will both clocks once again show that it is 12:00 Noon?

**Problem 1** - Draw two clock faces for John and Johanna. They live in the same town, but Johanna's clock runs 40 minutes behind John's clock. John says that it is 12:00 Noon. Draw the hour and minute hands for each clock that show when 12:00 Noon happens on Johanna's clock according to John's clock.

Answer: John's clock shows the hour and minute hands both on 12, but Johanna's clock has the hands indicating 11:20 am.

**Problem 2** - After 10 days, Johanna's clock says that it is 12:00 Noon. What does John's clock say?

Answer: Johanna's clock is 40 minutes behind John's clock so if John's clock says 12:00 Noon, Johanna's clock says it is **11:20 AM**. It is the same 40 minutes as in Problem 1 because both locations use Earth's 24-hour day.

**Problem 3** - Suppose Johanna is a colonist on Mars and John is back on Earth. On a particular date, time and place on Mars where Johanna was living, it was 12:00 Noon at exactly the same time as it was 12:00 Noon on Earth where John was living. When John calls Johanna two Earth days later he says that he is having lunch because it is 12:00 Noon by his clock. What time does Johanna's clock read?

Answer: Because Mars rotates once every 24 hours and 40 minutes, the slower Mars clock will fall behind by 40 minutes after the first Earth day and an additional 40 minutes after the second Earth day, so on Johanna's clock, John will be having Noon at 12:00 - 80 minutes or **10:40 AM**.

**Problem 4** - After how many Mars days will both clocks once again show that it is 12:00 Noon?

Answer: For every Earth day, Mars falls behind by 40 minutes. We want  $N \times 40$  minutes to add up to one full Mars day of 24h 40 minutes. Solving for  $N$  we get:

$$N = 24\text{h } 40\text{m} / 40\text{ m} = 24.6666 / 0.6666 = \mathbf{37\text{ Mars days.}}$$

Scientists work on Mars Time because Landers use solar panels and so most activity occurs during the Martian daytime. Sunrise and sunset on Mars follow the 24h 40m length of the martian day, not the shorter 24h 00m Earth solar day. This means that by the normal earth clock, martian sunrise occurs 40 minutes earlier each Earth day.