## Problem

The circumference of the Earth, (i.e., the distance around the equator) is 40 075 kilometres (km). The distance from the Earth to the Moon is 384 403 km. The distance from the Earth to the Sun is about 149 600 000 km.

a) Estimate how many times you would have to travel around the equator in order to cover the same distance as from the Earth to the Moon. Then calculate the actual number of times, using the given data. Was your estimate high or low?

b) Repeat part a) for the distance from the Earth to the Sun.

c) A Boeing 747 flies at an average speed of 893 km per hour. If such an aircraft could fly to the Moon, how many hours would it take? How many days? How many years?

d) Repeat part c) for the distance from the Earth to the Sun.
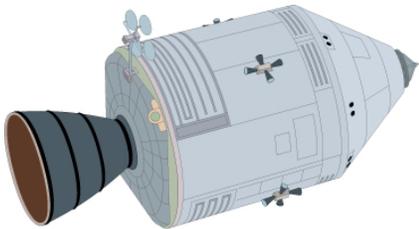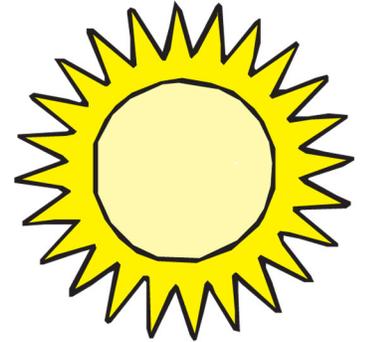
e) Apollo 13 took about 4 days to reach its closest approach to the Moon. What was its average speed (in km per hour) for this part of its journey?

Hints

Hint 1 - a),b) If a string 50 centimetres (cm) long will wrap around a ball, and your bedroom is 300 cm wide, how many such strings (i.e., circumferences of the ball) could you place end-to-end across your room? What arithmetic is needed to answer this question?

Hint 2 - c),d) How many hours are there in a day? Days in a year?

Solution

a) If the circumference of the Earth, 40 075 km, is estimated as 4×10^4 km, and the distance to the moon, 384 403 km is estimated as 384×10^3 km, then the number of times you would have to travel around the equator in order to cover the distance from the earth to the moon would be roughly $384\,000 \div 40\,000 = 9.6$, i.e., about ten trips around the equator. (An alternative estimate for the distance to the moon is $384\,403$ km $\approx 4 \times 10^5$ km, which gives the estimate of $400\,000 \div 40\,000 = 10$ trips directly.)
The actual number of times is $384\,403 \div 40\,075 = 9.592089832$, which is pretty close to our first estimate of 9.6 times.

b) Estimating the distance 149 600 000 km from the Earth to the sun as 15×10^7 km, the number of trips around the equator that would be roughly equivalent to the trip to the sun is $150\,000\,000 \div 40\,000 = 3\,750$.
The actual number of trips is $149\,600\,000 \div 40\,075 \approx 3\,733.0006 \approx 3\,733$ times around the Earth.

c) Since a Boeing 747 flies at 893 km/hr, the time for the trip from the Earth to the moon would be distance $\div$ speed $= 384\,403 \div 873 \approx 430.462486$ hr.
Since there are 24 hours in one day, the time in days would be $430.462486 \div 24 \approx 17.93593692$ days $\approx$ 18 days.
Since there are 365 days in one year, the time in years would be about $18 \div 365 \approx \dfrac{1}{20}$ of a year.

d) The time for a Boeing 747 trip to the sun would be $149\,600\,000 \div 893 \approx 167\,525.196 \approx 167\,525$ hours which is about $6\,980.2$ days, or 19.124 years.

e) Since Apollo 13 took about 4 days, or 96 hours to reach the moon, its average speed was the total distance travelled in km divided by the time in hours, or $384\,403 \div 96 \approx 4\,004.1979 \approx 4\,004.2$ km/hr.