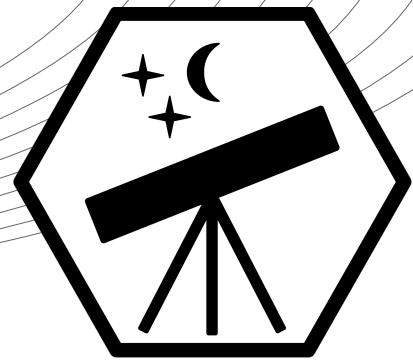# International Astronomy and Astrophysics Competition
Qualification Round 2020

Problem A : The Solar System (5 Points)

Fill in the blank spaces with the correct information:

The Sun is in the center of Solar System and is composed mainly of the elements (1) and (2). The distance from the Earth to the Sun is also called (3). Many people dream about building a colony on Mars, but the atmosphere is primarily made of (4). We have discovered the (5) between Mars and Jupiter, which contains millions of small objects. Jupiter has a total of (6) moons: The four largest moons are easily visible with a telescope and (7) is the closest and most active one. Uranus and Neptune are the outermost planets and it takes Neptune (8) years to complete one orbit around the Sun.

(1) _____ (2) _____ (3) _____ (4) _____
(5) _____ (6) _____ (7) _____ (8) _____

Problem B : Cosmic Scales (5 Points)

Assume the diameter of the Earth (12,700 km) is scaled down to 1 cm and answer the following:

(a) How large is the Sun (diameter: 1.4×10^6 km) on this scale?
(b) How far away is the nearest star (distance: 4.24 light-years) on this scale?

Problem C : Distance to the Moon (5 Points)

During the daylight, you hold a ruler in a distance of 60 cm away from your eyes, and you find the size of the Moon to be 0.55 cm (try it yourself!). At night, you use a telescope to observe rock formations and craters on the Moon to estimate the diameter of the Moon to be about 3500 km.
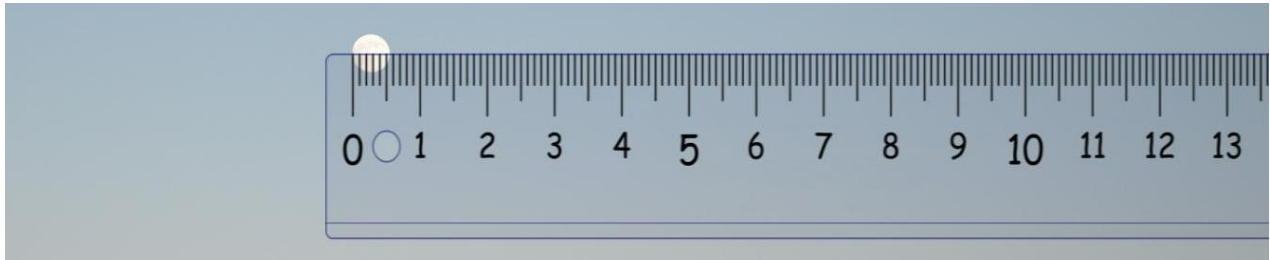
Find the distance to the Moon by using only the information from this experiment.

Problem D : Energy of Satellites (5 Points)

A satellite of mass m_S orbits the Earth (with mass m_E and radius R_E) with a velocity v and an altitude h. The gravitational force F_G and the centripetal force F_C are given by:

$$F_G = G \frac{m_S \cdot m_E}{(R_E + h)^2}, \quad F_C = \frac{m_S \cdot v^2}{R_E + h}, \quad G = const.$$

(a) Find an equation for the kinetic energy $E_{kin}(h)$ of a satellite with an altitude h.
(b) Based on the kinetic energy, how much liquid hydrogen (energy density: 10^6 J/Litre) is at least needed to bring a small 1 kg satellite in an orbit of 400 km. (Use literature to find m_E, R_E, G.)

Problem E : Nuclear Fusion (5 Points)

The light from the Sun is essential for all life on Earth. For a long time, we did not understand where all of this energy is coming from and how the sunlight is generated. Today, we know that the process of nuclear fusion is responsible for the energy production in the Sun and other stars.
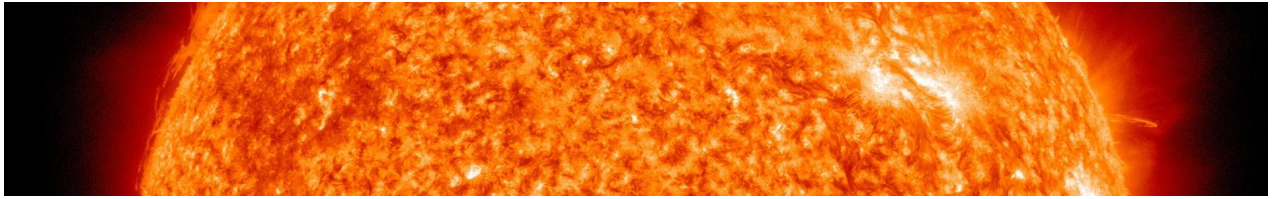
Explain how nuclear fusion in the Sun produces the sunlight we see on Earth.