Theoretical round.

Group A.

1.
As you know, the most widely used calendar in the middle centuries was Julian. Just now most countries use the Gregorian calendar and the difference between Julian and Gregorian calendars is 13 days: for the same days dates in the Julian calendar fall behind the dates in the Gregorian calendar by 13. Last time the dates in these calendars coincided were in the 3rd century.
Calculate in what century such a difference will be 1 year and the 22nd of October (for example) in Gregorian calendar will coincide with the 22nd of October in the Julian once again.

2.
Two stars have the same apparent magnitude and are of the same spectral type. One is twice as far away as the other. What is the relative size of the two stars?

Group B.

1.
A quasar is observed and it is found that a line whose rest wavelenght is 3000 A^o is observed at 15000 A^o. Estimate:

a) How fast is the quasar receding?
b) How far away is it if its distance is given by the Hubble relation (The Hubble constant is
H = 75 km/s/Mpc)?

Both answers may be done with an accuracy of 30 %.

2.
Young scientists from the Komi-Republic territory (in the Russian Federation) registered a few days ago a new object looking like an eclipsing binary star. But the period of this star was not stable: the stellar magnitude of the object is usually equal to 24.32$^{\mathbf{m}}$. Once every 7-11 seconds it is rising to 24.52$^{\mathbf{m}}$ for 0.2-0.3 seconds. After investigations it was clear that the shining object is eyes of a group of absolutely black cats sitting on a small absolutely black body in our Solar System and looking towards the Sun! And one of the cats is blinking! Calculate the number of cats in the group sitting on the small body and looking to the Sun. Draw a picture explaining your solution. Consider that all the cats are equal in size.

Groups A and B.

3. There are two photos of the Moon taken by the same camera mounted on the same telescope (the telescope is placed on the Earth). The first photo has been made while the Moon was near its perigee and the second one – near the apogee. Find from these data the value of the Moon's orbit eccentricity. Estimate the minimal period between the moments at which these two photos could be taken.

4.
A cosmonaut in a spacecraft is moving over the Moon surface through the Mare Frigoris at an altitude of 100 km. An astronaut is walking on the Moon's surface at Mare Frigoris and it is daytime at that place (the Sun is shining). Can the cosmonaut register the astronaut using binoculars with a magnification of 20^x. Take into account all the possibilities.

5.
There is a radio source placed on a satellite of some planet named "Olympia". The radio source is working all the time but an observer does not register the signal all the time due to eclipses. The figure shows the level of the receiving signal by the observer vs time. Find from these data the average density of the planet. Take into account that the orbit of the satellite is circular, the observer is in the plane of the satellite's orbit and "Olympia" is far away from the observer.

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6.
An 1.2-meter Schmidt camera has a 6° × 6° field of view. Estimate how many photographs you would have to take to cover the whole sky. (Please, make an estimation of the maximum and minimum number of photos.) Explain your calculations. Where do you have to place your telescope to be able to do this?