Team Problem

This is a team problem. The teams will have 4 days to conclude it and each team shall be able to allocate enough time to work, dividing the time between individual and group work time.

The solution must be delivered on August 11th at 9 AM. It must contain not more than **four sheets (eight pages), with all the essential assumptions, insights and results** from the team. In addition to the four main **sheets**, the teams can attach some appendices containing raw data (lists, tables) and auxiliary calculations/derivations/drawings.

Part I

Imagine a binary stellar system, consisting of two main sequence stars, with one star at least 30 times more massive than the other. Now imagine a planet located at one of the Lagrange points of the system, L4 or L5. Imagine the orbital plane of the system is aligned to our line of sight, i. e., it is perpendicular to the plane of the sky ("edge-on"), so you can detect it using its light curve.

1) Make a schematic drawing of this system.
2) Create a hypothetical light curve for this system and use it to understand the mechanics of the system. Do not take into account any instrumental effect.
3) Assuming the light curve from item (2) is accurate, calculate the values of the **relevant** physical parameters for each of the three bodies: mass, radius, orbital period, mean orbital radius, luminosity, effective temperature.

Part II

Now let's examine the planet from Part I, called Troll by its inhabitants, more closely. Troll has a rotation axis inclined by 30° with respect to the normal of the orbital plane, sidereal rotation period of five terrestrial days and mass of 0.5 terrestrial masses.

4) For an observer located at the Trollian equator, draw a sketch of the sky in the moment of the day when the incident light on the surface of the planet reaches its maximum intensity.

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5) At which latitude during the Trollian year, is there at least one Trollian sidereal day that there is no night?

Part III

Suppose now that Troll has a moon that can't be detected from Earth and whose radius is ¼ of Troll's radius. The moon's orbital plane is inclined 15° with respect to the orbital plane of the planet. The orbital period of the moon is about 30 Trollian sidereal days.

6) For an observer at a Trollian latitude φ, what will be the longest time interval for which the moon will stay above the horizon? In which part of Trollian year will it happen?

7) Under the same conditions and in the same day of item (6), calculate the duration of the moon setting, that is, the time since the moon touches the Troll horizon until it disappears completely below it.

8) How many total (T) and how many partial (P) eclipses can be seen during a Trollian sidereal year?

Part IV

Assume that the binary system is at 277 pc from Earth, located at equatorial coordinates $\alpha = 3^h$ and $\delta = -15°$, as seen from Earth.

9) Is it possible for a Trollian observer to see the Sun being occulted by any of the other bodies of its system? Say **YES** if it possible and **NO** otherwise.

10) What is the "Trollian ecliptic latitude" of the Sun, to a Trollian observer?

11) In which conditions can the Trollian observer see a transit of the Jupiter in front of the Sun? Make a drawing to explain your answer.

12) Estimate the apparent magnitudes of the following stars, as seen from Troll sky: Sun, Vega, Sirius, Rigel, Aldebaran.

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	α	δ	m	M
Vega	18h36m56s	+38°47'01"	0.03	0.58
Sirius	06h45m09s	-16°42'58"	-1.47	1.42
Rigel	05h14m32s	-08°12'06"	0.12	-7.84
Aldebaran	04h35m55s	+16°30'34"	0.75	-0.63