Team name: _____ **Date:** _____
Team members: _____

Designing a Spectroscopy Mission

You and your team are NASA engineers. You have been asked to create an innovative spectrograph to conduct research in the visible region of the spectrum. Since your team knows a lot about spectroscopy, you help NASA identify the mission, establish and build a design, and present your mission and design at a national engineering conference. Consult the project manager (your teacher) with your plans before proceeding at each step below.

Step 1: Establishing the Mission

- Identify a problem related to solar system spectroscopy for the mission you will undertake. Conduct your research from current events, magazines, journals and books. If you use the Internet (which is a great place to search), please verify the sources with your teacher.
- Establish whether your mission is ground- or space-based and why. What are the associated problems with ground- and space-based missions?

Step 2: Building Your Spectrograph

- Construct your own spectrograph using a grating with 1,000 grooves per mm. Determine the grating spacing using the following equation:

$$\mathbf{d = 1/N} \qquad \text{(Equation 1)}$$

where "d" is the grating spacing, and "N: is the number of grooves per unit length. Convert "d" into nanometers.

- Determine the location of the spectrum by establishing the angle between the grating and the spectrum, and designing a box based on your calculations. Use Equation 2 to determine the angle of the spectrograph optimized for viewing a spectrum, solving for wavelength or angle:

$$\sin(\theta) = \frac{\lambda}{d} \qquad \text{(Equation 2)}$$

where "λ" is the wavelength of light, and "θ" is the diffraction angle (angle to any specific color from the center of the grating).

- Construct the spectrograph, keeping in mind the following concepts:

  Spectrograph Shape
  - What shape will make your spectrum lie on a flat surface?
  - What is the simplest design to build and look through?
  - Where will the light enter your spectrograph and where will the spectrum show up?

  Spectrograph Size
  - How big does a spectrograph need to be to work?
  - Is there a limit to how big it could be?
  - Do you want a smaller spectrograph that is easy to take with you?
  - What is the best size to use for it to be useful and portable?
  - What are the size and weight restrictions of a space-based mission?

  Parts Placement
  - Where will you place your diffraction grating?
  - Where will the slit be placed?
  - Where will you spectrum be when you look into the spectrograph?
  - Is there anything you can do to make your spectrum easier to see?

Step 3: Mission and Design Analysis

Determine whether your spectrograph could actually achieve the mission.
Consider the following questions:

- What are the limitations of your design and the grating?

- What aspects of the spectrograph would you need to change in order to make it work?

- What additional engineering would help to achieve the goal?

Step 4: Engineering Conference Presentations

Give your class a 10-minute presentation, answering audience questions at the end. In the presentation, make sure to describe:

- Your mission

- Engineering you accomplished

- Problems you may have encountered