



Designing a Spectroscopy Mission

Student Instructions:

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 of the steps listed below.

Step 1: Establishing the mission

- You and your team will identify a problem related to solar system spectroscopy for the mission you will undertake. You can use current events, magazines, journals, and books for research. If you choose to 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

- You and your team will construct your own spectrograph using a grating that has 1000 grooves/mm. Determine the grating spacing using the equation:

$$d = 1/N \quad (\text{eq. 1})$$

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. Your team will determine the angle of the spectrograph optimized for viewing a spectrum by using equation 2 and solving for either wavelength or angle:

(eq. 2)

$$\sin(\Theta) = \frac{\lambda}{d}$$

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

- You and your team will construct the spectrograph. Some concepts to keep in mind:

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?

Size of spectrograph:

- 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?

Placement of Parts:

- Where will you place your diffraction grating?
- Where will the slit be placed?
- Where will your 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

Your team must 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

You and your team will give the class a 10-minute presentation and answer questions from the classroom audience. In the presentation, you will describe:

- Your mission
- Engineering you accomplished
- Problems you may have encountered
- Any other topics relevant to the project