



# Sample Needed Math Project Scenario

Award # 2100062

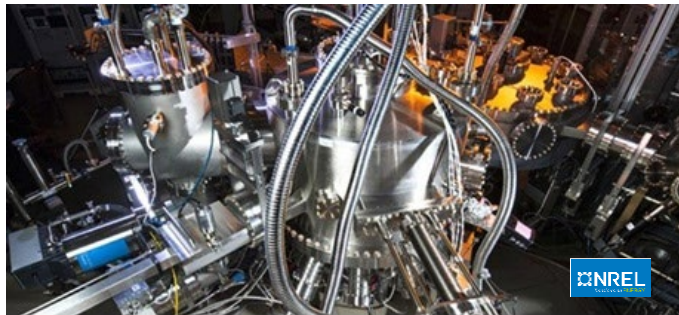
## Pump Down Scenario

Developed by Dr. Richard Gilbert, University of South Florida, Tampa, FL

### Industry Related Problem Statement:

Physical Vapor Deposition, PVD, is one option to produce desired thin films and is a staple process in every major chip production facility. Thin films lower final device weight, increase device flexibility, and assure cost-effective use of expensive raw source materials. The PVD system creates an ion beam that hits the substrate surface that causes the ejection of atoms in a pattern as shaped by the moving ion beam. These patterns are subsequently used in the photolithographic device design process step. Thin-film technology operates at very low pressures and has multiple ports for various support operations.

### Scenario Description and Specific Example:



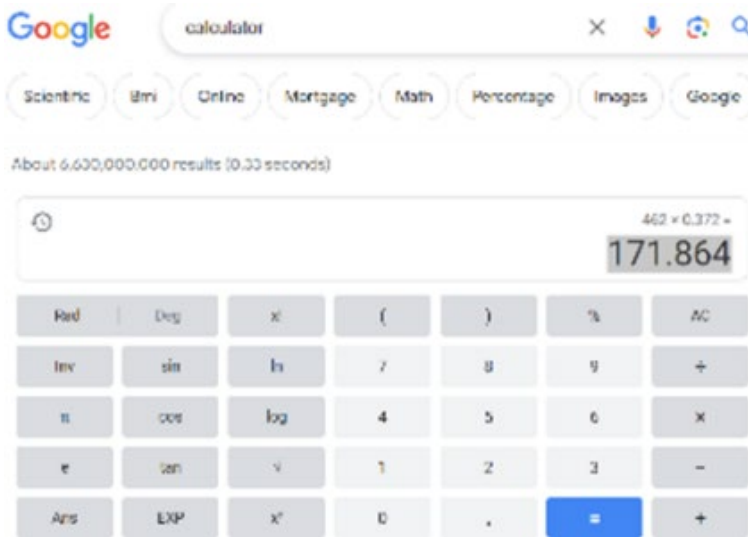
The National Renewable Energy Laboratory has purchased a new Vapor Deposition System to develop thin films for solar cell applications.

In anticipation of this new system's operation, NREL hired a new technician: a very recent graduate from Normandale Community College with a two-degree in

Vacuum and Thin Film technology. This is the technician's first week of work after NREL orientation sessions.

On the way to the loading dock to sign in and assume responsibility for the new thin film system, she received a request from the engineer managing the existing PVD system shown above. That system was just restarted, and system pressure was lowered. The engineer wants to confirm the system's cryopump has created the correct pressure environment for the system and is operating as expected.





The technician used the system’s Human Machine Interface, HMI, to ascertain the status of the cryopump responsible for the vacuum pressure in the system shown above. After one simple math operation, she informed the engineer that the system pump down was a success.



Is this a correct statement? (yes/no) Why? What was the simple math operation? Why did she elect to execute that math operation?

**Issues to be addressed in the lesson:**

- (i) There is no useful (technology or mathematics) reason to think or talk about numbers with units.
- (ii) Mathematics operate on and technology work with scalar entities;
- (iii) Mathematics does works with numbers however technicians with two- year degrees already know how to use math operators on numbers;
- (iv) This is not a mathematics lesson but a practice event with the objective of helping scenario users become comfortable with math tools technicians frequently use;
- (v) Euler’s number to a negative exponent as an attenuation factor.

**Mathematic competencies technicians possess and use in scenario:**

- (i) The “If then” mathematics operator;
- (ii) Multiplication by a value greater than zero but less than one);
- (iii) Practical use of exponential attenuation statement as a rapid method to evaluate vacuum pump down curve.

Opinions, findings, conclusions or recommendations are those of the authors and not necessarily those of the National Science Foundation.