

## Overview

The Mathematical Routines (MR) question is the first free-response question in Section 2 of the AP Physics 1 exam. It assesses students' ability to use mathematics to analyze a scenario, derive relationships between variables, calculate numerical values, and use representations to make and justify predictions.

## Points and Timing

- Worth 10 points out of 40 total points in Section 2.
- Suggested time: 20 to 25 minutes out of 100 minutes total in Section 2.

## Typical Question Structure

A Mathematical Routines question follows this general pattern:

- **Diagram or representation:** Represent the physics scenario visually. This is often a free-body diagram, but could also be a graph. It may appear before or after the derivation.
- **Multi-step derivation:** An intensive symbolic derivation, typically spread across multiple parts. Expect to derive relationships between variables more than once.
- **Conceptual interpretation:** Make a claim or prediction about the scenario, then use words to provide a physics justification for that claim or prediction.

## Example from the AP Physics 1 Course and Exam Description (FRQ #1 on [pages 193-194](#))

The disk-rolling-down-a-ramp question in the AP Physics 1 CED illustrates the typical MR structure clearly.

- **Part a(i):** Draw a free-body diagram of all forces on the disk as it rolls down the ramp. This is the “represent the scenario in diagram form” step.
- **Parts a(ii), a(iii), and a(iv):** Derive, derive, derive. This is the intensive multi-step derivation portion of the question.
- **Part b:** Indicate which object reaches the bottom of the incline first and justify your reasoning in words. This is the conceptual interpretation step.

## Key Takeaways

- Every Mathematical Routines question follows the same basic structure: draw something, derive something, make a claim or prediction, then justify it with words.
- The diagram or graph representing the scenario can appear before or after the derivation parts, depending on the specific question.
- The conceptual interpretation at the end always requires a written justification, not just a calculation or answer.
- All Mathematical Routines questions in the Ultimate Exam Slayer practice exams and the Ultimate Review Packet follow this same structure, which is also what to expect on the actual AP Physics 1 exam.