NAME _____ DATE _____

Scenario

A power supply provides a constant potential difference ε but has internal resistance r. Angela wishes to build a light bulb and must select a resistance R for the light bulb. The resistance is determined when she cuts a filament to a certain length. She wishes to choose a value of R that will maximize the brightness (power P delivered to) the light bulb when it is connected to the power supply.

Using Representations

PART A: Draw a circuit diagram showing the potential difference ε, resistor r, and light bulb R. Also draw a voltmeter and an ammeter that are correctly connected to measure the potential difference across and the current through the light bulb. Label all components.

Analyze Data

PART B: Angela cuts several different filaments of different resistances R and connects them individually to the power supply. She notices that very large values of R result in dim illumination (low P) and very small values of R also result in dim illumination. Provide brief answers to the following questions in terms of current, potential difference, or both.

i. Why do high values of R result in low values of P?

ii. Why do low values of R result in low values of P?

Quantitative Analysis

PART C: Derive an expression for P, the power delivered to the light bulb, in terms of ε, r, and R.

PART D:

i. Show how your expression in Part C supports the idea that high values of R result in low values of P.

ii. Show how your expression in Part C supports the idea that low values of R result in low values of P.