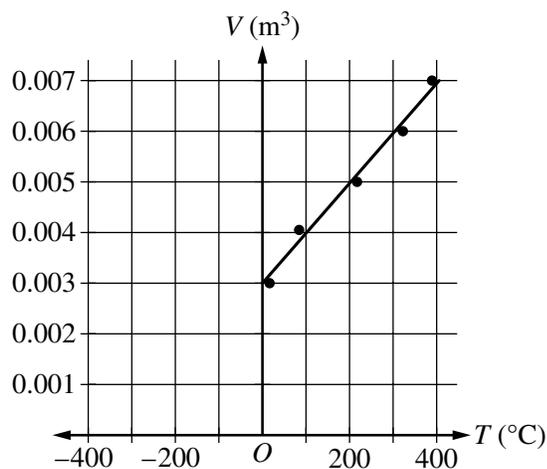


Section II: Free-Response Questions

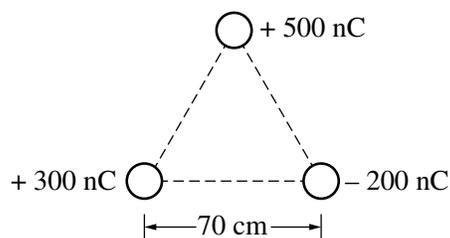
The following are examples of the kinds of free-response questions found on the exam. Note that on the actual AP Exam, there will be one experimental design question, one quantitative/qualitative translation question, one paragraph argument short answer question, and one additional short answer question.

1. Students use a sample of gas to investigate the behavior of the pressure P of the gas at constant temperature T as the volume V changes. The gas is in a cylinder with a movable piston and volume markings. Pressure and temperature probes can be inserted into the cylinder. A hot water bath and a cold water bath are also available.
 - (A) Describe a procedure that would allow the students to obtain data for the pressure P of the gas at constant temperature T as volume changes.
 - (B) One student suggests that the temperature probe is not needed. Is the student correct? Briefly explain your answer.
 - (C) Describe a method of analyzing the pressure and volume data that could be used to determine whether the gas is ideal. Explicitly indicate the results of the analysis that would indicate an ideal gas.

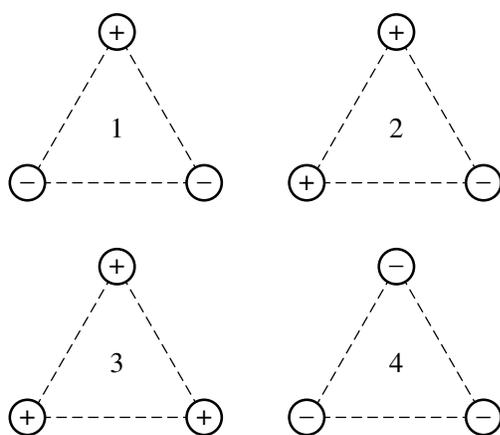
The students are now given a sample of ideal gas in a similar container with a piston. They investigate the behavior of the temperature T of the gas at known constant pressure P as the volume V changes. Their graph of the data, including a best-fit line, is shown below.



- (D) Describe a method for using the graph to determine the number of moles of gas in the container.
- (E) From the graph, determine the students' experimental value for absolute zero temperature on the Celsius scale. Describe the method you used.



2. Three small spheres, with net charges indicated above, are held fixed at the corners of an equilateral triangle with sides of length 70 cm .
- (A) Calculate the magnitude of the net electric force acting on the sphere with charge $+500\text{ nC}$ at the top of the triangle due to the other two spheres.



Spheres with positive or negative charges of equal magnitude are now held fixed at the corners of four identical equilateral triangles, as shown above. Each triangle is isolated from all other charges.

- (B) For which of the triangles will the net electric field at the center of the triangle be zero?
 ___ 1 ___ 2 ___ 3 ___ 4
 Briefly describe the method you used to arrive at your answer.
- (C) Rank the electric potentials V_1 , V_2 , V_3 , and V_4 at the center of the triangles.
 Briefly describe the method you used to arrive at your answer.