**Lab Based Questions**

A lab based question is guaranteed on every AP Physics 1 exam from here on out. It will be worth 25 points and usually involves picking a lab setup, writing a procedure to answer a question/define a relationship, making calculations and analysis.

Look at the calculations/analysis part of the lab first. There is usually a defined relationship (distance vs time for example) that can be found on the equation table. If they can find the equation (or a relationship between the two variables) on the equation table, they can easily determine what two quantities should be graphed to find a linear relationship.

Make a graph for the analysis portion of the lab, and use either the slope, area, or general trend to answer the questions.

* When using a graph to find the slope of a best fit line, NEVER, NEVER, NEVER use data points, but points on the line that are convenient to read such as where the best fit line crosses a grid intersection.
* Data points are drawn into the graph by estimating their position.
* Once a best fit line is drawn, it represents the data instead of the data points.
* If a graph shows a quadratic or rational relationship, modify the data to find a linear relationship--this will usually involve squaring one of the axes.

Determine what to measure and then work on the how. It will change for every question.

Explain and identify

1) what variables will remain constant and how to achieve this

2) what single variable will be manipulated

3) what variable is expected to respond

The procedure needs to be detailed enough for someone else to perform the lab.

**Free Response:**

1. You are conducting an experiment to measure the acceleration due to gravity gu at an unknown location. In the measurement apparatus, a simple pendulum swings past a photogate located at the pendulum's lowest point, which records the time t10 for the pendulum to undergo 10 full oscillations. The pendulum consists of a sphere of mass m at the end of a string and has a length *l*. There are four versions of this apparatus, each with a different length. All four are at the unknown location, and the data shown below are sent to you during the experiment.

|  |  |  |  |
| --- | --- | --- | --- |
| (cm) | *t10*(s) | *T*(s) |  |
| 12 | 7.62 |  |  |
| 18 | 8.89 |  |  |
| 32 | 12.08 |  |  |

1. For each pendulum, calculate the period T. Use a reasonable number of significant figures. Enter these results in the table above.
2. On the axes below, plot the period versus the length of the pendulum. What does the graph suggest about the relationship between the length of the pendulum and its period?



1. What two quantities should be graphed to give a linear relationship? Put those values into the blank column in the table above.
2. On the axes below, plot the terms in part (c). Draw a best‑fit straight line for this data. 
3. Assuming that each pendulum undergoes small amplitude oscillations, from your fit determine the experimental value gexp of the acceleration due to gravity at this unknown location. Justify your answer.
4. If the measurement apparatus allows a determination of gu that is accurate to within 4%, is your experimental value in agreement with the value 9.80 m/s2 ? Explain fully.
5. The figure above represents a racetrack with semicircular sections connected by straight sections. Each section has length *d*, and markers along the track are spaced *d*/4 apart. Two people drive cars counterclockwise around the track, as shown. Car *X* goes around the curves at constant speed *vc* , increases speed at constant acceleration for half of each straight section to reach a maximum speed of 2*vc* , then brakes at constant acceleration for the other half of each straight section to return to speed *vc* . Car *Y* also goes around the curves at constant speed *vc* , increases speed at constant acceleration for one fourth of each straight section to reach the same maximum speed 2*vc* , stays at that speed for half of each straight section, then brakes at constant acceleration for the remaining fourth of each straight section to return to speed *vc* .
6. On the figures below, draw an arrow showing the direction of the net force on each of the cars at the positions noted by the dots. If the net force is zero at any position, label the dot with 0.



b)

1. Indicate which car, if either, completes one trip around the track in less time, and justify your answer qualitatively without using equations.
2. Justify your answer about which car, if either, completes one trip around the track in less time quantitatively with appropriate equations.
3. A world-class runner can complete a 100 m dash in about 10 s. Past studies have shown that runners in such a race accelerate uniformly for a time *tu* and then run at constant speed for the remainder of the race. A world-class runner is visiting your physics class. You are to develop a procedure that will allow you to determine the uniform acceleration *au* and an approximate value of *tu* for the runner in a 100 m dash. By necessity your experiment will be done on a straight track and include your whole class of eleven students.
4. By checking the line next to each appropriate item in the list below, select the equipment, other than the runner and the track, that your class will need to do the experiment.

\_\_\_\_ Stopwatches \_\_\_\_ Tape measures \_\_\_\_ Rulers \_\_\_\_ Masking tape

\_\_\_\_ Metersticks \_\_\_\_ Starter’s pistol \_\_\_\_ String \_\_\_\_ Chalk

1. Outline the procedure that you would use to determine *au* and *tu*, including a labeled diagram of the experimental setup. Use symbols to identify carefully what measurements you would make and include in your procedure how you would use each piece of the equipment you checked in part (a).
2. In a clear, concise paragraph, outline the process of data analysis, including how you would identify the portion of the race that has uniform acceleration, and how you would calculate the uniform acceleration.



1. A group of students has two carts, *A* and *B*, with wheels that turn with negligible friction. The carts can travel along a straight horizontal track. Cart *A* has known mass *mA*. The students are asked to use a one dimensional collision between the carts to determine the mass of cart *B*. Before the collision, cart *A* travels to the right and cart *B* is initially at rest, as shown above. After the collision, the carts stick together
2. Describe an experimental procedure to determine the velocities of the carts before and after a collision, including all the additional equipment you would need. You may include a labeled diagram of your setup to help in your description. Indicate what measurements you would take and how you would take them. Include enough detail so that another student could carry out your procedure.

A group of students took measurements for one collision. A graph of the students’ data is shown below.



1. Given *mA* = 0.50 kg, use the graph to calculate the mass of cart *B*. Explicitly indicate the principles used in your calculations.
2. The students are now asked to consider the kinetic energy changes in an inelastic collision, specifically whether the initial values of one of the physical quantities affect the fraction of mechanical energy dissipated in the collision. How could you modify the experiment to investigate this question? Be sure to explicitly describe the calculations you would make, specifying all equations you would use (but do not actually do any algebra or arithmetic).