

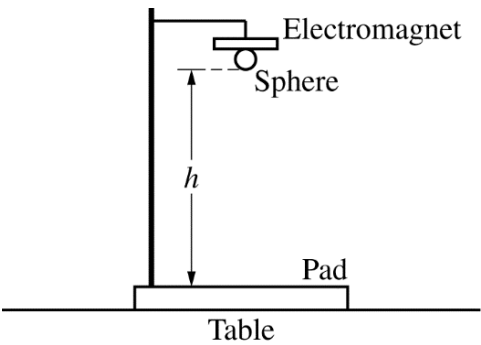
PHYSICS C: MECHANICS

SECTION II

Time—45 minutes

3 Questions

Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part.



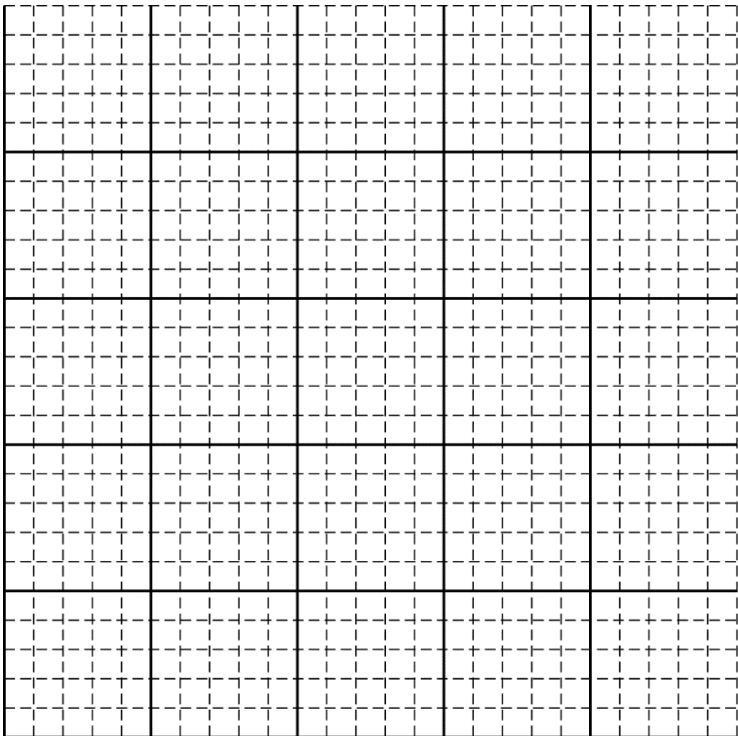
1. A student wants to determine the value of the acceleration due to gravity g for a specific location and sets up the following experiment. A solid sphere is held vertically a distance h above a pad by an electromagnet, as shown in the figure above. The experimental equipment is designed to release the sphere when the electromagnet is turned off. A timer also starts when the electromagnet is turned off, and the timer stops when the sphere lands on the pad.
- (a) While taking the first data point, the student notices that the electromagnet actually releases the sphere after the timer begins. Would the value of g calculated from this one measurement be greater than, less than, or equal to the actual value of g at the student’s location?
- ____ Greater than ____ Less than ____ Equal to

Justify your answer.

The electromagnet is replaced so that the timer begins when the sphere is released. The student varies the distance h . The student measures and records the time Δt of the fall for each particular height, resulting in the following data table.

h (m)	0.10	0.20	0.60	0.80	1.00
Δt (s)	0.105	0.213	0.342	0.401	0.451

- (b) Indicate below which quantities should be graphed to yield a straight line whose slope could be used to calculate a numerical value for g .
- Vertical axis: _____
- Horizontal axis: _____
- Use the remaining rows in the table above, as needed, to record any quantities that you indicated that are not given in the table. Label each row you use and include units.
- (c) Plot the data points for the quantities indicated in part (b) on the graph below. Clearly scale and label all axes, including units if appropriate. Draw a straight line that best represents the data.



- (d) Using the straight line, calculate an experimental value for g .
- Another student fits the data in the table to a quadratic equation. The student’s equation for the distance fallen y as a function of time t is $y = At^2 + Bt + C$, where $A = 5.75 \text{ m/s}^2$, $B = -0.524 \text{ m/s}$, and $C = +0.080 \text{ m}$. Vertically down is the positive direction.
- (e) Using the student’s equation above, do the following.
- i. Derive an expression for the velocity of the sphere as a function of time.
 - ii. Calculate the new experimental value for g .
 - iii. Using 9.81 m/s^2 as the accepted value for g at this location, calculate the percent error for the value found in part (e)ii.
 - iv. Assuming the sphere is at a height of 1.40 m at $t = 0$, calculate the velocity of the sphere just before it strikes the pad.