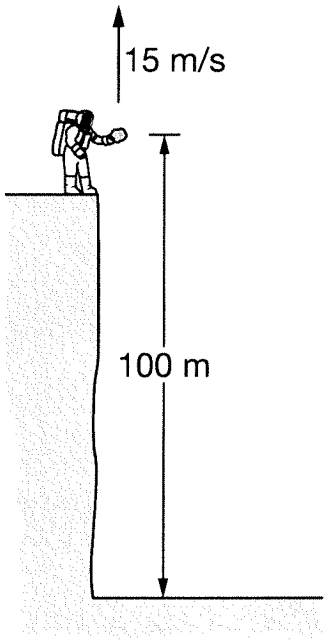
AP PHYSICS – UNIT 1 PRE EXAM– KINEMATICS

FRQ

#1

This question is a short free-response question. Show your work for each part of the question.



An astronaut holds a rock $100\ \text{m}$ above the surface of Planet X. The rock is then thrown upward with a speed of $15\ \text{m/s}$, as shown in the figure. The rock reaches the ground $10\ \text{s}$ after it is thrown. The atmosphere of Planet X has a negligible effect on the rock when it is in free fall.

2pts (a)

(i) Determine the acceleration due to gravity of the rock when it is on Planet X.

ii. How does the speed of the rock when it reaches the ground v_d compare to the speed of the rock when it is thrown upward v_u?

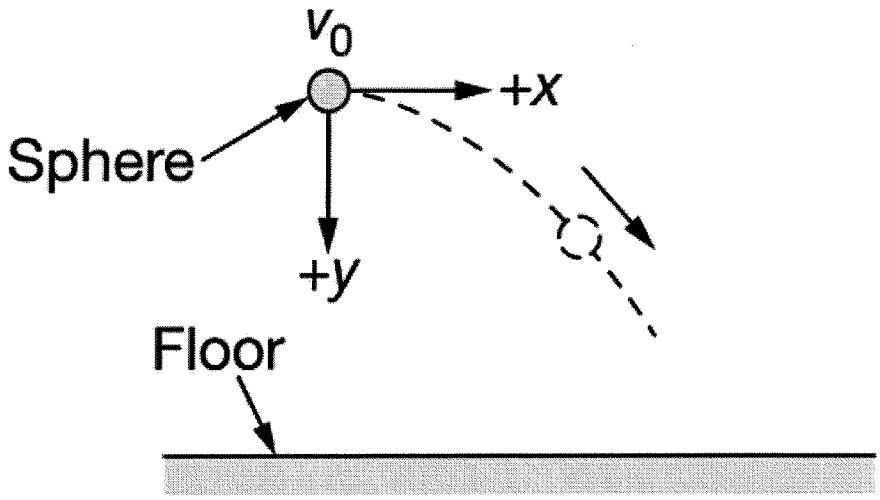
_____$v_d > v_u$ _____$v_d = v_u$ _____$v_d < v_u$

State your reasoning.

5pts (b) A student wants to know how the motion of the rock would be different if it was thrown upward at $15\ \text{m/s}$ from a height of $100\ \text{m}$ above Earth's surface. In a clear, coherent, paragraph-length response that may also contain figures and/or equations, explain how the motion of the rock on Earth will be different from its motion on Planet X in terms of its maximum height above the ground, the speed at which it reaches the ground, the time in which it is in free fall, and its acceleration due to gravity.

FRQ Long Answer

#2



Motion of a Sphere

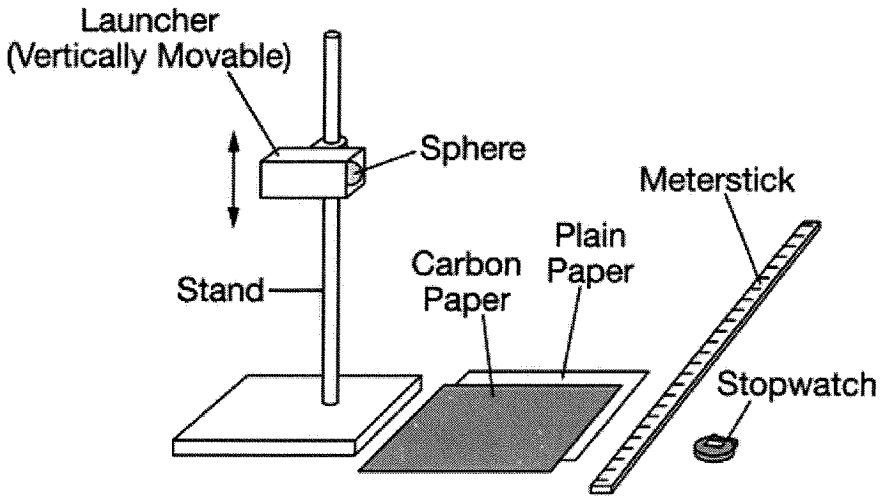
Students are studying the two-dimensional motion of objects as they move through the air. Specifically, they are examining the behavior of a sphere that is launched horizontally from a location above the floor with an initial velocity v_0 in the $+x$ direction, as shown in the figure. The students assume that the positive directions are along the sphere's initial velocity for horizontal motion and downward for vertical motion.

The horizontal displacement of the object from its starting point is x, and the vertical displacement of the object from its starting point is y. One of the students derives an equation for y in terms of x and other quantities. After examining the equation, the student claims that y is proportional to x^2.

#2 (a) Derive an equation for the vertical coordinate y of the sphere as a function of x, v_0, and physical constants, as appropriate.

2pts

Please respond on separate paper, following directions from your teacher.

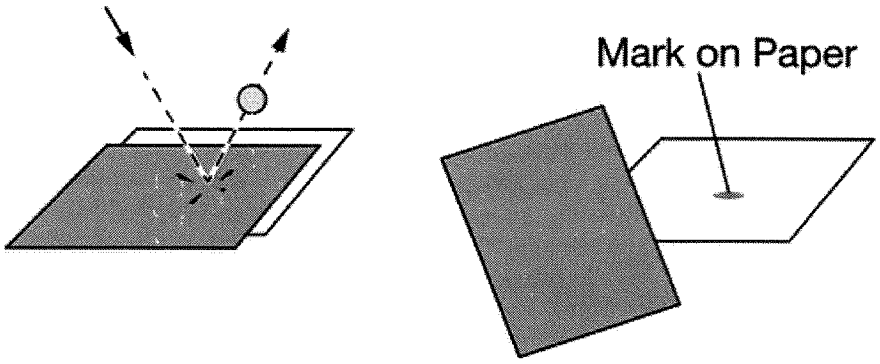


Experimental Apparatus

The students have access to the experimental apparatus shown in the figure. Besides the sphere, the apparatus consists of the following.

A launcher that launches the sphere horizontally, always with the same unknown speed v_0
A stand that can be used to adjust the height of the launcher above the floor

The students also have several sheets of plain paper, several sheets of carbon paper, a meterstick, and a stopwatch. Whenever the sphere bounces off of the carbon paper, the carbon paper produces a visible mark on the sheet of plain paper that is under the carbon paper, as shown in the figure.



Marking the Paper with the Sphere

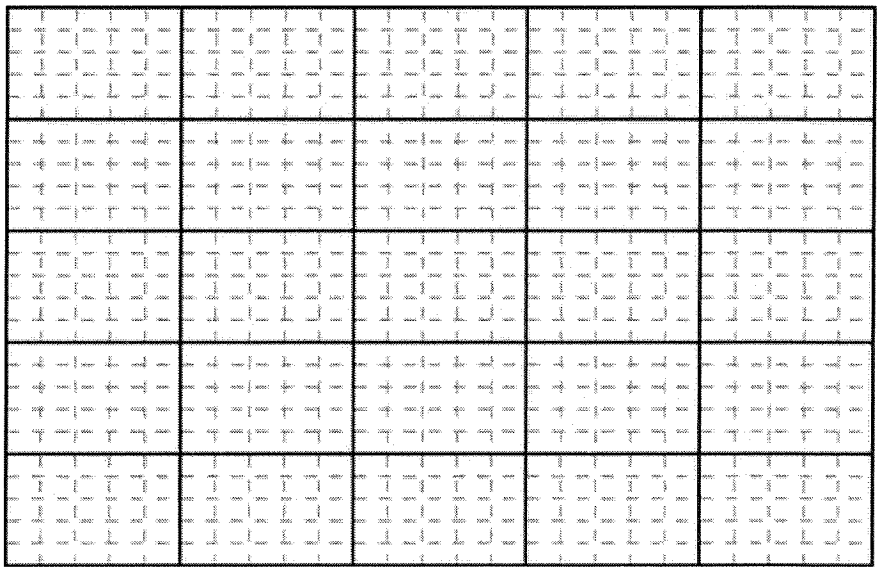
2 (b) Design an experimental procedure that the students could use to test the claim that y is proportional to x^2. In the table below, list the quantities and associated symbols that would be measured in your experiment and the equipment used to measure them. Also list the equipment that would be used to measure each quantity. You do not need to fill in every row. If you need additional rows, you may add them to the space just below the table.

5pts

Please respond on separate paper, following directions from your teacher.

2 (c) ii. On the grid below, plot the appropriate quantities to determine whether the claim is true. Clearly scale and label all axes, including units as appropriate.

2pts



Please respond on separate paper, following directions from your teacher.

2 (c) iii. Do the data in the above graph support the claim that y is proportional to x^2 is true?

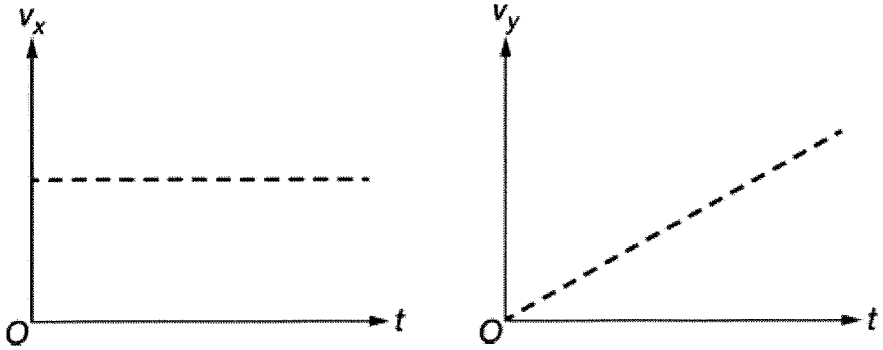
Yes No

1pt State your reasoning.

Please respond on separate paper, following directions from your teacher.

2 (d) The graphs show the sphere's horizontal and vertical velocity components, v_x and v_y, as functions of time t, where $t = 0$ at the instant the sphere is launched. On the same graphs, sketch what v_x and v_y would look like for a different launcher that has a launch speed less than v_0.

2pts



Quantity to Be Measured	Symbol for Quantity	Equipment for Measurement

Describe the overall procedure to be used, referring to the table. Provide enough detail so that another student could replicate the experiment, including any steps necessary to reduce experimental uncertainty. As needed, use the symbols defined in the table and/or include a simple diagram of the setup.

Please respond on separate paper, following directions from your teacher.

The students' teacher has a video camera, which is not available for use in the experimental procedure described in part (b). The teacher uses the camera and video analysis software to generate the data shown in the table below. The table shows the sphere's horizontal and vertical displacements x and y, as measured from the location of the sphere's launch point.

Horizontal Displacement $x\,(m)$	Vertical Displacement $y\,(m)$		
0.50	0.065		
1.00	0.245		
1.50	0.560		
2.00	0.990		

#2 (c) The students want to use the teacher's data to determine whether the claim that y is proportional to x^2 is true.

i. Indicate below which quantities could be graphed to determine whether the claim is true. You may use the remaining columns in the table, as needed, to record any quantities (including units) that are not already in the table.

Vertical axis: Horizontal axis: