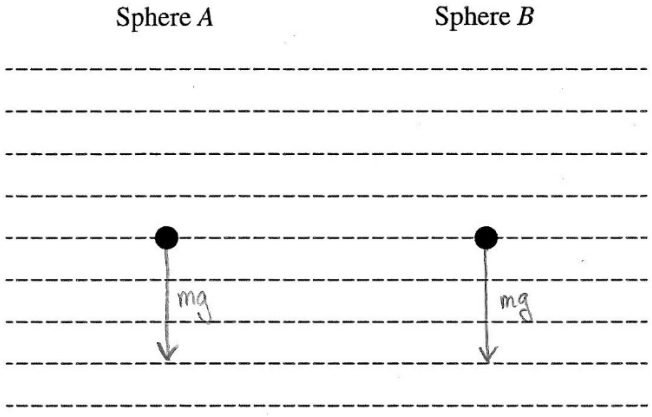
AP® PHYSICS 1
2015 SCORING GUIDELINES

Question 4

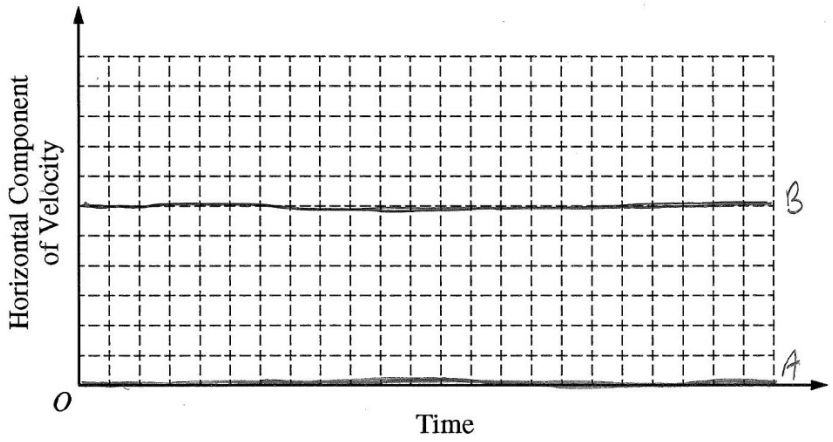
7 points total **Distribution of points**

(a) 1 point



For sketching only one force pointing straight down from each sphere and indicating that this force represents the force of gravity — 1 point

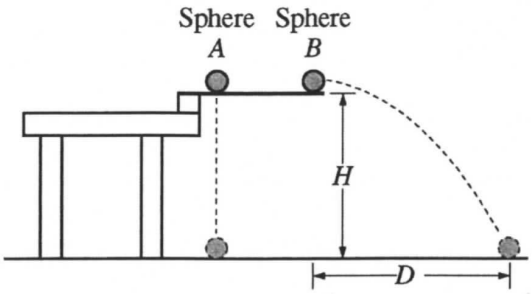
(b) 1 point



For sketching a horizontal line at zero velocity for sphere *A*, and sketching a horizontal line at some non-zero velocity for sphere *B* — 1 point

(c) 5 points

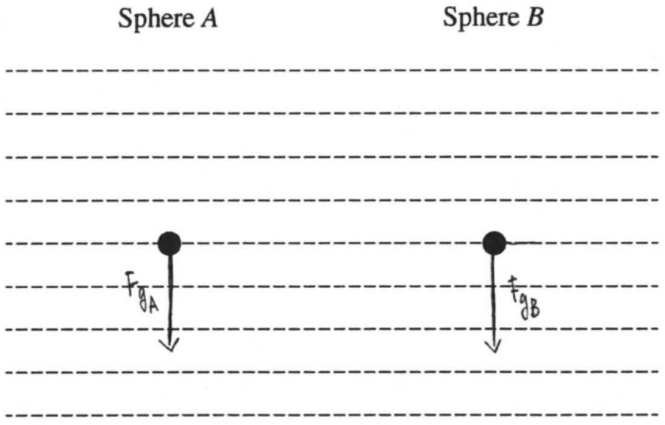
For indicating that the difference in horizontal motion does not affect the vertical motion of the spheres — 1 point
For indicating that both spheres start with the same vertical velocity — 1 point
For indicating that both spheres have the same vertical acceleration — 1 point
For indicating that falling the same height would take the same time — 1 point
For no incorrect or irrelevant statements — 1 point



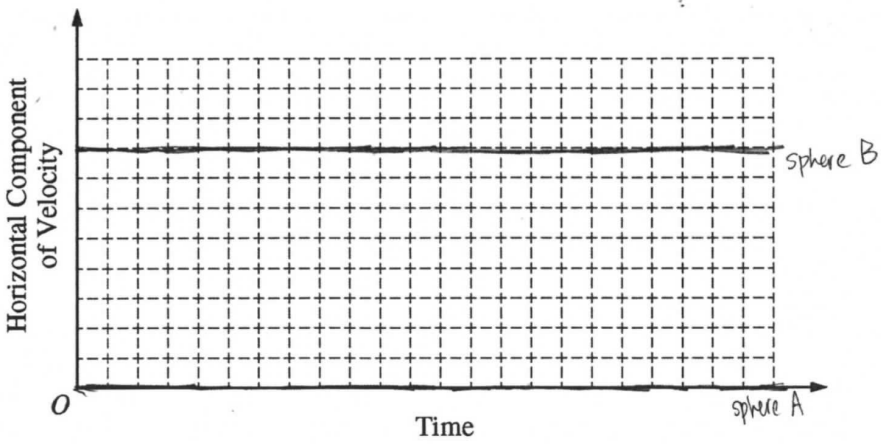
4. (7 points, suggested time 13 minutes)

Two identical spheres are released from a device at time $t = 0$ from the same height H, as shown above. Sphere A has no initial velocity and falls straight down. Sphere B is given an initial horizontal velocity of magnitude v_0 and travels a horizontal distance D before it reaches the ground. The spheres reach the ground at the same time t_f, even though sphere B has more distance to cover before landing. Air resistance is negligible.

(a) The dots below represent spheres A and B. Draw a free-body diagram showing and labeling the forces (not components) exerted on each sphere at time $\frac{t_f}{2}$.



(b) On the axes below, sketch and label a graph of the horizontal component of the velocity of sphere A and of sphere B as a function of time.

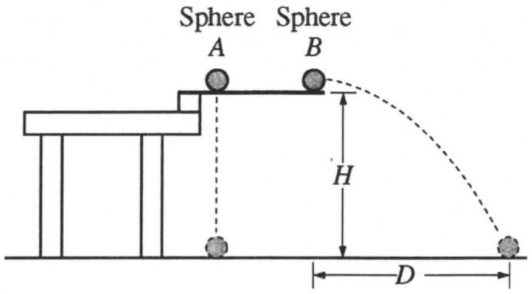


(c) In a clear, coherent, paragraph-length response, explain why the spheres reach the ground at the same time even though they travel different distances. Include references to your answers to parts (a) and (b).

-Reaching the ground from the table concerns only vertical distance. Thus, the only component of velocity that impacts the time to reach the ground is the y component of velocity. The x-component makes a ball travel farther horizontally during the same time, but it won't make it fall at a faster speed toward the ground. This can also be shown using the following kinematic equation:

$$y = y_0 + v_{y_0} t + \frac{1}{2} a_y t^2$$

y final and y_0 are the same for both spheres because they start and end at the same heights. The initial y component of velocity is zero for both spheres. Acceleration is also equal, for gravity is the only thing acting on the spheres in the vertical direction. Thus, the time it takes for the spheres to reach the ground must be equal.



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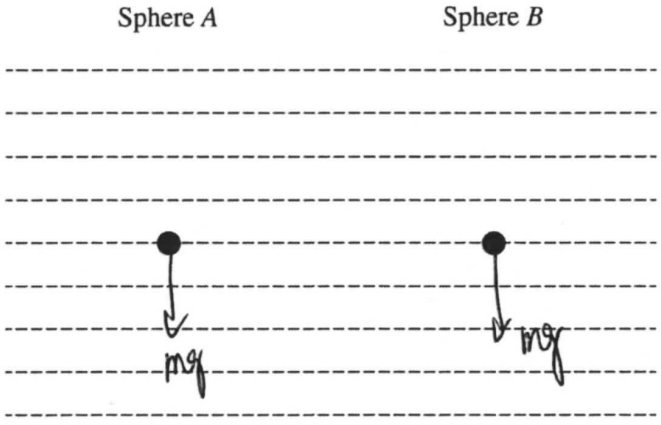

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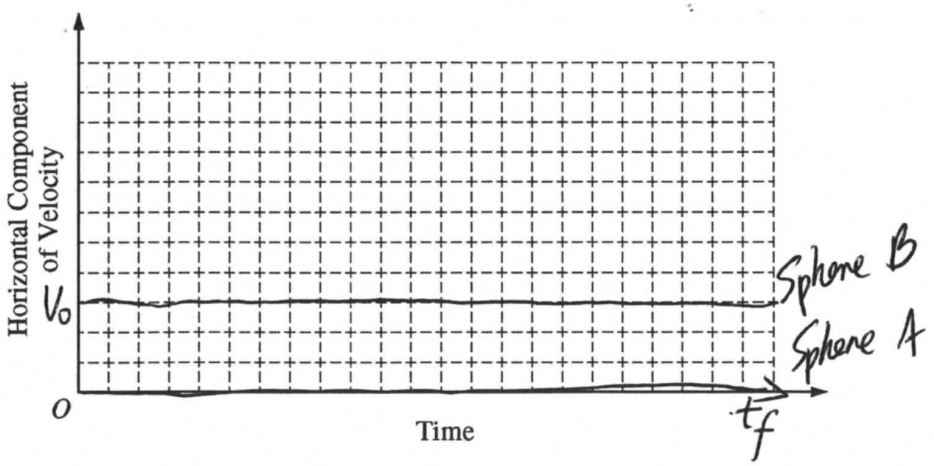

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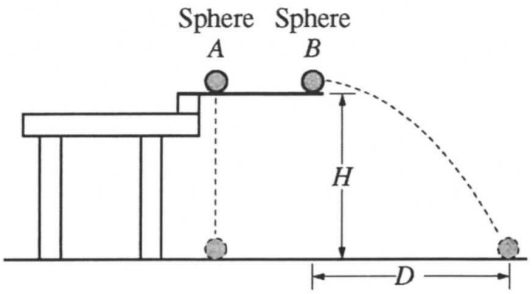
(c) In a clear, coherent, paragraph-length response, explain why the spheres reach the ground at the same time even though they travel different distances. Include references to your answers to parts (a) and (b).

First, the two sphores are identical. They have the same mass. During the falling, the only force they exterted is the gravity. Since they have same mass, according to formula F=mg, they exerted same force.

Second, the sphere A ~~dont~~ doesn't have horizotal component of velocity. and sphere B's horizontal component is same through out, the only factor is their vertical compoent of velocity. They also ~~been~~ fall in same height. Therefore, even though they travel different distance, they reach The ground at same time.



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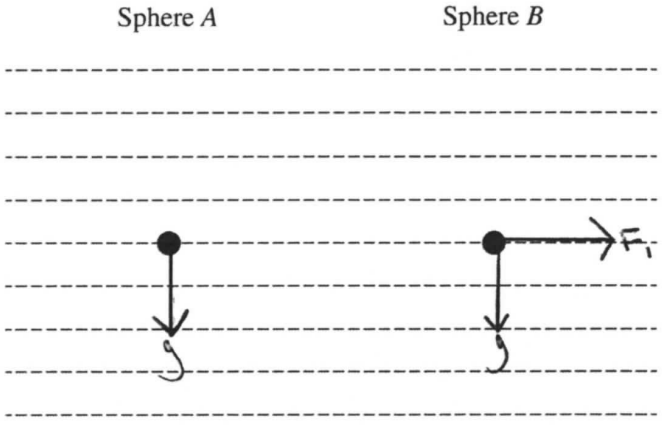

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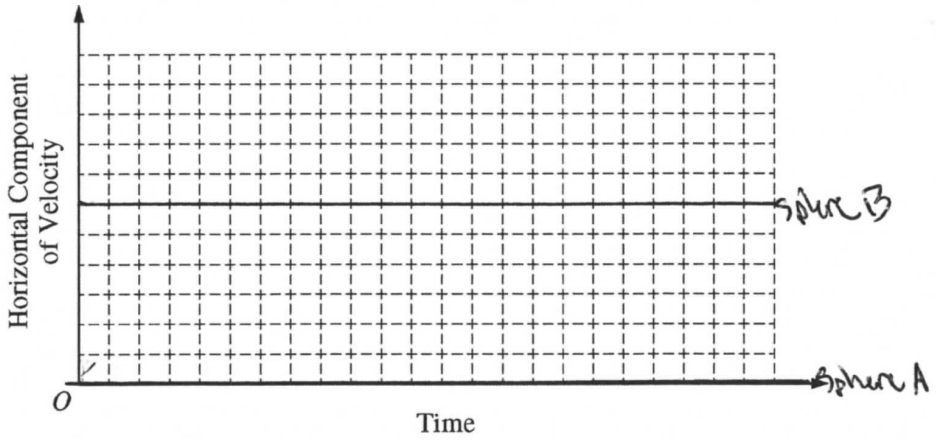

(c) In a clear, coherent, paragraph-length response, explain why the spheres reach the ground at the same time even though they travel different distances. Include references to your answers to parts (a) and (b).

They reach the ground at the same time because gravity effects them both differently. In answer (a) we can see that no forces are pushing up on either of the spheres so they have the same acceleration down since nothing is pushing up. Just because it is horizontal doesn't mean it slows down. It doesn't because it is not pushing up on the object, it is only pushing to the right. If they both have the same force down then they will reach the ground at the exact same time.

AP® PHYSICS 1
2015 SCORING COMMENTARY

Question 4

Overview

The intent of this question was to assess the level of student understanding of 2D motion by describing in words (a coherent paragraph) and equations the physics behind one ball dropped from rest and a second identical ball projected with an initial horizontal velocity from the same height.

Sample: P1Q4 A
Score: 7

This concise, accurate, and clearly written response that fully answers the question earned full credit.

Sample: P1Q4 B
Score: 5

Part (a) and part (b) earned full credit, for a net of 2 points. The response to part (c) earned 3 points. It does not say that both spheres have the same initial vertical velocity and does not indicate that the acceleration of both spheres is the same. It is mentioned that the force on each sphere is the same, but this is not connected with the acceleration.

Sample: P1Q4 C
Score: 2

Part (a) earned no credit, since there is an extra force drawn. Part (b) earned 1 point for full credit. Part (c) earned 1 point stating that the acceleration is the same for both spheres. Stating that "gravity affects them both differently" lost the 'no incorrect statement' point.