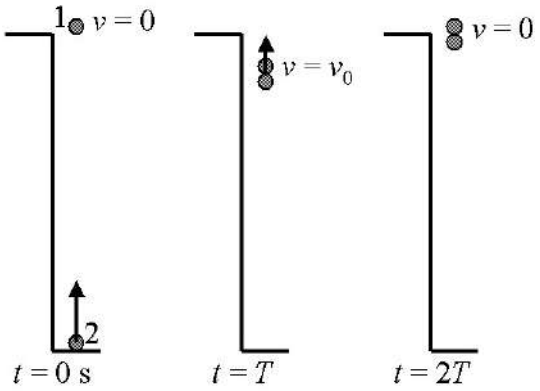
NAME _____ DATE _____

## Scenario

*A time $t = 0$, clay ball 1 is dropped from rest at the top of a building. At the same time, identical clay ball 2 is launched upward from ground level. At time $t = T$, the two collide and stick. Just after the collision, the combined object has upward speed $v_0$. At time $t = 2T$, the combined object is momentarily at rest at the top of the building.*

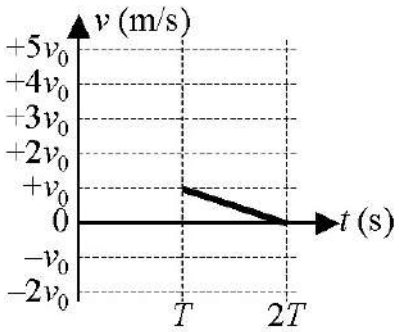


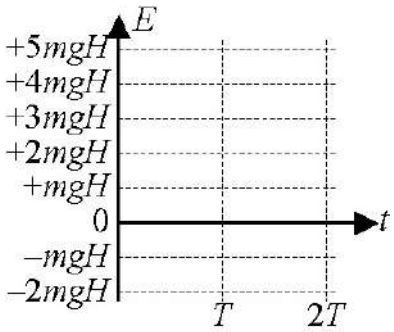

**PART A:** The graph on the left below shows velocity as a function of time, where up is positive. The velocity of the combined object is already drawn for $T < t < 2T$. Draw and label the following for the interval $0 < t < T$.

i. The velocity of ball 1 and label the graph "1."

ii. The velocity of ball 2 and label the graph "2."

iii. The velocity of the center of mass of the two-ball system and label the graph "C."




**PART B:** Let $E$ represent the total mechanical energy of the two-balls-and-Earth system, defining gravitational potential energy as zero on the ground. At time $t = 0$, $E = 3mgH$, where $m$ is the mass of one ball and $H$ is the height of the building. At time $t = 2T$, $E = 2mgH$. On the graph above and to the right, draw a graph of $E$ as a function of time for $0 < t < 2T$.

**PART C:** Use the $v$ vs. $t$ graph above and to the left to calculate the height of the building $H$ in terms of $v_0$, $T$, and $g$. Explain your method.

**PART D:** If the experiment is repeated but this time ball 2 has the same upward launch speed but greater mass, would the two-ball combination rise higher, the same height, or lower than the top of the building? Explain your reasoning.