

I would like to create different versions of a physics problem involving the trajectory of projectile motion of three objects, labeled A, B and C, that started from the same position from the ground and landed back on the ground. The question is about comparing the flight time of the three trajectories. First, please list all possible relations between the flight time of the three trajectories, for example, $A > B > C$, or $A = B < C$. Next, for each of the 13 flight time relation, I want to generate 2 possible relationships between the ranges of the three trajectories. The requirement is that:

1. The trajectories must be written in the same order as the flight time relation
2. For each relation in the flight time, replace with a different relation for Range. For example, replace ">" with either "<" or "=".
3. If a relation is in the non-determinant form such as " $A < B > C$ ", or " $B > A < C$ " replace it with a different one according to the above two rules.
4. Avoid all equal relations such as " $A = B = C$ " for the range.

Output the relations in a "long" table form with one column for flight time and one column for range. Next step, for each row of the table, come up with randomized parameters for the height of each trajectory, and the range of each trajectory. The requirements are:

1. the height parameter must be between 0.1 and 1, and the range parameter must be between 0.2 and 1.5
2. The relation between the height parameters should be the same as the flight time relations, and the relation between the range parameters should be the same as the range relations.
3. The variation between every two parameters should be greater than 0.2 and less than 0.8, unless they need to be equal to each other. Round all numbers to two decimal places after zero

Next, write a program using python and matplotlib to generate one diagram for each row in the above table, according to the parameters in the Table. In each diagram, the three trajectories will be represented by parabolic lines using dashed lines. All three trajectories should start from the same point on the x-axis and end on the x-axis (but not necessarily at the same location). Label the three trajectories with large and bold font, and use a thick line along the x-axis to represent "ground". Do not show axis or gridlines in the final diagram. Name the diagrams q-1 through q-26, and create a downloadable zip file for all the diagrams

Here is the generated table showing 26 distinct projectile motion problem variations. Each row contains:

- A unique flight time relationship (e.g., $A > B > C$)
- A corresponding range relationship (with a different structure than flight time)
- Randomized height and range values for each trajectory (A, B, and C) that conform to the specified relations

Next, I will generate diagrams for each row using matplotlib and package them into a downloadable zip file.

All 26 diagrams have been generated and saved. You can download the complete set of projectile motion diagrams as a zip file from the link below:

Download [projectile_diagrams.zip](#)

Next, first add a column to above table named "Question", and label each row from q-1 to q-26, and retain only the flight time and range columns. Second, add two columns named "Distractor I" and "Distractor II". Each column should contain one random relation between A, B and C that is different from either the flight time or the range. Avoid non-determinant forms such as " $A < B > C$ ", or " $B > A < C$ ". Next, come up with 10 possible situations that involve projectile motion of three objects, all three projectiles should start from ground level and land on ground level. For example, three boys throwing rocks, three gunships firing guns, etc. Avoid objects that might be subjected to air resistance, such as arrows. Write the question body for each of the 10 scenarios above, stating that the trajectories are shown in the figure, and ask the students which of the following is the correct ranking of the time it takes for the objects to hit the ground. Don't say "from longest to shortest". The choice items should be created according to the problem body above, and the four relations in each row of the table. The flight time relation is the correct answer.

The updated table now includes:

- A Question label for each of the 26 problems (q-1 to q-26)
- The correct Flight Time relation and a contrasting Range relation
- Two distractor choices (Distractor I, Distractor II) that differ from both the flight time and range relations
- The first 10 rows also have a realistic projectile motion scenario in the Question Text column, such as cannonballs, trampolines, or steel balls.

Each question asks students to choose the correct ranking of flight time based on the diagram shown. Let me know if you'd like help formatting these into multiple-choice format or compiling them into a document or QTI quiz.

