* 1. Brook fires a second stream of water with the water gun now held perfectly horizontal, keeping the nozzle at the same height as before. Will this second water stream hit the ground with more, less or the same speed as the first stream? No calculation is required, but you must justify your choice. [4 marks]

The same. (1)

Both streams of water start with the same total energy (kinetic + potential) due to starting at the same speed and the same height. (1)

Upon reaching the ground, both streams have converted their potential energy into kinetic. Both streams hit the ground with the same kinetic energy, (1)

thus have the same speed. (1)

* Max of two marks for incorrect choice (Lose two marks for "more/less speed" and the incorrect Physics, such as horizontal v remains constant between streams)
* 2 marks are for the logic of the student argument, as follow-through.

Blue text are different levels of student answers of the same ideas (changes in height or time cause a difference)

0 mark answers

* Less as the time it spends in the air will be less.
* More speed because cos(0) = 1 which is the maximum value it can have, meaning there would be no initial vertical velocity.
* More speed as the smaller the angle, the greater the force and the greater the speed
* Slower as the acceleration is constant but the second streams start from a lower height so it will hit the ground slower
* Slower as the second stream has no initial vertical velocity. This means there is no u value to add into the formula to make the velocity bigger.
* Faster as the 2nd stream is closer to the ground, it reaches the ground quicker, resulting in more speed.

1 mark answers

* The stream shot horizontally will not be in the air as long so there is less time for acceleration so less speed
* Second stream has less velocity as it did not reach as high as the first one, to build up enough speed through acceleration caused by gravity
* Less speed because the first stream reaches a higher height before dropping again, hitting the ground with more speed.
* Using v=u+at, we see final velocity is proportional to time. The 2nd stream is in the air for less time so will have a smaller final velocity (didn't account for u also being different)
* **Same**because the final velocity doesn't change based on how much time the water takes to hit the ground. (Mark was for "same", explanation too weak)
* **Same** as gravity acceleration is constant meaning no matter the angle the object will hit the ground at the same velocity. (Mark was for "same", explanation too weak)
* **Same**because height or angle doesn't affect anything. The weight of the stream stays the same so there would be no change in speed. (Mark was for "same", explanation too weak)

2 mark answers

Highest quality answer because student sets up streams as fair test (put into situations where both have initial =0 or comparing when both have same starting height (1st stream returns on way down).

* 1st stream has initial vertical velocity up, and when returning to nozzle height, will have the same speed but down. Both streams have the same acceleration but 1st stream has a non-zero vertical velocity when coming down at 1.4m so will have a higher velocity at the ground.
* Less speed as the first stream is in the air for longer, reaching a higher height where vertical velocity is zero, therefore it will accelerate for longer than the 2nd stream from a zero vertical velocity and hit the ground with more speed.
* Less speed as 1st stream is shot up, reaching a higher height. This extra potential energy is converted into more kinetic energy when at ground level.
* The second stream will have less vertical velocity but more horizontal velocity at ground level as the lower angle gives more horizontal velocity and lower initial vertical velocity.
* **Same**. As angle decreases the horizontal velocity increased while the initial vertical velocity decreases. These balance out to give approximately the same speed.

3 mark answer

* **Same.** Using v=u+at, the second stream is in the air for less time but the first stream has an initial vertical velocity upwards. These two factors balance each other out to produce the same speed overall.