HMS Belfast is a warship situated on the River Thames. Its guns are aimed to fire at a motorway service station 19 km away. Assuming no air resistance, and that the ship and service station are at the same height above sea level, at what velocity must the shells leave the guns in order to reach the service station in a time of 25 seconds?

(Give your answer in m/s to 1.d.p.)

(Use a value of g of -9.8 m/s²)

First of all, work out the velocity in the x-direction, and then obtain an expression for the initial velocity in the y-direction. Then combine these two expressions to calculate the angle of trajectory of the shells, and then their velocity.

Vo = initial velocity.

θ = angle of trajectory.

In the x-direction, [s=Vo\*cosθ\*t], therefore Vo\*cosθ = 19,000/25 = 760

The maximum height attained by the shells occurs at t/2 = 12.5 seconds, at which point Vy=0.

As [v = u + a\*t], u = Vo\*sinθ = 9.8\*12.5 = 122.5

Using the identity [sinθ/cosθ = tanθ] gives tanθ = 122.5/760

Therefore θ = 9.16 degrees

Using Vo = 122.5/sinθ OR Vo = 760/cosθ gives Vo = 769.8 m/s