Student: SVN-S4

Sheet: T-001

Side: B

Task 3

Each ~~one~~ small piece (droplet) of water is moving along a parabola. These parabolae are ~~all~~ sets of point equidistant ~~f~~ from a focus (specific to ~~each~~ parabola) and a line (~~tola~~ (this is the ~~height~~ horizontal line in x-y plane that has the same potential energy as full energy of particle (kinetic + potential)) Thus the line is equal for all of the parabolae. Denote this line as ~~l~~, equation $y=h$

If we consider the parabola of the particle of water, that just left the hose and is in position P its focus is clearly outside the area ~~d~~ enclosed by the parabolas between $(0,0)$ and P and straight line connecting both points

If we consider the parabola of the particle that just landed at point Q, ~~Its~~ its focus is inside the shape bounded by parabola and line $(0,0)$ & Q

This is true because the hose direction was always higher than $45°$ and thus its ~~the~~ focus of parabola is higher than line $y=0$ (highest point of that particle is $p > \frac{h}{2}$)

Since movement was continuous ~~that~~ ~~mean~~ the line conecting $(0,0)$ and the parabola the particle at R covered R is moving continuously as is the focus of that parabola. Thus by intermediate value theorem there is a point where focus was either on the parabola that particle ~~r~~ covered (which is only possible if ~~r~~ went straight up) or on the line $(0,0)$-R

Thus there exists a point R on locus of ~~points~~ particles such that the inequality

$d((0,0),R) \leq d((0,0),F) + d(F,R)$ ~~reaches~~ has a equality case. (here F is the focus of parabola that particle at R covered. This means that

$d((0,0),R) = d((0,0),F) + d(F,R) = d((0,0),l) + d(l,R)$ for that point $R(x_R, y_R)$

$$= 2h - y_R$$

Thus we have to find the maximum of $\alpha = \sqrt{x_R^2 + y_R^2} + y_R$ among point on graph since

$I = \max\left(\sqrt{x_R^2 + y_R^2} + y_R\right) = 2h$

Calculating the value of I we get that $I = 14{,}66 \approx 14{,}7\ m$

This has been done by first eliminating all parts that have a point ~~lower~~ higher or more right, then calculating value at $(10{,}5; 3{,}5)$ eliminating everything lower-left from $(10,8)$ since $\alpha(10,8) < \alpha(10{,}5; 3{,}5)$ Then checking through remaining values.

$h = 7{,}33\,m$ $\quad mgh_{max} = m\frac{v_0^2}{2}$

$v_0 = \sqrt{2gh} = \underline{12\ m/s}$